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Final Orbital Rail Reports

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West London Alliance

WEST LONDON ORBITAL RAIL SERVICE

Outline Case

WLO5C
OCTOBER 2017

INTERNAL

West London Alliance

WEST LONDON ORBITAL RAIL SERVICE

Outline Case

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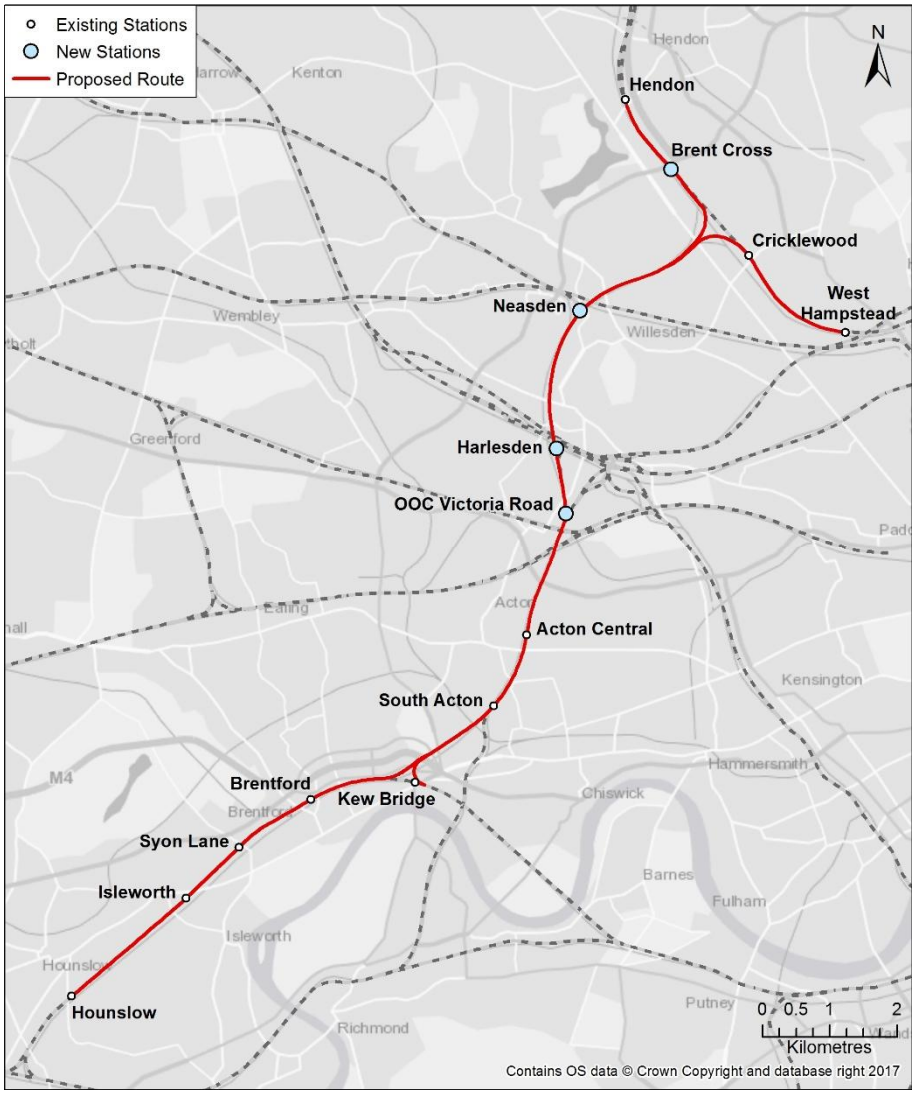
EXECUTIVE SUMMARY

BACKGROUND

The West London Alliance is currently investigating ways of accommodating the additional passenger demand resulting from the growth of population and employment in the area and across London as a whole. This includes substantial additional housing planned along much of the corridor between Hounslow and West Hampstead/Hendon. An option to serve these developments in a sustainable way, consistent with the draft Mayor's Transport Strategy ambitions, is to restore rail passenger services on the Dudding Hill Line and the Kew – Acton link to provide a West London Orbital (WLO) rail service from Hounslow to West Hampstead and Hendon.

This business case presents the findings from a study of the feasibility of introducing a West London Orbital rail service and identification and assessment of a preferred service option.

Figure 1 – Proposed West London Orbital Railway

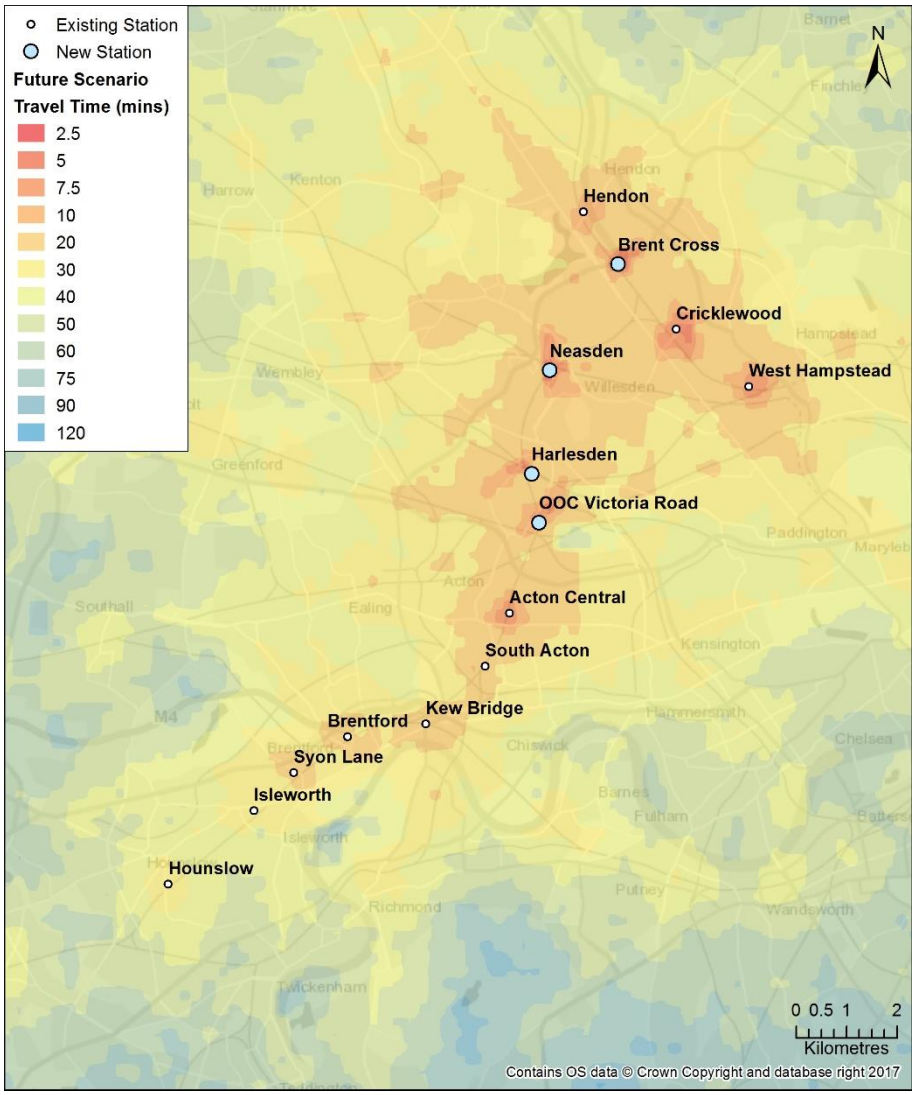


STRATEGIC CASE

The Strategic Case demonstrates the rationale for the development of a heavy rail solution for the Hounslow to West Hampstead/Hendon corridor given its existing role as a freight route and the opportunity to provide connectivity across the wider rail network. Retention of the heavy rail corridor on the Dudding Hill Line section will also permit integration of the WLO services into London Overground operations and to support the further success of this brand.

The introduction of a high quality orbital public transport service, integrated with the wider public transport network, will support the accommodation of forecast population and employment growth in West London in a manner consistent with the draft Mayor's Transport Strategy. The scheme will deliver significant connectivity and accessibility benefits by introducing new stations and new services. This will result in the attraction of existing public transport and highway users, as well as new users, contributing to relieving forecast crowding on LUL and national rail services, addressing highway congestion and supporting local environmental improvements. In doing so, it will play an important role supporting mode shift from car to more sustainable means of orbital transport for part of outer London that is currently heavily dependent on car use.

Figure 2 – Accessibility of new WLO stations



Within the areas benefitting from the significantly improved accessibility and connectivity are many sites and larger regeneration opportunities identified by boroughs. In addition to serving these sites and the associated

proposed housing and employment space, the introduction of WLO services will support an intensification of development facilitating increased numbers of housing units to be delivered on the sites.

A preferred rail service option has been identified based upon demand forecasting and operations and infrastructure analysis to support option development. The preferred option is:

- **Phase 1**: 4 trains per hour from West Hampstead to Hounslow, calling at West Hampstead, Cricklewood, Neasden, Harlesden, Old Oak Common (OOC) Victoria Road, Acton Central, South Acton, Brentford, Syon Lane, Isleworth, Hounslow
- **Phase 2**: additional 4 trains per hour from Hendon to Kew Bridge, calling at Hendon, Brent Cross, Neasden, Harlesden, OOC Victoria Road, Acton Central, South Acton, Kew Bridge

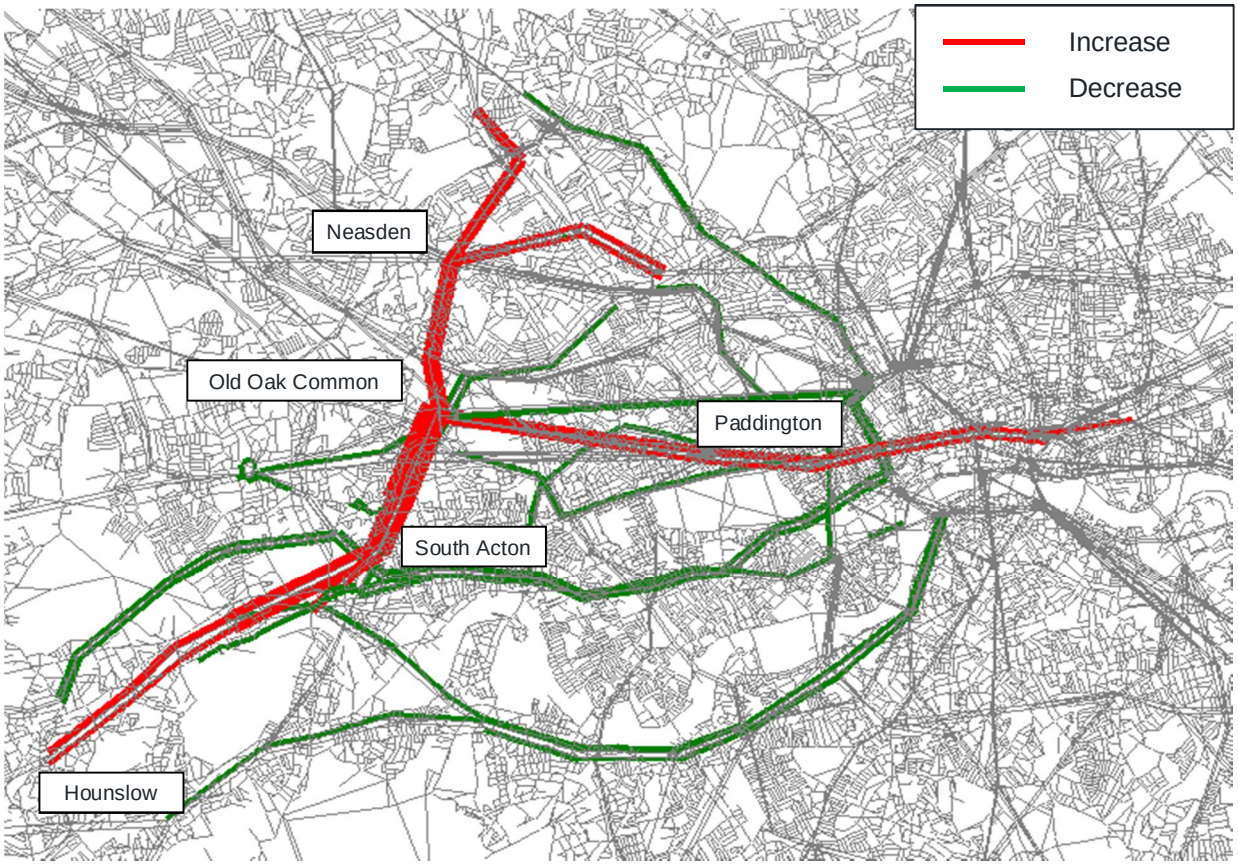
Phase 1 services are assumed to commence operation in 2026, with phase 2 services running from 2029.

ECONOMIC CASE

The Economic Case presents the economic appraisal of the value for money for the preferred option. The outputs from the preliminary demand modelling, along with capital and operating cost estimates, have been used as inputs for the economic appraisal. The appraisal has been undertaken in line with DfT guidance with the forecast benefits (from both quicker journey times and crowding relief in generalised time) for all London public transport users converted into monetary values (£47.77, £16.29 and £7.44 in 2041 prices for business, commuting and other trips respectively) to estimate the social benefits of the scheme.

The preferred option is forecast (as illustrated in Figure 3) to attract passengers from LUL lines such as the Northern, Jubilee, Central, District and Piccadilly as well as rail services currently operated by South West Trains and Great Western Railway. With the WLO passenger service operating these rail services are likely to witness lower levels of crowding, providing overall crowding relief to a broad range of other services. The direct connection between Old Oak Common Victoria Road station, which is considered as part of the WLO railway, and the main Old Oak Common station is estimated to attract additional passengers to the Elizabeth Line (Crossrail 1).

Figure 3 - Passenger flow difference for Preferred Option vs 2041 Maximum Growth Scenario (AM)



Given the significant levels of forecast passenger demand for the West London Orbital rail service (around 9,500 and 10,500 boarders in the AM and PM periods respectively in 2041) and the forecast journey time savings and crowding benefits across the wider public transport network (over 250,000 minutes and 600,000 minutes for the AM and PM periods respectively in 2041), the preliminary modelling suggests total social benefits exceeding £1.25bn PV over the 60-year appraisal period. Due to the constrained timescales of the study, it has not been possible to review base year LTS-PT model validation in the area of interest or undertake a detailed network audit. Therefore it is recommended that a thorough review and a possible improvement of the accuracy of the public transport model in line with TfL and DfT guidance in undertaken as part of future work.

The cost of delivering these benefits has been estimated for the capital and operating elements over the appraisal period. Together these amount to £596m PV (2010 prices). An annual revenue forecast of around £9m (current prices) for the WLO services has been estimated (as reported in the Financial Case), however for the purposes of this preliminary economic appraisal the revenue impact across the whole network is assumed to be neutral and is not included at the public transport network level. This is consistent with the results from the LTS-PT model, which is based on trip reassignment and hence largely a redistribution of revenue, e.g. from LUL to WLO. Further analysis of the operating position will be required.

The resulting indicative benefit to cost ratio (BCR) for the preferred WLO option is greater than 2:1, meeting the DfT's high value for money category. This strong BCR reflects the significant forecast benefits of the scheme to the wider economy and society through journey time savings and crowding benefits, and their realisation through better utilisation of existing infrastructure with selective capital investment, e.g. new platforms and four-tracking. Further analysis will be needed to refine this BCR.

Table 1 – Summary of Economic Appraisal Results

Item	60 year PV 2010
Journey time benefits	£684m
Crowding benefits	£614m
Total Benefits	**£1,298m**
Capital costs	£259m
Operating costs	£337m
Revenue	Assumed neutral at public transport network level
Net Financial Effect	**£596m**
Net Present Value	**£703m**
Benefit:Cost Ratio	**2.2:1**

Wider benefits are anticipated to accrue from additional demand resulting from the transfer of trips from road to rail (which is not captured in the demand modelling). This will benefit both those transferring and those who continue to use the roads, but experience less congestion. The reduction in congestion and vehicle-miles driven on the road will also provide environmental and social benefits, e.g. improved local air quality, reduction in road accidents.

FINANCIAL CASE

The Financial Case addresses the affordability of the delivery and operation of the proposed rail services. With a capital cost estimate of £263m (current prices, with 80% risk), significant funding will need to be secured to deliver the scheme. Initial analysis by the West London boroughs indicates that there is scope to derive a significant contribution towards this capital cost through funding from the Community Infrastructure Levy (CIL).

With potentially 15,000 to 20,000 new homes planned in West London the associated value of the CIL could approach around £150m-£200m.

As further scheme development is undertaken greater certainty will emerge over the level of funding required given the confirmation of infrastructure requirements, value engineering where appropriate and detailed quantified risk assessments. Further, through the identification of potential rail industry synergies, opportunities for cost efficiencies and rail industry funding can be explored.

It has been assumed that the proposed West London Orbital rail service will be operated as part of the London Overground network, with integration with the TfL fares and ticketing arrangements. Annual operating costs of around £15m (current prices) have been estimated for the proposed rail service. When set against the estimated annual farebox revenue of around £9m (current prices), based on the preliminary demand modelling results, this initial analysis suggests an operating subsidy would be required. Opportunities to meet the 'gap' will therefore need to be considered in order to confirm the affordability of West London Orbital rail service operations. This consideration should address:

- Future TfL fares' policy for orbital travel (e.g. premium fares), which is often lower than for equivalent radial journeys because they can be made without crossing fare boundaries
- Potential re-zoning of the London transport network, e.g. zoning Old Oak Common as Zone 1
- Opportunities to harness future technology for ticketing and fares to most effectively manage demand across the network and price fares appropriately
- Additional fare revenue received from demand transferring from road to rail, but not captured in the current demand forecasting (which is solely reassignment)
- Opportunities for commercial revenue streams through station and/or on-train commercial activities
- Future rolling stock choices, e.g. electric or battery, and implications for operating and whole-life costs
- Future operating practices, e.g. provision of ticket offices, staffing

COMMERCIAL & MANAGEMENT CASE

The Commercial & Management Case sets out the current thinking on the approach to manage and deliver the proposals for the West London Orbital rail service. To date, the project has been led by the West London Alliance, with representatives of the boroughs of Barnet, Brent, Ealing and Hounslow, along with Transport for London and Old Oak and Park Royal Development Corporation, represented on the project Steering Group.

With the demonstration in this business case of the robust strategic rationale for the scheme, its operational feasibility and the forecast significant social benefits that will result from the introduction of the West London Orbital rail service, further development of the project should be undertaken. The involvement of the entire rail industry will be necessary. Regardless of possible funding streams, the Department for Transport will need to be content with the proposal, and may suggest amendments to facilitate its implementation, in line with other network-wide schemes such as the Digital Railway. Network Rail will be a central player in the project management and delivery of the scheme, be it undertaking the work directly or with an asset protection role.

Given the current use of the route for freight, freight operators will be important parties to engage with and there will also be the interface with the South Western franchise's emerging service planning on the Hounslow loop to ensure that neither sets of plans are compromised. With its experience of planning and management of major transport investment in London and the synergy between the proposed West London Orbital service and the North and West London lines (London Overground), its role with many train operators in the London area and with the HS2 interface at Old Oak Common, Transport for London is best placed to provide project leadership as the scheme is progressed.

CONCLUSIONS

This business case demonstrates that significant economic, social and policy benefits will result from the introduction of WLO rail services due to the improved connectivity and accessibility provided on an important orbital route, as well as significant crowding relief on the wider public transport network. The delivery and operation of the services has been shown to be feasible with the key infrastructure challenges identified. These will require further work to confirm the identified solutions have stakeholder support and to refine the total level of funding required for the project. At this stage the study has identified plausible options for funding the construction of the line itself and for responding to any potential operating subsidy given its significant regeneration and economic benefits. These merit further more detailed technical analysis.

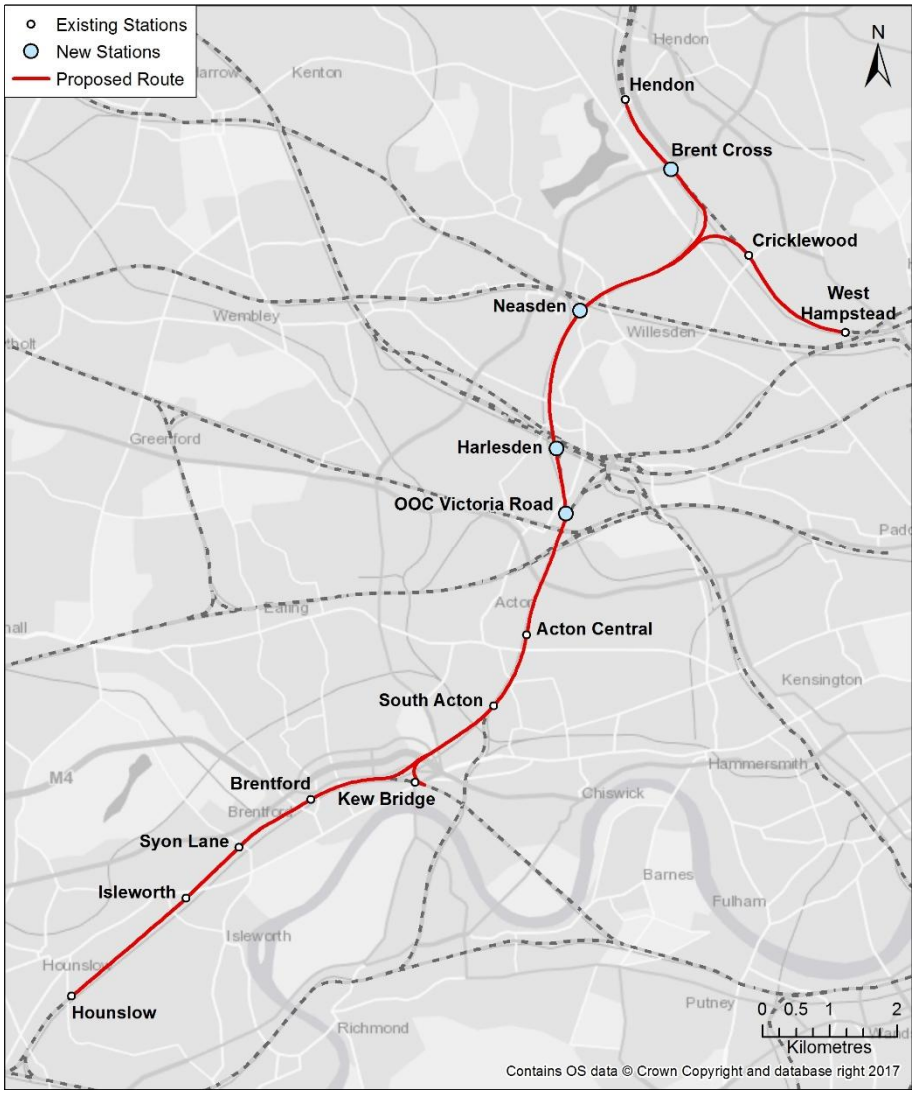
1 INTRODUCTION

1.1 BACKGROUND

1.1.1. The West London Alliance is currently investigating ways of accommodating the additional demand resulting from the growth of population and employment in the area and across London as a whole. This includes substantial additional housing planned along much of the corridor between Hounslow and West Hampstead/Hendon. An option to serve these developments in a sustainable way, consistent with the draft Mayor's Transport Strategy ambitions, is to restore passenger services on the Dudding Hill Line and the Kew – Acton link to provide a West London Orbital rail service from Hounslow to West Hampstead and Hendon.

1.1.2. The Dudding Hill Line is an existing railway line in north-west London running from Acton to Cricklewood. The line itself has had no scheduled passenger service for over a century. It has no stations, no electrification and a 30 miles per hour (48 km/h) speed limit with semaphore signalling, and is lightly used by freight and very occasional passenger charter trains. It is roughly 4 miles (6.4 km) long. Near the site of Old Oak Common, trains would join the existing North London Line, and then further south at Acton, use the link down to the Hounslow Loop to reach Brentford and Hounslow. We refer to this set of routes as the West London Orbital railway.

Figure 4 – Proposed West London Orbital Railway



1.1.3. WSP was commissioned to carry out a feasibility study into the case for introducing a new passenger service using the West London Orbital railway. The study addressed the strategic options for the route, forecast passenger demand and undertook operational and infrastructure analysis. A series of technical notes were produced documenting the study approach and findings. These have been collated into a technical report – *'West London Orbital Rail: Technical Analysis and Conclusions'*.

1.2 FIVE-CASE BUSINESS CASE

1.2.1. This document is based on the work undertaken for the feasibility study. This document presents the study's findings against the five-case business case structure set out by HM Treasury *('Green Book Supplementary Guidance'* (2013)) and the Department for Transport (*'The Transport Business Cases'* (2013)).

1.2.2. This business case focuses on the emerging strategic and economic case for the proposals, in line with WebTAG Stage 1 – Option Development. It presents the case for the intervention and the identification and assessment of options to identify the better performing one to be taken forward for further development and appraisal work. Given the early stage of the project and the associated uncertainty at this time regarding the affordability of the proposals and the delivery model to implement them, current emerging thinking is set out demonstrating the plausibility of successfully delivering the scheme, but recognising that further work is required.

1.2.3. The structure of this document follows the five-case business case model (with the Commercial and Management Cases combined):

- Chapter 2 - The **Strategic Case**: setting out the context and the case for change, including the identification of the preferred option;
- Chapter 3 - The **Economic Case**: assessing the preferred option in terms of the scheme costs and the arising benefits to society (value for money);
- The **Financial Case**: identifying the scheme's affordability and potential funding arrangements over the lifespan of the project; and
- Chapter 4 - The **Commercial & Management Case**: considering the commercial viability of the scheme's delivery and operation and the proposed model for leading the project forward.

2 STRATEGIC CASE

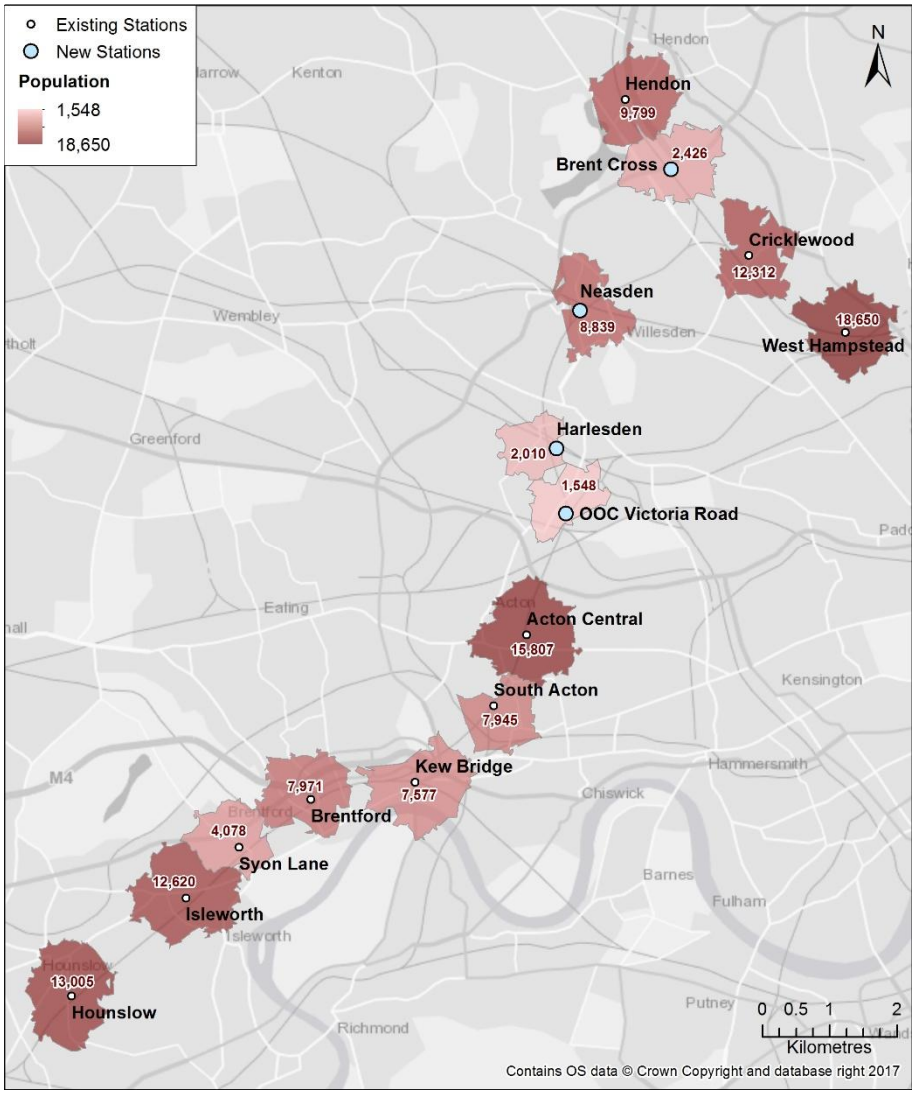
2.1 INTRODUCTION

2.1.1. The Strategic Case demonstrates the rationale for the development of a heavy rail solution for the Hounslow to West Hampstead/Hendon corridor. The proposed West London Orbital rail service will provide a high quality orbital public transport service, integrated with the wider public transport network. In doing so it will address a missing 'link' in the orbital rail network, support the accommodation of forecast population and employment growth in West London and align with the ambitions set out in the draft Mayor's Transport Strategy.

2.2 STRATEGIC RATIONALE

2.2.1. The West London Orbital rail service will deliver significant connectivity and accessibility benefits by introducing new stations and new services in West London along a currently under-utilised corridor. Figure 5 illustrates the current extent of the walk-in catchments and the population resident within the catchment who will benefit from the new service. These catchments will increase significantly with the forecast growth in population and housing in West London.

Figure 5 – Current Catchment Population along WLO Railway



2.2.2. Within the areas benefitting from the significantly improved accessibility and connectivity are many sites and larger regeneration opportunities identified by boroughs. In addition to serving these sites and the associated

proposed housing and employment sites, the introduction of WLO services will support an intensification of development facilitating increased numbers of housing units to be delivered on the sites

2.2.3. The resulting demand growth for both the public transport and highway network will impose increased costs on individuals and the economy, in terms of congestion and environmental and social dis-benefits in the absence of investment in additional capacity. The draft Mayor's Transport Strategy states that without action, by 2041 71% of travel in the morning peak on London Underground will be in crowded conditions. The respective figure for National Rail is 65%.

2.2.4. Delivery of the West London Orbital rail service will support the vision set out in the draft Mayor's Transport Strategy to reduce the need for car use (including taxis and private hire vehicles) in London to 20% by 2041 compared with 36% currently, which is largely due to the levels of car use in Outer London. The new rail service will also support sustainable development and provide the capacity required for the public transport network.

2.3 STRATEGIC OPTIONS

DUDDING HILL LINE

2.3.1. The Dudding Hill Line section of the West London Orbital railway is a 4-mile railway line between Cricklewood and Acton Wells. At the northern end connections are provided to the Midland Main Line, both to the north and south. At Acton Wells it joins the North London Line. From there, trains may proceed to the Great Western Main Line (Ealing), or continue along the North London Line towards Hounslow or Richmond. There are single-track link lines from the West Coast Main Line at Willesden and the Chiltern main line at Neasden.

2.3.2. The Dudding Hill Line is not an independent line: it links four main lines together, and by way of the North London Line, provides valuable links to the South Western network. It is an important freight artery, providing a means by which stone trains from the Mendips, for example, can operate to the West Coast or Midland Main Lines. While providing a corridor for freight, the Dudding Hill Line does not see any passenger services (either public transport or private vehicles). Passenger services last ran on the route in 1902.

2.3.3. The provision of passenger services would provide improved accessibility, support economic and housing growth along the corridor and relieve passenger demand on adjacent rail and highway networks. A high level consideration has been undertaken into the merit of seeking to utilise the existing heavy rail infrastructure or to replace the freight alignment with alternative transport facilities.

ASSESSMENT OF STRATEGIC OPTIONS

2.3.4. The strategic options considered for passenger services were: heavy rail, tram, tram-train, bus rapid transit and conversion to highway. Each of these was assessed against a multi-criteria sifting framework. The purpose of the framework was to support the differentiation between the options in order to inform the decision on the strategic option to proceed with. The framework was developed to enable a proportionate approach to be taken, cognisant of the information available and the stage of the project.

2.3.5. The framework addressed for each option, its:

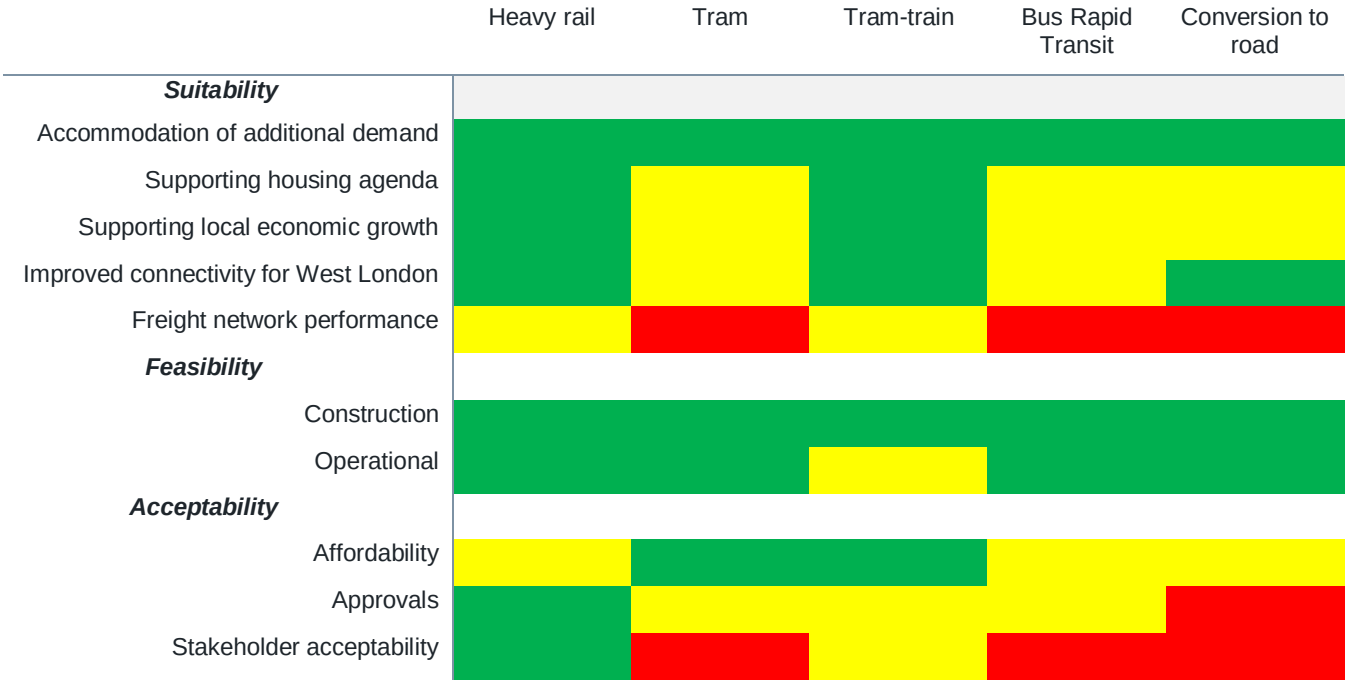
- Suitability: e.g. meeting the identified needs and objectives for the proposed scheme
- Feasibility: e.g. delivery and operational issues
- Acceptability: e.g. powers/consents, capital cost/affordability, stakeholder acceptability

2.3.6. Criteria for each of the above elements were determined and the performance of each option against them was assessed in comparison with the current situation as an improvement or detrimental and whether slight, moderate or significant.

ASSESSMENT FINDINGS

2.3.7. The findings of the high level assessment of the strategic options are summarised in the table below. The extent of the improvement or detriment has been assessed and illustrated with green indicating the greatest level of benefit and red the least (or a negative impact). The individual assessments are not additive, but should be considered on a comparative basis against other options and in the round for the overall assessment.

Table 2 – Summary of High Level Assessment of Passenger Service Strategic Options



2.3.8. While all the options, by enhancing the local transport network in West London, would contribute positively to the intent for the scheme, the greatest benefit is anticipated to arise from the heavy rail and tram-train options as they offer being part of the existing wider transport network (as does conversion to road), as well as providing the perceived permanency of fixed rails, which is attractive to developers, investors and the public due to the perceived greater value of these forms of public transport.

2.3.9. However, the most material differentiator between the heavy rail and tram-train options and the others is the ability of these passenger services to operate alongside the existing freight services on the line. With each of the other options freight movements could not take place on the line. The permanent diversion of freight services elsewhere does not appear feasible given geography and the utilisation of the rail network in the area. Constructing a new rail route for freight has been discounted due to deliverability and affordability challenges.

2.3.10. Freight trains under some very limited circumstances can share tracks with passenger trams, but there are onerous safety considerations to be addressed, which it may not be possible to satisfactorily overcome. A line not dissimilar to the Dudding Hill line in Paris, called the Tangentielle Nord line, has seen part of the former Grande Ceinture line re-used for trams. The French authorities have not closed the Grande Ceinture, which, like the North London Line, is an important freight artery, but have built a separate tram alignment next to it. A similar option for the Dudding Hill line might be possible, but it would require significant land-take, would be expensive and present engineering challenges (and therefore has not been assessed further).

2.3.11. The incompatibility between maintaining the existing freight services and introducing trams, bus rapid transit or a highway arguably indicates that none of these options is suitable for further consideration, notwithstanding that all the options are feasible in terms of construction and operation. The least confidence for operational feasibility relates to tram-train, which is still being trialled on the South Yorkshire rail network.

2.3.12. The findings for the assessment of acceptability reinforce the conclusions on suitability of the options. While introducing tram or tram-trains may provide a lower cost alternative to re-introducing heavy rail passenger services (and compared to having to remove the rails and lay a new carriageway for bus rapid transit or cars), their acceptability to stakeholders such as TfL, GLA, Network Rail, freight operators and local authorities is expected to be poor and hence achieving the necessary approvals would be very challenging. Similarly, given the policy context of the draft Mayor's Transport Strategy, the construction of a new road and transfer of freight from rail to road would be anticipated to also be opposed by key stakeholders.

2.3.13. In conclusion, having considered potential strategic options for the introduction of passenger services along the Dudding Hill Line, the findings from the high level assessment demonstrate that the line should remain part of the national rail network and not be a candidate for conversion to another mode. The retention of the Dudding Hill Line as a heavy rail line avoids the negative implications for freight and facilitates the realisation of benefits which the re-introduction of heavy rail passenger services has the potential to achieve, both in terms of transport connectivity and supporting the housing and economic growth agendas for the local areas. This conclusion was supported by the client group.

2.4 OPTION DEVELOPMENT

INTRODUCTION

2.4.1. Building on the conclusion of the strategic options assessment, a number of heavy rail passenger service options for the West London Orbital railway were defined. The option definitions were shaped by stakeholder contributions on the scheme requirements and priorities.

2.4.2. The three defined options were:

- **Option 1**: 4 trains per hour (tph) Hendon - Hounslow, calling at Hendon, Brent Cross, Neasden, Harlesden, Old Oak Common (OOC) Victoria Road, Acton Central, South Acton, Brentford, Syon Lane, Isleworth, Hounslow
- **Option 2**: 4 tph West Hampstead - Hounslow, calling at West Hampstead, Cricklewood, Neasden, Harlesden, OOC Victoria Road, Acton Central, South Acton, Brentford, Syon Lane, Isleworth, Hounslow
- **Option 3**: 4 tph West Hampstead - Hounslow and 4 tph Hendon - Hounslow, stops as above.

2.4.3. Consideration was given to the inclusion of a new station at Lionel Road, which is situated just east of Brentford and north of Kew Bridge stations. This proposal has been the subject of previous extensive work. This work suggests there is a good case for the station. However, we have excluded it from the options above because it is not integral to the re-opening of the line: the line could be re-opened and perform well without Lionel Road station. If the new station was constructed it would further increase the local regeneration benefits resulting from improved local rail services.

2.4.4. Demand forecasting, as described below, was undertaken for each of the options. A review of the infrastructure and operating requirements for introducing each of the options was also completed. The findings from both these analyses shaped the definition of the preferred option for further assessment.

DEMAND FORECASTING APPROACH

2.4.5. TfL's LTS-PT model was used to provide a preliminary forecast of the implications of the passenger service options. LTS-PT is a public transport model which covers the whole of London and predicts the demand by public transport mode (rail, underground, bus) and route that a person chooses to get to their destination, as well as the associated crowding impacts. The software platform for LTS-PT is Cube Voyager.

2.4.6. Travellers in London may respond in a number of different ways when they are faced with the introduction of a new passenger service including:

- Change their route to benefit from a faster and possibly less crowded passenger service;
- Change the destination of some trips;
- Change mode of travel, for example from road to rail; and
- Change the number of trips (trip generation and trip suppression).

2.4.7. Some of these responses will be more profound than others and TfL has a suite of models (LTS, HAM, LTS-PT) to assess all the above mentioned responses. However, at this stage of the project and to provide an initial indication of the demand on the re-introduced service, only the re-routing response has been assessed. This is considered to be the strongest response to the introduction of a new passenger service in London.

2.4.8. As a reassignment model of public transport demand LTS-PT does not capture the transfer from private cars or induced demand growth, both of which we would expect to play a substantial role in a West London Orbital passenger service. As such, the results presented here are almost certainly underestimated.

2.4.9. Given the constrained timescales of the study, it was not possible to review base year LTS-PT model validation in the area of interest or undertake a detailed network audit. Therefore it is recommended that a thorough review and a possible improvement of the accuracy of the public transport model in line with TfL and DfT guidance in undertaken as part of future work.

2.4.10. The passenger service options were tested against the following baselines:

- Standard LTS-PT 2041 Reference Case Scenario (A141rc01a)
  - This scenario includes HS2, but not Old Oak Common (OOC) or Brent Cross development.
- 2041 Maximum Growth Scenario without Crossrail 2 (A141rc20a)
  - This scenario includes HS2 and additional trips associated with OOC and Brent Cross development, as well as other additional development across London. Given the commitment to these developments (e.g. the planned breaking ground for Brent Cross next year) this is deemed more representative of the anticipated scenario for West London in 2041.

2.4.11. The 2041 Reference Case Scenario and 2041 Maximum Growth Scenario networks are the same, but the demand matrices are different. The assessment was undertaken for the AM (0700-1000) and PM (1600-1900).

2.4.12. The introduction of West London Orbital passenger services is forecast to result in an increase in passenger kilometres, passenger minutes and total passenger boardings on rail services (including WLO). The results for Option 1 and Option 2 are similar. However, Option 3 (8 tph rather than 4 tph) is forecast to make a more significant impact on the rail network with the changes almost double of those for Option 1 or Option 2. For example, against the Reference Case in 2041 AM Option 1 is forecast to result in 5,556 additional rail boarders, Option 2 – 5,002 boardings and Option 3 – 12,834 boardings.

DEMAND FORECASTS

2.4.13. Table 3 presents the summary statistics across all public transport modes in London for the incremental effect of the three options compared to the Reference Case.

Table 3 – Summary statistics: WLO Options versus 2041 Reference Case Scenario

Mode	Peak	*Description*	*2041 TfL Ref Case*	*Change in user benefits*		
		Scenario	A141rc01a	Option 1 minus Ref. Case	Option 2 minus Ref. Case	Option 3 minus Ref. Case
All PT	AM	Passenger Kms	85,795,810	-25,424	-22,445	-35,614
		Uncrowded Passenger Minutes	115,348,652	-88,989	-77,060	-178,966
		Crowded Passenger Minutes	154,400,839	-241,381	-210,768	-316,253
		Passenger Boardings	6,244,762	-1,957	-2,121	-1,605
	PM	Passenger Kms	89,635,043	-21,387	-17,409	-30,172
		Uncrowded Passenger Minutes	120,021,714	-82,387	-70,612	-147,691
		Crowded Passenger Minutes	154,108,212	-219,549	-190,719	-387,404
		Passenger Boardings	6,791,486	-2,268	-2,350	-1,779

2.4.14. The reduction in passenger kilometres, passenger minutes and total passenger boardings on LUL and buses indicates that the demand for the West London Orbital services is likely to be abstracted from LUL and bus services, providing crowding relief for them.

2.4.15. The WLO services are anticipated to improve connectivity and provide extra capacity on the public transport network in London resulting in lower levels of distance travelled, total boardings, journey times and crowding levels, most notably in the north-western and south-western quadrants of London. The impact of Option 1 and Option 2 is estimated to be very similar, with Option 3, which assumes double the number of trains on the core section, showing more significant changes.

2.4.16. When tested against the Maximum Growth scenario, the pattern of the results is similar as for the Reference Case scenario. However, the additional trip generation associated with the Maximum Growth Scenario means changes are greater, as summarised in Table 4.

Table 4 – Summary statistics: WLO Options versus 2041 Maximum Growth Scenario

Mode	Peak	Description	2041 Max Growth	Change in user benefits		
		Scenario		Option 1 minus Max Growth	Option 2 minus Max Growth	Option 3 minus Max Growth
All PT	**AM**	Passenger Kms	88,152,748	-26,651	-23,275	-37,204
		Uncrowded Passenger Minutes	118,927,182	-90,796	-78,050	-155,426
		Crowded Passenger Minutes	160,705,541	-242,933	-212,086	-447,184
		Passenger Boardings	6,485,584	-2,108	-2,262	-1,831
	PM	Passenger Kms	92,436,014	-22,333	-18,018	-32,261
		Uncrowded Passenger Minutes	124,289,369	-88,546	-75,299	-155,144
		Crowded Passenger Minutes	162,352,074	-252,329	-218,843	-436,387
		Passenger Boardings	7,068,359	-2,352	-2,443	-1,971

2.4.17. The introduction of West London Orbital passenger services is forecast to attract passengers from LUL lines such as the Northern, Jubilee, Central, District and Piccadilly as well as rail services currently operated by South West Trains and Great Western Railway. With the WLO passenger services operating, these national

rail services are likely to witness lower levels of crowding, providing overall crowding relief to a broad range of other services.

2.4.18. The direct connection between Old Oak Common (OOC) Victoria Road station, which is considered as part of the WLO railway, and the main Old Oak Common station is estimated to attract additional passengers to the Elizabeth Line (Crossrail 1).

2.4.19. In terms of line loading, station boardings and alightings, the demand analysis shows the following:

Baseline: Standard LTS-PT 2041 Reference Case Scenario

- In the AM (0700-1000) Option 1 is forecast to carry 6,064 passengers, Option 2 - 5,758 passengers and Option 3 - 12,646 passengers.
- In the PM (1600-1900) Option 1 is forecast to carry 6,337 passengers, Option 2 - 6,146 passengers and Option 3 - 13,437 passengers.
- The demand will vary by station with OOC Victoria Road being utilised the most. For example, in Option 1 in the AM 1,000 passengers are forecast to board the West London Orbital services and 2,823 to alight. In Option 2 these numbers are 952 and 2,479 passengers respectively and in Option 3 - 2,122 and 6,173 passengers.
- In the PM OOC Victoria Road demand is: Option 1 - 2,036 boarders and 1,579 alighters, Option 2 - 1, 889 and 1,478, Option 3 - 4,984 and 3,346. The majority of these passengers are those interchanging from/to the Elizabeth Line (Crossrail 1).

Baseline: 2041 Maximum Growth Scenario without Crossrail 2

- In the AM (0700-1000) Option 1 is forecast to carry 6,243 passengers, Option 2 - 5,920 passengers and Option 3 - 12,943 passengers.
- In the PM (1600-1900) Option 1 is forecast to carry 6,659 passengers, Option 2 - 6,437 passengers and Option 3 - 13,992 passengers.
- In the Maximum Growth Scenario WLO services are forecast to carry more passengers than in the Reference Case: on average 2.7% more in the AM and 4.6% in the PM.
- The demand estimates vary by station with OOC Victoria Road being utilised the most. For example, in Option 1 in the AM 1,100 passengers are forecast to board West London Orbital services and 2,772 to alight. In Option 2 these numbers are 1,045 and 2,428 respectively and in Option 3 - 2,342 and 6,022.
- In the PM OOC Victoria Road demand is: Option 1 - 2,036 boarders and 1,748 alighters, Option 2 - 1, 884 and 1,618, Option 3 - 4,936 and 3,671. The majority of these passengers are those interchanging from/to the Elizabeth Line (Crossrail 1).

2.5 OPERATIONS AND INFRASTRUCTURE ANALYSIS

2.5.1. The feasibility of delivering the rail services tested in the demand analysis was assessed, along with the associated capital cost implications. The analysis built upon previous work by TfL, Network Rail and WSP (and is reported in full in the *'West London Orbital Rail: Technical Analysis and Conclusions'* report). The principal issues include:

- Construction of new stations at Harlesden and Neasden;
- Construction of new platforms at Old Oak Common, Cricklewood, West Hampstead and Brent Cross;
- Platform turnround capability at Hounslow;
- Capacity between Hounslow and Key East junction given the proposed increased use of that route by the new South Western franchise;
- Bollo Lane level crossings given the very substantial increase in use of the Kew - Acton line;
- Capacity between Acton and Old Oak Common, especially around Acton Wells junction; and
- Resignalling of Dudding Hill Line and Acton – Kew.

2.5.2. The conclusions of the analysis were that capacity could not be provided for eight trains an hour to Hounslow and therefore Option 3 would not be deliverable. While feasible the four-tracking around Acton Wells and identifying a satisfactory solution for the level crossings at Bollo Lane present the most significant challenges for implementation given the scheme requirements and the nature of the areas in which they will be constructed.

2.6 IDENTIFICATION OF PREFERRED SERVICE OPTION

2.6.1. Based on the demand forecasting and analysis of operational and infrastructure requirements for the three options, conclusions were drawn to inform the specification of the preferred option to be assessed. The conclusions were:

- Option 3 (4 tph West Hampstead - Hounslow and 4 tph Hendon - Hounslow) attracts a higher level of demand and therefore higher total benefits (reduced passenger distance and passenger minutes) when compared with Option 1 (4 tph Hendon - Hounslow) and Option 2 (4 tph West Hampstead - Hounslow).
- Old Oak Common is central to the demand profile on the route, and it appears feasible to construct a station on the Dudding Hill lines at Brent Cross.
- With appropriate enhancements to the railway, which are assessed to be feasible, the assumed level of service can be accommodated, but providing in excess of 4 trains per hour to Hounslow, on top of the South West Trains service, is deemed prohibitively expensive.
- The preferred option should seek to deliver the benefits of option 3 (or as much of them as possible) for the most economical level of capital costs, e.g. a turnback at Kew Bridge and potentially with a phased introduction.

2.6.2. Based on these conclusions a preferred scenario was developed and agreed with the client group. The preferred option is specified as:

- **Phase 1**: 4 trains per hour from West Hampstead to Hounslow.
- **Phase 2**: additional 4 trains per hour from Hendon to Kew Bridge.

2.6.3. Phase 1 services are assumed to commence operation in 2026, with phase 2 services running from 2029.

3 ECONOMIC CASE

3.1 INTRODUCTION

3.1.1. The Economic Case presents the economic appraisal of the value for money for the preferred option. The outputs from the demand modelling, along with the capital and operating cost estimates have been used as inputs for the economic appraisal. Alongside the quantified comparison of social benefits and the costs for the preferred option a qualitative consideration of wider benefits has been made.

3.2 DEMAND AND BENEFITS MODELLING

3.2.1. The LTS-PT model has been used to undertake preliminary demand and benefit forecasting for the preferred option, consistent with the initial options modelling.

Baseline: Standard LTS-PT 2041 Reference Case (A141rc01a)

3.2.2. The introduction of the new services is forecast to result in an increase in passenger kilometres, passenger minutes and total passenger boardings on rail services (including WLO) of 9,374 in the AM and 9,327 in the PM. A reduction in passenger kilometres, passenger minutes and total passenger boardings on LUL and buses indicates that the demand for the West London Orbital services is likely to be abstracted from LUL and bus services, providing crowding relief for them.

3.2.3. The new services are estimated to improve connectivity and provide extra capacity on the public transport network in London resulting in lower levels of distance travelled, total boardings, journey times and crowding levels, most notably in the north-western and south-western quadrants of London. The table below provides a summary across all public transport modes in London.

Table 5 – Summary statistics: WLO Preferred Option versus 2041 Reference Case Scenario

Mode	Peak	*Description*	*2041 TfL Ref Case*	*Change in user benefits*
		Scenario	A141rc01a	Preferred Option minus Reference Case
All PT	AM	Passenger Kms	85,795,810	-33,096
		Uncrowded Passenger Minutes	115,348,652	-140,143
		Crowded Passenger Minutes	154,400,839	-317,792
		Passenger Boardings	6,244,762	-1,827
	PM	Passenger Kms	89,635,043	-26,986
		Uncrowded Passenger Minutes	120,021,714	-119,500
		Crowded Passenger Minutes	154,108,212	-308,646
		Passenger Boardings	6,791,486	-1,913

Baseline: 2041 Maximum Growth Scenario without Crossrail 2

3.2.4. When tested against the Maximum Growth Scenario, the pattern of the results is similar as for the Reference Case Scenario. However, the additional trip generation associated with the Maximum Growth Scenario means changes are greater as summarised in Table 6.

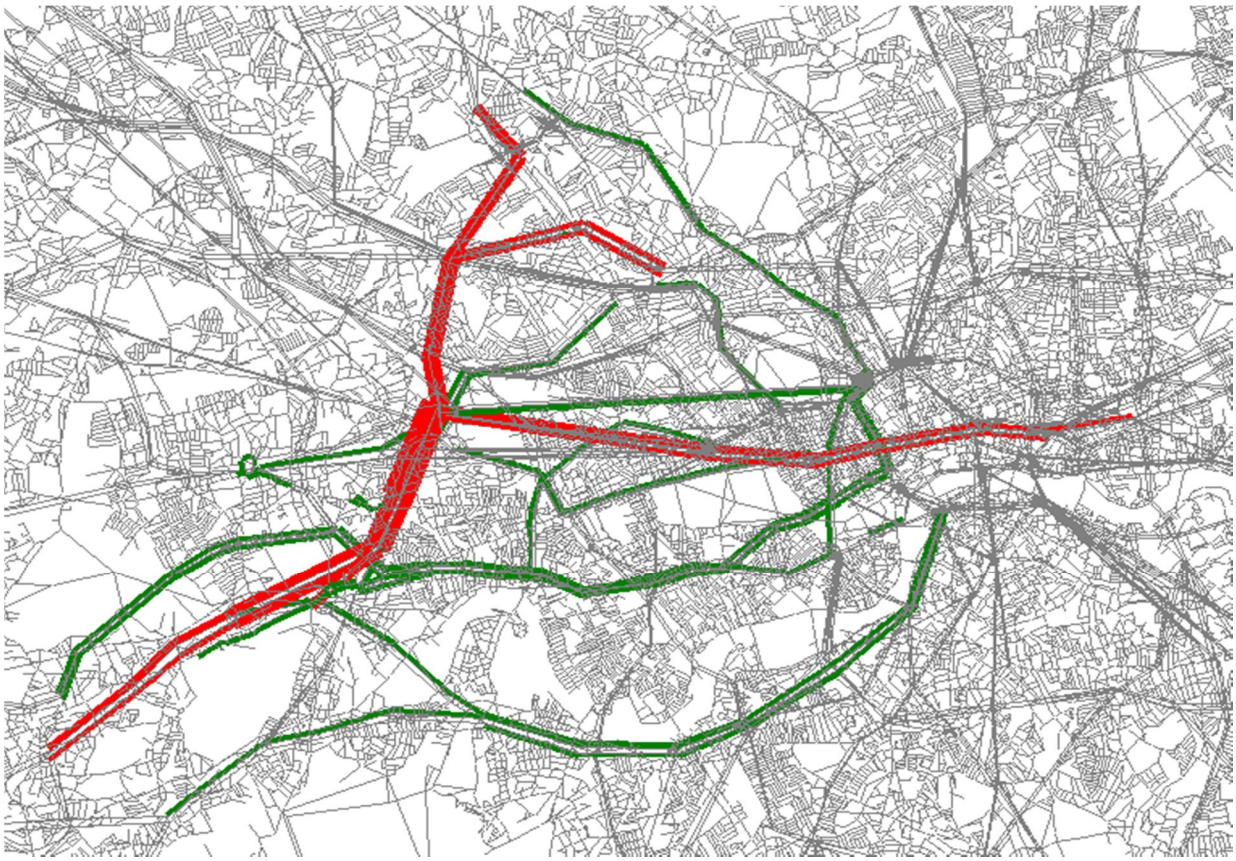
Table 6 – Summary statistics: WLO Preferred Option versus 2041 Maximum Growth Scenario

Mode	Peak	*Description*	*2041 Max Growth*	*Change in user benefits*
		Scenario	A141rc01a	Preferred Option minus Max Growth
All PT	AM	Passenger Kms	88,152,748	-34,613
		Uncrowded Passenger Minutes	118,927,182	-129,397
		Crowded Passenger Minutes	160,705,541	-370,356
		Passenger Boardings	6,485,584	-2,010
	PM	Passenger Kms	92,436,014	-28,444
		Uncrowded Passenger Minutes	124,289,369	-126,955
		Crowded Passenger Minutes	162,352,074	-351,499
		Passenger Boardings	7,068,359	-2,028

3.2.5. As with the initial options, the preferred option is forecast (as illustrated in Figure 6) to attract passengers from LUL lines such as the Northern, Jubilee, Central, District and Piccadilly as well as rail services currently operated by South West Trains and Great Western Railway. With the WLO passenger services operating these rail services are likely to witness lower levels of crowding, providing overall crowding relief to a broad range of other services.

3.2.6. The direct connection between Old Oak Common (OOC) Victoria Road station, which is considered as part of the WLO railway, and the main Old Oak Common station is estimated to attract additional passengers to the Elizabeth Line (Crossrail 1). However, the number of passengers transferring at OOC between the WLO services and the Elizabeth Line drops by around 25% in comparison with Option 3 as the WLO Hounslow-Hendon service gets truncated to Kew Bridge providing a less frequent connection to/from Hounslow.

Figure 6 – Passenger flow difference for Preferred Option vs Maximum Growth Scenario (AM)



3.2.7. In terms of line loading, station boardings and alightings, the demand analysis shows the following:

Baseline: Standard LTS-PT 2041 Reference Case (A141rc01a)

- The WLO services are forecast to carry 9,504 passengers In the AM (0700-1000) and 10,165 passengers in the PM (1600-1900).
- The demand will vary by station with OOC Victoria Road being utilised the most. For example, in the AM 1,537 passengers are forecast to board the West London Orbital services and 4,660 to alight. In the PM these numbers are 3,917 and 2,428 passengers respectively. The majority of these passengers are those interchanging from/to the Elizabeth Line (Crossrail 1).

Baseline: 2041 Maximum Growth Scenario without Crossrail 2

- The WLO services are forecast to carry 9,758 passengers In the AM (0700-1000) and 10,623 passengers in the PM (1600-1900).
- In the Maximum Growth Scenario WLO services are forecast to carry more passengers than in the Reference Case: on average 2.7% more in the AM and 4.5% in the PM.
- The demand will vary by station with OOC Victoria Road being utilised the most. For example, in the AM 1,682 passengers are forecast to board the WLO services and 4,593 to alight. In the PM these numbers are 3,916 and 2,669 passengers respectively. The majority of these passengers are those interchanging from/to the Elizabeth Line (Crossrail 1).

3.3 COST ESTIMATES

CAPITAL COST ESTIMATE

3.3.1. The capital cost estimate for the preferred option was developed following a review of a number of studies which have been completed over the last few years for sections of the West London Orbital railway, including those by TfL and Network Rail. The review considered both the assumptions made for the infrastructure requirements and the previously proposed costs.

Table 7 – Summary of Capital Cost Estimate

Item	Spot cost (2017 prices)
West Hampstead 2 new platforms (4-car)	£1m
Cricklewood 2 new platforms (4-car)	£5.5m
Hendon 2 new platforms (4-car)	£1m
Brent Cross new platforms (4-car)	£5m
Neasden new station (4-car)	£18m
Harlesden new station (4-car)	
OOC Victoria road new platforms (4-car)	
Re-signalling of Dudding Hill line and Acton - Kew	£8m
Quadrupling of Acton Wells Junction area	£45m
Bollo Lane level crossing replacement	£30m
Acton level crossing	£5m
Kew Bridge or Lionel Road turnback	£4m for each
Old Kew Junction doubling	£4.6m
Old Kew Junction flyover	£8.5m
Hounslow bay platform	£5.4m
Depot facilities	£5m
Total	**£146m**

OPERATING COST ESTIMATE

3.3.2. Forecast operating costs were estimated on the basis of consistency with standard industry assumptions. They are estimated to be (in current prices):

- £8.611m p.a. for Phase 1 from 2026
- £15.247m p.a. for the full service from 2029

3.4 ECONOMIC APPRAISAL (BCR)

3.4.1. The economic appraisal was undertaken in line with DfT guidance (WebTAG). The forecast benefits (from both quicker journey times and crowding relief in generalised time) for all London public transport users was converted into monetary values based upon DfT's values of time for rail users in work time (£47.77 in 2041), for commuting (£16.29) and other (7.44) journey purposes.

3.4.2. The forecast benefits were profiled over a 60-year appraisal period from 2026 to 2085. The profiling captures:

- Value of time growth (from WebTAG)
- Background demand growth to 2041 (from LTS-PT model)
- Build-up factor of 50% in years 2026-2028 prior to introduction of 8 tph services from 2029
- Discounting at 3.5% for next 30 years and then at 3%

3.4.3. Substantial benefits are forecast to arise from the journey time improvements provided by the new service, notably by accessing the Elizabeth Line at OOC Victoria Road and for journeys within the corridor which cannot currently be made directly (with travel time savings of up to 20 to 30 minutes). In total the preliminary value of the travel time benefits for the appraisal period exceed £680m PV (2010 prices) for both the Reference Case and Max Growth Scenario.

3.4.4. In addition, very significant benefits are forecast to be experienced not only by those using the WLO rail service, but by those experiencing less crowded travel conditions on other routes on the rail network. In total the preliminary value of the crowding relief benefits for the appraisal period exceed £600m PV (2010 prices) for the Max Growth Scenario and approach £500m PV (2010 prices) for the Reference Case.

3.4.5. Set against these social benefits (i.e. economic welfare) are the costs of the scheme, both capital and operating. In line with appraisal practice, an optimism bias uplift has been applied to the capital costs reflecting the early stage of scheme development. It is assumed that there will be real growth inflation on the capital costs of 1% per annum until scheme opening. This produces a discounted capital cost estimate for the appraisal of £259m PV (2010). For the operating costs 1% real growth inflation (in line with revenue) has been assumed. Over the life of the appraisal period the total operating cost is estimated to be £337m PV (2010).

3.4.6. An annual revenue forecast of around £9m (current prices) for the WLO services has been estimated (as reported in the Financial Case), however for the purposes of this preliminary economic appraisal the revenue impact across the whole network is assumed to be neutral and is not included at the public transport network level. This is consistent with the results from the LTS-PT model, which is based on trip reassignment and hence largely a redistribution of revenue, e.g. from LUL to WLO.

3.4.7. The resulting indicative benefit to cost ratio (BCR) for the preferred WLO option is greater than 2:1, meeting the DfT's high value for money category. This strong BCR reflects the significant forecast benefits of the scheme to the wider economy and society through journey time savings and crowding benefits, and their realisation through better utilisation of existing infrastructure with selective capital investment, e.g. new platforms and four-tracking. Further analysis will be needed to refine this BCR.

Table 8 – Summary of Economic Appraisal Results: Max Growth Scenario

Item	60 year PV 2010
Journey time benefits	£684m
Crowding benefits	£614m
Total Benefits	**£1,298m**
Capital costs	£259m
Operating costs	£337m
Revenue	Assumed neutral at public transport network level
Net Financial Effect	**£596m**
Net Present Value	**£703m**
Benefit:Cost Ratio	**2.2:1**
	For the Reference Case the BCR is 2.0:1.

3.5 WIDER BENEFITS

ACCESSIBILITY

3.5.1. Through the provision of new direct high quality public transport links and integration with the wider national rail network and LUL network, the introduction of the WLO rail service will deliver a step change in accessibility to and from the corridor between Hounslow and West Hampstead/Hendon.

3.5.2. Figures 7 and 8 illustrate the extent of the catchments for the new stations by time band in the 'with' and 'without' scenarios for the new service. As can be seen, the introduction of the WLO rail service significantly increases the areas accessible within 'reasonable' travel times (e.g. within 20 and 30 minutes) of these currently under-served locations.

3.5.3. Figure 9 shows the walk-in catchment for each of the stations served by the proposed services. It also presents the PTAL score for each station location in the absence of the scheme. The majority of the stations are scored as 3 or 4. (It should be noted that the baseline does not fully capture the large scale development around Old Oak Common, due to the forecast year available. It is therefore anticipated that the eventual baseline PTAL for the Old Oak Common (Victoria Road) will be considerably higher than shown in this analysis).

3.5.4. PTAL is a standardised measure used by TfL, which combines information about the proximity of public transport services and the morning peak frequencies. The PTAL scores have been produced from WebCAT PTAL output, which takes the closest point to the station. As this can be up to 100m from the platforms or station entrance, a manual adjustment was made. Figure 10 shows the effect on the PTAL score of introducing the scheme.

Figure 7 – Accessibility in Without WLO Rail Service Scenario

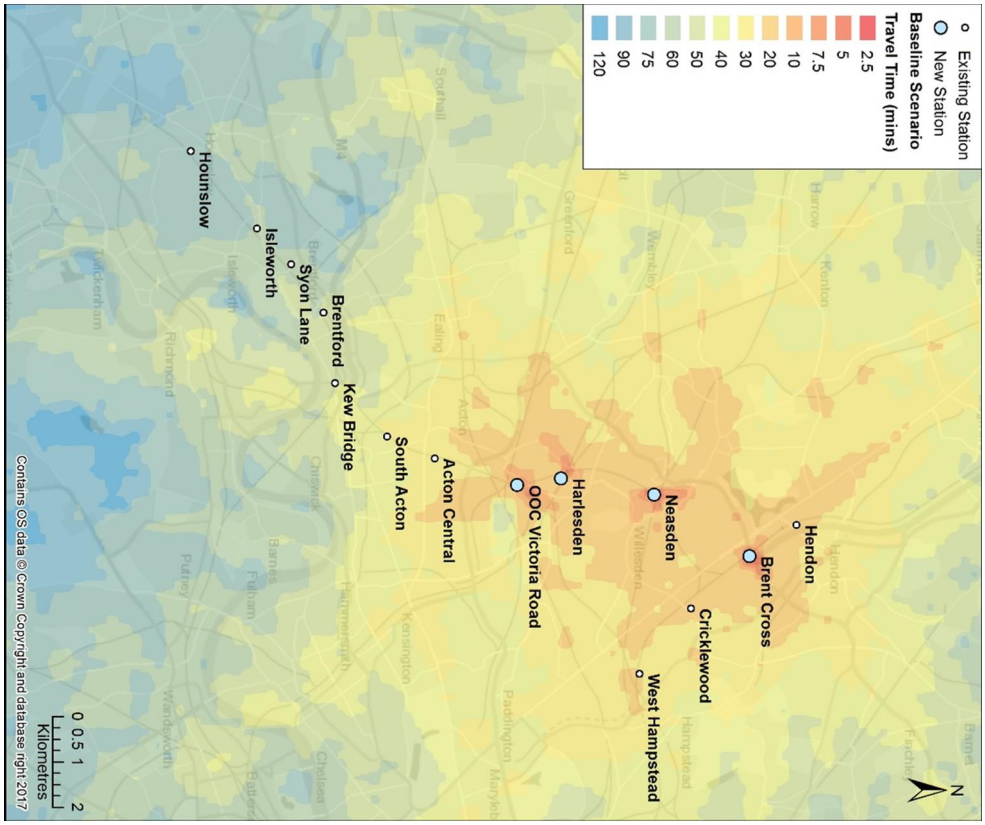


Figure 8 – Accessibility in With WLO Rail Service Scenario

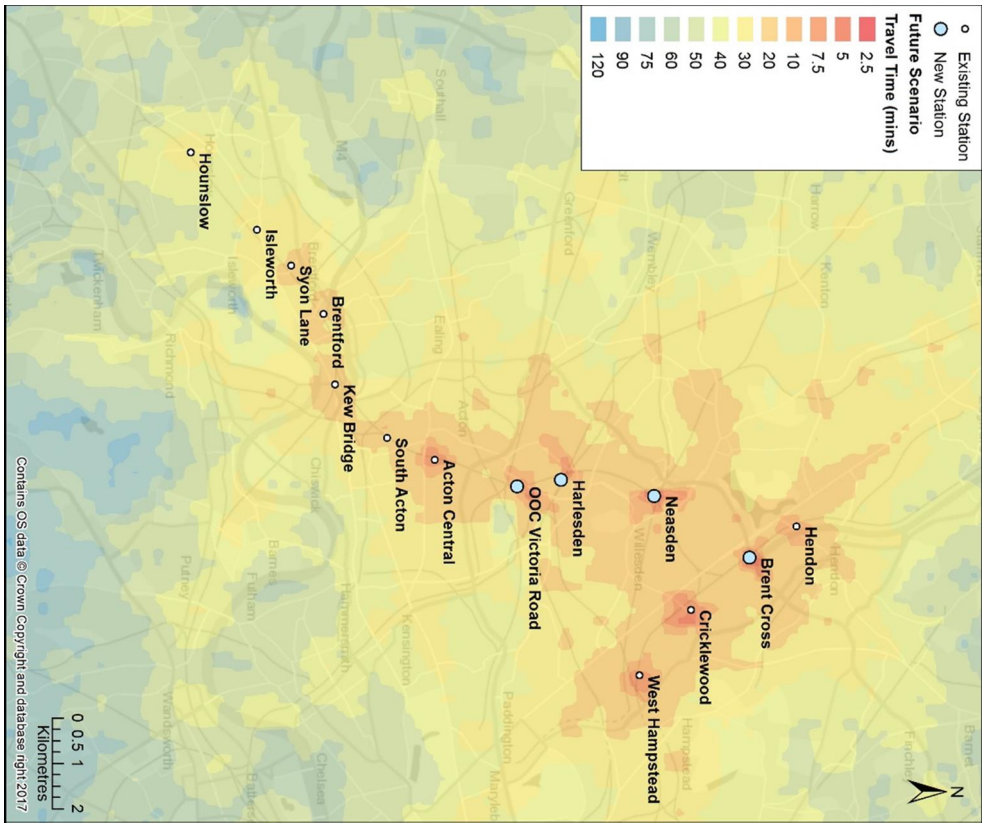


Figure 9 – PTAL Scores Without WLO Rail Service

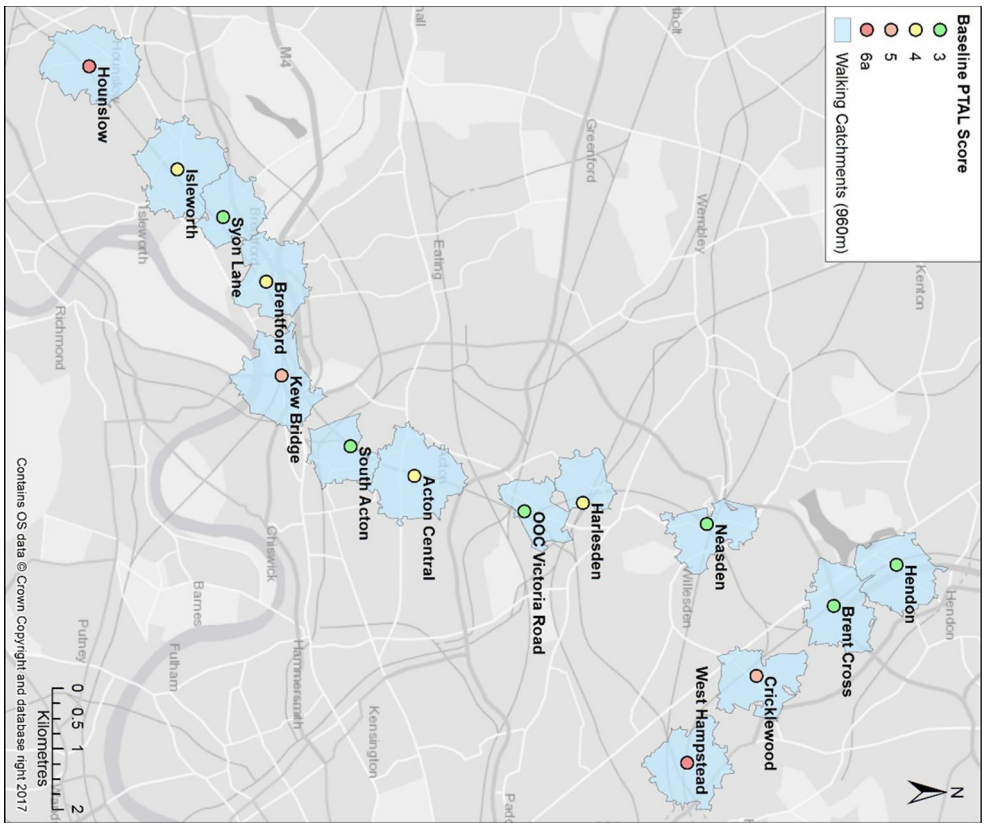
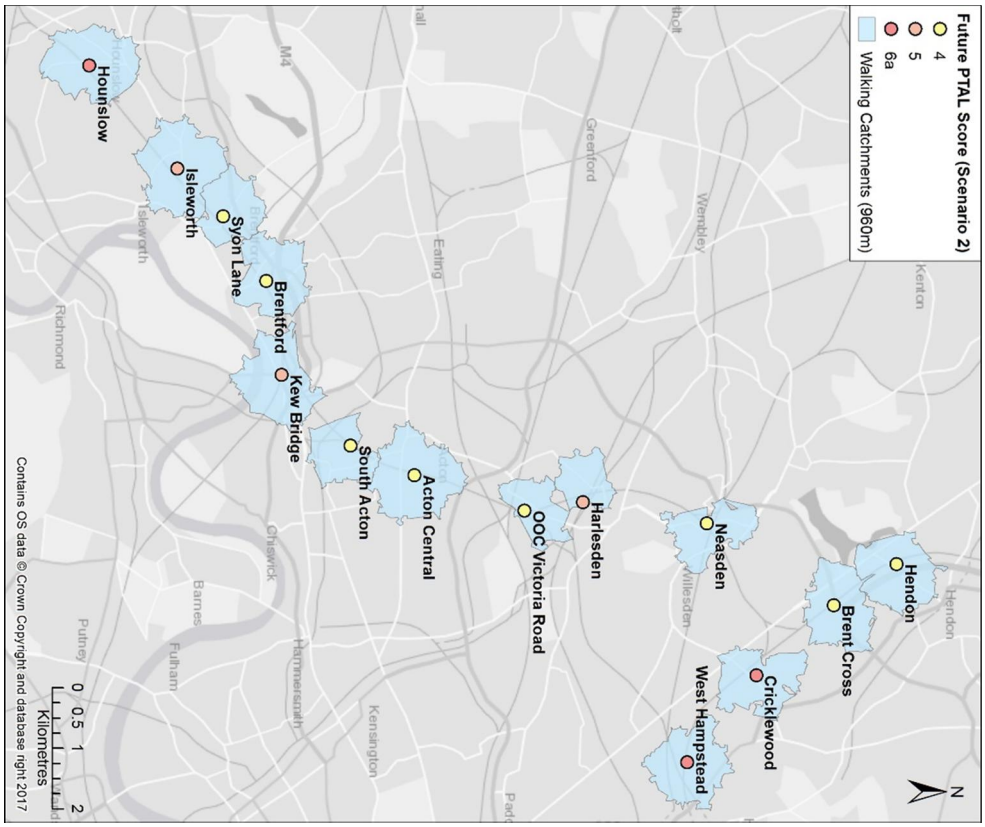


Figure 10 – PTAL Scores With WLO Rail Service



3.5.5. The results of the PTAL analysis illustrated in Figures 9 and 10 demonstrate an increase in score for nine of the 14 stations. All six of the stations with a score of 3 without WLO rail services gain a score of 4 after its introduction. Both Isleworth and Harlesden stations are promoted to a score of 5.

TACKLING HIGHWAY CONGESTION

3.5.6. The significant improvement in accessibility within and to and from the corridor will attract users from both the existing public transport network and the highway network. While at this stage of scheme development the demand modelling has not considered mode transfer, it is anticipated that given much greater journey time competitiveness with highway trips and potential journey time savings, particularly in the peak period, this will be significant. This will contribute to addressing current congestion on both orbital routes such as the A406 North Circular, A5 and Hendon Way and, given the attractiveness of the interchange at OOC Victoria Road with the Elizabeth Line, for radial routes such as the Westway and A4.

3.5.7. The provision of an attractive high quality public transport alternative to highway trips will also support the Mayor's ambition to reduce total traffic in London by 10-15% by 2041, as part of the Healthy Streets agenda, which includes addressing noise and air pollution and delivering local economic benefits.

SUPPORTING GROWTH

3.5.8. The demand forecasting and economic appraisal demonstrate the very significant benefits to the forecast public transport users in 2041, based on TfL's current assumptions. In West London there are ambitions to deliver additional significant housing and the provision of high quality public transport and good accessibility is seen as providing an opportunity to increase the density of developments and potentially open up new sites.

3.5.9. PTAL scores are used in the Housing Density Matrix in the London Plan to set out recommended housing densities for developments. As indicated in the extract from the London Plan below, (and assuming 'Urban' setting for West London), the range of expected densities around the stations served by the scheme (as shown in Figure 11) would increase to up to 700 habitable rooms per hectare and up to 260 units per hectare in the most accessible locations.

Figure 11 – Recommended Housing Densities in the London Plan

Setting	Public Transport Accessibility Level (PTAL)		
	0 to 1	2 to 3	4 to 6
Suburban	**150-200 hr/ha**	**150-250 hr/ha**	**200-350 hr/ha**
3.8-4.6 hr/unit	35-55 u/ha	35-65 u/ha	45-90 u/ha
3.1-3.7 hr/unit	40-65 u/ha	40-80 u/ha	55-115 u/ha
2.7-3.0 hr/unit	50-75 u/ha	50-95 u/ha	70-130 u/ha
Urban	**150-250 hr/ha**	**200-450 hr/ha**	**200-700 hr/ha**
3.8-4.6 hr/unit	35-65 u/ha	45-120 u/ha	45-185 u/ha
3.1-3.7 hr/unit	40-80 u/ha	55-145 u/ha	55-225 u/ha
2.7-3.0 hr/unit	50-95 u/ha	70-170 u/ha	70-260 u/ha
Central	**150-300 hr/ha**	**300-650 hr/ha**	**650-1100 hr/ha**
3.8-4.6 hr/unit	35-80 u/ha	65-170 u/ha	140-290 u/ha
3.1-3.7 hr/unit	40-100 u/ha	80-210 u/ha	175-355 u/ha
2.7-3.0 hr/unit	50-110 u/ha	100-240 u/ha	215-405 u/ha

Figure 2.1: Recommended housing densities in the London Plan

hr = habitable rooms
u = a dwelling unit, i.e. a flat or a house
ha = hectare

3.5.10. Assuming an increase in density around the stations where the PTAL score increased to 4 or above in the with WLO rail service scenario, the recommended increase in the number of units within the walk-in catchments of the stations could be around 200 units on the basis of the London Plan guidance. If the effect of the improved accessibility is extended to a one mile radius, the result could be over 300 additional units.

3.5.11. These indicative estimates however, are likely to be very conservative and developers will be keen to exploit the full commercial potential of the sites and seek to provide the highest densities they can. If this was to produce densities at some locations consistent with the 'Central' setting the level of additional units could approach around 1,000 units.

3.5.12. The above estimates are purely illustrative and do not reflect the current usage and densities in the areas which would benefit from the WLO rail service. Based on the emerging Strategic Housing Land Availability Assessments for the West London boroughs many identified sites will benefit from the introduction of the WLO rail service. This could potentially, subject to finalisation of site identification, developer appetite and local policies enable the intensification of housing development to potentially deliver 15,000 to 20,000 units in total.

3.5.13. The results of the demand forecasting indicate that in 2041 the WLO rail service will provide sufficient capacity to accommodate further significant growth in rail demand arising from further housing and employment development along the corridor.

4 FINANCIAL CASE

4.1 INTRODUCTION

4.1.1. The Financial Case addresses the affordability of the delivery and operation of the proposed rail services. At this stage plausible sources of funding to ensure the affordability of the scheme have been identified for further investigation.

4.2 FUNDING THE SCHEME

CIL CONTRIBUTION

4.2.1. With a capital cost estimate of £263m (current prices, with 80% risk), significant funding will need to be secured to deliver the scheme. Initial analysis by the West London boroughs indicates that there is scope to derive a significant contribution towards this capital cost through funding from the Community Infrastructure Levy (CIL). With potentially 15,000 to 20,000 new homes planned in West London the associated value of the CIL could approach around £150m-£200m.

OPPORTUNITIES FOR OVER-SITE DEVELOPMENT

4.2.2. One potential way to support both the densification of development in the corridor and to raise funding to assist in addressing the scheme affordability is to pursue opportunities for over-site development (OSD) at the West London Orbital railway stations, which themselves are only likely to be cost effective if constructed to a material density.

4.2.3. A new station at OOC Victoria Road provides a good opportunity for a relatively dense OSD structure, along with increased public space and thoroughfare provision. This could complement the OPDC development masterplan. There may be opportunities at other stations, for example the new station at Harlesden offers limited potential for OSD, given its low density surroundings and lack of immediate proximity to an employment centre, but there is some space in the local area to enable a more ambitious vision when the future OPDC starts to regenerate the adjacent surroundings, so a longer-term masterplan could enable viable OSD.

4.2.4. The likely timescale for the delivery and operation of the WLO rail service, combined with TfL's ambitions for development of its sites via its Property Partnership Framework, would provide the ideal timing and climate in which to bring forward plans for new transport-oriented development and new or rejuvenated local centres.

RAIL INDUSTRY CONTRIBUTION

4.2.5. As further scheme development is undertaken greater certainty will emerge over the level of funding required given the confirmation of infrastructure requirements, value engineering where appropriate and detailed quantified risk assessments. Further, through the identification of potential rail industry synergies, opportunities for cost efficiencies and rail industry funding can be explored.

4.3 OPERATIONS AFFORDABILITY

4.3.1. For the purposes of this study it has been assumed that the WLO rail service would be operated as a London Overground concession. Indicative revenue has been estimated on the basis of assuming that all additional rail boarders forecast in LTS-PT provide a yield of £1 for WLO rail services recognising that many trips are likely to be 'discounted' due to the use of travelcards, season tickets, capped fares etc. and as legs of multi-legged journeys. This produces an estimated revenue when the 8 tph service has commenced operation of around £9m (in current prices). This compares to an operating cost estimate of around £15m.

4.3.2. The requirement for an operating subsidy is standard for much of the rail network, but further consideration of means to meet the 'gap' between the forecast revenue and operating cost will need to be considered in order to confirm the affordability of WLO rail service operations. This consideration should address:

- Future TfL fares' policy for orbital travel (e.g. premium fares) which is often lower than for equivalent radial journeys because they can be made without crossing fare boundaries
- Potential re-zoning of the London transport network, e.g. zoning Old Oak Common as Zone 1
- Opportunities to harness future technology for ticketing and fares to most effectively manage demand across the network and price fares appropriately
- Additional fare revenue received from demand transferring from road to rail, but not captured in the current demand forecasting (which is solely reassignment)
- Opportunities for commercial revenue streams through station and/or on-train commercial activities

- Future rolling stock choices, e.g. electric or battery, and implications for operating and whole-life costs
- Future operating practices, e.g. provision of ticket offices, staffing

5 COMMERCIAL & MANAGEMENT CASE

5.1 INTRODUCTION

5.1.1. The Commercial & Management Case addresses the commercial viability of the proposals, namely their deliverability (beyond affordability, which is addressed in the Financial Case) and the associated approach to manage the project to successful completion. To date, the project has been led by the West London Alliance, with representatives of the boroughs of Barnet, Brent, Ealing and Hounslow, along with Transport for London (TfL) and Old Oak and Park Royal Development Corporation, represented on the project Steering Group.

5.1.2. With the demonstration in this business case of the robust strategic rationale for the scheme, its operational feasibility and the forecast significant social benefits that will result from the introduction of the West London Orbital rail service, further development of the project should be undertaken.

5.2 DELIVERING THE PROJECT

5.2.1. The involvement of the entire rail industry will be necessary to support the introduction of the West London Orbital rail service. Regardless of possible funding streams, the Department for Transport will need to be content with the scheme proposal and may suggest amendments to facilitate its implementation, in line with other network-wide schemes such as the Digital Railway.

5.2.2. Network Rail will be a central player in the project management and delivery of the scheme, be it undertaking the work directly or with an asset protection role. It is anticipated that the most challenging part of the programme is the 4-tracking of the Acton Wells area, and all parties will need to ensure that the design of the enhancement meets everybody's requirements (passenger and freight). Indeed, it may well prove beneficial to combine other works planned for the area into one programme. This will minimise disruption and potentially deliver financial savings.

5.2.3. Given the current use of the route for freight, freight operators will be important parties to engage with and there will also be the interface with the South Western franchise's emerging service planning on the Hounslow loop to ensure that neither sets of plans are compromised. Identifying an acceptable solution for Bollo Lane will also require effective rail industry and local authority working.

5.2.4. At this stage it appears that TfL is best placed to provide project leadership as the scheme is progressed. TfL has experience of planning and management of major transport investment in London and can realise the benefits from the synergies between the proposed West London Orbital service and the North and West London lines (London Overground), its role with many train operators in the London area and with the HS2 interface at Old Oak Common.

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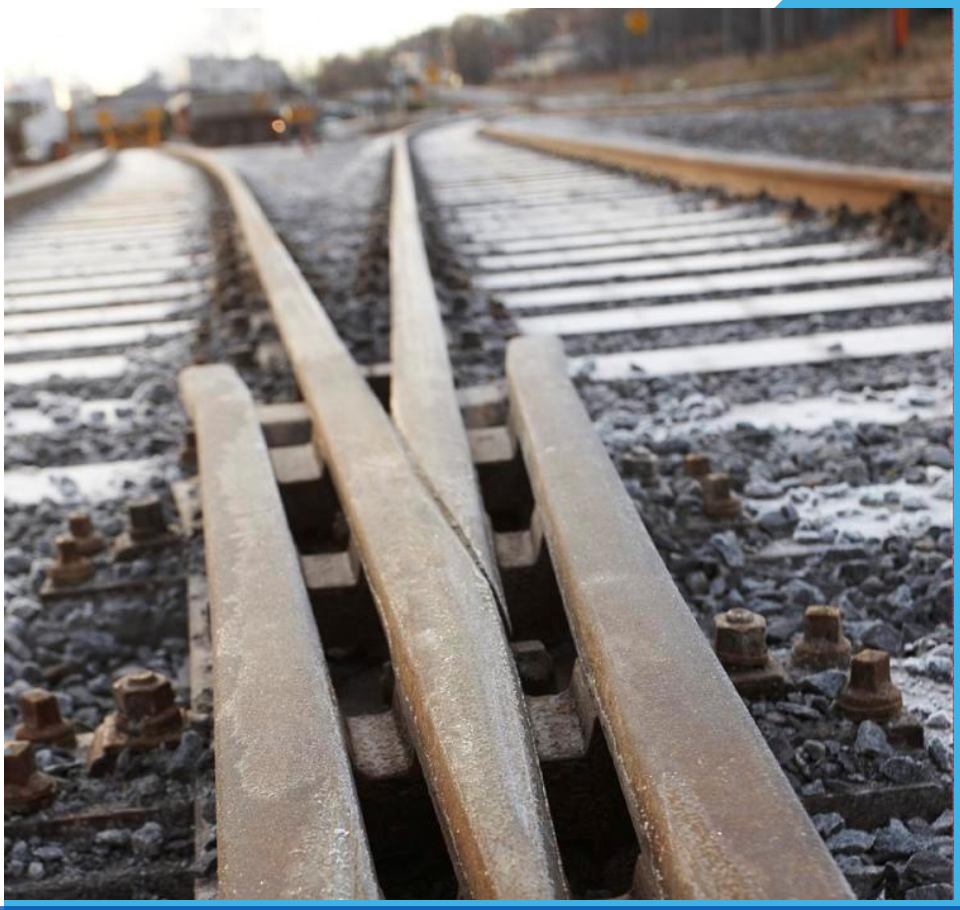
WEST LONDON ORBITAL RAIL

TECHNICAL ANALYSIS AND CONCLUSIONS



OCTOBER 2017

WSP | PARSONS BRINCKERHOFF

WEST LONDON ORBITAL RAIL

TECHNICAL ANALYSIS AND CONCLUSIONS

West London Alliance

Report

Project no: 70034419
Date: October 2017

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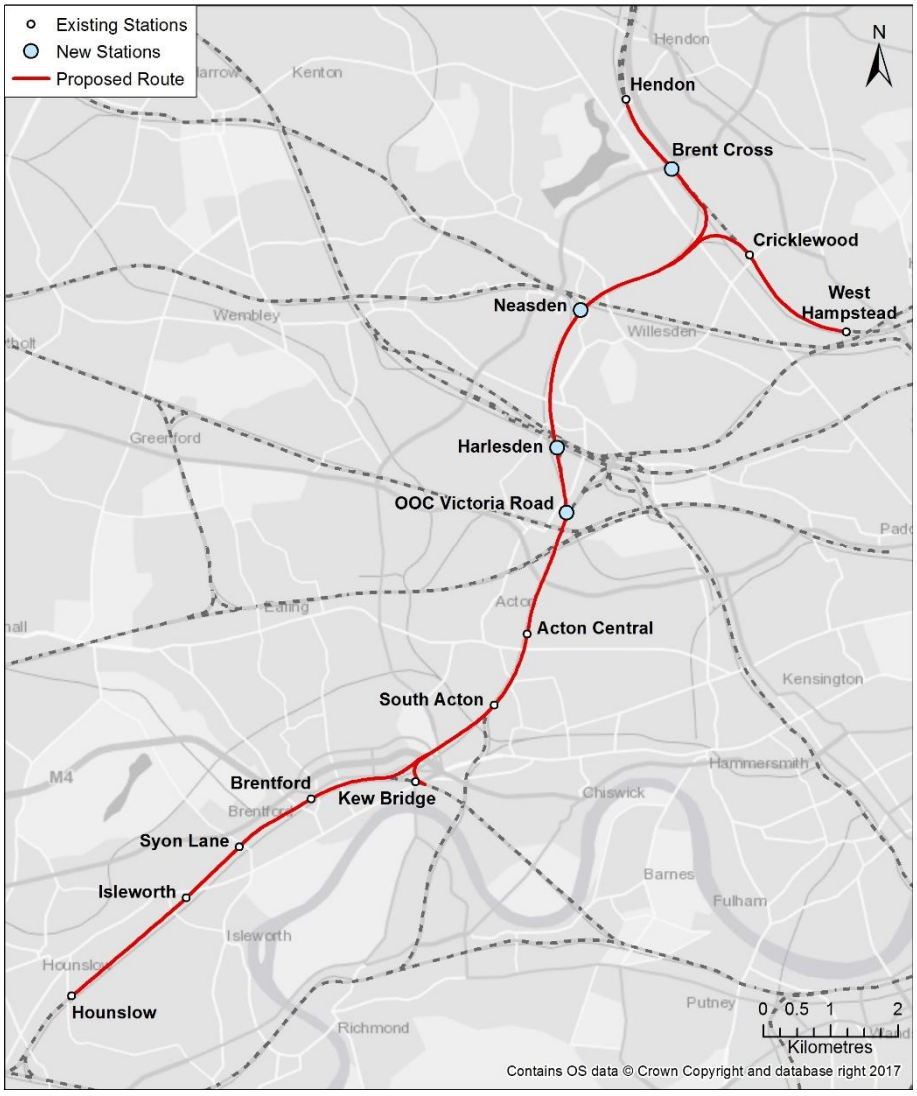
EXECUTIVE SUMMARY

BACKGROUND

The West London Alliance is currently investigating ways of accommodating the additional passenger demand resulting from the growth of population and employment in the area and across London as a whole. This includes substantial additional housing planned along much of the corridor between Hounslow and West Hampstead/Hendon. An option to serve these developments in a sustainable way, consistent with the draft Mayor's Transport Strategy ambitions, is to restore rail passenger services on the Dudding Hill Line and the Kew – Acton link to provide a West London Orbital (WLO) rail service from Hounslow to West Hampstead and Hendon.

Figure 1 – West London Orbital Rail Service



The Dudding Hill Line is an existing railway line in north-west London running from Acton to Cricklewood. The line itself has had no scheduled passenger service for over a century. It has no

stations, no electrification and a 30 miles per hour speed limit with semaphore signalling, and is lightly used by freight and very occasional passenger charter trains. It is roughly 4 miles long. Near the site of Old Oak, trains would join the existing North London Line, and then further south at Acton, use the link down to the Hounslow Loop to reach Brentford and Hounslow. We refer to this set of routes as the West London Orbital railway.

STUDY APPROACH

WSP was commissioned to carry out a feasibility study into the case for introducing a new passenger service using the West London Orbital railway. The study has assessed the case on the basis of consideration of the:

- à Strategic options for the route
- à Passenger demand assessment
- à Operational and infrastructure analysis
- à Assessment of the preferred option

STRATEGIC OPTIONS (CHAPTER 2)

The strategic options considered are heavy rail, tram, tram-train, bus rapid transit and conversion to highway. Each of these has been assessed against a multi-criteria sifting framework. The findings demonstrate that the line should remain part of the national rail network and not be a candidate for conversion to another mode. The retention of the Dudding Hill Line as a heavy rail line avoids the negative implications for freight and facilitates the realisation of benefits which the re-introduction of heavy rail passenger services has the potential to achieve, both in terms of transport connectivity and supporting the housing and economic growth agendas for the local areas. This conclusion was supported by the client group.

DEMAND ANALYSIS (CHAPTERS 3 & 4)

Demand modelling using TfL's LTS-PT model has been used to assess the implications of the restored passenger service. Three options were considered:

- à **Option 1**. 4 trains per hour (tph) Hendon – Hounslow, calling at Hendon, Brent Cross, Neasden, Harlesden, OO Victoria Road, Acton Central, South Acton, Brentford, Syon Lane, Isleworth, Hounslow
- à **Option 2**. 4 tph West Hampstead – Hounslow, calling at West Hampstead, Cricklewood, Neasden, Harlesden, OO Victoria Road, Acton Central, South Acton, Brentford, Syon Lane, Isleworth, Hounslow
- à **Option 3**. 4 tph West Hampstead – Hounslow and 4 tph Hendon – Hounslow, stops as above.

The forecasts from the demand analysis indicate that the introduction of WLO rail services will result in an increase in passenger kilometres, passenger minutes and total passenger boardings on all rail services (including WLO). The results for Option 1 and Option 2 are similar. However, Option 3 (8 tph rather than 4 tph) is forecast to make a more significant impact on the rail network with the changes almost double of those for Option 1 or Option 2.

The improved connectivity and extra capacity provided by WLO passenger services on the public transport network in London is forecast to attract passengers from LUL lines such as the Northern, Jubilee, Central, District and Piccadilly as well as rail services currently operated by South West Trains and Great Western Railway. Additional passengers to the Elizabeth Line (Crossrail 1) are estimated to be attracted as a result of the WLO providing a direct connection between Old Oak (OO) Victoria Road station and the main Old Oak Common station.

OPERATIONS AND INFRASTRUCTURE ANALYSIS (CHAPTER 5)

The feasibility of delivering the rail services tested in the demand analysis was assessed, along with the associated capital cost implications. The analysis built upon previous work by TfL, Network Rail and WSP. The principal issues and requirements include:

- Construction of new stations at Harlesden and Neasden
- Construction of a stop at Old Oak, referred to in this report at Old Oak, Victoria Road- the form of which needs to be further investigated.
- Construction of new platforms at, Cricklewood, West Hampstead and Brent Cross
- Platform turnround capability at Hounslow
- Capacity between Hounslow and Key East junction given the proposed increased use of that route by the new South Western franchise
- Bollo Lane level crossings given the very substantial increase in use of the Kew - Acton line
- Track Capacity between Acton and Old Oak, especially around Acton Wells junction
- Resignalling of Dudding Hill Line and Acton - Kew

Of these issues four-tracking around Acton Wells and identifying a satisfactory solution for the level crossings at Bollo Lane present the most significant challenges.

PREFERRED OPTION (CHAPTERS 6 & 7)

Derived from the findings from the demand analysis and the operations and infrastructure analysis the preferred option has been defined as:

- **Phase 1:** 4 trains per hour from West Hampstead to Hounslow, calling at West Hampstead, Cricklewood, Neasden, Harlesden, OO Victoria Road, Acton Central, South Acton, Brentford, Syon Lane, Isleworth, Hounslow
- **Phase 2:** additional 4 trains per hour from Hendon to Kew Bridge, calling at Hendon, Brent Cross, Neasden, Harlesden, OO Victoria Road, Acton Central, South Acton, Kew Bridge

The outputs from the LTS-PT modelling, along with the capital and operating cost estimates have been used as inputs for the economic appraisal and an assessment of wider benefits and affordability.

STUDY FINDINGS

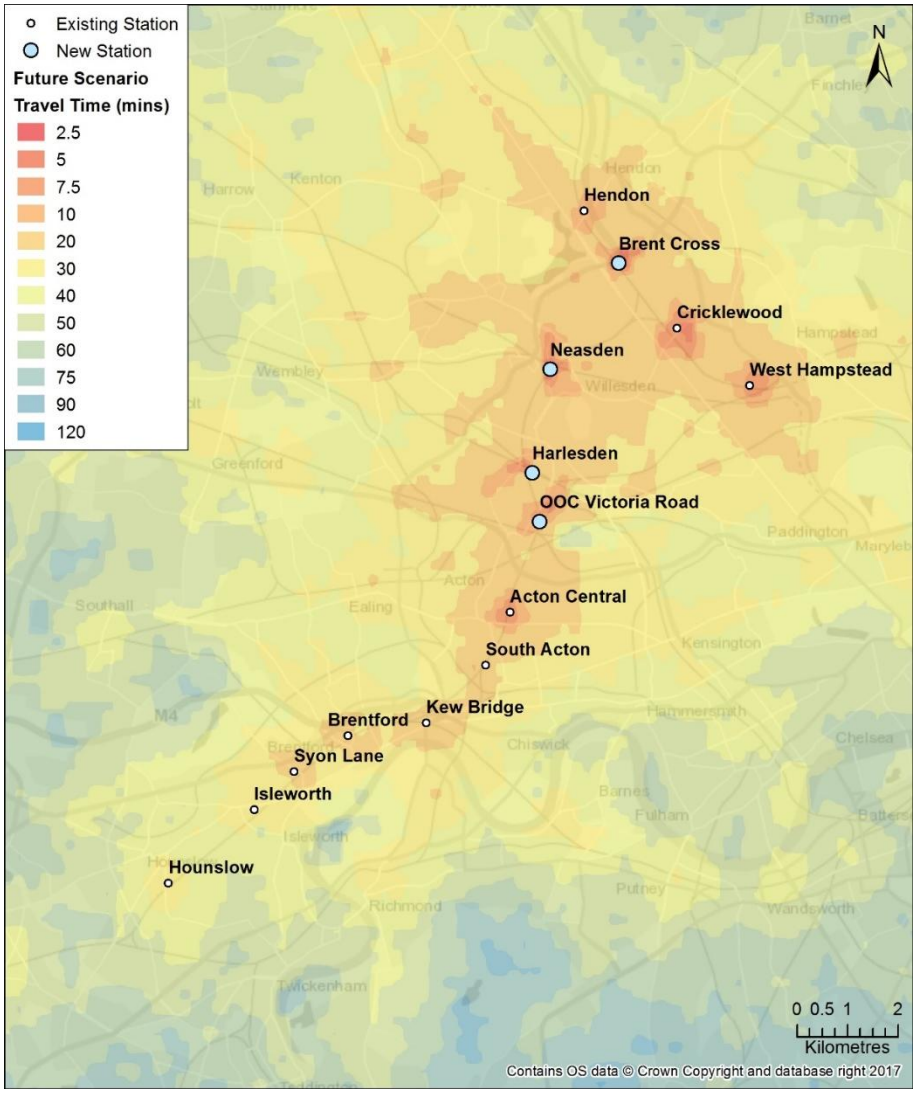
STRATEGIC RATIONALE

This study has confirmed the appropriateness of developing a heavy rail solution for the Hounslow to West Hampstead/Hendon corridor given its existing role as a freight route and the opportunity to provide connectivity across the wider rail network. Retention of the heavy rail corridor on the Dudding Hill Line section will also permit integration of the WLO services into London Overground operations and to support the further success of this brand.

The introduction of a high quality public transport service, integrated with the wider public transport network, will support the accommodation of forecast population and employment growth in West London in a manner consistent with the draft Mayor's Transport Strategy. The scheme will deliver significant connectivity and accessibility benefits by introducing new stations and new services. This will result in the attraction of existing public transport and highway users, as well as new users, contributing to relieving forecast crowding on LUL and national rail services, addressing highway congestion and supporting local environmental improvements.

Within the areas benefitting from the significantly improved accessibility and connectivity (as shown below) are many sites identified by the emerging Strategic Housing Land Availability Assessments. In addition to serving these sites and the associated proposed housing, the introduction of WLO services will support an intensification of development facilitating increased numbers of housing units to be delivered on the sites.

Figure 2 – Accessibility of new WLO stations



ECONOMIC CASE

The economic appraisal has been undertaken in line with DfT guidance with the forecast benefits (both uncrowded and crowded time in minutes) for all public transport users converted into monetary values to estimate the social benefits of the scheme. Given the significant levels of demand forecast for the WLO and the journey time savings and crowding benefits delivered, the total social benefits exceed £1.25bn PV (2010 prices) over the appraisal period. The cost of delivering these benefits has been estimated for the capital and operating elements over the appraisal period. Together these amount to £596m PV (2010 prices).

The resulting indicative benefit to cost ratio (BCR) for the preferred WLO option is greater than 2:1, meeting the DfT's high value for money category. This strong BCR reflects the significant forecast benefits of the scheme to the wider economy and society through journey time savings

and crowding benefits, and their realisation through better utilisation of existing infrastructure with selective capital investment, e.g. new platforms and four-tracking. Further analysis will be needed to refine this BCR.

Table 2 – Summary of Economic Appraisal Results

ITEM	60 YEAR PV 2010
Journey time benefits	£684m
Crowding benefits	£614m
Total Social Benefits	**£1,298m**
Capital costs	£259m
Operating costs	£337m
Revenue	Assumed neutral at public transport network level
Net Financial Effect	**£596m**
Net Present Value	**£703m**
Benefit:Cost Ratio	**2.2:1**

COMMERCIAL & FINANCIAL CASES

For the purposes of this study it has been assumed that the proposed WLO services will be operated by London Overground and the development and implementation of the infrastructure will be led by TfL and Network Rail to ensure efficient and effective integration with the wider rail network and recognising current roles and responsibilities.

Initial analysis suggests an operating subsidy would be required as assumed WLO operating costs are estimated to exceed estimated WLO revenue. Further consideration of means to meet the 'gap' will need to be considered in order to confirm the affordability of WLO rail service operations. This consideration should address:

- à Future TfL fares' policy for orbital travel, recognising the strategic nature of many of the trips (which can be made without crossing fare boundaries, in contrast with radial trips)
- à Opportunities to harness future technology for ticketing and fares to most effectively manage demand across the network and price fares appropriately
- à Future rolling stock choices, e.g. electric or battery, and implications for operating and whole-life costs

Further work will also be required to identify a funding proposition to confirm the affordability of implementing the scheme given its cost of over £250m. Initial analysis indicates that there is scope to derive a significant contribution towards this capital cost through funding from the Community Infrastructure Levy (CIL). With potentially 15,000 to 20,000 new homes planned in West London the associated value of the CIL could approach around £150m.

CONCLUSIONS

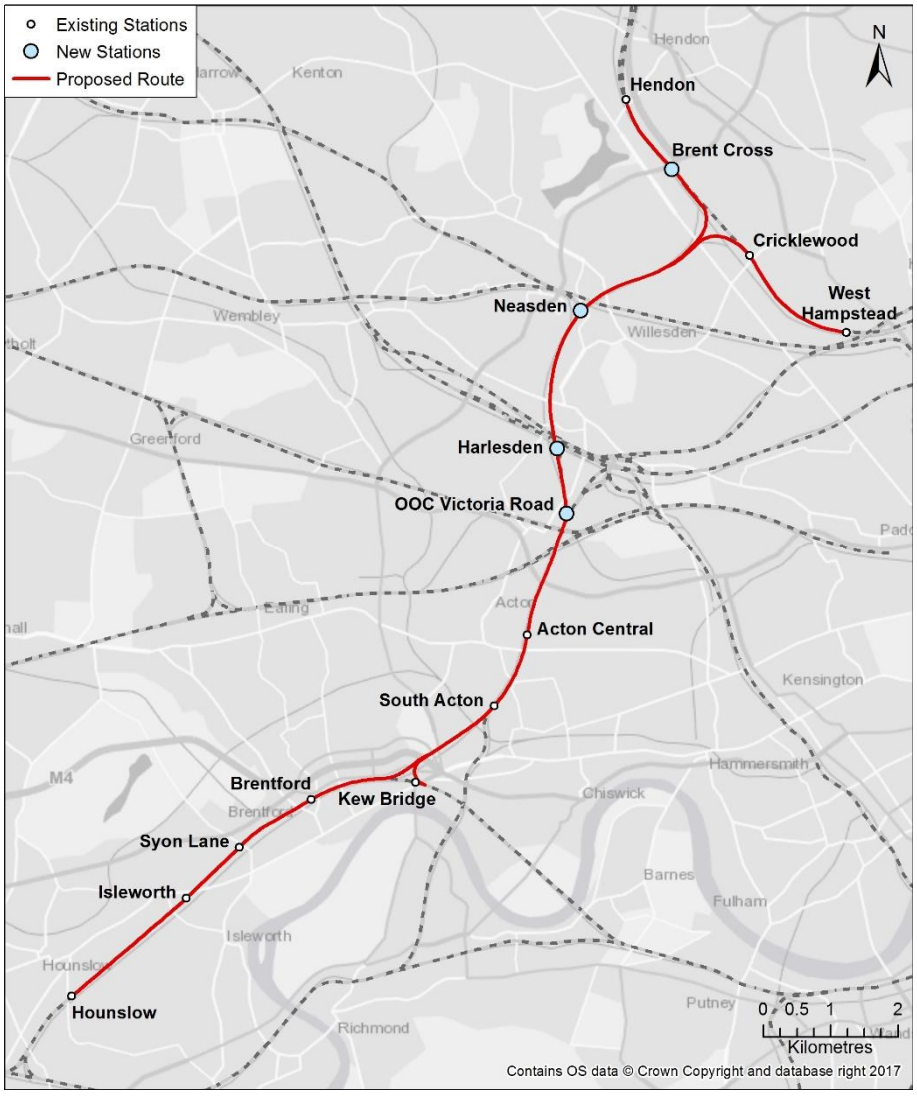
This study demonstrates that significant social benefits will result from the introduction of WLO rail services, which have been confirmed to be operationally feasible. The key technical challenges for scheme implementation have been identified with proposed solutions set out. At this stage the affordability of the scheme has not been confirmed, but plausible opportunities to achieve this have been identified providing confidence that it can be.

1 INTRODUCTION

1.1 CONTEXT

1.1.1 The West London Alliance is currently investigating ways of accommodating the additional demand resulting from the growth of population and employment in the area and across London as a whole. This includes substantial additional housing planned along much of the corridor between Hounslow and West Hampstead/Hendon. An option to serve these developments in a sustainable way, consistent with the draft Mayor's Transport Strategy ambitions, is to restore passenger services on the Dudding Hill Line and the Kew – Acton link to provide a West London Orbital rail service from Hounslow to West Hampstead and Hendon.

Figure 1-1 West London Orbital Rail Services



1.1.2 The Dudding Hill Line is an existing railway line in north-west London running from Acton to Cricklewood. The line itself has had no scheduled passenger service for over a century. It has no stations, no electrification and a 30 miles per hour (48 km/h) speed limit with semaphore signalling, and is lightly used by freight and very occasional passenger charter trains. It is roughly 4 miles (6.4 km) long. Near the site of Old Oak, trains would join the existing North London Line, and then further south at Acton, use the link down to the Hounslow Loop to reach Brentford and Hounslow. We refer to this set of routes as the West London Orbital railway.

1.2 THIS DOCUMENT

1.2.1 WSP was commissioned to carry out a feasibility study into the case for introducing a new passenger service using the West London Orbital railway.

1.2.2 This document presents the approach and findings of the technical analysis undertaken and the conclusions drawn. It covers:

- à Strategic options for the route
- à Passenger demand assessment
- à Operational and infrastructure analysis
- à Assessment of preferred option
- à Conclusions and recommendations for further work

2 STRATEGIC OPTIONS

2.1 INTRODUCTION

2.1.1 The Dudding Hill Line is a 4-mile railway line between Cricklewood and Acton Wells. At the northern end connections are provided to the Midland Main Line, both to the north and south. At Acton Wells it joins the North London Line. From there, trains may proceed to the Great Western Main Line (Ealing), or continue along the North London Line towards Hounslow or Richmond. There are single-track link lines from the West Coast Main Line at Willesden and the Chiltern main line at Neasden.

2.1.2 The Dudding Hill Line is not an independent line: it links four main lines together, and by way of the North London Line, provides valuable links to the South Western network. It is an important freight artery, providing a means by which stone trains from the Mendips, for example, can operate to the West Coast or Midland Main Lines.

2.1.3 This study addresses the potential for the entire route from West Hampstead/Hendon to Hounslow, but the focus of this chapter is the currently under-utilised northern section, for which a range of options have been advanced, including conversion from heavy rail.

2.2 CONSIDERATION OF STRATEGIC OPTIONS

2.2.1 The Dudding Hill Line provides a corridor for freight, but currently does not see any passenger services (either public transport or private vehicles). The provision of these would provide improved accessibility, support economic and housing growth along the corridor and relieve passenger demand on adjacent rail and highway networks. A high level consideration has been undertaken into the merit of seeking to utilise the existing heavy rail infrastructure for passenger services along the corridor, or replace the freight alignment with alternative transport facilities. Passenger services last ran on the route in 1902.

2.2.2 The strategic options considered for passenger services are: heavy rail, tram, tram-train, bus rapid transit and conversion to highway. Each of these has been assessed against a multi-criteria sifting framework. The purpose of the framework is to support the differentiation between the options in order to inform the decision on the strategic option to proceed with. The framework was developed to enable a proportionate approach to be taken, cognisant of the information available and the stage of the project.

2.2.3 The framework addresses for each option, its:

- à **Suitability**: e.g. meeting the identified needs and objectives for the proposed scheme
- à **Feasibility**: e.g. delivery and operational issues
- à **Acceptability**: e.g. powers/consents, capital cost/affordability, stakeholder acceptability

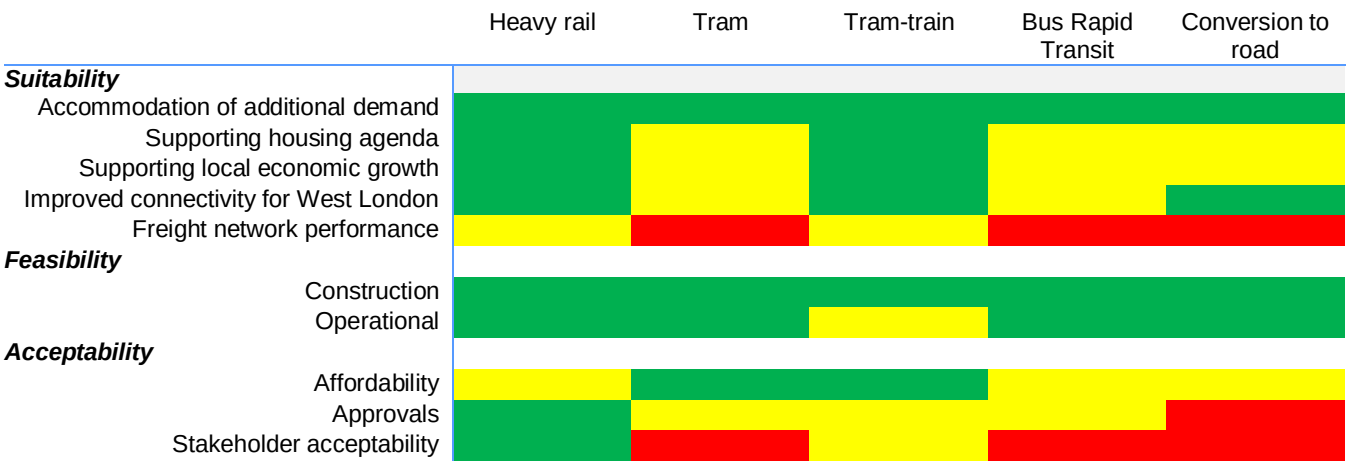
2.2.4 Criteria for each of the above elements have been determined and the performance of each option against them has been assessed as positive, neutral or negative in comparison to the existing situation.

2.3 FINDINGS OF ASSESSMENT

2.3.1 The findings of the high level assessment of the strategic options are summarised in the table

below. The extent of the improvement or detriment has been assessed and illustrated with green indicating the greatest level of benefit and red the least (or a negative impact). The individual assessments are not additive, but should be considered on a comparative basis against other options and in the round for the overall assessment.

Table 2-1 Summary of High Level Assessment of Passenger Service Strategic Options



2.3.2 While all the options, by enhancing the local transport network in West London, would contribute positively to the intent for the scheme, the greatest benefit is anticipated to arise from the heavy rail and tram-train options as they offer being part of the existing wider transport network (as does conversion to road), as well as providing the perceived permanency of fixed rails, which is attractive to developers, investors and the public due to the perceived greater value of these forms of public transport.

2.3.3 However, the most material differentiator between the heavy rail and tram-train options and the others is the ability of these passenger services to operate alongside the existing freight services on the line. With each of the other options freight movements could not take place on the line. Diverting freight services elsewhere does not appear feasible given geography and the utilisation of the rail network in the area. Constructing a new rail route for freight has been discounted.

2.3.4 Freight trains under some very limited circumstances can share tracks with passenger trams, but there are onerous safety considerations to be addressed, which it may not be possible to satisfactorily overcome. A line not dissimilar to the Dudding Hill line in Paris, called the Tangentielle Nord line, has seen part of the former Grande Ceinture line re-used for trams. The French authorities have not closed the Grande Ceinture, which, like the North London Line, is an important freight artery, but have built a separate tram alignment next to it. A similar option for the Dudding Hill line might be possible, but it would require significant land-take, would be expensive and present engineering challenges (and therefore has not been assessed further).

2.3.5 The incompatibility between maintaining the existing freight services and introducing trams, bus rapid transit or a highway arguably indicates that none of these options is suitable for further consideration, notwithstanding that all the options are feasible in terms of construction and operation. The least confidence for operational feasibility relates to tram-train, which is still being trialled on the South Yorkshire rail network.

2.3.6 The findings for the assessment of acceptability reinforce the conclusions on suitability of the options. While introducing tram or tram-trains may provide a lower cost alternative to re-introducing heavy rail passenger services (and compared to having to remove the rails and lay a new carriageway for bus rapid transit or cars), their acceptability to stakeholders such as TfL, GLA, Network Rail, freight operators and local authorities is expected to be poor and hence achieving the necessary approvals would be very challenging. Similarly, given the policy context

of the draft Mayor's Transport Strategy, the construction of a new road and transfer of freight from rail to road would be anticipated to also be opposed by key stakeholders.

2.3.7 In conclusion, having considered potential strategic options for the introduction of passenger services along the Dudding Hill Line, the findings from the high level assessment demonstrate that the line should remain part of the national rail network and not be a candidate for conversion to another mode. The retention of the Dudding Hill Line as a heavy rail line avoids the negative implications for freight and facilitates the realisation of benefits which the re-introduction of heavy rail passenger services has the potential to achieve, both in terms of transport connectivity and supporting the housing and economic growth agendas for the local areas. This conclusion was supported by the client group.

2.3.8 In this study, therefore, we have sought to develop the optimum specification for delivering improvements to the line through heavy rail retention, and in delivering the level of service quality that has become synonymous with the London Overground brand.

3 DEMAND ANALYSIS: APPROACH

3.1 APPROACH

3.1.1 In order to assess the implications of the restored passenger service we have used TfL's LTS-PT model. LTS-PT is a public transport model which covers the whole of London and predicts the demand on public transport mode (rail, underground, bus) and route that a person chooses to get to their destination, as well as the associated crowding impacts. The software platform for LTS-PT is Cube Voyager.

3.1.2 Travellers in London may respond in a number of different ways when they are faced with the introduction of a new passenger service including:

- à Change their route to benefit from a faster and possibly less crowded passenger service
- à Change the destination of some trips
- à Change mode of travel, for example from road to rail
- à Change the number of trips (trip generation and trip suppression)

3.1.3 Some of these responses will be more profound than others and TfL has a suite of models (LTS, HAM, LTS-PT) to assess all the above mentioned responses. However, to inform this feasibility study and to provide an initial indication of the demand on the re-introduced service, only the re-routing response has been assessed. This is considered to be the strongest response to the introduction of a new passenger service in London.

3.1.4 We should emphasise that LTS-PT is a reassignment model of public transport demand: it does not capture the transfer from private cars or induced demand growth, both of which we would expect to play a substantial role in a West London Orbital passenger service. As such, the results presented here are almost certainly underestimated.

3.1.5 Considering the constraints of the study timescales, it has not been possible to review base year LTS-PT model validation in the area of interest or undertake a detailed network audit. However, should the scheme be progressed to the next stage, we recommend a thorough review and a possible improvement of the accuracy of the public transport model in line with TfL and DfT guidance.

3.2 OPTIONS

3.2.1 For the demand modelling the following three options have been considered:

- à **Option 1**. 4 tph Hendon – Hounslow, calling at Hendon, Brent Cross, Neasden, Harlesden, a stop at Old Oak , Acton Central, South Acton, Brentford, Syon Lane, Isleworth, Hounslow
- à **Option 2.** 4 tph West Hampstead – Hounslow, calling at West Hampstead, Cricklewood, Neasden, Harlesden, a stop at Old Oak, Acton Central, South Acton, Brentford, Syon Lane, Isleworth, Hounslow
- à **Option 3.** 4 tph West Hampstead – Hounslow and 4 tph Hendon – Hounslow, stops as above.

3.2.2 A new station at Lionel Road, which is situated just east of Brentford and north of Kew Bridge stations, has been the subject of previous extensive work. This work suggests there is a good case for the station. However, we have excluded it from the options above because it is not integral to the re-opening of the line: the line could be re-opened and perform well without Lionel Road. If Lionel Road station was constructed it would further increase the local regeneration benefits resulting from improved local rail services.

3.2.3 The West London Orbital passenger service options have been tested against the following baseline:

- Standard LTS-PT 2041 Reference Case (A141rc01a)

  This scenario includes HS2, but not Old Oak (OO) or Brent Cross development.

- 2041 Maximum Growth Scenario without Crossrail 2 (A141rc20a)

  This scenario includes HS2 and additional trips associated with OO and Brent Cross development, as well as other additional development across London. Given the commitment to these developments (e.g. the planned breaking ground for Brent Cross next year) this is deemed more representative of the anticipated scenario for West London in 2041.

3.2.4 The 2041 Reference Case and 2041 Maximum Growth scenario networks are the same, but the demand matrices are different.

3.2.5 The assessment has been undertaken for the AM (0700-1000) and PM (1600-1900).

3.3 STUDY LIMITATIONS

3.3.1 TfL's strategic public transport model LTS-PT was used for this study because it is the only London wide modelling tool available to assess the impacts and benefits of the proposed scheme. It is appropriate for providing a strategic overview of the range of benefits likely to be generated by the proposed schemes and therefore in forming one part of the wider assessment of the benefits and costs of the schemes.

3.3.2 Given the constrained timescales of the study, it has not been possible to review base year LTS-PT model validation in the area of interest or undertake a detailed network audit. Should the scheme be progressed to the next stage, we recommend a thorough review and a possible improvement of the accuracy of the public transport model in line with TfL and DfT guidance.

3.3.3 LTS-PT does not include modal transfer from car to rail: it is a public transport reassignment model. This means that the demand figures indicated here are lower than might be expected. The re-introduction of passenger services will alleviate congestion on the A406 North Circular Road, for instance, and this impact is not captured in the LTS-PT results.

3.3.4 Travellers in London may respond in a number of different ways when they are faced with the introduction of a new passenger line. To inform the feasibility study and to provide an initial indication of the demand on the re-introduced service, only the re-routing response has been assessed. This is considered to be the strongest response to the introduction of a new passenger service in London. Should the scheme be progressed to the next stage an assessment using the complete TfL's modelling toolkit (Highway and Public Transport assignment models, Demand Model) is recommended.

4 DEMAND ANALYSIS: RESULTS

4.1 INTRODUCTION

4.1.1 This chapter presents the analysis of the modelled options. A range of model outputs have been generated from the LTS-PT model runs, including:

- à Summary statistics in a tabular form produced for each scenario and for differences between relevant scenarios
- à Flow difference plots
- à Charts showing boardings and alightings and line loading for each of the options

4.2 SUMMARY STATISTICS

4.2.1 Summary statistics at a global level for each AM and PM scenario modelled, as well as the difference with the associated baseline scenario are presented in Appendix A-1.

Baseline: Standard LTS-PT 2041 Reference Case (A141rc01a)

4.2.2 The introduction of West London Orbital passenger services is forecast to result in an increase in passenger kilometres, passenger minutes and total passenger boardings on rail services (including WLO). The results for Option 1 and Option 2 are similar. However, Option 3 (8 tph rather than 4 tph) is forecast to make a more significant impact on the rail network with the changes almost double of those for Option 1 or Option 2. For example, in 2041 AM Option 1 is forecast to result in 5,556 additional rail boarders, Option 2 – 5,002 boardings and Option 3 – 12,834 boardings.

4.2.3 A reduction in passenger kilometres, passenger minutes and total passenger boardings on LUL and buses indicates that the demand for the West London Orbital services is likely to be abstracted from LUL and bus services, providing crowding relief for them.

4.2.4 The WLO is estimated to improve connectivity and provide extra capacity on the public transport network in London resulting in lower levels of distance travelled, total boardings, journey times and crowding levels, above all in the north-western and south-western quadrants of London. The impact of Option 1 and Option 2 is estimated to be very similar, with Option 3, which assumes double the number of trains on the core section, showing more profound changes. The table below provides a summary across all public transport modes in London.

Table 4-1 Summary statistics. WLO Option Scenarios versus 2041 Reference Case

MODE	PEAK	*DESCRIPTION*	*2041 TFL REF CASE*	*CHANGE IN USER BENEFITS*		
		SCENARIO	A141RC01A	OPTION 1 MINUS RC	OPTION 2 MINUS RC	OPTION 3 MINUS RC
All PT	AM	Passenger Kms	85,795,810	-25,424	-22,445	-35,614
		Uncrowded Passenger Minutes	115,348,652	-88,989	-77,060	-178,966
		Crowded Passenger Minutes	154,400,839	-241,381	-210,768	-316,253
		Passenger Boardings	6,244,762	-1,957	-2,121	-1,605
	PM	Passenger Kms	89,635,043	-21,387	-17,409	-30,172

MODE	PEAK	DESCRIPTION	2041 TFL REF CASE	CHANGE IN USER BENEFITS		
		SCENARIO	A141RC01A	OPTION 1 MINUS RC	OPTION 2 MINUS RC	OPTION 3 MINUS RC
		Uncrowded Passenger Minutes	120,021,714	-82,387	-70,612	-147,691
		Crowded Passenger Minutes	154,108,212	-219,549	-190,719	-387,404
		Passenger Boardings	6,791,486	-2,268	-2,350	-1,779

Baseline: 2041 Maximum Growth Scenario without Crossrail 2

4.2.5 When tested against the Maximum Growth Scenario, the pattern of the results is similar as for the Reference Case Scenario. However, the additional trip generation associated with the Maximum Growth Scenario means changes are greater as summarised in Table 4-2.

Table 4-2 Summary statistics. WLO Option Scenarios versus 2041 Maximum Growth Scenarios

MODE	PEAK	DESCRIPTION	2041 MAX GROWTH (MG)	CHANGE IN USER BENEFITS		
		SCENARIO		OPTION 1 MINUS MG	OPTION 2 MINUS MG	OPTION 3 MINUS MG
All PT	AM	Passenger Kms	88,152,748	-26,651	-23,275	-37,204
		Uncrowded Passenger Minutes	118,927,182	-90,796	-78,050	-155,426
		Crowded Passenger Minutes	160,705,541	-242,933	-212,086	-447,184
		Passenger Boardings	6,485,584	-2,108	-2,262	-1,831
	PM	Passenger Kms	92,436,014	-22,333	-18,018	-32,261
		Uncrowded Passenger Minutes	124,289,369	-88,546	-75,299	-155,144
		Crowded Passenger Minutes	162,352,074	-252,329	-218,843	-436,387
		Passenger Boardings	7,068,359	-2,352	-2,443	-1,971

4.3 FLOW DIFFERENCE PLOTS

4.3.1 Differences in demand on the public transport network in the AM and PM between each option and its associated baseline scenario are presented in Appendix A-2. Increases in passenger volumes are shown in red with reductions in green.

4.3.2 The introduction of West London Orbital passenger services is forecast to attract passengers from LUL lines such as the Northern, Jubilee, Central, District and Piccadilly as well as rail services currently operated by South West Trains and Great Western Railway. With the WLO passenger services operating these national rail services are likely to witness lower levels of crowding, providing overall crowding relief to a broad range of other services.

4.3.3 A connection between Old Oak (OO) Victoria Road, which is considered as part of the WLO, and Old Oak Common interchange station to enable interchange between rail services is estimated to attract additional passengers to the Elizabeth Line (Crossrail 1). The access between a stop on the WLO in Old Oak and Old Oak Common station has not yet been investigated.

4.4 LINE LOADING BY STATION

4.4.1 Line loading, station boardings and alightings are detailed in Appendix A-3. This section summarises the findings of the analysis.

Baseline: Standard LTS-PT 2041 Reference Case (A141rc01a)

- In the AM (0700-1000) Option 1 is forecast to carry 6,064 passengers, Option 2 – 5,758 passengers and Option 3 – 12,646 passengers
- In the PM (1600-1900) Option 1 is forecast to carry 6,337 passengers, Option 2 – 6,146 passengers and Option 3 – 13,437 passengers
- The demand will vary by station with OO Victoria Road being utilised the most. For example, in Option 1 in the AM 1,000 passengers are forecast to board the West London Orbital services and 2,823 to alight at the stop at Old Oak. In Option 2 these numbers are 952 and 2,479 passengers respectively and in Option 3 - 2,122 and 6,173 passengers.
- In the PM demand at Old Oak is: Option 1 - 2,036 boarders and 1,579 alighters, Option 2 – 1, 889 and 1,478, Option 3 – 4,984 and 3,346.

Baseline: 2041 Maximum Growth Scenario without Crossrail 2

- In the AM (0700-1000) Option 1 is forecast to carry 6,243 passengers, Option 2 – 5,920 passengers and Option 3 – 12,943 passengers
- In the PM (1600-1900) Option 1 is forecast to carry 6,659 passengers, Option 2 – 6,437 passengers and Option 3 – 13,992 passengers
- In the Maximum Growth Scenario WLO services are forecast to carry more passengers than in the Reference Case: on average 2.7% more in the AM and 4.6% in the PM
- The demand estimates vary by station with OO Victoria Road being utilised the most. For example, in Option 1 in the AM 1,100 passengers are forecast to board West London Orbital services and 2,772 to alight. In Option 2 these numbers are 1,045 and 2,428 respectively and in Option 3 - 2,342 and 6,022.
- In the PM OOC Victoria Road demand is: Option 1 - 2,036 boarders and 1,748 alighters, Option 2 – 1, 884 and 1,618, Option 3 – 4,936 and 3,671.

5 OPERATIONS AND INFRASTRUCTURE ANALYSIS

5.1 INTRODUCTION

5.1.1 This study has drawn on a number of studies which have been completed over the past few years, including those by TfL and Network Rail. In this chapter we seek to build upon this work.

5.2 OPERATIONAL CONSIDERATIONS AND PREVIOUS WORK

5.2.1 Several studies into these issues have been prepared before, both by WSP and by Network Rail. The principal issues identified in relation to a service between Hounslow and Old Oak Common, which represented the geographical limits of these studies, included the following:

- à Platform turnround capability at Hounslow
- à Capacity between Hounslow and Key East junction given the proposed increased use of that route by the new South Western franchise
- à The availability of Bollo Lane level crossings given the very substantial increase in use of the Kew - Acton line
- à Capacity between Acton and Old Oak, especially around Acton Wells junction
- à The need for a turnback facility at Old Oak

5.2.2 With the exception of the final point, all these issues are relevant to the operation of the proposed Dudding Hill Line service through to West Hampstead or Hendon. A turnback facility at Old Oak is not necessary if trains continue to West Hampstead or Hendon, and the cost of its construction, as well as the possible requirement to safeguard land, will be saved

5.2.3 On the section north of Old Oak, the principal requirements surround the construction of new stations at Harlesden and Neasden, and the construction of new platforms at Old Oak (linked to, but separate from, the proposed London Overground platforms), Cricklewood and West Hampstead, or if the northerly option were to be adopted, new platforms at Hendon and (as part of the planned new Thameslink station) at Brent Cross.

5.2.4 An essential further element is re-signalling. The railway north of Old Oak is currently operated on an absolute block (AB) system, which relies on manual communication between signalmen. Whilst satisfactory for a relatively limited freight service of one or a maximum of two trains per hour, it would be unreliable and inadequate for a high-performing regular passenger service. An extract from Network Rail's Operational Rules states the following:

Figure 5-1 Extract from Network Rail Operational Rules

EA 1360 DUDDING HILL JUNCTION TO ACTON WELLS JUNCTION			
TIMING POINTS INCLUDED	DOWN	UP	NOTES
Dudding Hill Junction to Acton Canal Wharf Junction	AB	AB	
Action Canal Wharf to Action Wells Junction	AB	AB	

EA 1330 SOUTH ACTON JUNCTION TO OLD & NEW KEW JUNCTIONS			
TIMING POINTS INCLUDED	DOWN	UP	NOTES
South Acton Junction to Kew East Junction	*	*	* TCB timed as AB (one train in section)
Kew East Junction to New Kew Junction	*	*	* TCB timed as AB (one train in section)
Kew East Junction to Old Kew Junction	*	*	* TCB timed as AB (one train in section)

5.2.5 In short, the signalling on both these stretches of currently freight-only line is inadequate for anything approaching the level of service being contemplated.

5.2.6 Details have been sought from Network Rail regarding the intended timescale and scope of re-signalling. There are no re-signalling schemes for the Dudding Hill section in the remainder of CP5 or CP6 (2014-19, and 2019-24 respectively). Network Rail is carrying out asset life extension works during CP6 with the potential of re-signalling in CP7 (2024-29).

5.2.7 Consistent with the demand forecasting, the service options we have assessed are as follows:

- 4 tph Hendon – Hounslow, calling at Brent Cross, Neasden, Harlesden, a stop at OO Victoria Road, Acton Central, South Acton, Brentford, Syon Lane, Isleworth, Hounslow.
- 4 tph West Hampstead – Hounslow, calling at Cricklewood, Neasden, Harlesden, a stop at OO Victoria Road, Acton Central, South Acton, Brentford, Syon Lane, Isleworth, Hounslow
- 4 tph West Hampstead – Hounslow, calling at Cricklewood, Neasden, Harlesden, a stop at OO Victoria Road, Acton Central, South Acton, Brentford, Syon Lane, Isleworth, Hounslow *and*

  4 tph Hendon – Hounslow, calling at Brent Cross, Neasden, Harlesden, a stop at OO Victoria Road, Acton Central, South Acton, Brentford, Syon Lane, Isleworth, Hounslow.

5.2.8 The operating times have been provided by TfL and are reproduced below:

Table 5-1: Proposed stations, distances and run times

STATION		DISTANCE (MILES)	TIME (MINS)
West Hampstead	D	11.68	0
Cricklewood	A		2
	D	10.48	2.5
Neasden	A		4.5
	D	8.86	5
Harlesden	A		7.5
	D	7.5	8
Old Oak Victoria Road	A		15
	D	6.71	15.5
Acton Central	A		18.5

STATION		DISTANCE (MILES)	TIME (MINS)
	D	5.5	19
South Acton	A		22
	D	4.81	22.5
Brentford	A		25.5
	D	2.85	26
Syon Lane	A		29
	D	2.08	29.5
Isleworth	A		36.5
	D	1.38	37
Hounslow	A	0	39

5.2.9 We believe that it will be beneficial to increase the linespeed on the Hendon line (freight-only lines on the west side of the Midland Main Line) to permit a higher operating speed on the section from the end of the Dudding Hill line to either or both of Hendon or West Hampstead. At this stage of the assessment, however, we have not assumed this upgrade.

5.3 FURTHER OPTIONS CONSIDERED

OPERATION OF TRAINS TO THE CHILTERN LINE AT NEASDEN JUNCTION

5.3.1 This option has been suggested as a potential spur off the Dudding Hill Line, with trains operating from West Hampstead to Wembley, via a new link line at Neasden, then reversing on to an existing spur, and continuing their journey towards Hounslow. This option would require the construction of new infrastructure, with its associated significant cost, and introduce complexities for operating a regular high-performing service on to and off the Chiltern lines. There is very little capacity on what has become Chiltern's main line from London to Birmingham, which operates via Wembley. We believe connections between Neasden Jubilee line station and the new Dudding Hill Line station will provide a very good interchange and is the best way to address onward orbital journeys from locations on the Chiltern line to Amersham and Aylesbury. This option has not been assessed for its likely levels of demand because of these severe infrastructure and operational issues, and it has therefore not been developed further for this study.

CROSSRAIL TO TRING

5.3.2 In the past it has been proposed that some Crossrail trains operate to and from Tring. One option for the link between Old Oak Common station and the West Coast Main Line is the use of the Dudding Hill Line. Should the line be used for this purpose in the future, it would be incompatible with the proposal to operate a service from Hounslow to West Hampstead/Hendon without very substantial enhancement work.

5.3.3 It is understood, though, that no more work is to be undertaken for the foreseeable future on options to extend Crossrail services to and from the West Coast Main Line.

PROVISION OF LINK FROM RUISLIP TO OLD OAK COMMON

5.3.4 The DfT is investigating the possibility of making greater use of the railway which currently runs from Ruislip to London, as a means to relieve capacity constraints at Marylebone station. The intention is that trains may in future run from High Wycombe, Princes Risborough and Banbury to two new platforms at Old Oak Common station, where passengers would transfer to Crossrail for

their onward journey to different parts of London. One benefit of this proposal is to avoid a very costly and disruptive expansion of Marylebone, which would otherwise be necessary in light of continuing growth on the Chiltern lines.

5.3.5 The West London Orbital proposal does not conflict with this scheme.

5.4 INFRASTRUCTURE REQUIREMENTS

NEW STATIONS – NEASDEN, HARLESDEN

5.4.1 At a minimum, new stations would need to be provided at Neasden and Harlesden as they are integral to the re-opening of the northern stretch of line from Old Oak to West Hampstead/Hendon.

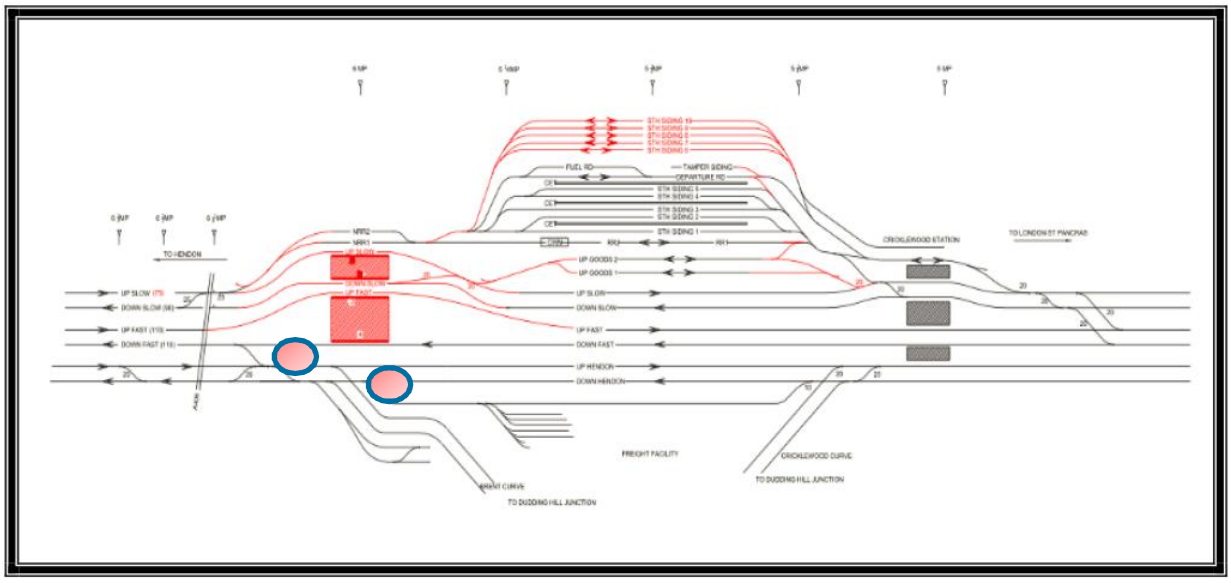
5.4.2 We have reviewed the costs provided by TfL for these stations and believe them to be appropriate. We do believe however, that possession costs could be lessened by combining works: for instance if the line was closed for a period of time, the new stations/platforms were installed at all the relevant locations, and the new signalling (see next point) installed, the cost would be for one possession, not several.

5.4.3 We believe that the costs of Neasden and Harlesden stations, both with 2 x 4-car platforms and associated facilities, will be in the order of £12m (spot cost).

NEW STATION – BRENT CROSS

5.4.4 A new station for Thameslink services is to be provided at Brent Cross. This station is not required for passenger services to operate on the Dudding Hill Line. However, by serving Brent Cross, WLO services would provide valuable access to the new development, and enhance the business case for the scheme. A phased approach for WLO could be considered with trains operating between West Hampstead and Hounslow initially and therefore not operating to Brent Cross.

Figure 5-2 Diagram of proposed stations in the Brent Cross area



5.4.5 The figure above illustrates the Thameslink station location on the Midland Main Line. The Dudding Hill Lines are towards the bottom of the figure, and form the triangular junction. Two possible locations are indicated for platforms for the WLO service: both appear feasible at this

very early stage of development. The northern site may involve the need (and the cost) to purchase land. However, in both instances the platforms would be some distance away from those to be built to serve the Thameslink lines, and a lengthy footbridge would most probably need to be provided. The topology of the area and the railway junctions precludes providing platforms further south.

5.4.6 We have included a cost of £5m (spot cost) for the platforms in this location.

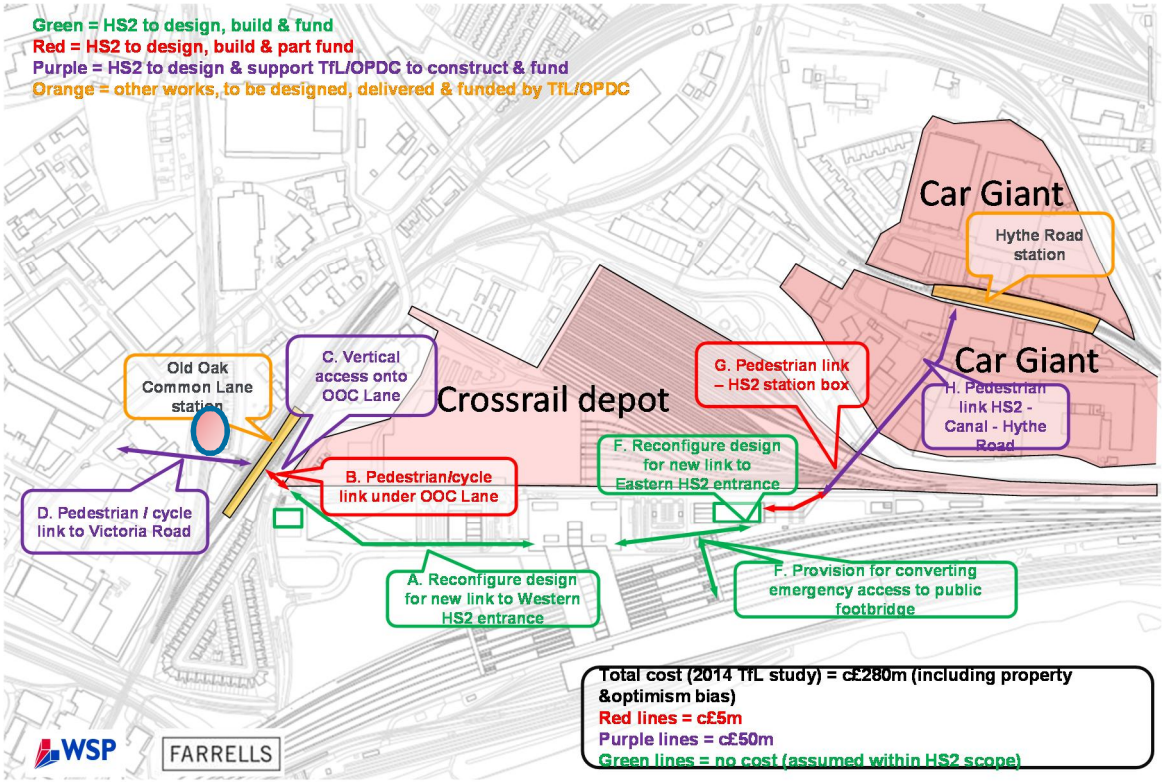
NEW PLATFORMS – WEST HAMPSTEAD, HENDON, CRICKLEWOOD, OLD OAK VICTORIA ROAD

5.4.7 New platforms will be needed at each of these stations. Consistent with the TfL analysis, two new platforms need to be provided at Cricklewood. New platforms would be required to facilitate a stop at Old Oak, the form of which still needs to be investigated). One possibility is that it would be linked to, but slightly separate from, the proposed Old Oak Common Lane London Overground station on the North London Line. We believe however, that West Hampstead and Hendon only require one new platform at each, based on a maximum of 4 trains per hour turning back at each. At both stations, the existing platform 4 would need to be converted to an island platform, with the removal of fencing and some limited construction work. This should lead to a substantial reduction in estimated costs, and we believe that £1m at each of Hendon and West Hampstead is the appropriate sum. It should be noted that no changes to the junction layout will be necessary at either Hendon or West Hampstead to permit the operation of trains into and out of the single platform at each location.

5.4.8 At Cricklewood, two new platforms will be needed, for by this stage of their journey, the trains will be operating on the correct line for their direction of travel. The platforms would be provided on the freight lines on the west of the railway. In TfL's analysis, it was assumed that the entire station would need to be made step-free, involving the provision of lifts to all platforms. West Hampstead, 2 minutes south of Cricklewood, was, within the last decade, made fully step-free after the installation of lifts and a new footbridge. We have included the full cost of step-free provision as the construction of two new platforms is clearly a material change to the station, but feel that at a later stage of work, it may be considered satisfactory for West Hampstead to be the recommended option for people needing lifts to access the platforms.

5.4.9 Two platforms will need to be constructed at the southern end of the Dudding Hill Line in the vicinity of Old Oak, on Victoria Road (at approximately the location marked with an oval on the figure below). It would clearly be of value if this station and the proposed North London Line station – situated directly next to it - were to be planned and marketed as one, with appropriate walkways, footbridge and signage. We have adopted TfL's cost estimate for this station, but in line with our recommendations about the possession costs noted above, believe that one possession should be implemented for all the station construction works and re-signalling, in the interest of cost efficiency. We have included a cost of £14m (spot cost) for the platforms at these locations.

Figure 5-3 Diagram of proposed stations in the Old Oak Common area



HOUNSLOW, KEW BRIDGE AND LIONEL ROAD

5.4.10 The South Western franchise service on the Hounslow loop is changing as a result of the DfT's specification for the new franchise. It is expected that 8 trains per hour will operate; 4 West London Orbital trains can be accommodated provided that a turnback facility at Hounslow is provided along with the doubling of the Kew East junction.

5.4.11 Any West London Orbital service in excess of 4 trains per hour will not be able to operate to Hounslow, and we are assuming under this circumstance that any service above 4 tph will turn round at Kew Bridge or Lionel Road. Infrastructure modifications to the track and signalling will be necessary to permit this, and the disused platforms at Kew Bridge would need rebuilding.

5.4.12 Hounslow: plans were developed to serve South West Trains services. This involved the construction of a reversing siding to the west of the station. This scheme has been postponed for the foreseeable future. We believe that the alternative scheme of a new turnback platform would serve the role better, and deliver better punctuality. It would avoid any delays caused by the driver needing to check the trains for any left-behind passengers and would avoid frequent shunting moves. One platform would be adequate for 4 trains per hour. The necessary pointwork is in place to provide access to the new platform, which would be provided on the south side of the layout - a platform 3. We do not believe that there is any cost-effective way of running more than 4 trains per hour beyond Old Kew Junction and so, if the full service of 8 trains per hour is to operate, an alternative location needs to be found to turn the other 4 trains. We have included a cost of £5.4m (spot cost) for the construction of a new bay platform at Hounslow.

5.4.13 Kew Bridge/Lionel Road: if the option of 8 trains per hour is adopted, no more than four will be able to run all the way to Hounslow, and Network Rail has confirmed this in its own analysis. The reinstatement of the platforms on the Kew east spur, at Kew Bridge would provide one solution.

Another solution is for Lionel Road to be equipped with a turnback facility, probably an extra side platform. The use of the platforms at Kew Bridge will provide easy interchange with trains operated by the South Western franchise to Barnes, Clapham Junction and Hounslow. In addition, some signalling and trackwork will be necessary to allow reversal of trains at this location. We have allowed a total of £4m for the works at this station. We believe this cost will also be appropriate should enhanced facilities need to be provided at Lionel Road to allow the turn back of trains, as an alternative to Kew Bridge.

RE-SIGNALLING

5.4.14 We have assumed a figure of £8m (spot cost) for re-signalling the line between Cricklewood/ Hendon and Old Oak, and for Acton – Kew, to modern 3-minute headway colour light signalling. This is essential if the service pattern is to be 4 or 8 trains per hour in each direction, in addition to the freight traffic that uses the route.

5.4.15 The current signalling is on the 'absolute block' principle, involving manual communication between signalmen, and is inadequate for a railway with the proposed type of frequency and requirement for good punctuality.

5.4.16 While Network Rail is proposing re-signalling in CP7 (2024-29), so consistent with our assumption on the possible re-opening of the route, it would normally replace the signalling with 'modern equivalent form', in other words not adding any capacity to the route. The cost we have indicated is an estimate for the work for like-for-like re-signalling.

5.4.17 By the point of delivery, it may be that the Digital Railway concept will have been established nationally, and/or the North London Line will have been equipped with Automatic Train Operation equipment, which could easily be applied to the Dudding Hill Line as well. This would represent a step-change in capability and automate the process.

FOUR-TRACKING AROUND ACTON WELLS

5.4.18 Acton Wells Junction, being the most heavily-used junction on the East Anglia route, is confirmed to be a significant challenge for this project. Our construction team has direct experience with this area and with the previous, low-level enhancement of the two bridges at Acton Wells, which cost an order of magnitude of £10m. Quadrupling Acton Wells Junction, which includes new bridges and the likely addition of electrification, would be significantly more complicated than the previous works.

5.4.19 Just south of the proposed Old Oak Common Lane London Overground station, the North London Line, by this point joined with the Dudding Hill Line, crosses the Central Line and the single track national rail route from Ruislip to London. Just south of this bridge is the junction used by freight trains running on to the Great Western Main Line at Acton. There is a section of about 350 metres which is two-track, and this acts as a significant bottleneck on the route today. Eight extra trains per hour (and almost certainly not even four) could not operate without a substantial upgrade of capacity.

5.4.20 For our study, we are including the cost of 4-tracking this section of route (marked in red on the figure below). Much of it will be an additional bridge, with some impact on light industrial land. We appreciate the impact to the local residents of further disruption on top of HS2 related works, and there are ways in which this disruption could be mitigated, such as the co-ordination of major activities.

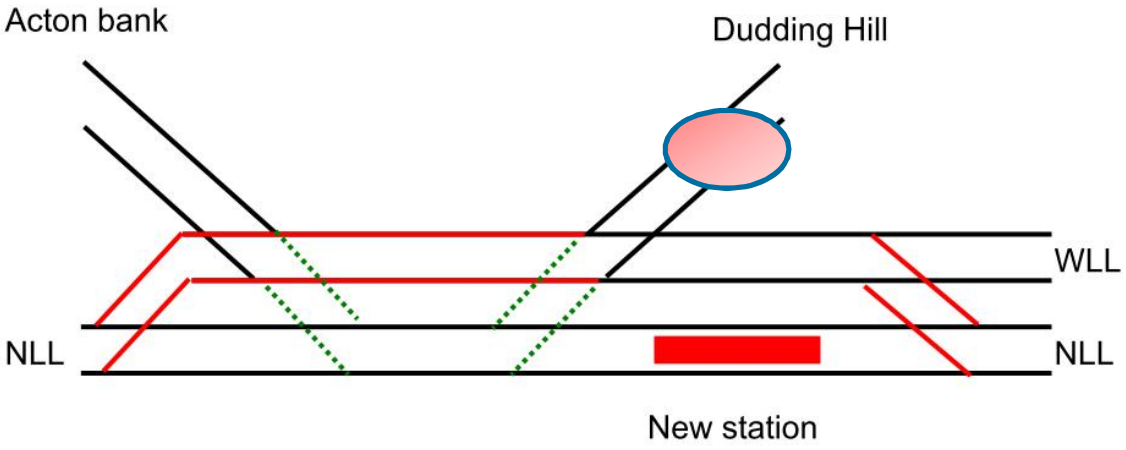
5.4.21 We believe that this proposed infrastructure would provide the capacity to support the current North London Line service of 5 tph, the proposed West London Orbital service of 8 tph and up to 11 other trains per hour (which we assume would be freight). Some of this freight traffic operates to and from Acton and the Great Western Main Line, whilst other freight trains head south along the North London Line. Our analysis does not take into account other constraints on the North

London Line or elsewhere, and a longer-term timetable plan for the North London, West London and West London Orbital routes would need to incorporate assumptions on all these routes, as well as plans for freight routing through and around London in the medium term.

Figure 5-4 Diagram of proposed four-tracking in the Acton Wells area

5.4.22 The proposed infrastructure is appropriate for the proposals at this time, however over the coming decade as both passenger and freight services evolve, the scope of infrastructure capacity enhancements should be kept under review. In the diagram below, it is assumed that there are 5 passenger trains per hour in each direction on the lower pair of tracks and 8 on the upper pair. The majority of freight traffic (an average of 3 trains per hour) will go on the upper pair of tracks and then head towards Acton, with 1 train per hour on the lower pair of tracks. The remaining two-track section to South Acton, and the junction in particular, will remain a capacity constraint, but with a notional capacity of 20+ trains per hour, it should be able to accommodate 14 in each direction.

Figure 5-5: Diagram of proposed track layout in the Acton Wells area



5.4.23 Acton Wells Junction was recently renewed in Christmas 2015. The entire track system was replaced and local upgrades were made to the signalling and overhead line. The proposed layout will require a new underbridge that spans the Wycombe single and the Central line. The Central line is now designated as a night tube route and possessions are very scarce. The site around Acton Wells has a high level of contamination from Japanese Knotweed, which requires specialist handling, clearance, and ongoing management.

5.4.24 The bridge construction will be very challenging and will require temporary land take of the surrounding commercial properties. The existing under bridges, which cross the Wycombe single and the Central line have had recent repair, but are classified as being in “poor condition” by Network Rail. Consideration should be given to replacing these bridges at the same time as the other works are undertaken; economies of scale might be achieved with possessions and infrastructure costs if this is accomplished as a joined-up programme with Network Rail.

5.4.25 There are a number of HV routes that run adjacent to and below the tracks that will potentially need to be relocated. It is also likely that the overhead line electrification would need to be moved or duplicated on the new tracks in Acton Wells junction, as it would allow more effective capacity planning for the electric rolling stock services.

5.4.26 Possessions on this route are extremely rare and are limited to Christmas and six hour Saturday night closures. Access for machines and personnel is through either the Ikea car park on the Dudding Hill Lines or through the redundant EWS shed off of Old Oak Common Lane.

5.4.27 Upgrading and quadrupling of Acton Wells will be very challenging, but enhancing the capacity of Acton Wells will allow segregation of the many competing services in the area, with significant capacity increases, and would most likely be very popular with all of the railway stakeholders, including freight companies and Network Rail. This may attract pooled capital investment contributions. A more detailed scoping analysis of electrification, HV relocation, track layout, and access planning will be needed to better inform cost estimates. However, a high level estimate for capital and possession costs is £45m (spot cost).

DOUBLING KEW EAST CURVE AND POTENTIAL GRADE SEPARATION

5.4.28 Network Rail has undertaken timetable analysis for the route from Hounslow to Old Oak Common. The analysis assumed the doubling of Old Kew junction, as that location was deemed to be the most tightly constrained of the entire route.

5.4.29 The doubling of the junction is a relatively straightforward construction activity. However, there

would be some significant enabling works to be carried out such as the relocation of location cases, troughing routes and power supplies. It is anticipated that no additional land would be required as the limit of development would be within the limits of deviation for Network Rail. A bank holiday weekend would provide a sufficient duration to install and commission the double junction. We estimate a figure of £4.6m (spot cost) for doubling the junction.

5.4.30 If the junction was to be grade separated with a single line viaduct, it will need to be approximately 400m based on a 1:30 gradient in length and will more than likely extend beyond the Network Rail boundary. The capital cost of such a flyover, with ballasted rail and turnouts, would be of the order of £8.5m (in addition to the above cost). To reduce the impact on the operational railway, offline construction will need to be considered, which may result in further acquisition of land. The duration of construction will depend upon possession and land availability, but would be approximately 18 – 24 months.

5.4.31 There would be the opportunity to integrate required possessions with the Hounslow works and potentially the Bollo Lane works (described below).

BOLLO LANE LEVEL CROSSINGS

5.4.32 There are two level crossings just south of South Acton station, one on the North London Line and one on the line from South Acton to Kew, collectively termed the Bollo Lane level crossings. The operation of a much more intensive service on the latter of these routes will lead to greatly increased level crossing down time, with all the disruption that that causes to local traffic, as well as increased safety concerns.

5.4.33 Given the close proximity with the level crossing on the North London Line, and the fact that there are some small industrial units between the two crossings, it is not feasible to only seek to replace the level crossing affected by the proposed introduction of passenger services on the Dudding Hill Line. However, closure of the Bollo Lane level crossings will present significant challenges as there are not clearly viable infrastructure solutions.

5.4.34 Elevating the railway over the road will be expensive and create significant disruption to the railway and local environment. It would likely require the purchase of some properties. Placing the railway beneath the existing road appears feasible, but again will be very disruptive to the railway as a considerable amount of closures will be required to carry out the work.

5.4.35 The most affordable solution would be to permanently close the two level crossings and provide bridges to maintain access and permeability for pedestrians and cyclists, with associated re-planning. Highway traffic would have to be re-routed and the surrounding network upgraded to accommodate additional traffic. Such proposals may be unacceptable to local stakeholders.

5.4.36 Further investigation and work will be required before a more detailed scope can be determined, which would include consideration of the traffic impacts of closure, volumes of HGVs using alternative routes (and what these routes are) and, of course, the cost impacts.

5.4.37 For the purposes of this study we have included a figure of £30m to provide a solution, but at this stage it has not been defined. Such a solution would permit the West London Orbital trains to operate, but also provide a wide range of other benefits for the local road network and local communities, by removing the severance and safety issues of interfacing with the rail network.

CHURCHFIELD ROAD CROSSING (ACTON)

5.4.38 There is a level crossing just north of Acton Central station which will see significantly increased downtime following the introduction of the West London Orbital services. Subject to modelling/local consultation, closure could be considered, and we have assumed a cost of £5m representing an estimated cost for a footbridge with ramps.

ELECTRIFICATION, ROLLING STOCK CHOICES, DEPOTS AND STABLING

5.4.39 At this stage we are assuming that the railway will be operated by diesel traction, or possibly battery or hybrid traction. While the Kew – Acton and Dudding Hill Line sections are not electrified, all the rest of the line is and battery technology may have developed sufficiently by the time of opening to be a viable option. Therefore, potential subsequent phases of the enhancement plans could electrify the non-electrified sections.

5.4.40 Depot and stabling facilities need to be provided, regardless of the choice of rolling stock. We recommend use of the facilities at Cricklewood for stabling, either in the triangle between the north- and south-facing Dudding Hill curves, or on the other side of the Midland Main Line. At present there is sufficient capacity for a small fleet of 4-car multiple units; this may have changed by the time of implementation, but should be included in ongoing plans for the development of the site. Fuelling, cleaning and minor maintenance could be undertaken here. An alternative location could be the south west sidings at Willesden, which see very little use.

5.4.41 Depot facilities are harder to identify for diesel rolling stock in the London area. There are very clearly cost efficiencies in sub-contracting the maintenance to a depot which is already there (and preferably currently services diesel trains), rather than a depot solely for the small fleet of trains necessary for this new service. Options include:

- à Wembley depot, which is used by Chiltern for its entire fleet of rolling stock. It is a small depot, but is closest to the route.
- à Reading depot, which will retain a small fleet of diesel rolling stock for the non-electrified routes in the Thames Valley operated by GWR. There would probably be capacity at Reading depot, but it would require operation of empty coaching stock trains to and from Reading (approximately 34 miles from Acton) on a regular basis.
- à Salisbury depot, which is known to be capacity constrained and a considerable distance from the route. The depot current maintains SWT's fleet of class 158/9s, which operate from Waterloo to Exeter.
- à Selhurst depot, which would create a complex journey, albeit not too lengthy, for units to travel to this depot. It currently services class 171s operated by GTR, and deployed on the Uckfield and Brighton – Ashford services. The depot probably has capacity.
- à Willesden depot, where the diesel facilities are to be withdrawn after the electrification of the Gospel Oak – Barking route, but there may be scope to reinstate them at a modest cost.

5.4.42 At this stage it would be inappropriate to be definitive about the choice of depot as matters will evolve between now and the implementation date. For the purposes of the study we have included a capital cost of £5m for the provision of capital equipment for diesel rolling stock at a location, and access charges would need to be paid on an ongoing basis to the operator of the depot.

5.5 PROPOSED INFRASTRUCTURE ENHANCEMENT COSTS

5.5.1 The table below provides a summary of the estimated capital costs associated with the proposed new service.

Table 5-2 Infrastructure Capital Cost Estimates

ITEM	SPOT COST PROPOSED	COMMENTS
West Hampstead 2 new platforms (4-car)	£1m	If conventional rolling stock is used, only one platform needed, as an extension of current platform 4.
Cricklewood 2 new platforms (4-car)	£5.5m	Extend subway to new platform or add AFA lift and footbridge; cost estimate is based on step-free access to the newly built platform, will be similar in either case.
Hendon 2 new platforms (4-car)	£1m	Only one platform needed, as an extension of current platform 4.
Brent Cross	£5m	£5m increment on new station to be provided for Thameslink on the Midland Main Lines.
Neasden new station (4-car)	£18m	We agree with the construction costs provided by TfL, but by taking the possessions at the same time, we believe a cost saving of £800,000 can be made.
Harlesden new station (4-car)		
OO Victoria road new platforms (4-car)		
Re-signalling of Dudding Hill line and Acton - Kew	£8m	Efficiencies could be found if re-signalling is combined with other possessions for the stations, but signalling project costs are often underestimated. Cost of data exchange and expanded Kew Bridge East scope added as minimum.
Quadrupling of Acton Wells Junction area	£45m	The required scope would be larger than considered in the initial report, due to anticipated renewals of existing bridges, site complications, and new electrification needed.
Bollo Lane level crossing replacement	£30m	Significant further work will be necessary to determine the scope of this.
Acton level crossing	£5m	Removal, and replacement with a footbridge.
Kew Bridge or Lionel Road turnback	£4m for each	Turnback facilities and refettling work necessary for turnback of 4tph (in addition to Hounslow).
Old Kew Junction doubling	£4.6m	In line with TfL report.
Old Kew Junction flyover	£8.5m	400m single track viaduct, ballasted track, and turnouts.
Hounslow bay platform	£5.4m	Bay platform to turn back 4 tph.
Depot facilities	£5m	Capital cost of necessary equipment.
Total	**£146m**	**Excludes risk/contingency and optimism bias.**

5.5.2 Given the early stage in the development of the scheme and the uncertainties and challenges described above, in line with guidance we have included a risk/contingency allowance of 80%. This produces a total capital cost of £263m.

6 PREFERRED OPTION

6.1 INTRODUCTION

6.1.1 Based on the demand forecasting and analysis of operational and infrastructure requirements for the three options described in Chapter 3, conclusions were drawn to inform the specification of the preferred option to be assessed. The conclusions were:

- à Option 3 (4 tph West Hampstead – Hounslow and 4 tph Hendon – Hounslow) attracts a higher level of demand and therefore higher total benefits (reduced passenger distance and passenger minutes) when compared with Option 1 (4 tph Hendon – Hounslow) and Option 2 (4 tph West Hampstead – Hounslow).
- à Old Oak is central to the demand profile on the route, and it appears feasible to construct a station on the Dudding Hill lines at Brent Cross.
- à With appropriate enhancements to the railway, the assumed level of service can be accommodated, but providing in excess of 4 trains per hour to Hounslow, on top of the South West Trains service, is deemed prohibitively expensive.
- à The preferred option should seek to deliver the benefits of option 3 (or as much of them as possible) for the most economical level of capital costs, e.g. a turnback at Kew Bridge and potentially with a phased introduction.

6.1.2 Based on these conclusions a preferred scenario has been developed and agreed with the client group. The preferred option is specified as:

- à Phase 1 – 4 trains per hour from West Hampstead to Hounslow.
- à Phase 2 – additional 4 trains per hour from Hendon to Kew Bridge.

6.1.3 The run times are the same as assumed in the initial demand modelling for Options 1 to 3.

6.2 DEMAND MODELLING

6.2.1 The LTS-PT model has been used to undertake demand and benefit forecasting for the preferred option, consistent with the initial options modelling. A range of model outputs have been generated, including summary statistics, flow difference plots, new services line loading, boardings and alightings.

SUMMARY STATISTICS

6.2.2 Summary statistics at a global level for each AM and PM scenario modelled, as well as the difference with the associated baseline scenario are presented in Appendix B-1.

Baseline: Standard LTS-PT 2041 Reference Case (A141rc01a)

6.2.3 The introduction of West London Orbital passenger services is forecast to result in an increase in passenger kilometres, passenger minutes and total passenger boardings on rail services (including WLO) of 9,374 in the AM and 9,327 in the PM. A reduction in passenger kilometres, passenger minutes and total passenger boardings on LUL and buses indicates that the demand for the West London Orbital services is likely to be abstracted from LUL and bus services, providing crowding relief for them.

6.2.4 The WLO is estimated to improve connectivity and provide extra capacity on the public transport network in London resulting in lower levels of distance travelled, total boardings, journey times and crowding levels, above all in the north-western and south-western quadrants of London. The table below provides a summary across all public transport modes in London.

Table 6-1 Summary statistics. WLO Preferred Option versus 2041 Reference Case

MODE	PEAK	DESCRIPTION	2041 TFL REF CASE	CHANGE IN USER BENEFITS
		Scenario	A141rc01a	Preferred Option minus RC
All PT	AM	Passenger Kms	85,795,810	-33,096
		Uncrowded Passenger Minutes	115,348,652	-140,143
		Crowded Passenger Minutes	154,400,839	-317,792
		Passenger Boardings	6,244,762	-1,827
	PM	Passenger Kms	89,635,043	-26,986
		Uncrowded Passenger Minutes	120,021,714	-119,500
		Crowded Passenger Minutes	154,108,212	-308,646
		Passenger Boardings	6,791,486	-1,913

Baseline: 2041 Maximum Growth Scenario without Crossrail 2

6.2.5 When tested against the Maximum Growth Scenario, the pattern of the results is similar as for the Reference Case Scenario. However, the additional trip generation associated with the Maximum Growth Scenario means changes are greater as summarised in Table 6-2.

Table 6-2 Summary statistics. WLO Option Scenarios versus 2041 Maximum Growth Scenarios

MODE	PEAK	DESCRIPTION	2041 MAX GROWTH (MG)	CHANGE IN USER BENEFITS
		Scenario	A141rc01a	Preferred Option minus MG
All PT	AM	Passenger Kms	88,152,748	-34,613
		Uncrowded Passenger Minutes	118,927,182	-129,397
		Crowded Passenger Minutes	160,705,541	-370,356
		Passenger Boardings	6,485,584	-2,010
	PM	Passenger Kms	92,436,014	-28,444

	Uncrowded Passenger Minutes	124,289,369	-126,955
	Crowded Passenger Minutes	162,352,074	-351,499
	Passenger Boardings	7,068,359	-2,028

FLOW DIFFERENCE PLOTS

6.2.6 Differences in demand on the public transport network in the AM and PM between each option and its associated baseline scenario are presented in Appendix B-2. Increases in passenger volumes are shown in red and reductions in green.

6.2.7 The introduction of West London Orbital passenger services is forecast to attract passengers from LUL lines such as the Northern, Jubilee, Central, District and Piccadilly as well as rail services currently operated by South West Trains and Great Western Railway. With the WLO passenger services operating these national rail services are likely to witness lower levels of crowding, providing overall crowding relief to a broad range of other services.

6.2.8 A direct connection between Old Oak (OO) Victoria Road station, which is considered as part of the WLO, and the main Old Oak Common station is estimated to attract additional passengers to the Elizabeth Line (Crossrail 1). However, the number of passengers transferring at OOC between the WLO services and the Elizabeth Line drops by around 25% in comparison with Option 3 as the WLO Hounslow-Hendon service gets truncated to Kew Bridge providing less frequent connection to/from Hounslow.

LINE LOADING BY STATION

6.2.9 Line loading, station boardings and alightings are detailed in Appendix B-3. This section summarises the findings of the analysis.

Baseline: Standard LTS-PT 2041 Reference Case (A141rc01a)

- à The WLO services are forecast to carry 9,504 passengers In the AM (0700-1000) and 10,165 passengers in the PM (1600-1900).
- à The demand will vary by station with OO Victoria Road being utilised the most. For example, in the AM 1,537 passengers are forecast to board the West London Orbital services and 4,660 to alight. In the PM these numbers are 3,917 and 2,428 passengers respectively. The majority of these passengers are those interchanging from/to the Elizabeth Line (Crossrail 1).

Baseline: 2041 Maximum Growth Scenario without Crossrail 2

- à The WLO services are forecast to carry 9,758 passengers In the AM (0700-1000) and 10,623 passengers in the PM (1600-1900).
- à In the Maximum Growth Scenario WLO services are forecast to carry more passengers than in the Reference Case: on average 2.7% more in the AM and 4.5% in the PM.
- à The demand will vary by station with OO Victoria Road being utilised the most. For example, in the AM 1,682 passengers are forecast to board the WLO services and 4,593 to alight. In the PM these numbers are 3,916 and 2,669 passengers respectively. The majority of these passengers are those interchanging from/to the Elizabeth Line (Crossrail 1).

7 ASSESSMENT OF PREFERRED OPTION

7.1 INTRODUCTION

7.1.1 A preliminary assessment to support a decision on whether or not to proceed with the development of the scheme has been undertaken drawing upon the outputs of the demand forecasting and capital cost estimates, supported by further analysis.

7.2 ECONOMIC APPRAISAL

7.2.1 The economic appraisal has been undertaken in line with DfT guidance (WebTAG). The forecast benefits (both uncrowded and crowded time in minutes) for all public transport users have been converted into monetary values based upon WebTAG's values of time for rail users in work time and for commuting and other journey purposes.

7.2.2 The forecast benefits have been profiled over a 60-year appraisal period from 2026 to 2085. The profiling captures:

- à Value of time growth (from WebTAG)
- à Background demand growth to 2041 (from LTS-PT model)
- à Build-up factor of 50% in years 2026-2028 prior to introduction of 8 tph services from 2029
- à Discounting at 3.5% for next 30 years and then at 3%

7.2.3 Substantial benefits are forecast to arise from the journey time improvements provided by the new service, notably by accessing the Elizabeth Line at OO Victoria Road and for journeys within the corridor which cannot currently be made directly (with travel time savings of up to 20 to 30 minutes). In total the preliminary value of the travel time benefits for the appraisal period exceed £680m PV (2010 prices) for both the Reference Case and Max Growth Scenario.

7.2.4 In addition, very significant benefits are forecast to be experienced not only by those using the WLO rail service, but by those experiencing less crowded travel conditions on other routes on the rail network. In total the preliminary value of the crowding relief benefits for the appraisal period exceed £600m PV (2010 prices) for the Max Growth Scenario and approach £500m PV (2010 prices) for the Reference Case.

7.2.5 Set against these social benefits (i.e. economic welfare rather than financial) are the costs of the scheme, both capital and operating. The capital costs have been described in Chapter 5 with a total cost including 80% risk identified as £263m. In line with appraisal practice, an optimism bias uplift reflecting the early stage of scheme development has been applied for the assessment. It is assumed that there will be real growth inflation on this current year estimate of 1% per annum until scheme opening. This produces a discounted capital cost estimate for the appraisal of £259m PV (2010 prices).

7.2.6 Forecast operating costs have been estimated on the basis of consistency with standard industry assumptions. They are estimated to be (in current prices):

- à £8.611m p.a. for Phase 1 from 2026
- à £15.247m p.a. for the full service from 2029

7.2.7 As with the capital costs, real growth inflation (1% p.a. in line with revenue) has been assumed. Over the life of the appraisal period the total operating cost is estimated to be £337m PV (2010

prices).

7.2.8 For the purposes of this preliminary economic appraisal, and reflecting the results from LTS-PT being based on trip reassignment and hence largely redistribution of revenue, we have not included revenue in the appraisal as the net effect on the overall case will be negligible. However, as discussed below, we have forecast estimated revenue for the WLO rail services in order to inform consideration of the anticipated operating position.

7.2.9 The resulting indicative benefit to cost ratio (BCR) for the preferred WLO option is greater than 2:1, meeting the DfT's high value for money category. This strong BCR reflects the significant forecast benefits of the scheme to the wider economy and society through journey time savings and crowding benefits, and their realisation through better utilisation of existing infrastructure with selective capital investment, e.g. new platforms and four-tracking. Further analysis will be needed to refine this BCR.

Table 7-1 Summary of Economic Appraisal Results: Max Growth Scenario

ITEM	60 YEAR PV 2010
Journey time benefits	£684m
Crowding benefits	£614m
Total Social Benefits	**£1,298m**
Capital costs	£259m
Operating costs	£337m
Revenue	Assumed neutral at public transport network level
Net Financial Effect	**£596m**
Net Present Value	**£703m**
Benefit:Cost Ratio	**2.2:1**
	For the Reference Case the BCR is 2.0:1

7.3 OPERATING POSITION

7.3.1 For the purposes of this study it has been assumed that the WLO rail service would be operated as a London Overground concession. Indicative revenue has been estimated on the basis of assuming that all additional rail boarders forecast in LTS-PT provide a yield of £1 for WLO rail services recognising that many trips are likely to be 'discounted' due to the use of travelcards, season tickets, capped fares etc. and as legs of multi-legged journeys. This produces an estimated revenue when the 8 tph service has commenced operation of around £9m (in current prices). This compares to an operating cost estimate of around £15m.

7.3.2 The requirement for an operating subsidy is standard for much of the rail network, but further consideration of means to meet the 'gap' between the forecast revenue and operating cost will need to be considered in order to confirm the affordability of WLO rail service operations. This consideration should address:

- à Future TfL fares' policy for orbital travel (e.g. premium fares) which is often lower than for equivalent radial journeys because they can be made without crossing fare boundaries
- à Potential re-zoning of the London transport network, e.g. zoning Old Oak Common as Zone 1
- à Opportunities to harness future technology for ticketing and fares to most effectively manage demand across the network and price fares appropriately
- à Additional fare revenue received from demand transferring from road to rail, but not captured in the current demand forecasting (which is solely reassignment)

7.4 WIDER BENEFITS

ACCESSIBILITY

7.4.1 Through the provision of new direct high quality public transport links and integration with the wider national rail network and LUL network, the introduction of WLO rail services will deliver a step change in accessibility to and from the corridor between Hounslow and West Hampstead/Hendon.

7.4.2 Figures 7-1 and 7-2 illustrate the extent of the catchments for the new stations by time band in the 'with' and 'without' scenarios for WLO rail services. As can be seen, the introduction of WLO rail services significantly increases the areas accessible within 'reasonable' travel times (e.g. within 20 and 30 minutes) of these currently under-served locations.

7.4.3 Figure 7-3 shows the walk-in catchment for each of the stations served by the proposed services. It also presents the PTAL score for each station location in the absence of the scheme. The majority of the stations are scored as 3 or 4. (It should be noted that the baseline does not fully capture the large scale development around Old Oak Common, due to the forecast year available. It is therefore anticipated that the eventual baseline PTAL for the Old Oak (Victoria Road) will be considerably higher than shown in this analysis.

7.4.4 PTAL is a standardised measure used by TfL, which combines information about the proximity of public transport services and the morning peak frequencies. The PTAL scores have been produced from WebCAT PTAL output, which takes the closest point to the station. As this can be up to 100m from the platforms or station entrance, a manual adjustment was made. Figure 7-4 shows the effect on the PTAL score of introducing the scheme.

Figure 7-1 Accessibility in without WLO rail services scenario

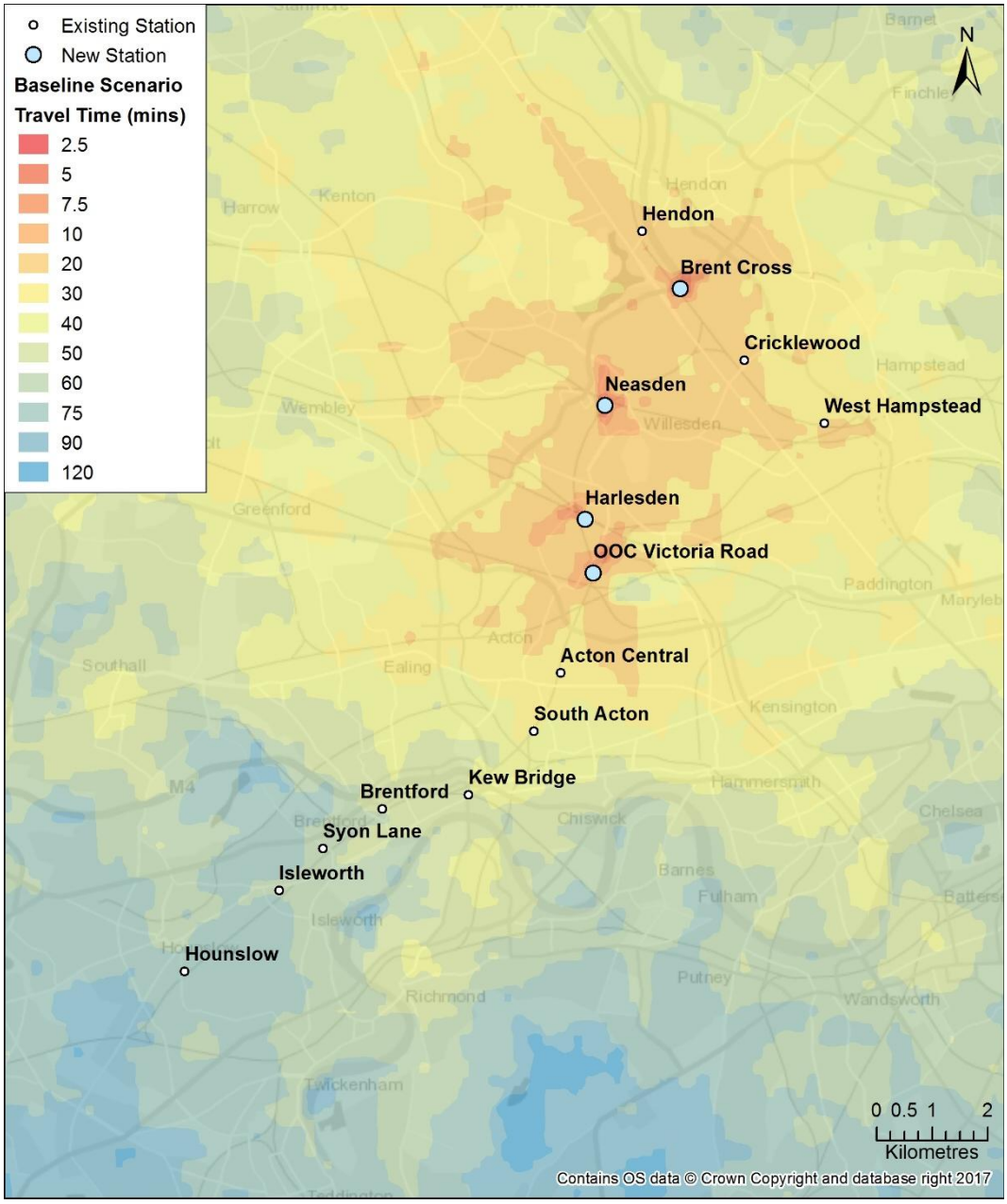


Figure 7-2 Accessibility in with WLO rail services scenario

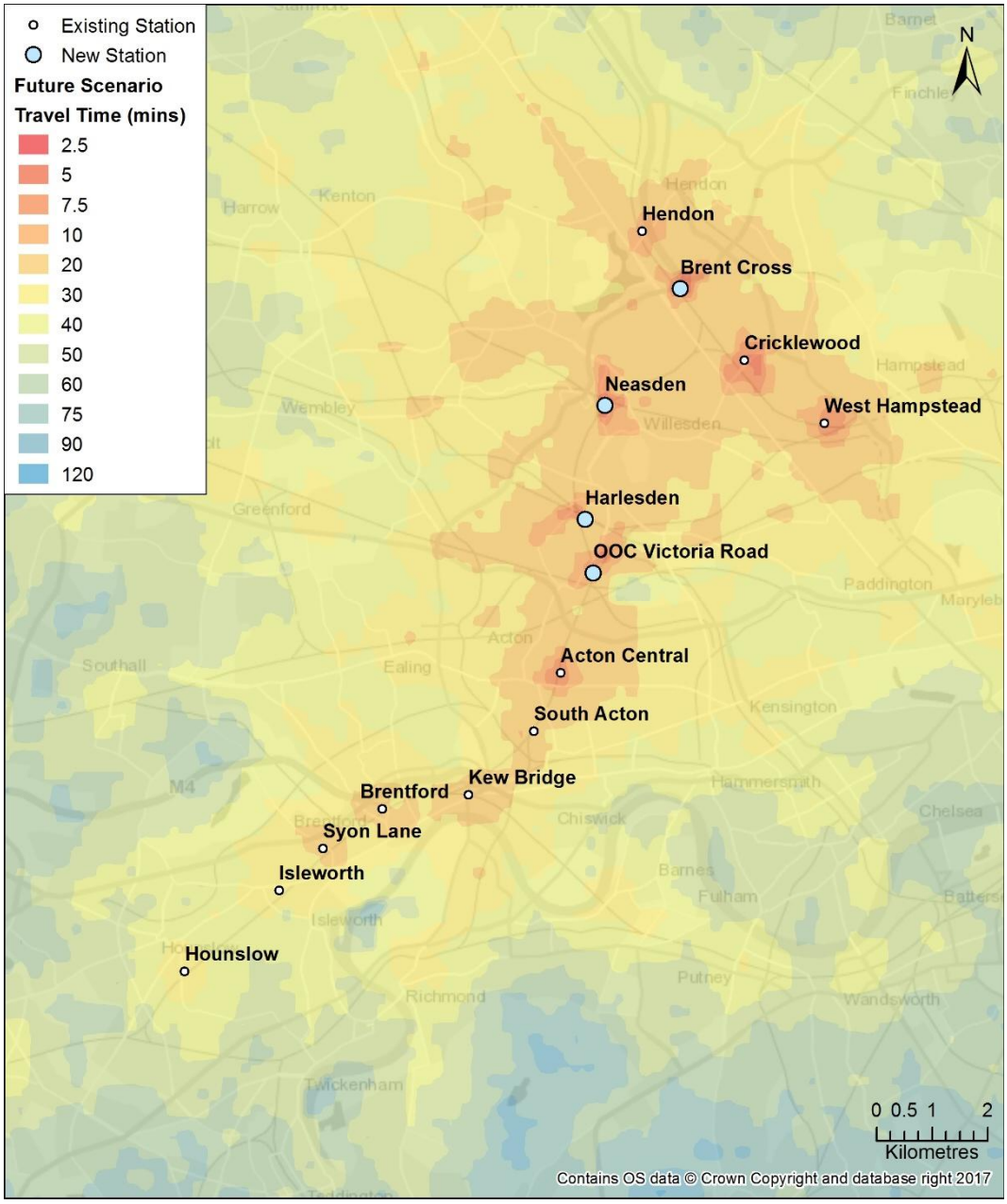


Figure 7-3 PTAL scores without WLO rail services

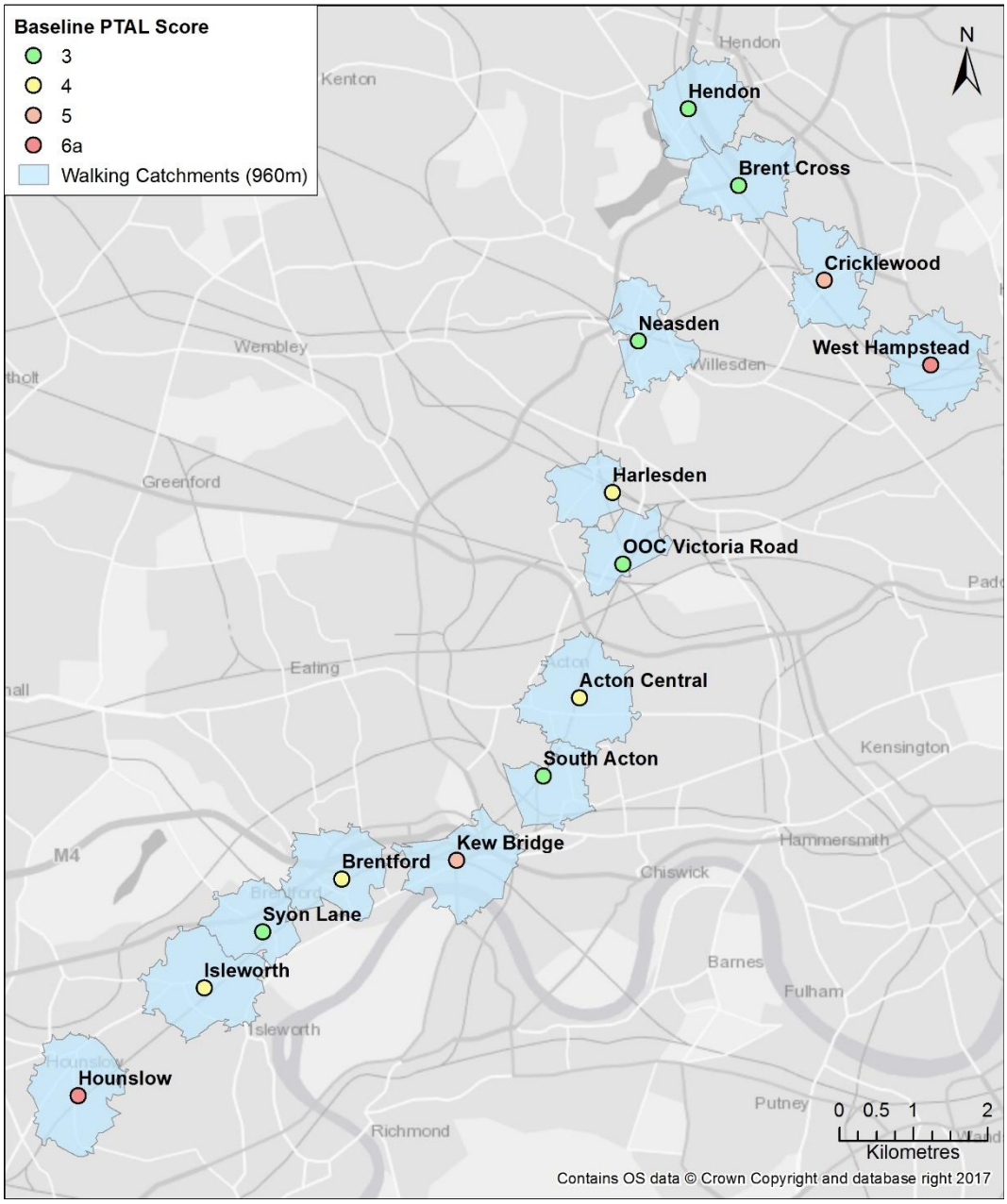
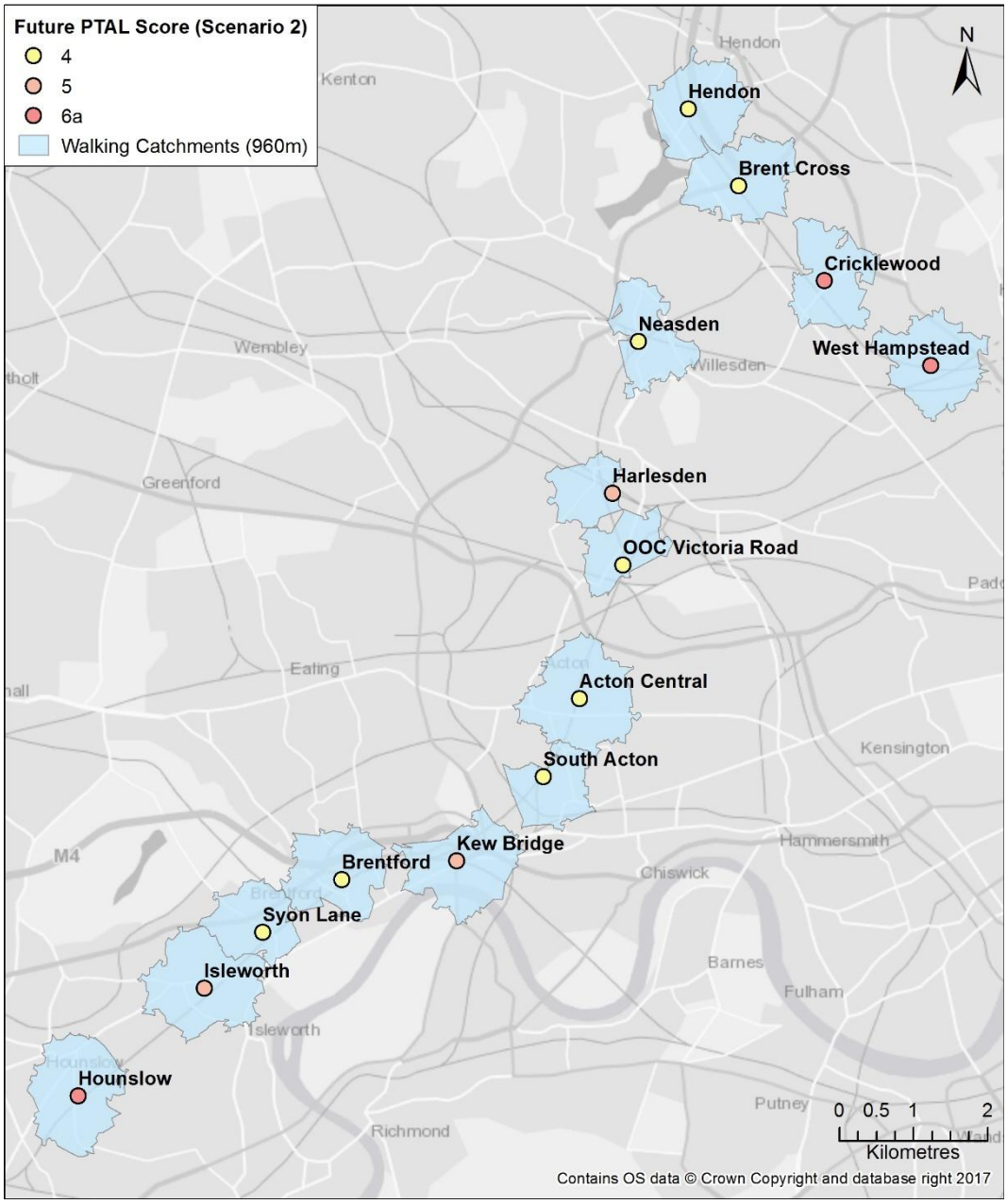


Figure 7-4 PTAL scores with WLO rail services



7.4.5 The results of the PTAL analysis illustrated in Figures 7-3 and 7-4 demonstrate an increase in score for nine of the 14 stations. All six of the stations with a score of 3 without WLO rail services gain a score of 4 after its introduction. Both Isleworth and Harlesden stations are promoted to a score of 5.

SUPPORTING GROWTH

7.4.6 The demand forecasting and economic appraisal demonstrate the very significant benefits to the forecast public transport users in 2041, based on TfL's current assumptions. In West London there are ambitions to deliver additional significant housing and the provision of high quality public transport and good accessibility is seen as providing an opportunity to increase the density of developments and potentially open up new sites.

7.4.7 PTAL scores are used in the Housing Density Matrix in the London Plan to set out recommended housing densities for developments. As indicated in the extract from the London Plan below, (and assuming 'Urban' setting for West London), the range of expected densities around the stations served by the scheme would increase to up to 700 habitable rooms per hectare and up to 260 units per hectare in the most accessible locations.

Figure 7-5 Recommended Housing Densities in the London Plan

Setting	Public Transport Accessibility Level (PTAL)		
	0 to 1	2 to 3	4 to 6
Suburban	**150-200 hr/ha**	**150-250 hr/ha**	**200-350 hr/ha**
3.8-4.6 hr/unit	35-55 u/ha	35-65 u/ha	45-90 u/ha
3.1-3.7 hr/unit	40-65 u/ha	40-80 u/ha	55-115 u/ha
2.7-3.0 hr/unit	50-75 u/ha	50-95 u/ha	70-130 u/ha
Urban	**150-250 hr/ha**	**200-450 hr/ha**	**200-700 hr/ha**
3.8-4.6 hr/unit	35-65 u/ha	45-120 u/ha	45-185 u/ha
3.1-3.7 hr/unit	40-80 u/ha	55-145 u/ha	55-225 u/ha
2.7-3.0 hr/unit	50-95 u/ha	70-170 u/ha	70-260 u/ha
Central	**150-300 hr/ha**	**300-650 hr/ha**	**650-1100 hr/ha**
3.8-4.6 hr/unit	35-80 u/ha	65-170 u/ha	140-290 u/ha
3.1-3.7 hr/unit	40-100 u/ha	80-210 u/ha	175-355 u/ha
2.7-3.0 hr/unit	50-110 u/ha	100-240 u/ha	215-405 u/ha

Figure 2.1: Recommended housing densities in the London Plan

hr = habitable rooms
u = a dwelling unit, i.e. a flat or a house
ha = hectare

7.4.8 Assuming an increase in density around the stations where the PTAL score increased to 4 or above in the with WLO rail services scenario, the recommended increase in the number of units within the walk-in catchments of the stations could be around 200 units on the basis of the London Plan guidance. If the effect of the improved accessibility is extended to a one mile radius, the result could be over 300 additional units.

7.4.9 These indicative estimates however, are likely to be very conservative and developers will be keen to exploit the full commercial potential of the sites and seek to provide the highest densities they can. If this was to produce densities at some locations consistent with the 'Central' setting the level of additional units could approach around 1,000 units.

7.4.10 The above estimates are purely illustrative and do not reflect the current usage and densities in the areas which would benefit from the WLO rail services. Based on the emerging Strategic Housing Land Availability Assessments for the West London boroughs many identified sites will benefit from the introduction of the WLO rail services. This could potentially, subject to finalisation of site identification, developer appetite and local policies enable the intensification of housing development to potentially deliver 15,000 to 20,000 units.

7.4.11 The results of the demand forecasting indicate that in 2041 the WLO rail services will provide sufficient capacity to accommodate further significant growth on rail demand arising from further housing and employment development along the corridor.

OPPORTUNITIES FOR OVER-SITE DEVELOPMENT

7.4.12 One potential way to support both the densification of development in the corridor and to raise funding to assist in addressing the scheme affordability, is to pursue opportunities for over-site development (OSD) at the WLO stations, which themselves are only likely to be cost effective if constructed to a material density.

7.4.13 The likely timescale for the delivery and operation of the WLO rail services, combined with TfL's ambitions for development of its sites via its Property Partnership Framework, would be the ideal timing and climate in which to bring forward plans for new transport-oriented development and new or rejuvenated town centres.

8 CONCLUSIONS & RECOMMENDATIONS

8.1 BACKGROUND

8.1.1 The Dudding Hill line running from Acton to Cricklewood, has been identified as providing the opportunity for transport investment to support the sustainable growth of population and employment in the area. The line is currently lightly used by freight and very occasional passenger charter trains. The re-introduction of passenger services on the Dudding Hill Line and the Kew – Acton link to provide a West London Orbital (WLO) rail service from Hounslow to West Hampstead and Hendon would provide an efficient and effective means to serve the proposed developments for the corridor between Hounslow and West Hampstead/Hendon.

8.1.2 This study has confirmed the appropriateness of developing a heavy rail solution for the corridor given its existing role as a freight route and the opportunity to provide connectivity across the wider rail network. Retention of the heavy rail corridor on the Dudding Hill Line section would also permit integration of the WLO services into London Overground operations and to support the further success of this brand.

8.1.3 The preferred WLO service is based upon the findings from demand forecasting for different service options and analysis of the operations and infrastructure implications of delivering the options. The preferred WLO service, agreed with the client group, is the phased introduction of:

- à 4 trains per hour from West Hampstead to Hounslow (from 2026)
- à Additional 4 trains per hour from Hendon to Kew Bridge (from 2029)

8.2 THE CASE FOR THE PREFERRED OPTION

8.2.1 The results of the demand forecasting (using TfL's LTS-PT model) demonstrate a forecast increase in passenger kilometres, passenger minutes and total passenger boardings on rail services (including WLO) of around 9,500 in both the AM and the PM periods. A reduction in passenger kilometres, passenger minutes and total passenger boardings on LUL and buses indicates that the demand for the WLO services is likely to be abstracted from LUL (notably Northern, Jubilee, Central, District and Piccadilly lines) and bus services, providing crowding relief for them.

8.2.2 The value of the passenger benefits, when quantified in line with DfT guidance, more than offsets the estimated capital costs for the scheme and the cost of operating the services (producing a benefit to cost ratio above 2:1). This strong economic appraisal result is supported by the additional unquantified benefits that would arise from the transfer of highway trips to rail services, e.g. from the A406 North Circular Road (which are not included in the demand forecasting), and supporting the local housing and employment agendas and the draft Mayor's Transport Strategy.

8.2.3 Demonstrating the implications of the introduction of the WLO rail service, PTAL analysis identifies a significant increase in the accessibility provided. Of the 14 stations served by the WLO services, nine improve by a PTAL score. On the basis of this increase in scores and the London Plan's guidance on associated densities for housing developments, the WLO rail service could support significant additional units subject to finalisation of site identification through the Strategic Housing Land Availability Assessments process, developer appetite and local policies.

8.2.4 The assessment of the preferred option indicates a strong value for money case, encompassing both quantified and unquantified benefits.

8.3 DELIVERABILITY OF THE PREFERRED OPTION

8.3.1 While the introduction of WLO rail services is anticipated to provide significant benefits for West London, and beyond, the delivery of the scheme presents some very significant challenges. As identified in the study these relate to the affordability of the scheme and the technical feasibility of implementing it.

8.3.2 The capital cost estimate for the scheme is around £150m, with an additional 80% risk assumed at this initial stage of scheme development. Given the magnitude of this cost estimate, significant funding sources will need to be identified in order to achieve scheme affordability. Initial analysis indicates that there is scope to derive a significant contribution towards this capital cost through funding from the Community Infrastructure Levy (CIL). With potentially 15,000 to 20,000 new homes planned in West London the associated value of the CIL could approach around £150m-£200m.

8.3.3 While there is an existing rail corridor, which serves freight trains, to accommodate the introduction of frequent passenger services requires capacity enhancements and the closure of level crossings. The most challenging enhancement is the quadrupling of track around Acton Wells. This will be technically difficult both in regards to the works required, including the construction of a new bridge, and given the very limited availability of possessions in which to undertake the work. However, such are the benefits to the rail industry if a solution can be delivered, that funding contributions towards it may be forthcoming. Similarly, the delivery of a satisfactory solution at Bollo Lane, where the existing level crossings will need to be closed, will potentially create significant disruption while the construction works are underway. Stakeholder and public acceptability will be influential in shaping the solutions.

8.3.4 Once operating, the option has been designed to best utilise the capacity available and necessary infrastructure resulting in the proposal to run 8 trains per hour on the core section between Neasden and South Acton, with 4 tph for the sections to the north and south. The currently forecast revenue for WLO rail services will not fully offset the forecast operating costs, but opportunities in relation to innovative fares policy and operating practices offer areas for consideration to close the gap.

8.4 RECOMMENDATIONS

8.4.1 A strong economic case has been demonstrated for the introduction of operationally feasible WLO rail services using the Dudding Hill Line. This supports the rationale for developing the scheme further, with a focus on the identified technical challenges for the implementation of the scheme, i.e. for Acton Wells and Bollo Lane.

8.4.2 Subject to the development of viable solutions, the strength of the case should be revisited on the basis of revised cost estimates and more detailed demand forecasting, incorporating a full run through the TfL model suite to capture forecast mode transfer. It would also be an opportunity for a thorough review and a possible improvement of the accuracy of the public transport model in line with TfL and DfT guidance.

8.4.3 In the expectation that the case for the scheme will remain strong, and with refined capital cost estimates, a funding proposal should be developed cognisant of the scope for developer contributions and the requirements for incorporating the services within London Overground in a manner that addresses the currently forecast operating deficit.

Appendix A

DEMAND ANALYSIS. OPTIONS 1 - 3

APPENDIX A-1

GLOBAL STATISTICS

This section presents key model statistics at a global level for each AM Peak and PM peak scenario modelled, as well as differences in those model statistics between each scheme scenario and its associated baseline scenario.

Baseline: **Standard LTS-PT 2041 Reference Case (A141rc01a)**

Mode	Peak	*Description*	*2041 TfL Ref Case*	*Dudding Hill Option 1*	*Dudding Hill Option 2*	*Dudding Hill Option 3*	*Difference*		
		Scenario	A141rc01a	A141DH01a	A141DH02a	A141DH03a	A141DH01a-A141rc01a	A141DH02a-A141rc01a	A141DH03a-A141rc01a
Rail	AM	Passenger Kms	61,984,155	62,016,662	62,012,664	62,059,289	32,507	28,509	75,134
		Uncrowded Passenger Hrs	57,719,229	57,777,414	57,770,667	57,817,208	58,185	51,438	97,979
		Crowded Passenger Hrs	77,959,930	77,986,499	77,979,181	78,132,445	26,569	19,251	172,514
		Passenger Boardings	1,937,480	1,943,036	1,942,482	1,950,314	5,556	5,002	12,834
	PM	Passenger Kms	63,991,947	64,030,999	64,028,295	64,077,715	39,052	36,348	85,769
		Uncrowded Passenger Hrs	57,473,633	57,542,266	57,537,479	57,617,507	68,633	63,845	143,874
		Crowded Passenger Hrs	73,205,216	73,276,088	73,269,513	73,362,298	70,872	64,297	157,082
		Passenger Boardings	1,996,416	2,001,814	2,001,511	2,009,314	5,398	5,095	12,898
LUL	AM	Passenger Kms	16,267,356	16,225,889	16,230,396	16,185,807	-41,466	-36,960	-81,549
		Uncrowded Passenger Hrs	29,182,762	29,104,438	29,112,603	29,028,623	-78,324	-70,159	-154,139
		Crowded Passenger Hrs	43,191,304	43,026,123	43,045,825	42,863,924	-165,182	-145,479	-327,380
		Passenger Boardings	2,272,048	2,267,928	2,268,300	2,264,134	-4,120	-3,748	-7,914
	PM	Passenger Kms	16,552,743	16,509,536	16,514,085	16,469,409	-43,207	-38,658	-83,334
		Uncrowded Passenger Hrs	30,074,167	29,992,731	30,000,849	29,915,406	-81,436	-73,318	-158,762
		Crowded Passenger Hrs	41,269,408	41,106,803	41,121,782	40,949,028	-162,605	-147,627	-320,381
		Passenger Boardings	2,416,620	2,412,513	2,412,830	2,408,901	-4,108	-3,791	-7,720
Bus	AM	Passenger Kms	6,749,006	6,732,698	6,735,147	6,720,018	-16,308	-13,859	-28,988
		Uncrowded Passenger Hrs	26,478,568	26,410,056	26,420,524	26,356,202	-68,512	-58,044	-122,366
		Crowded Passenger Hrs	30,735,987	30,633,814	30,651,975	30,575,417	-102,173	-84,012	-160,569
		Passenger Boardings	1,852,325	1,848,954	1,848,970	1,845,825	-3,370	-3,355	-6,500
	PM	Passenger Kms	8,199,665	8,182,581	8,184,708	8,167,247	-17,084	-14,957	-32,418
		Uncrowded Passenger Hrs	30,291,568	30,222,305	30,230,735	30,159,154	-69,263	-60,833	-132,414
		Crowded Passenger Hrs	36,796,301	36,669,085	36,689,483	36,572,932	-127,216	-106,818	-223,369
		Passenger Boardings	2,177,500	2,173,966	2,173,870	2,170,569	-3,534	-3,630	-6,931

Mode	Peak	*Description*	*2041 TfL Ref Case*	*Dudding Hill Option 1*	*Dudding Hill Option 2*	*Dudding Hill Option 3*	*Difference*		
		Scenario	A141rc01a	A141DH01a	A141DH02a	A141DH03a	A141DH01a-A141rc01a	A141DH02a-A141rc01a	A141DH03a-A141rc01a
DLR	AM	Passenger Kms	632,655	632,502	632,523	632,453	-153	-132	-202
		Uncrowded Passenger Hrs	1,538,078	1,537,752	1,537,793	1,537,667	-326	-285	-411
		Crowded Passenger Hrs	1,899,277	1,898,692	1,898,759	1,898,507	-585	-518	-770
		Passenger Boardings	147,849	147,826	147,829	147,824	-23	-20	-25
	PM	Passenger Kms	701,112	700,968	700,975	700,931	-144	-137	-181
		Uncrowded Passenger Hrs	1,695,600	1,695,290	1,695,307	1,695,233	-310	-293	-367
		Crowded Passenger Hrs	2,080,741	2,080,177	2,080,211	2,080,072	-563	-529	-669
		Passenger Boardings	162,406	162,383	162,383	162,381	-23	-23	-25
Tram	AM	Passenger Kms	162,639	162,635	162,635	162,629	-4	-4	-10
		Uncrowded Passenger Hrs	430,015	430,004	430,004	429,986	-11	-11	-29
		Crowded Passenger Hrs	614,341	614,331	614,332	614,294	-10	-9	-48
		Passenger Boardings	35,061	35,061	35,061	35,060	0	0	-1
	PM	Passenger Kms	189,577	189,573	189,571	189,568	-4	-5	-9
		Uncrowded Passenger Hrs	486,745	486,735	486,732	486,722	-10	-13	-22
		Crowded Passenger Hrs	756,547	756,511	756,505	756,480	-36	-42	-67
		Passenger Boardings	38,543	38,543	38,542	38,542	0	-1	-1
All PT	AM	Passenger Kms	85,795,810	85,770,385	85,773,364	85,760,195	-25,424	-22,445	-35,614
		Uncrowded Passenger Hrs	115,348,652	115,259,663	115,271,591	115,169,686	-88,989	-77,060	-178,966
		Crowded Passenger Hrs	154,400,839	154,159,458	154,190,072	154,084,586	-241,381	-210,768	-316,253
		Passenger Boardings	6,244,762	6,242,806	6,242,642	6,243,157	-1,957	-2,121	-1,605
	PM	Passenger Kms	89,635,043	89,613,656	89,617,634	89,604,871	-21,387	-17,409	-30,172
		Uncrowded Passenger Hrs	120,021,714	119,939,327	119,951,102	119,874,022	-82,387	-70,612	-147,691
		Crowded Passenger Hrs	154,108,212	153,888,664	153,917,493	153,720,809	-219,549	-190,719	-387,404
		Passenger Boardings	6,791,486	6,789,219	6,789,137	6,789,708	-2,268	-2,350	-1,779

Baseline: 2041 Maximum Growth Scenario without Crossrail 2

Mode	Peak	*Description*	*2041 TfL Max Growth*	*Dudding Hill Option 1*	*Dudding Hill Option 2*	*Dudding Hill Option 3*	*Difference*		
		Scenario	A141rc20a	A141DH04a	A141DH05a	A141DH06a	A141DH04a-A141rc20a	A141DH05a-A141rc20a	A141DH06a-A141rc20a
Rail	AM	Passenger Kms	63,543,061	63,577,045	63,572,735	63,620,409	33,984	29,673	77,347
		Uncrowded Passenger Hrs	59,261,438	59,322,964	59,315,636	59,392,105	61,526	54,198	130,667
		Crowded Passenger Hrs	80,539,375	80,583,136	80,571,795	80,652,649	43,761	32,420	113,275
		Passenger Boardings	2,009,641	2,015,302	2,014,719	2,022,622	5,662	5,078	12,981
	PM	Passenger Kms	65,808,704	65,851,019	65,847,597	65,898,022	42,315	38,892	89,318
		Uncrowded Passenger Hrs	59,357,651	59,429,049	59,423,219	59,506,059	71,399	65,569	148,409
		Crowded Passenger Hrs	76,530,731	76,601,652	76,593,474	76,682,476	70,921	62,743	151,745
		Passenger Boardings	2,077,290	2,083,114	2,082,734	2,090,696	5,823	5,444	13,406
LUL	AM	Passenger Kms	16,651,343	16,607,306	16,612,485	16,567,202	-44,037	-38,857	-84,141
		Uncrowded Passenger Hrs	29,861,747	29,778,544	29,788,007	29,702,773	-83,203	-73,740	-158,974
		Crowded Passenger Hrs	44,507,659	44,331,416	44,353,861	44,170,433	-176,243	-153,798	-337,226
		Passenger Boardings	2,334,658	2,330,290	2,330,723	2,326,505	-4,367	-3,934	-8,152
	PM	Passenger Kms	17,064,166	17,017,429	17,022,776	16,976,105	-46,738	-41,391	-88,061
		Uncrowded Passenger Hrs	30,975,294	30,887,517	30,897,181	30,808,234	-87,777	-78,113	-167,060
		Crowded Passenger Hrs	43,170,281	42,990,865	43,009,032	42,825,111	-179,416	-161,249	-345,170
		Passenger Boardings	2,493,211	2,488,706	2,489,093	2,484,970	-4,505	-4,118	-8,241
Bus	AM	Passenger Kms	7,020,708	7,004,258	7,006,737	6,990,477	-16,450	-13,971	-30,231
		Uncrowded Passenger Hrs	27,493,659	27,424,854	27,435,407	27,366,943	-68,805	-58,252	-126,716
		Crowded Passenger Hrs	32,489,132	32,379,296	32,398,924	32,266,761	-109,836	-90,208	-222,371
		Passenger Boardings	1,927,422	1,924,039	1,924,033	1,920,782	-3,383	-3,389	-6,640
	PM	Passenger Kms	8,516,962	8,499,199	8,501,582	8,483,609	-17,762	-15,380	-33,353
		Uncrowded Passenger Hrs	31,405,075	31,333,233	31,342,630	31,268,921	-71,842	-62,445	-136,154
		Crowded Passenger Hrs	39,115,825	38,972,718	38,996,175	38,873,642	-143,107	-119,650	-242,184
		Passenger Boardings	2,263,218	2,259,570	2,259,473	2,256,103	-3,648	-3,745	-7,114

Mode	Peak	*Description*	*2041 TfL Max Growth*	*Dudding Hill Option 1*	*Dudding Hill Option 2*	*Dudding Hill Option 3*	*Difference*		
		Scenario	A141rc20a	A141DH04a	A141DH05a	A141DH06a	A141DH04a-A141rc20a	A141DH05a-A141rc20a	A141DH06a-A141rc20a
DLR	AM	Passenger Kms	772,475	772,332	772,362	772,305	-142	-113	-170
		Uncrowded Passenger Hrs	1,873,801	1,873,502	1,873,562	1,873,427	-298	-239	-374
		Crowded Passenger Hrs	2,543,780	2,543,195	2,543,313	2,542,971	-584	-466	-809
		Passenger Boardings	178,172	178,152	178,156	178,152	-19	-16	-20
	PM	Passenger Kms	853,060	852,920	852,927	852,909	-140	-133	-151
		Uncrowded Passenger Hrs	2,054,730	2,054,424	2,054,440	2,054,426	-306	-290	-304
		Crowded Passenger Hrs	2,754,186	2,753,524	2,753,564	2,753,519	-662	-622	-667
		Passenger Boardings	195,390	195,368	195,367	195,369	-22	-23	-21
Tram	AM	Passenger Kms	165,161	165,155	165,155	165,151	-6	-6	-10
		Uncrowded Passenger Hrs	436,538	436,521	436,520	436,509	-17	-18	-29
		Crowded Passenger Hrs	625,596	625,566	625,562	625,543	-30	-34	-53
		Passenger Boardings	35,692	35,692	35,692	35,692	0	0	0
	PM	Passenger Kms	193,122	193,115	193,115	193,109	-8	-8	-13
		Uncrowded Passenger Hrs	496,620	496,601	496,600	496,585	-19	-19	-35
		Crowded Passenger Hrs	781,050	780,987	780,986	780,938	-64	-64	-112
		Passenger Boardings	39,250	39,249	39,249	39,249	-1	-1	-1
All PT	AM	Passenger Kms	88,152,748	88,126,096	88,129,473	88,115,544	-26,651	-23,275	-37,204
		Uncrowded Passenger Hrs	118,927,182	118,836,386	118,849,132	118,771,756	-90,796	-78,050	-155,426
		Crowded Passenger Hrs	160,705,541	160,462,607	160,493,455	160,258,357	-242,933	-212,086	-447,184
		Passenger Boardings	6,485,584	6,483,476	6,483,322	6,483,753	-2,108	-2,262	-1,831
	PM	Passenger Kms	92,436,014	92,413,681	92,417,996	92,403,753	-22,333	-18,018	-32,261
		Uncrowded Passenger Hrs	124,289,369	124,200,823	124,214,070	124,134,226	-88,546	-75,299	-155,144
		Crowded Passenger Hrs	162,352,074	162,099,745	162,133,231	161,915,686	-252,329	-218,843	-436,387
		Passenger Boardings	7,068,359	7,066,006	7,065,916	7,066,387	-2,352	-2,443	-1,971

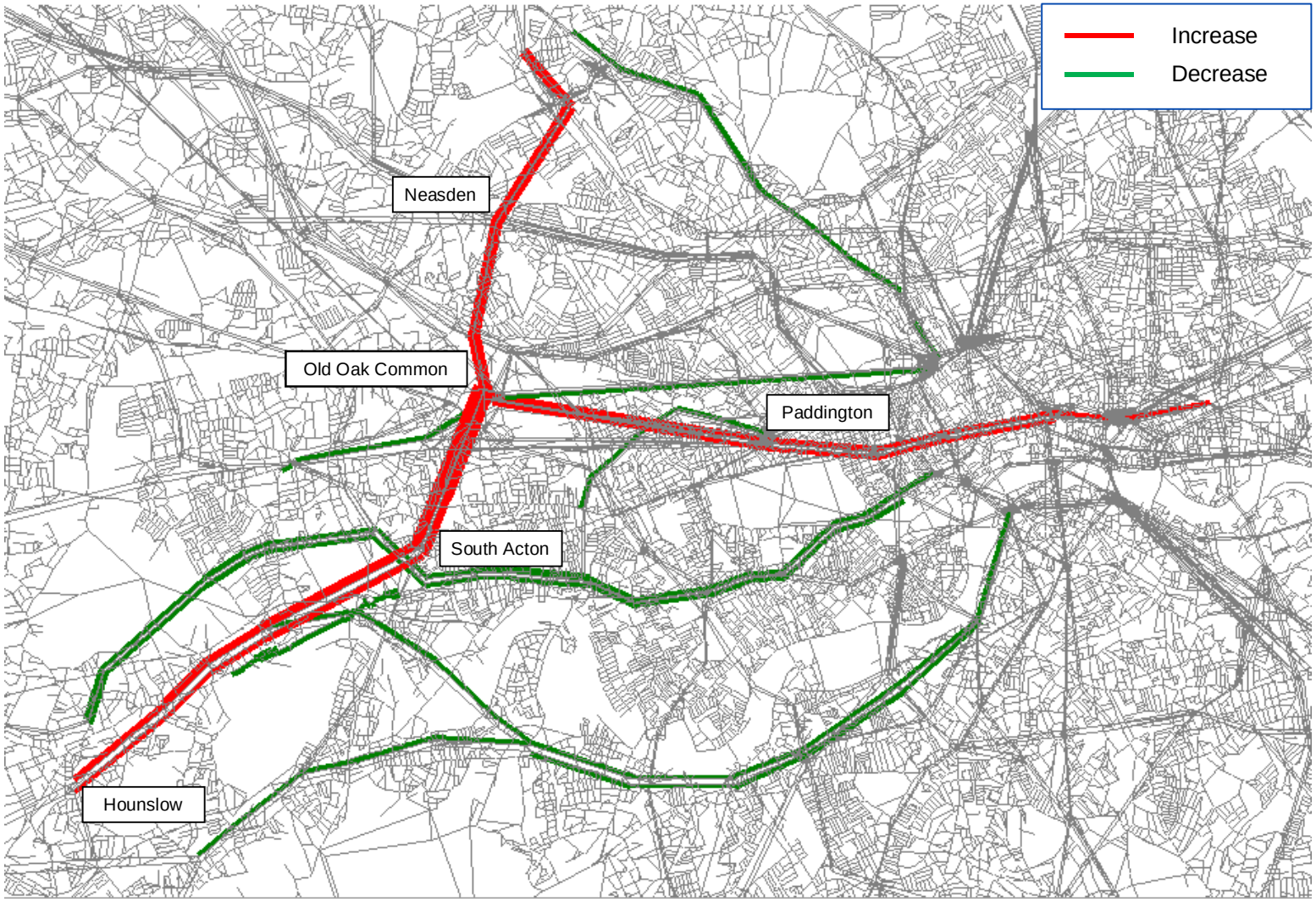
APPENDIX A-2

FLOW DIFFERENCE PLOTS

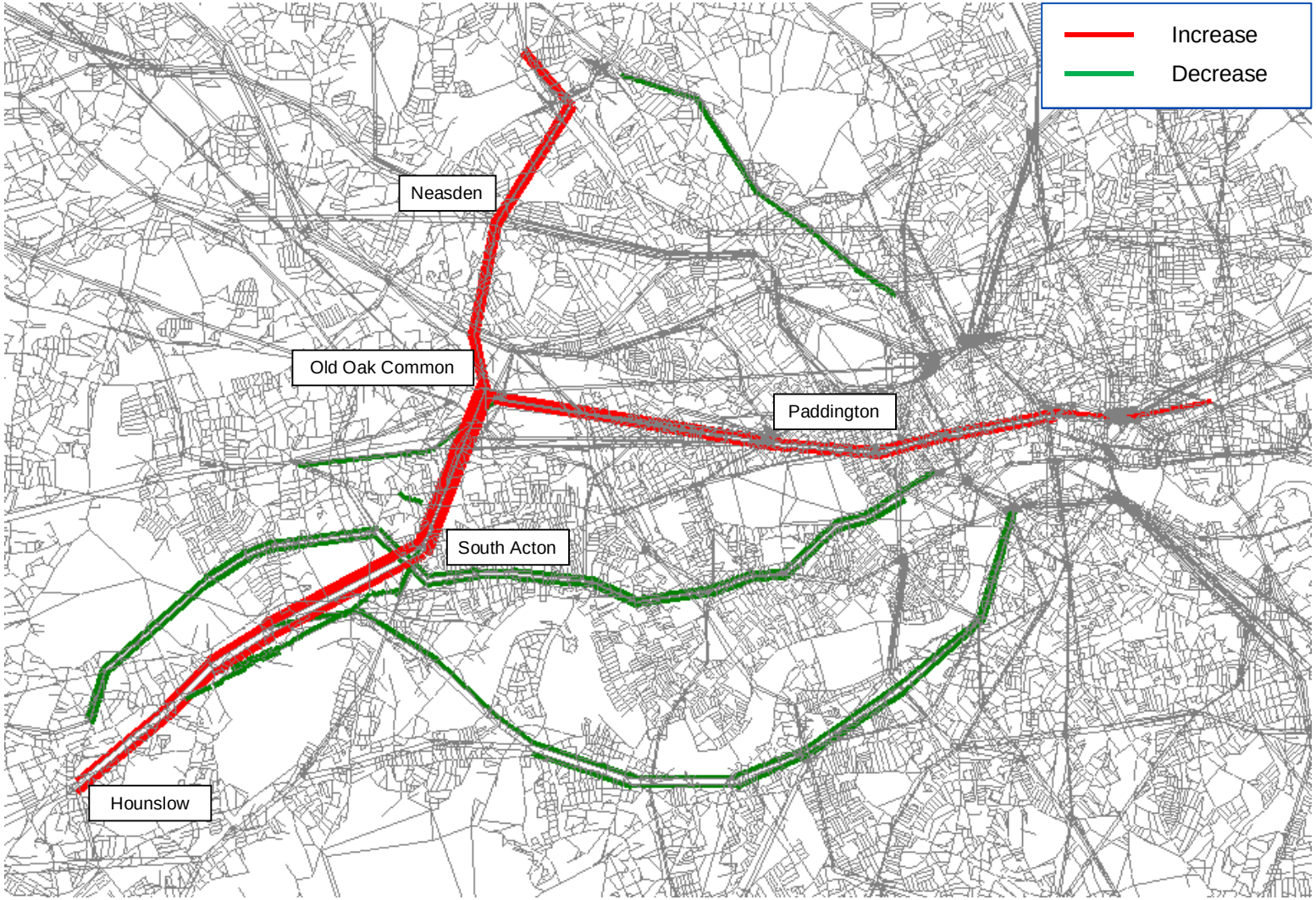
This section displays public transport network plots showing differences in demand on the public transport network in the AM and PM between each scheme option and its associated baseline scenario.

Baseline: **Standard LTS-PT 2041 Reference Case (A141rc01a)**

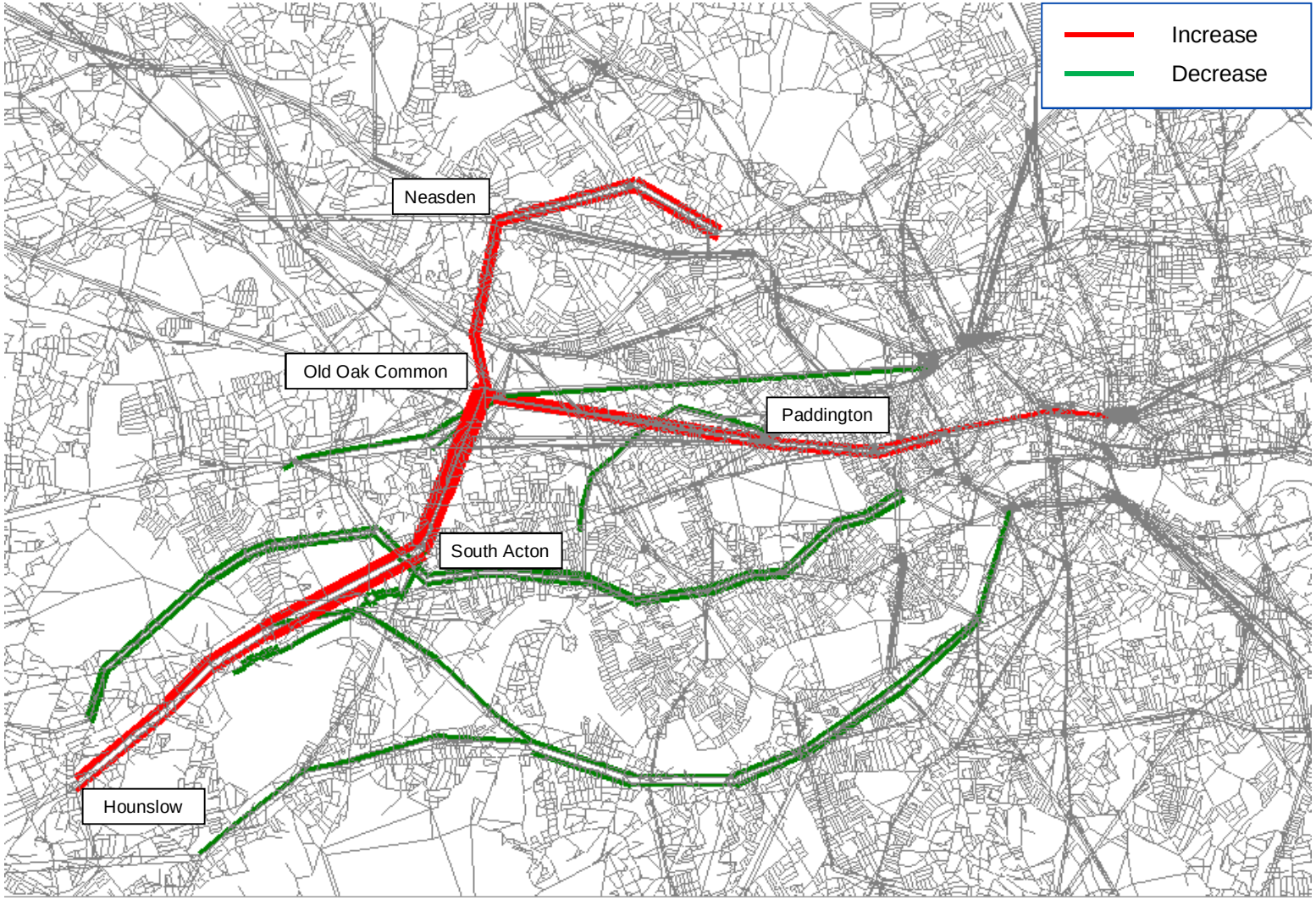
Passenger flow difference Option 1 minus Reference Case, AM



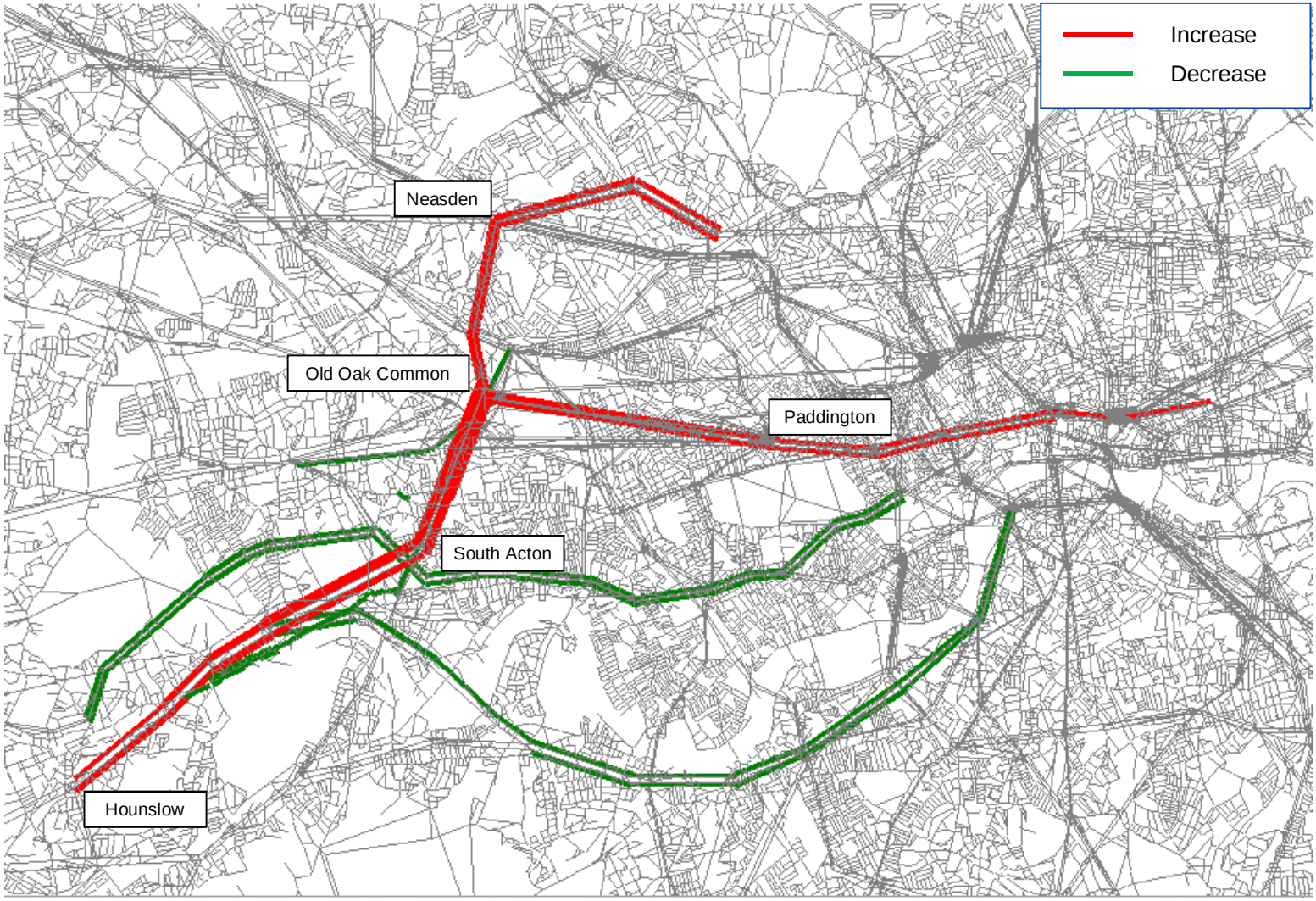
Passenger flow difference Option 1 minus Reference Case, PM



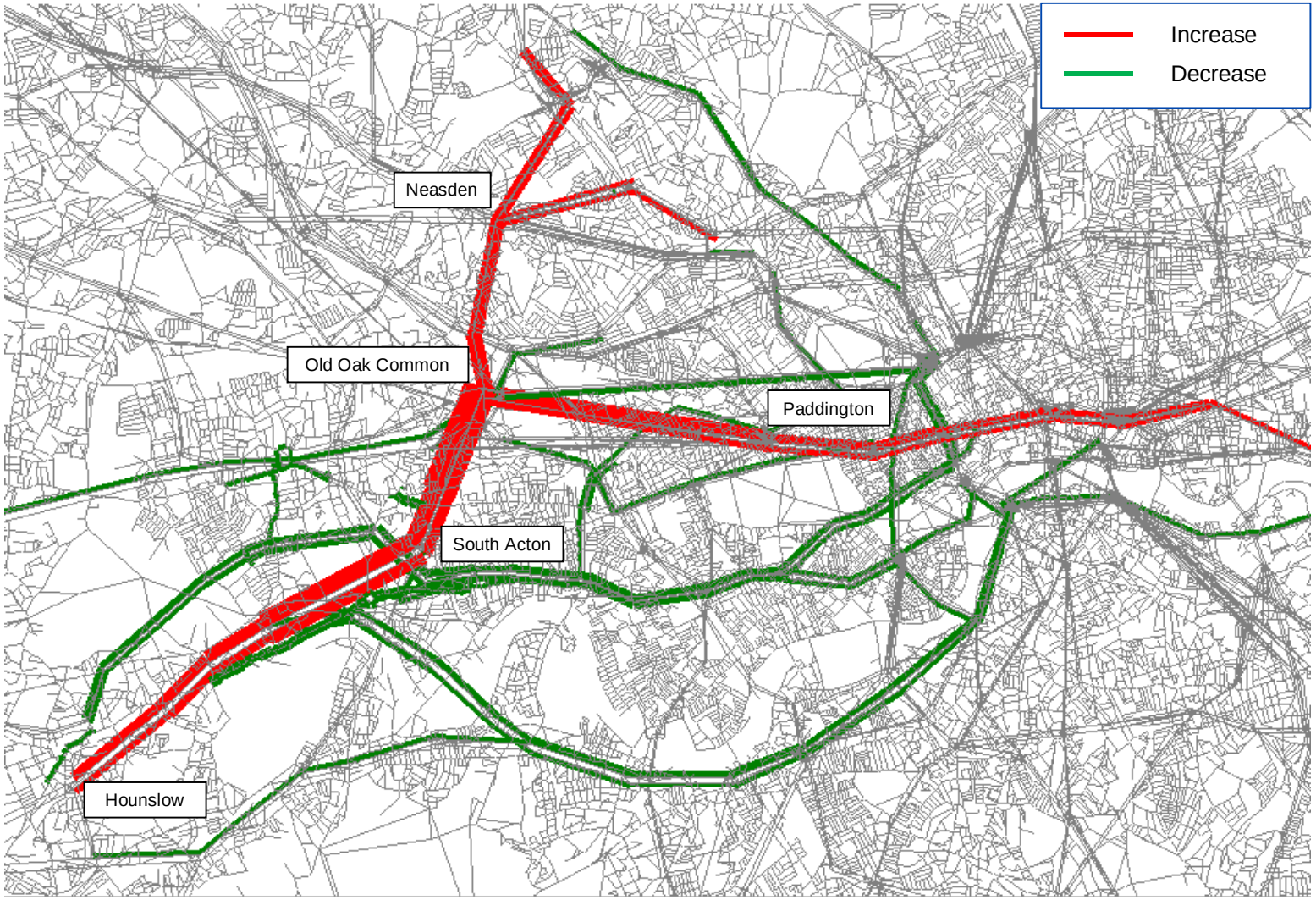
Passenger flow difference Option 2 minus Reference Case, AM



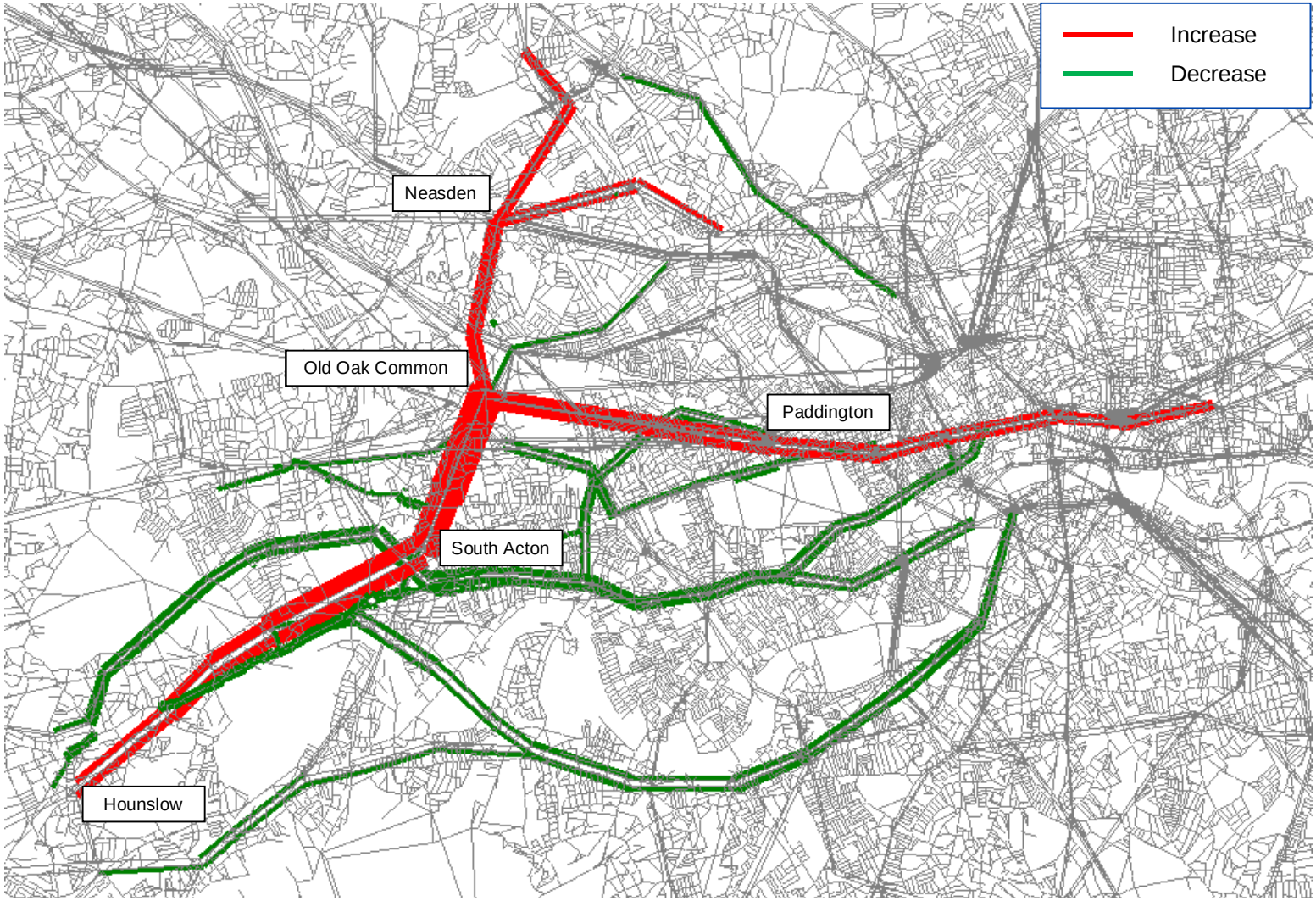
Passenger flow difference Option 2 minus Reference Case, PM



Passenger flow difference Option 3 minus Reference Case, AM

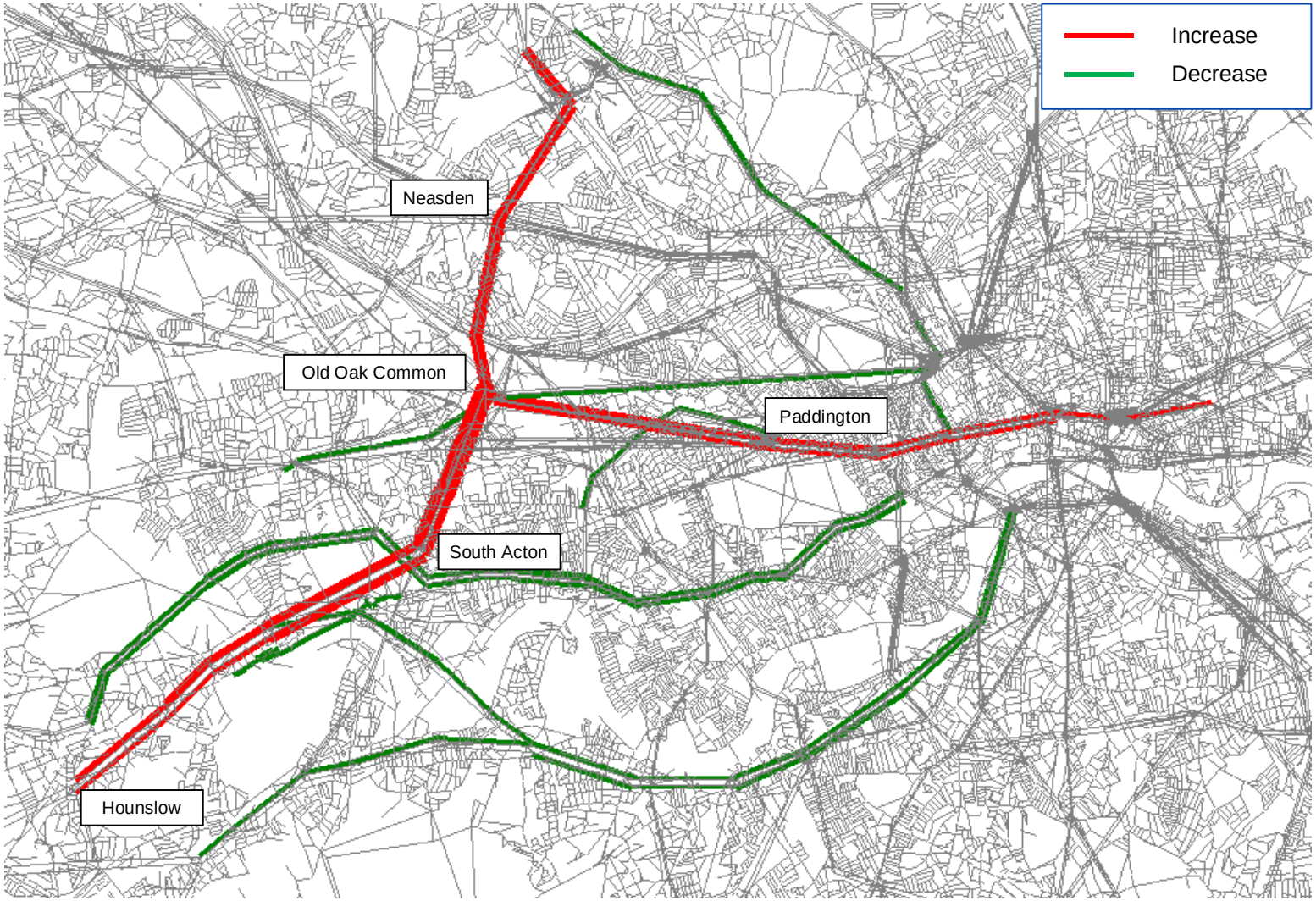


Passenger flow difference Option 3 minus Reference Case, PM

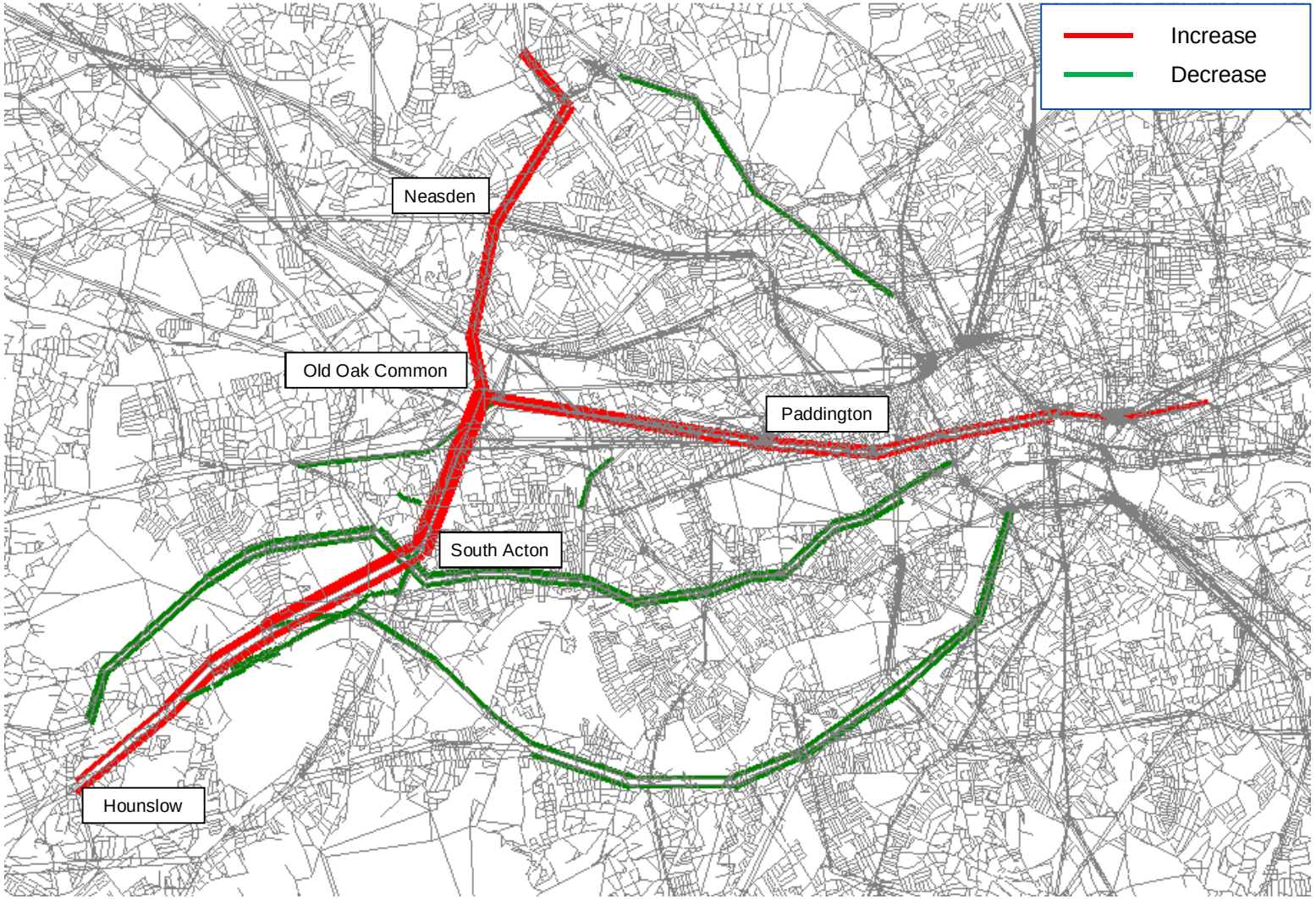


Baseline: **2041 Maximum Growth Scenario without Crossrail 2**

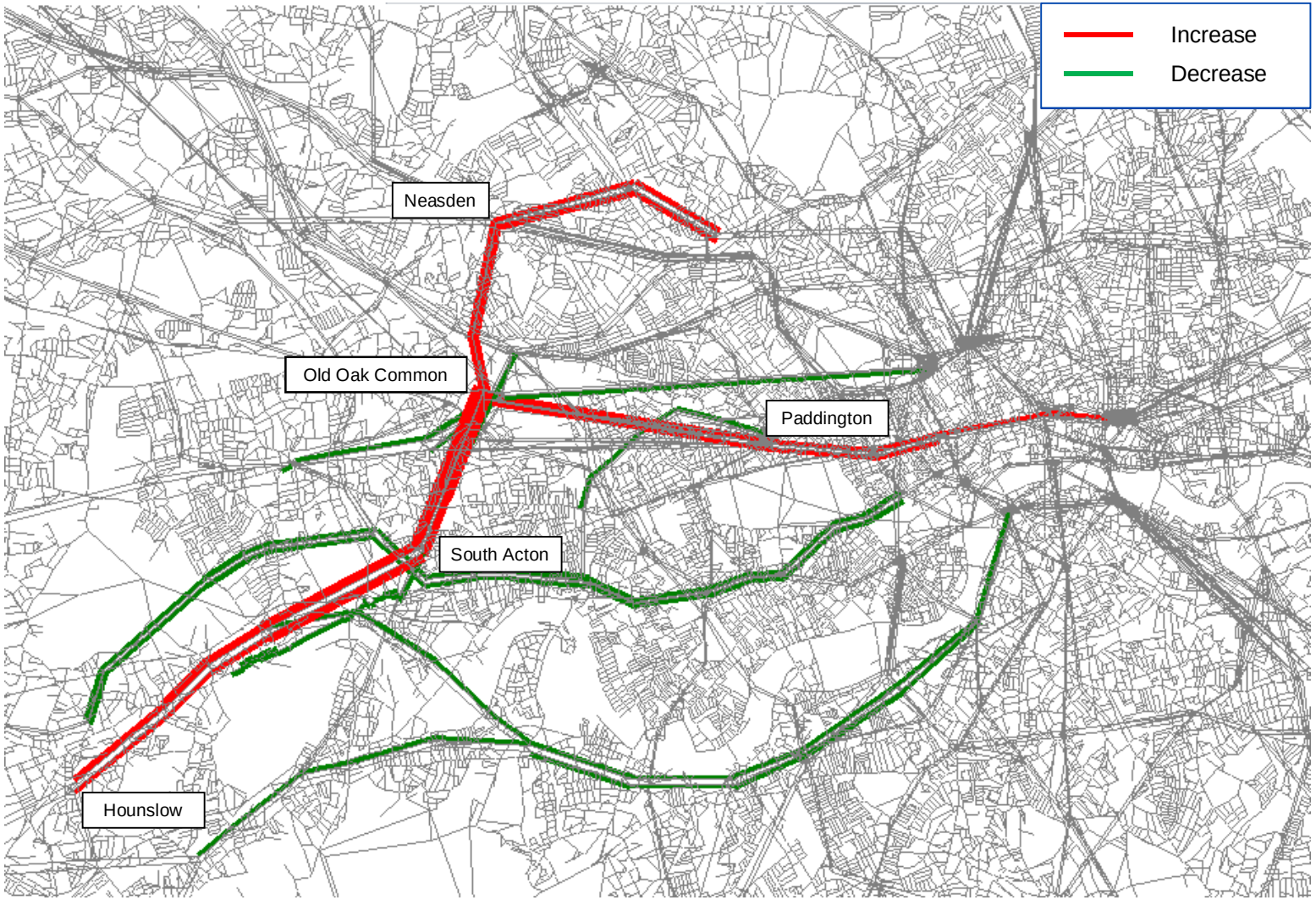
Passenger flow difference Option 1 minus Maximum Growth Scenario, AM



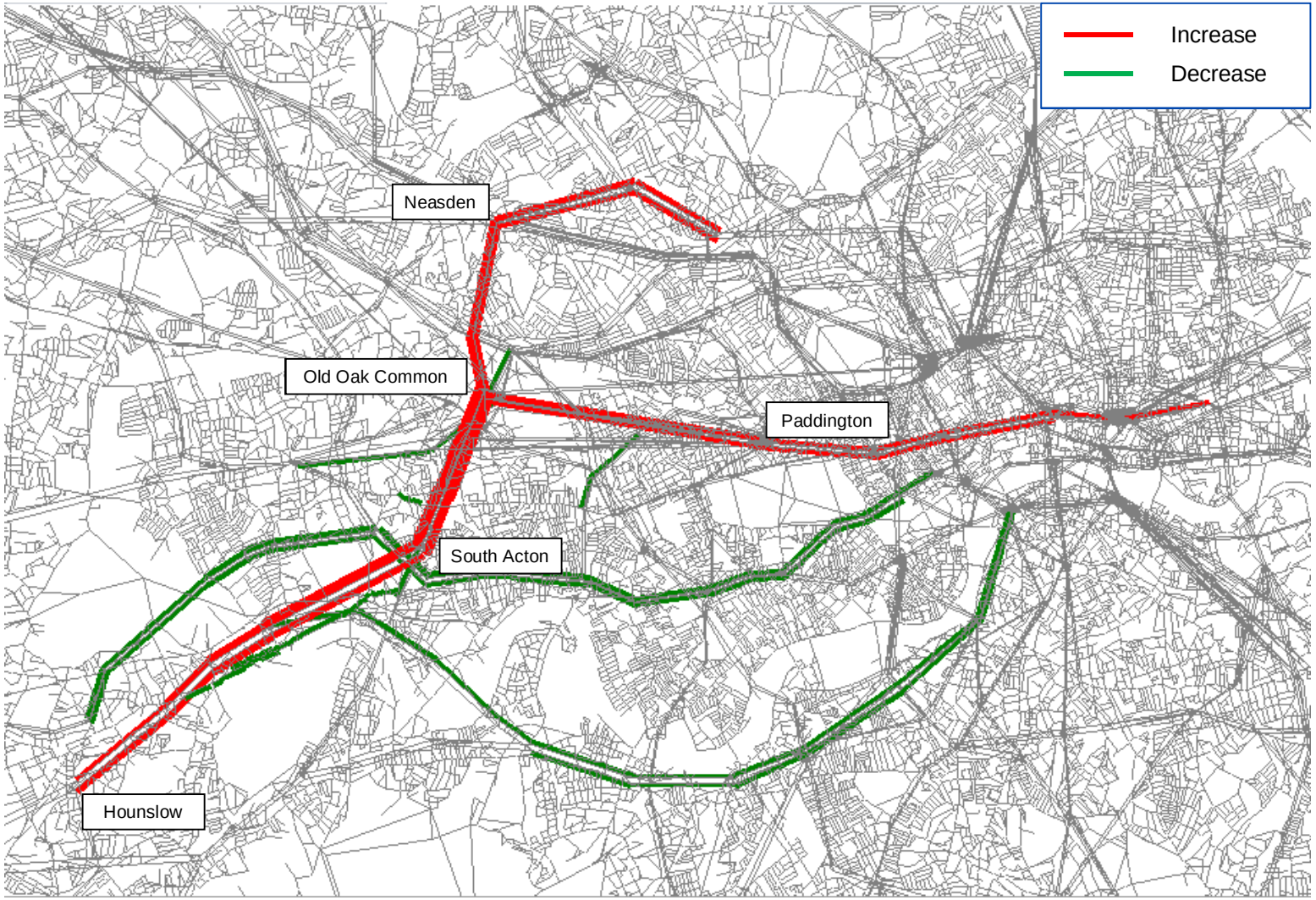
Passenger flow difference Option 1 minus Maximum Growth Scenario, PM



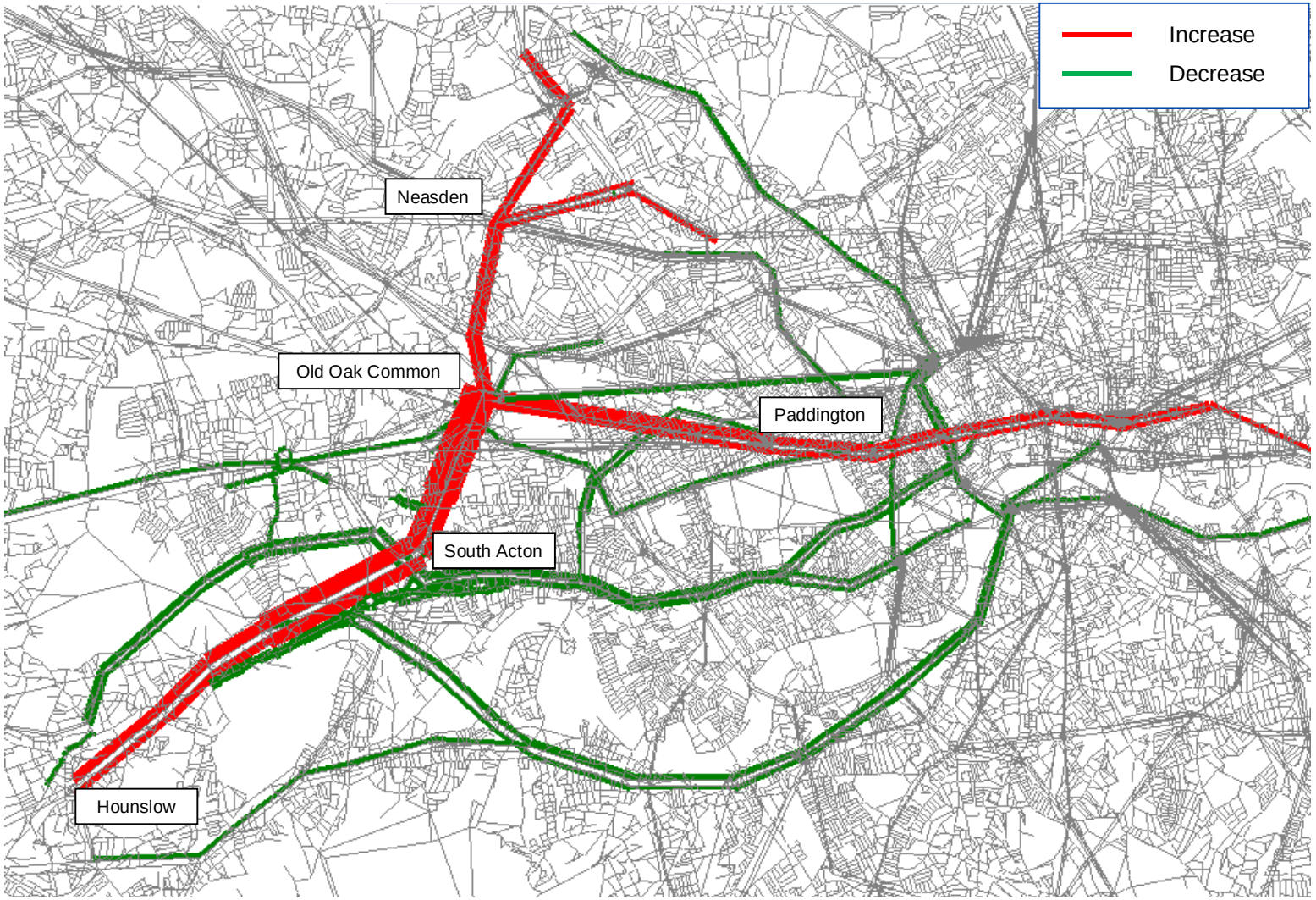
Passenger flow difference Option 2 minus Maximum Growth Scenario, AM



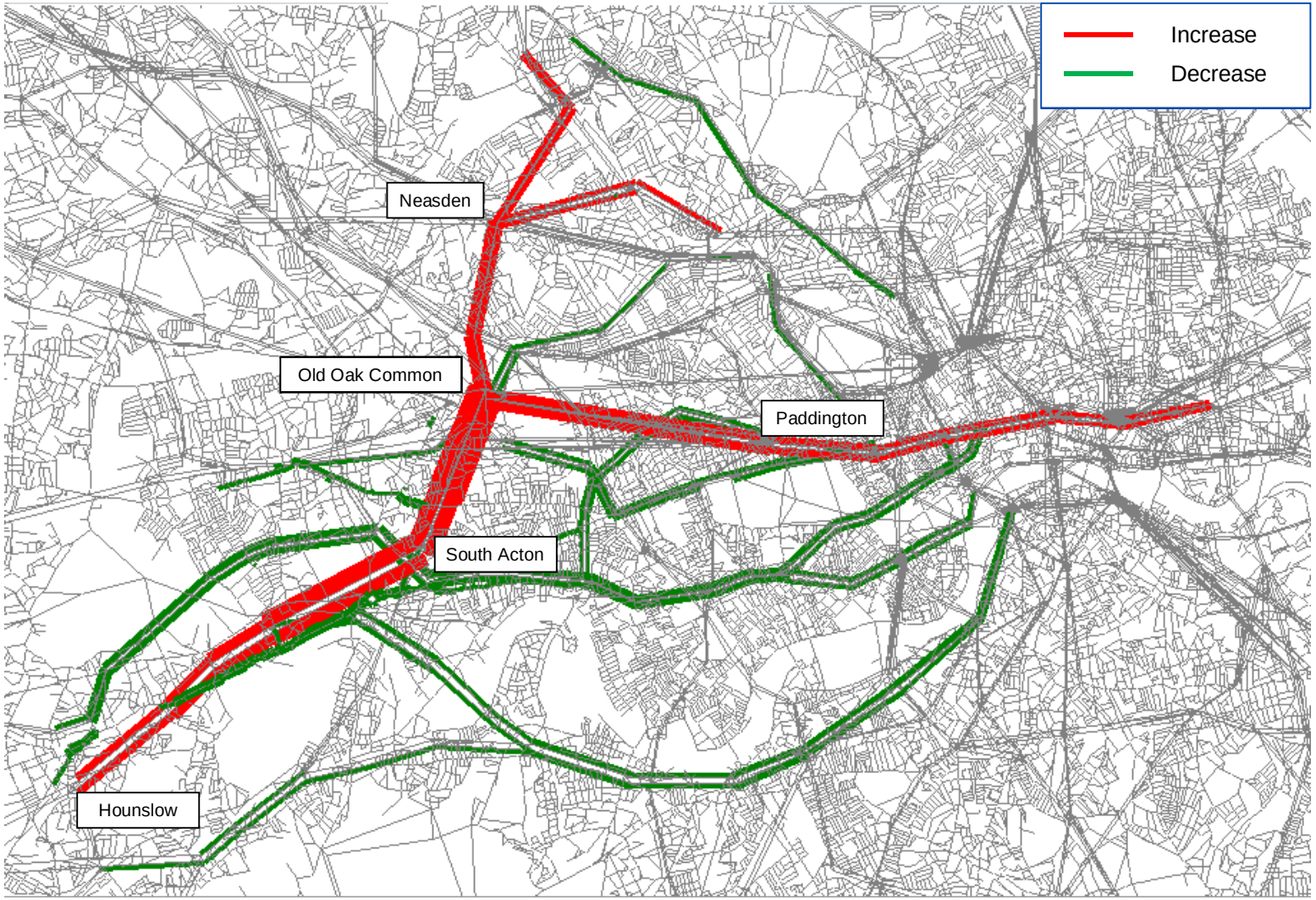
Passenger flow difference Option 2 minus Maximum Growth Scenario, PM



Passenger flow difference Option 3 minus Maximum Growth Scenario, AM



Passenger flow difference Option 3 minus Maximum Growth Scenario, PM



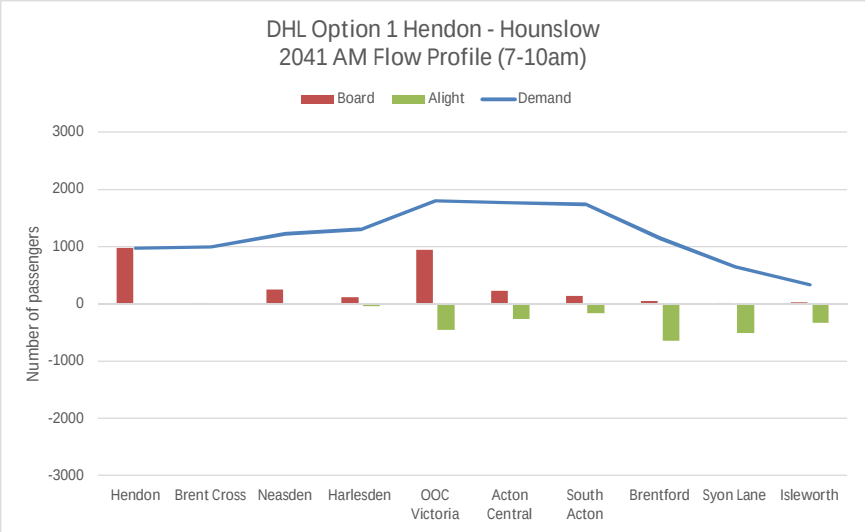
APPENDIX A-3

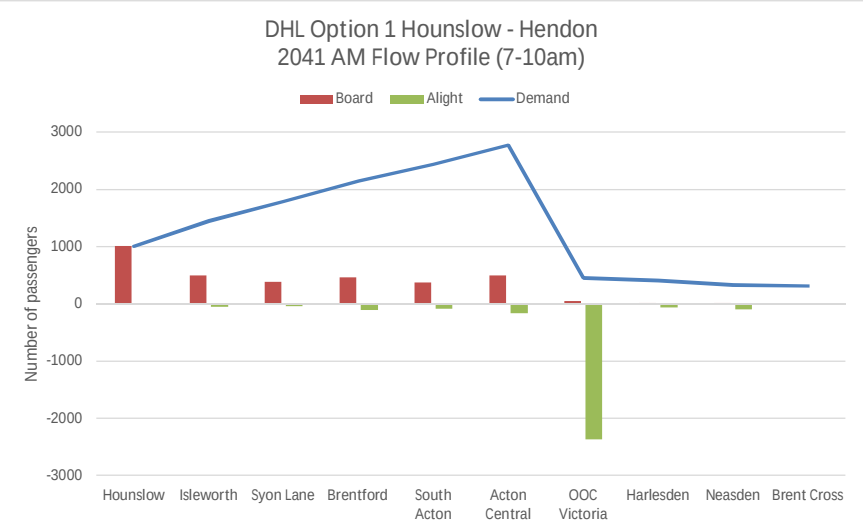
WLO LINE LOADING, BOARDINGS AND ALIGHTINGS

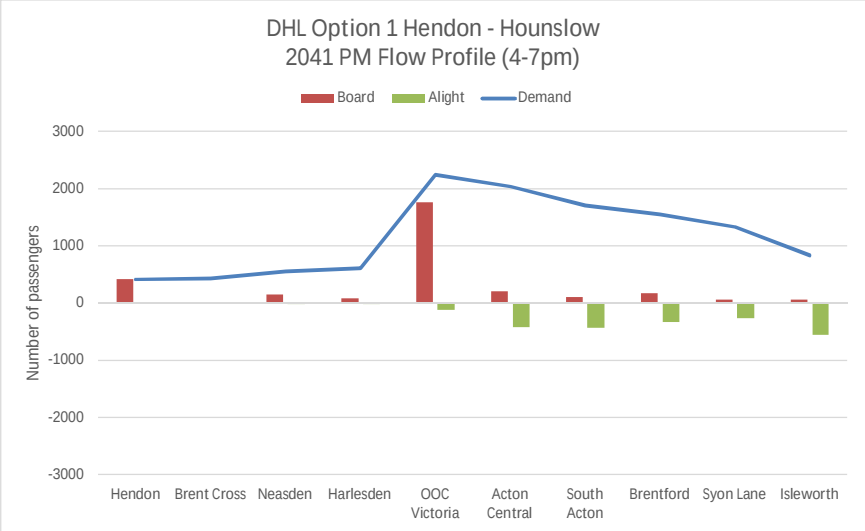
Baseline: **Standard LTS-PT 2041 Reference Case (A141rc01a)**

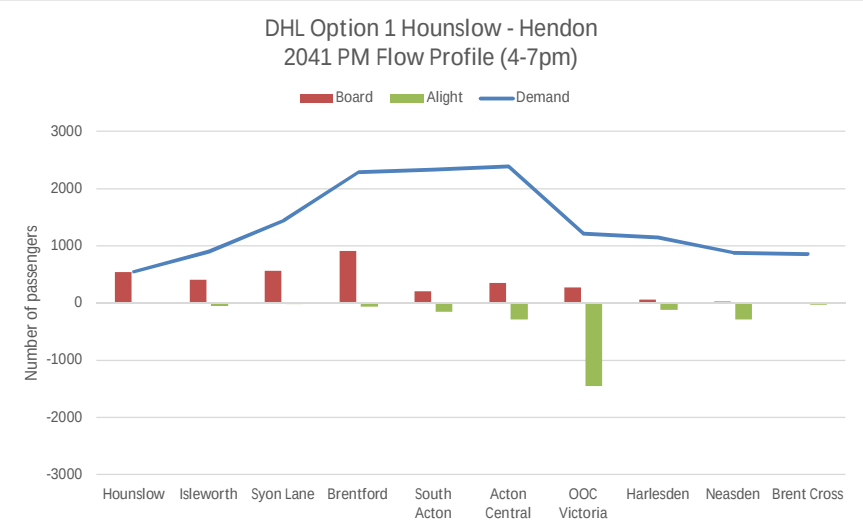
Option 1

					AM			PM		
Direction	From	To	NAME	LONGNAME	Demand	Board	Alight	Demand	Board	Alight
Southbound	Hendon	Brent Cross	DH001D	HENDON-HOUNSLOW	976	976	0	411	411	0
	Brent Cross	Neasden	DH001D	HENDON-HOUNSLOW	995	20	0	427	16	0
	Neasden	Harlesden	DH001D	HENDON-HOUNSLOW	1226	246	-15	550	149	-25
	Harlesden	OOC Victoria	DH001D	HENDON-HOUNSLOW	1299	112	-39	606	81	-25
	OOC Victoria	Acton Central	DH001D	HENDON-HOUNSLOW	1800	950	-449	2245	1762	-123
	Acton Central	South Acton	DH001D	HENDON-HOUNSLOW	1769	232	-263	2036	207	-417
	South Acton	Brentford	DH001D	HENDON-HOUNSLOW	1743	142	-169	1703	102	-434
	Brentford	Syon Lane	DH001D	HENDON-HOUNSLOW	1145	45	-642	1546	176	-333
	Syon Lane	Isleworth	DH001D	HENDON-HOUNSLOW	646	13	-512	1334	57	-269
	Isleworth	Hounslow	DH001D	HENDON-HOUNSLOW	333	23	-336	830	59	-562
Northbound	Hounslow	Isleworth	DH002U	HOUNSLOW-HENDON	1005	1005	0	546	546	0
	Isleworth	Syon Lane	DH002U	HOUNSLOW-HENDON	1451	500	-54	898	401	-49
	Syon Lane	Brentford	DH002U	HOUNSLOW-HENDON	1792	381	-40	1441	559	-16
	Brentford	South Acton	DH002U	HOUNSLOW-HENDON	2148	459	-103	2288	910	-63
	South Acton	Acton Central	DH002U	HOUNSLOW-HENDON	2444	378	-82	2336	204	-156
	Acton Central	OOC Victoria	DH002U	HOUNSLOW-HENDON	2779	496	-161	2390	346	-292
	OOC Victoria	Harlesden	DH002U	HOUNSLOW-HENDON	455	50	-2374	1209	274	-1455
	Harlesden	Neasden	DH002U	HOUNSLOW-HENDON	410	19	-63	1146	55	-118
	Neasden	Brent Cross	DH002U	HOUNSLOW-HENDON	326	17	-101	880	22	-289
	Brent Cross	Hendon	DH002U	HOUNSLOW-HENDON	312	0	-14	851	0	-29


DHL Option 1 Hendon - Hounslow
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hendon
Brent Cross
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth

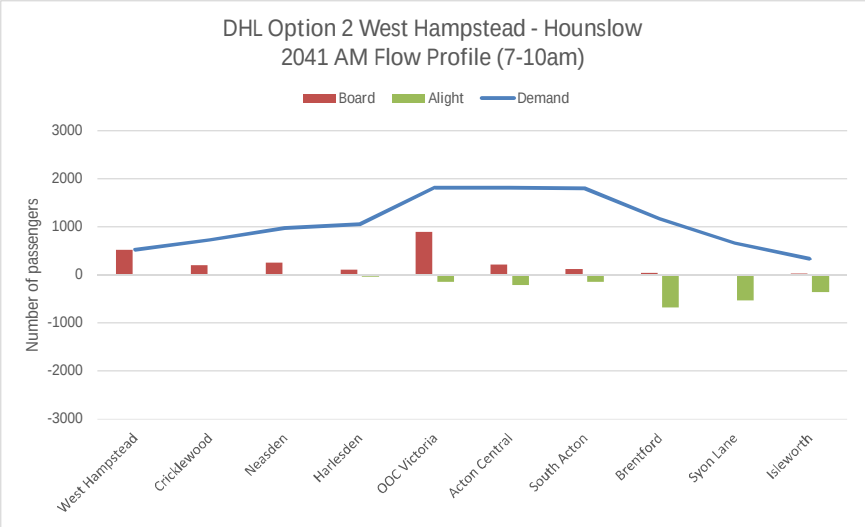

DHL Option 1 Hounslow - Hendon
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Brent Cross

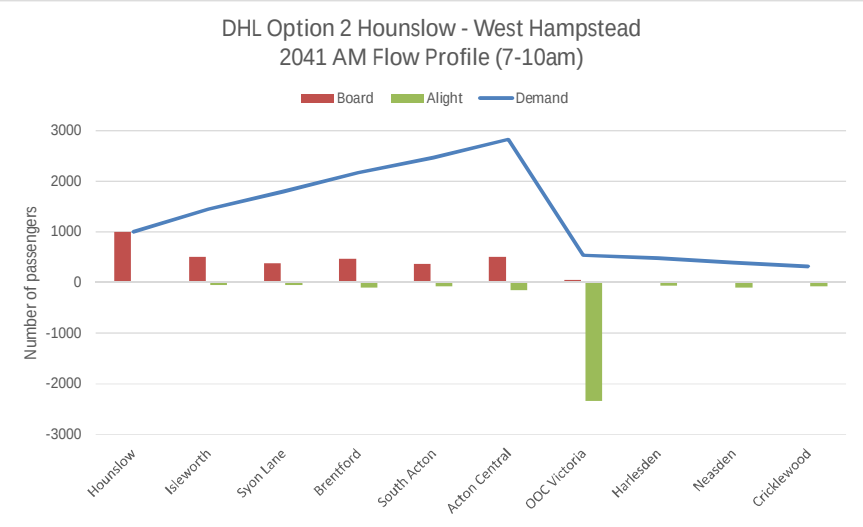

DHL Option 1 Hendon - Hounslow
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hendon
Brent Cross
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth

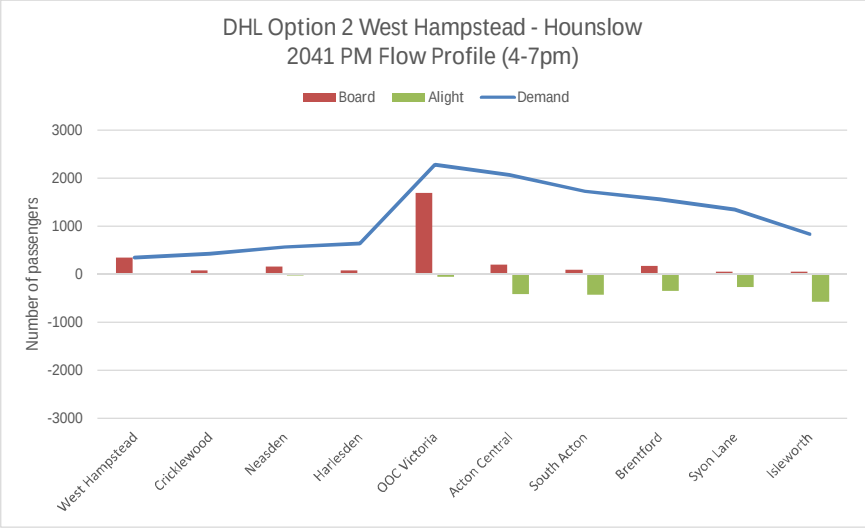

DHL Option 1 Hounslow - Hendon
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Brent Cross

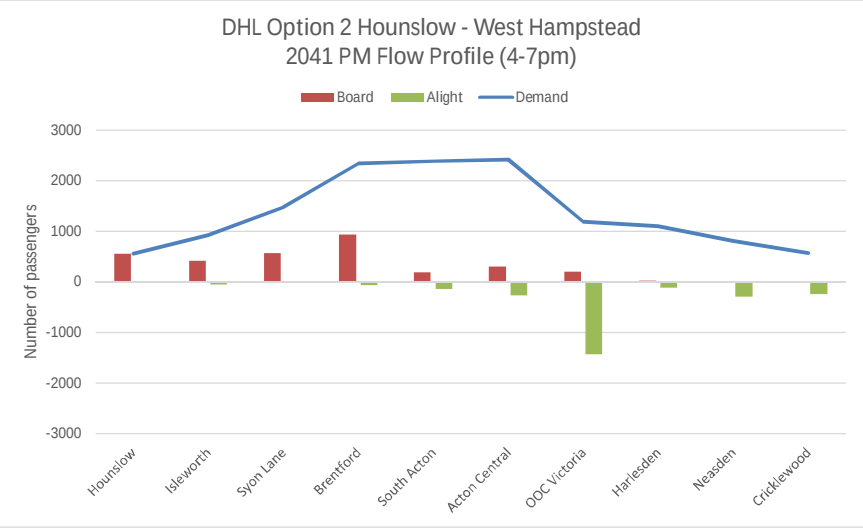
Option 2

					AM			PM		
Direction	From	To	NAME	LONGNAME	Demand	Board	Alight	Demand	Board	Alight
Southbound	West Hampstead	Cricklewood	DH003D	WESTHAMPSTEAD-HOUNSLOW	525	525	0	343	343	0
	Cricklewood	Neasden	DH003D	WESTHAMPSTEAD-HOUNSLOW	733	212	-3	425	85	-4
	Neasden	Harlesden	DH003D	WESTHAMPSTEAD-HOUNSLOW	980	259	-13	564	160	-20
	Harlesden	OOC Victoria	DH003D	WESTHAMPSTEAD-HOUNSLOW	1059	115	-36	636	83	-11
	OOC Victoria	Acton Central	DH003D	WESTHAMPSTEAD-HOUNSLOW	1820	901	-140	2281	1694	-50
	Acton Central	South Acton	DH003D	WESTHAMPSTEAD-HOUNSLOW	1818	215	-217	2063	202	-420
	South Acton	Brentford	DH003D	WESTHAMPSTEAD-HOUNSLOW	1803	124	-140	1726	95	-432
	Brentford	Syon Lane	DH003D	WESTHAMPSTEAD-HOUNSLOW	1177	45	-671	1560	176	-342
	Syon Lane	Isleworth	DH003D	WESTHAMPSTEAD-HOUNSLOW	666	13	-523	1344	57	-273
	Isleworth	Hounslow	DH003D	WESTHAMPSTEAD-HOUNSLOW	336	23	-353	830	59	-574
Northbound	Hounslow	Isleworth	DH004U	HOUNSLOW-WESTHAMPSTEAD	1005	1005	0	555	555	0
	Isleworth	Syon Lane	DH004U	HOUNSLOW-WESTHAMPSTEAD	1458	506	-54	920	414	-49
	Syon Lane	Brentford	DH004U	HOUNSLOW-WESTHAMPSTEAD	1805	387	-40	1471	568	-16
	Brentford	South Acton	DH004U	HOUNSLOW-WESTHAMPSTEAD	2173	471	-103	2340	932	-63
	South Acton	Acton Central	DH004U	HOUNSLOW-WESTHAMPSTEAD	2473	375	-75	2386	187	-141
	Acton Central	OOC Victoria	DH004U	HOUNSLOW-WESTHAMPSTEAD	2832	512	-153	2420	308	-273
	OOC Victoria	Harlesden	DH004U	HOUNSLOW-WESTHAMPSTEAD	544	51	-2339	1187	194	-1428
	Harlesden	Neasden	DH004U	HOUNSLOW-WESTHAMPSTEAD	485	4	-63	1094	25	-118
	Neasden	Cricklewood	DH004U	HOUNSLOW-WESTHAMPSTEAD	394	12	-102	813	7	-288
	Cricklewood	West Hampstead	DH004U	HOUNSLOW-WESTHAMPSTEAD	324	3	-73	570	1	-244


DHL Option 2 West Hampstead - Hounslow
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
West Hampstead
Cricklewood
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth


DHL Option 2 Hounslow - West Hampstead
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Cricklewood

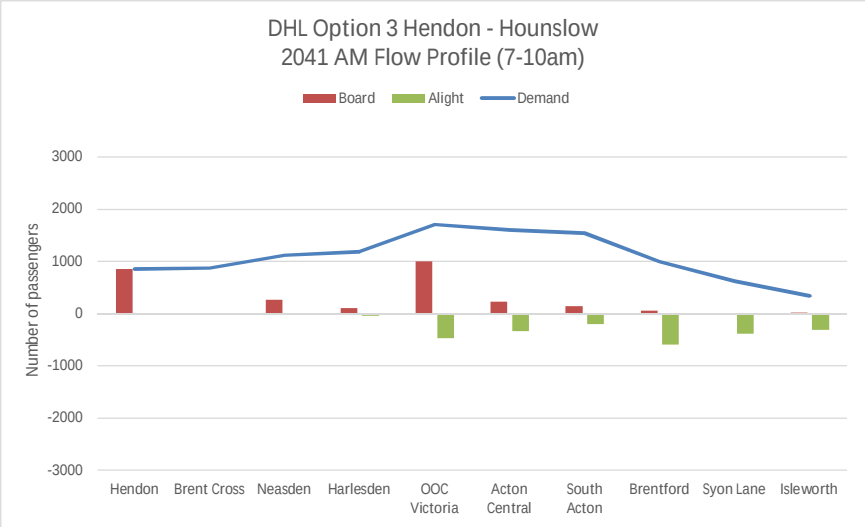

DHL Option 2 West Hampstead - Hounslow
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
West Hampstead
Cricklewood
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth

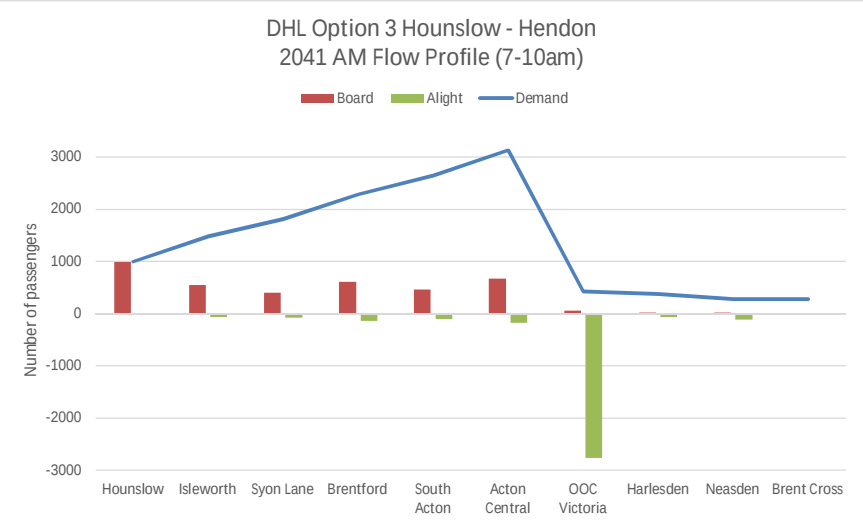

DHL Option 2 Hounslow - West Hampstead
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Cricklewood

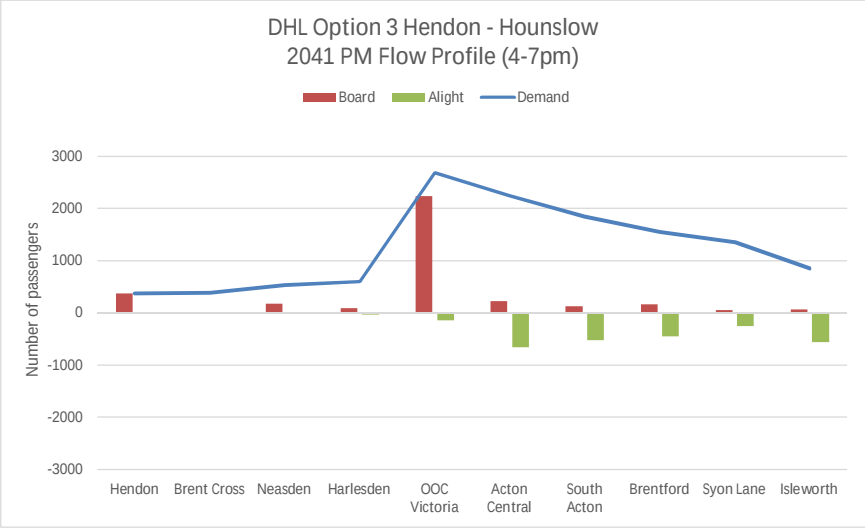
Option 3

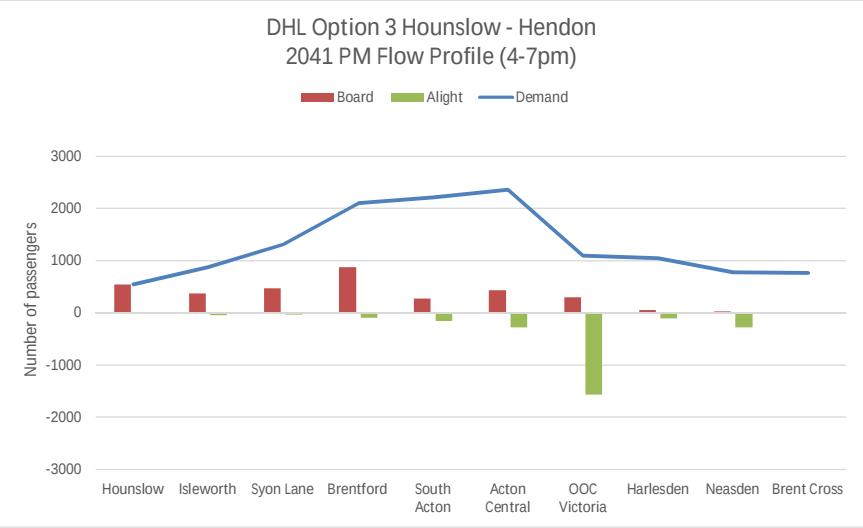
					AM			PM		
Direction	From	To	NAME	LONGNAME	Demand	Board	Alight	Demand	Board	Alight
Southbound	Hendon	Brent Cross	DH001D	HENDON-HOUNSLOW	855	855	0	373	373	0
	Brent Cross	Neasden	DH001D	HENDON-HOUNSLOW	870	15	0	384	11	0
	Neasden	Harlesden	DH001D	HENDON-HOUNSLOW	1118	264	-15	533	174	-25
	Harlesden	OOC Victoria	DH001D	HENDON-HOUNSLOW	1188	111	-41	597	91	-27
	OOC Victoria	Acton Central	DH001D	HENDON-HOUNSLOW	1710	998	-476	2682	2231	-146
	Acton Central	South Acton	DH001D	HENDON-HOUNSLOW	1602	222	-329	2240	223	-665
	South Acton	Brentford	DH001D	HENDON-HOUNSLOW	1542	142	-203	1840	129	-529
	Brentford	Syon Lane	DH001D	HENDON-HOUNSLOW	998	51	-595	1549	156	-447
	Syon Lane	Isleworth	DH001D	HENDON-HOUNSLOW	624	13	-387	1351	53	-251
	Isleworth	Hounslow	DH001D	HENDON-HOUNSLOW	342	25	-307	848	62	-565
Northbound	Hounslow	Isleworth	DH002U	HOUNSLOW-HENDON	996	996	0	546	546	0
	Isleworth	Syon Lane	DH002U	HOUNSLOW-HENDON	1479	551	-68	870	373	-49
	Syon Lane	Brentford	DH002U	HOUNSLOW-HENDON	1809	407	-77	1311	468	-28
	Brentford	South Acton	DH002U	HOUNSLOW-HENDON	2284	613	-138	2096	880	-95
	South Acton	Acton Central	DH002U	HOUNSLOW-HENDON	2645	461	-100	2207	269	-158
	Acton Central	OOC Victoria	DH002U	HOUNSLOW-HENDON	3127	664	-182	2357	427	-278
	OOC Victoria	Harlesden	DH002U	HOUNSLOW-HENDON	425	62	-2765	1092	301	-1566
	Harlesden	Neasden	DH002U	HOUNSLOW-HENDON	376	19	-67	1040	59	-110
	Neasden	Brent Cross	DH002U	HOUNSLOW-HENDON	282	16	-110	778	22	-285
	Brent Cross	Hendon	DH002U	HOUNSLOW-HENDON	273	0	-9	762	0	-16

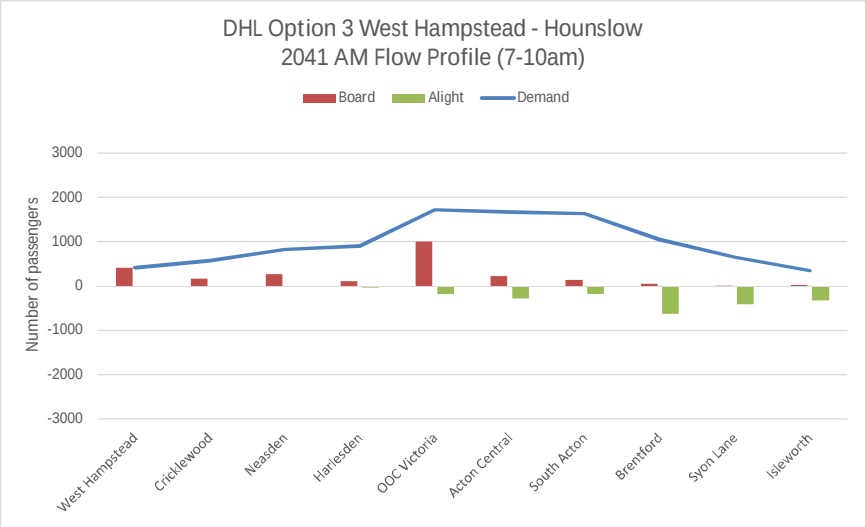
					AM			PM		
Direction	From	To	NAME	LONGNAME	Demand	Board	Alight	Demand	Board	Alight
Southbound	West Hampstead	Cricklewood	DH003D	WESTHAMPSTEAD-HOUNSLOW	410	410	0	234	234	0
	Cricklewood	Neasden	DH003D	WESTHAMPSTEAD-HOUNSLOW	575	168	-3	296	65	-4
	Neasden	Harlesden	DH003D	WESTHAMPSTEAD-HOUNSLOW	826	264	-13	449	174	-20
	Harlesden	OOC Victoria	DH003D	WESTHAMPSTEAD-HOUNSLOW	901	111	-37	527	91	-13
	OOC Victoria	Acton Central	DH003D	WESTHAMPSTEAD-HOUNSLOW	1722	997	-176	2683	2230	-74
	Acton Central	South Acton	DH003D	WESTHAMPSTEAD-HOUNSLOW	1664	222	-279	2250	223	-656
	South Acton	Brentford	DH003D	WESTHAMPSTEAD-HOUNSLOW	1633	142	-173	1855	129	-523
	Brentford	Syon Lane	DH003D	WESTHAMPSTEAD-HOUNSLOW	1049	52	-636	1561	157	-452
	Syon Lane	Isleworth	DH003D	WESTHAMPSTEAD-HOUNSLOW	651	13	-410	1360	53	-254
	Isleworth	Hounslow	DH003D	WESTHAMPSTEAD-HOUNSLOW	347	25	-329	847	62	-574
Northbound	Hounslow	Isleworth	DH004U	HOUNSLOW-WESTHAMPSTEAD	989	989	0	545	545	0
	Isleworth	Syon Lane	DH004U	HOUNSLOW-WESTHAMPSTEAD	1472	551	-68	875	378	-49
	Syon Lane	Brentford	DH004U	HOUNSLOW-WESTHAMPSTEAD	1804	409	-76	1318	471	-27
	Brentford	South Acton	DH004U	HOUNSLOW-WESTHAMPSTEAD	2285	617	-136	2110	887	-95
	South Acton	Acton Central	DH004U	HOUNSLOW-WESTHAMPSTEAD	2640	453	-98	2204	249	-156
	Acton Central	OOC Victoria	DH004U	HOUNSLOW-WESTHAMPSTEAD	3118	657	-180	2309	381	-276
	OOC Victoria	Harlesden	DH004U	HOUNSLOW-WESTHAMPSTEAD	425	64	-2757	970	222	-1560
	Harlesden	Neasden	DH004U	HOUNSLOW-WESTHAMPSTEAD	362	5	-67	888	29	-111
	Neasden	Cricklewood	DH004U	HOUNSLOW-WESTHAMPSTEAD	262	12	-112	612	8	-284
	Cricklewood	West Hampstead	DH004U	HOUNSLOW-WESTHAMPSTEAD	209	3	-56	429	1	-183

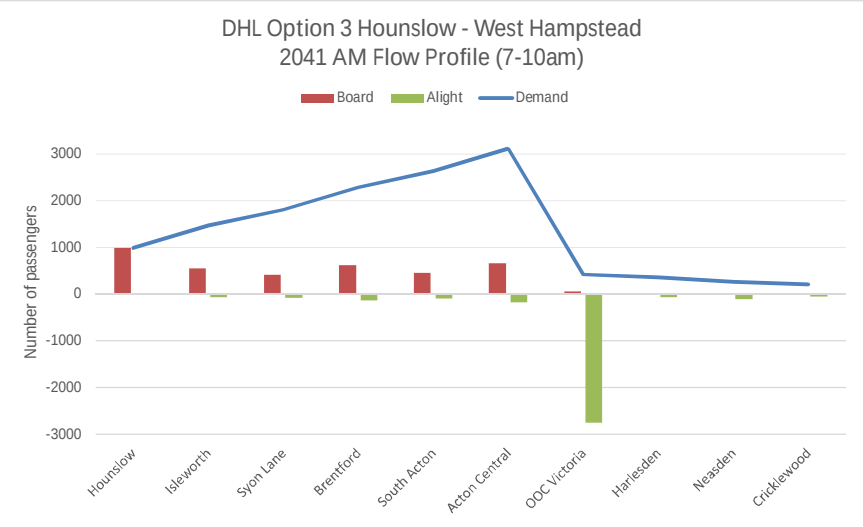

DHL Option 3 Hendon - Hounslow
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hendon
Brent Cross
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth

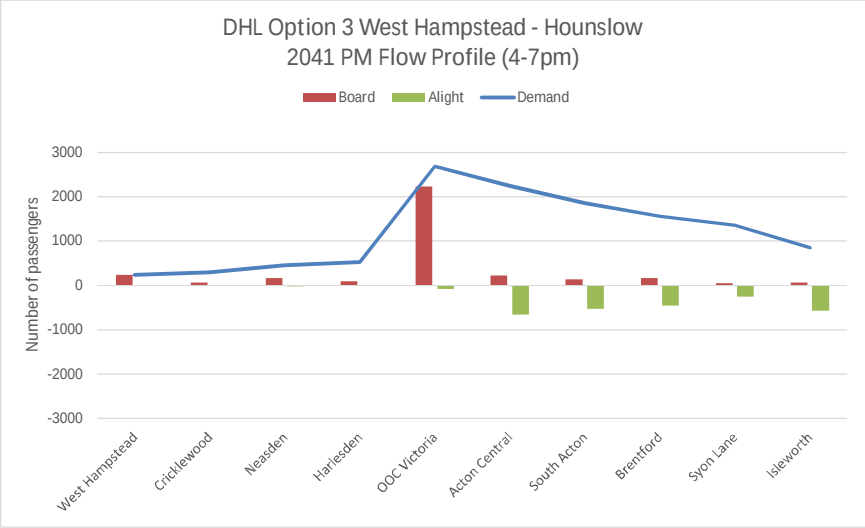

DHL Option 3 Hounslow - Hendon
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Brent Cross

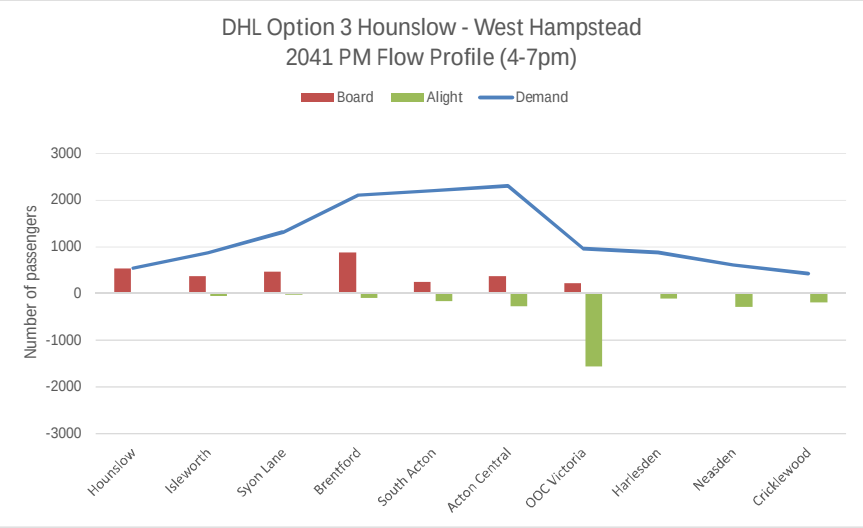

DHL Option 3 Hendon - Hounslow
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hendon
Brent Cross
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth


DHL Option 3 Hounslow - Hendon
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Brent Cross


DHL Option 3 West Hampstead - Hounslow
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
West Hampstead
Cricklewood
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth


DHL Option 3 Hounslow - West Hampstead
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Cricklewood

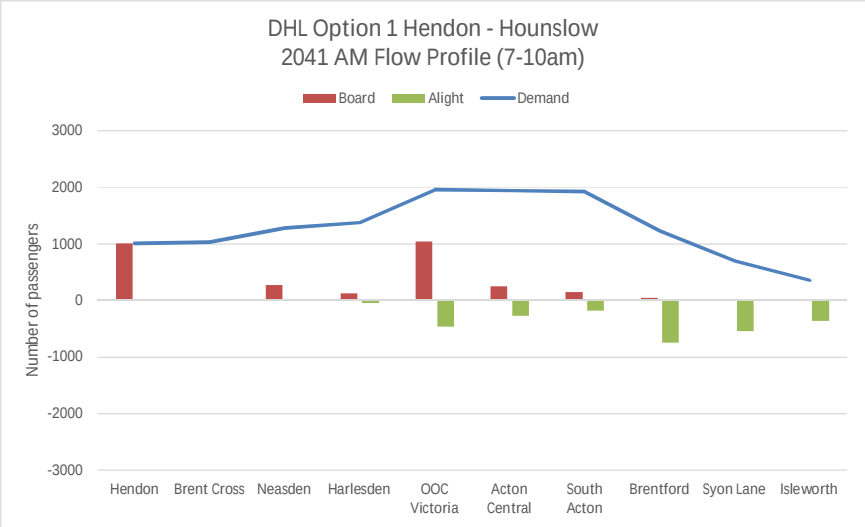

DHL Option 3 West Hampstead - Hounslow
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
West Hampstead
Cricklewood
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth


DHL Option 3 Hounslow - West Hampstead
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Cricklewood

Baseline: **2041 Maximum Growth Scenario without Crossrail 2**

Option 1

					AM			PM		
Direction	From	To	NAME	LONGNAME	Demand	Board	Alight	Demand	Board	Alight
Southbound	Hendon	Brent Cross	DH001D	HENDON-HOUNSLOW	1011	1011	0	471	471	0
	Brent Cross	Neasden	DH001D	HENDON-HOUNSLOW	1032	21	0	488	17	0
	Neasden	Harlesden	DH001D	HENDON-HOUNSLOW	1286	269	-15	613	152	-27
	Harlesden	OOC Victoria	DH001D	HENDON-HOUNSLOW	1379	132	-38	663	80	-30
	OOC Victoria	Acton Central	DH001D	HENDON-HOUNSLOW	1960	1044	-463	2242	1737	-157
	Acton Central	South Acton	DH001D	HENDON-HOUNSLOW	1945	255	-269	2017	202	-428
	South Acton	Brentford	DH001D	HENDON-HOUNSLOW	1926	154	-174	1672	98	-442
	Brentford	Syon Lane	DH001D	HENDON-HOUNSLOW	1230	46	-741	1528	184	-329
	Syon Lane	Isleworth	DH001D	HENDON-HOUNSLOW	698	13	-545	1323	56	-262
	Isleworth	Hounslow	DH001D	HENDON-HOUNSLOW	359	23	-362	829	59	-553
Northbound	Hounslow	Isleworth	DH002U	HOUNSLOW-HENDON	989	989	0	585	585	0
	Isleworth	Syon Lane	DH002U	HOUNSLOW-HENDON	1422	486	-54	967	431	-49
	Syon Lane	Brentford	DH002U	HOUNSLOW-HENDON	1751	369	-39	1541	591	-16
	Brentford	South Acton	DH002U	HOUNSLOW-HENDON	2088	444	-108	2535	1057	-64
	South Acton	Acton Central	DH002U	HOUNSLOW-HENDON	2388	378	-78	2576	209	-168
	Acton Central	OOC Victoria	DH002U	HOUNSLOW-HENDON	2734	500	-153	2611	355	-320
	OOC Victoria	Harlesden	DH002U	HOUNSLOW-HENDON	492	66	-2308	1319	299	-1591
	Harlesden	Neasden	DH002U	HOUNSLOW-HENDON	454	24	-62	1235	55	-139
	Neasden	Brent Cross	DH002U	HOUNSLOW-HENDON	372	19	-101	938	22	-319
	Brent Cross	Hendon	DH002U	HOUNSLOW-HENDON	357	0	-15	907	0	-31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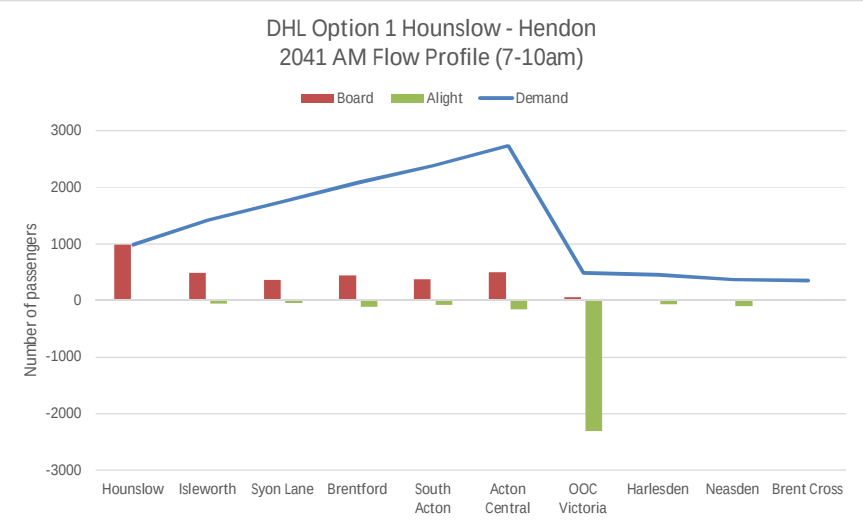
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hendon
Brent Cross
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth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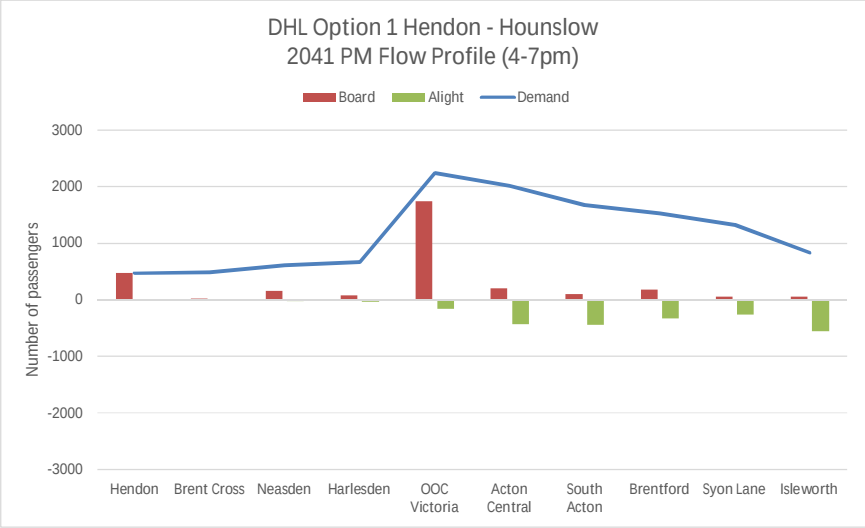
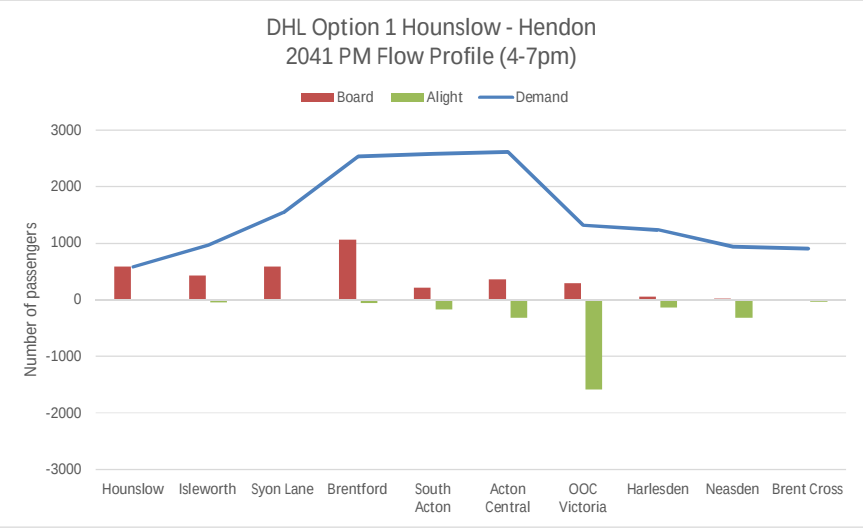
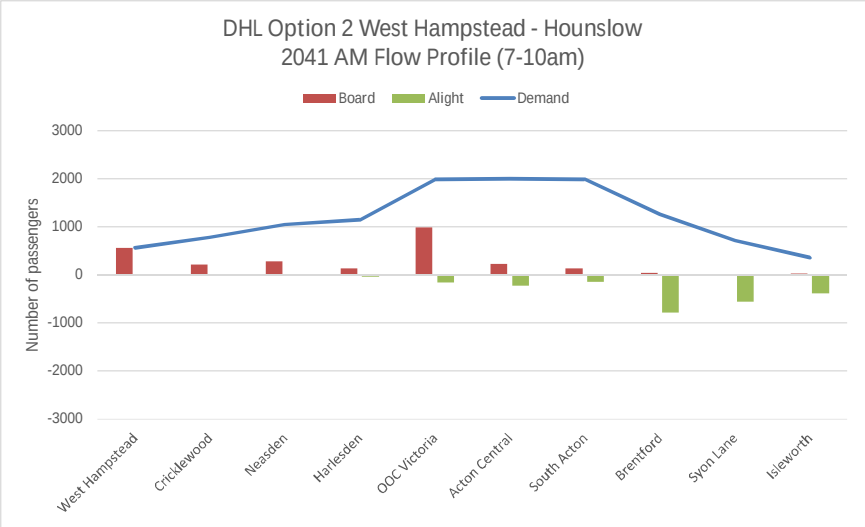
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Brent Cross


DHL Option 1 Hendon - Hounslow
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hendon
Brent Cross
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth


DHL Option 1 Hounslow - Hendon
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Brent Cross

Option 2

					AM			PM		
Direction	From	To	NAME	LONGNAME	Demand	Board	Alight	Demand	Board	Alight
Southbound	West Hampstead	Cricklewood	DH003D	WESTHAMPSTEAD-HOUNSLOW	563	563	0	356	356	0
	Cricklewood	Neasden	DH003D	WESTHAMPSTEAD-HOUNSLOW	783	224	-3	451	99	-4
	Neasden	Harlesden	DH003D	WESTHAMPSTEAD-HOUNSLOW	1054	283	-12	592	163	-22
	Harlesden	OOC Victoria	DH003D	WESTHAMPSTEAD-HOUNSLOW	1152	135	-36	660	82	-14
	OOC Victoria	Acton Central	DH003D	WESTHAMPSTEAD-HOUNSLOW	1989	988	-151	2272	1671	-59
	Acton Central	South Acton	DH003D	WESTHAMPSTEAD-HOUNSLOW	2003	237	-223	2042	197	-427
	South Acton	Brentford	DH003D	WESTHAMPSTEAD-HOUNSLOW	1995	136	-144	1693	91	-440
	Brentford	Syon Lane	DH003D	WESTHAMPSTEAD-HOUNSLOW	1262	46	-779	1542	185	-336
	Syon Lane	Isleworth	DH003D	WESTHAMPSTEAD-HOUNSLOW	718	13	-557	1333	56	-265
	Isleworth	Hounslow	DH003D	WESTHAMPSTEAD-HOUNSLOW	362	23	-380	828	59	-564
Northbound	Hounslow	Isleworth	DH004U	HOUNSLOW-WESTHAMPSTEAD	988	988	0	594	594	0
	Isleworth	Syon Lane	DH004U	HOUNSLOW-WESTHAMPSTEAD	1426	492	-54	989	444	-49
	Syon Lane	Brentford	DH004U	HOUNSLOW-WESTHAMPSTEAD	1761	375	-39	1573	600	-16
	Brentford	South Acton	DH004U	HOUNSLOW-WESTHAMPSTEAD	2109	456	-108	2595	1086	-64
	South Acton	Acton Central	DH004U	HOUNSLOW-WESTHAMPSTEAD	2412	374	-71	2634	192	-153
	Acton Central	OOC Victoria	DH004U	HOUNSLOW-WESTHAMPSTEAD	2777	511	-145	2650	316	-300
	OOC Victoria	Harlesden	DH004U	HOUNSLOW-WESTHAMPSTEAD	558	57	-2277	1303	212	-1560
	Harlesden	Neasden	DH004U	HOUNSLOW-WESTHAMPSTEAD	501	5	-62	1190	26	-138
	Neasden	Cricklewood	DH004U	HOUNSLOW-WESTHAMPSTEAD	412	12	-102	879	7	-318
	Cricklewood	West Hampstead	DH004U	HOUNSLOW-WESTHAMPSTEAD	332	3	-82	617	1	-263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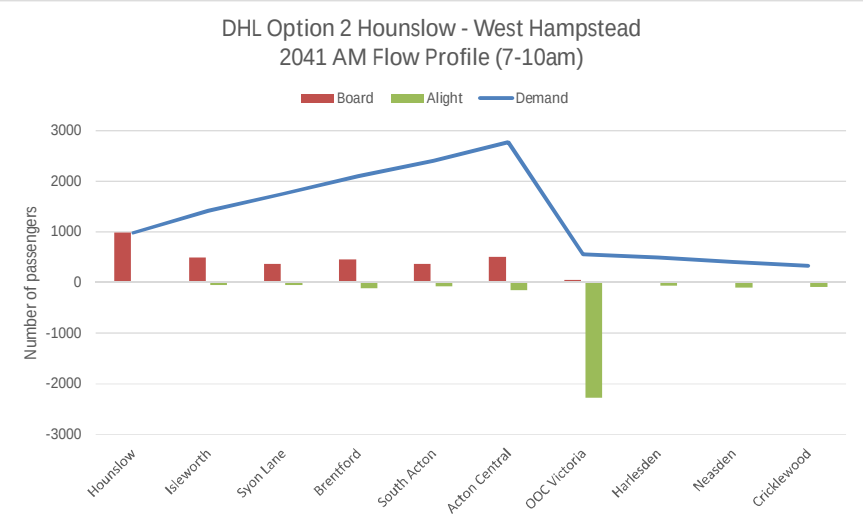
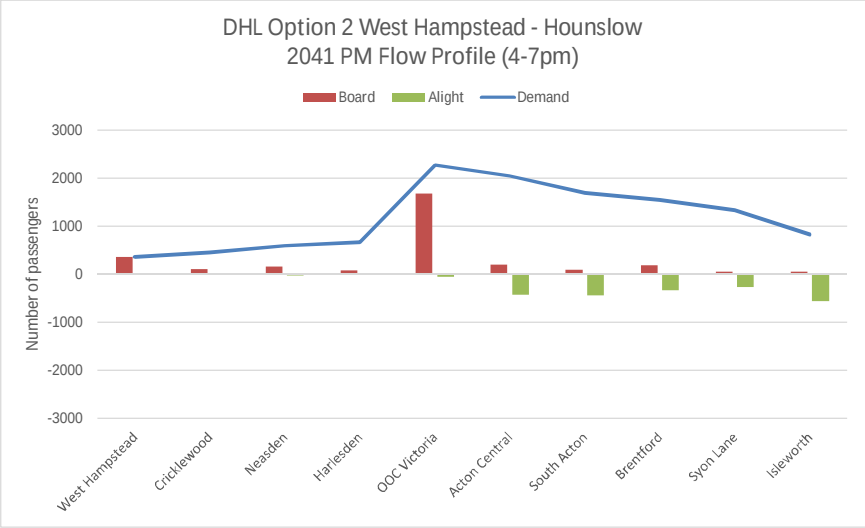
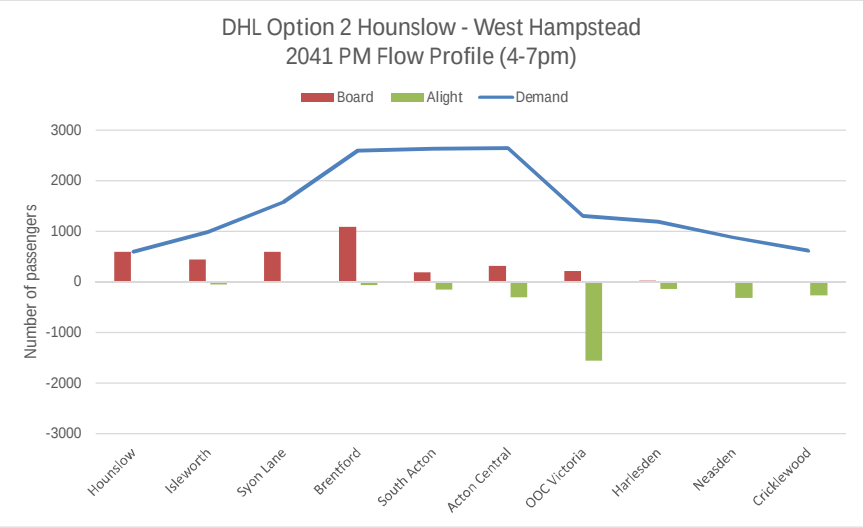
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
West Hampstead
Cricklewood
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth


DHL Option 2 Hounslow - West Hampstead
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Cricklewood

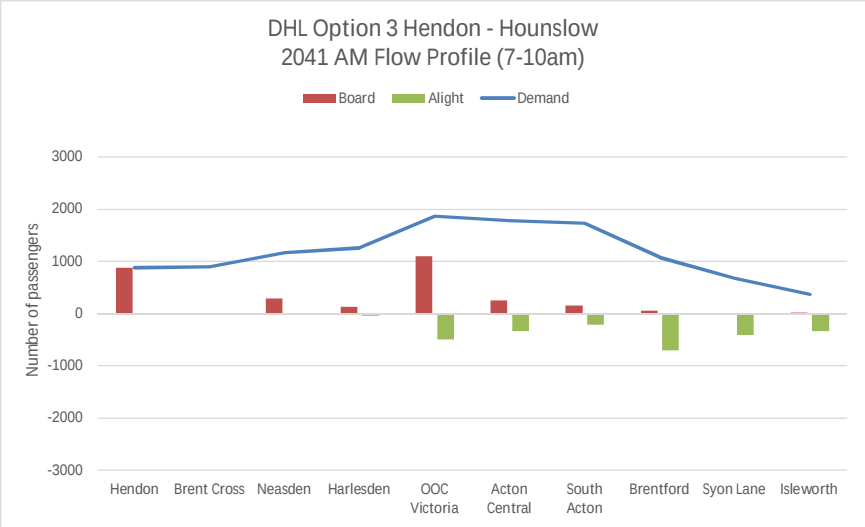

DHL Option 2 West Hampstead - Hounslow
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
West Hampstead
Cricklewood
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth

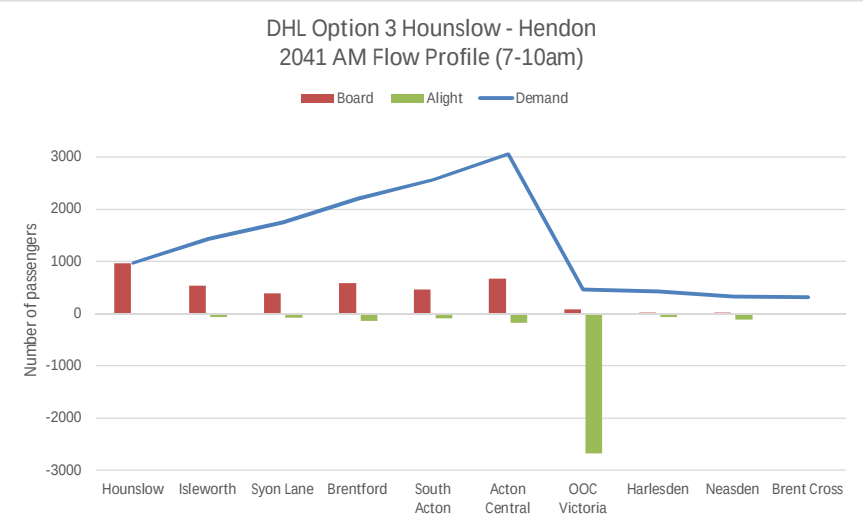

DHL Option 2 Hounslow - West Hampstead
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Cricklewood

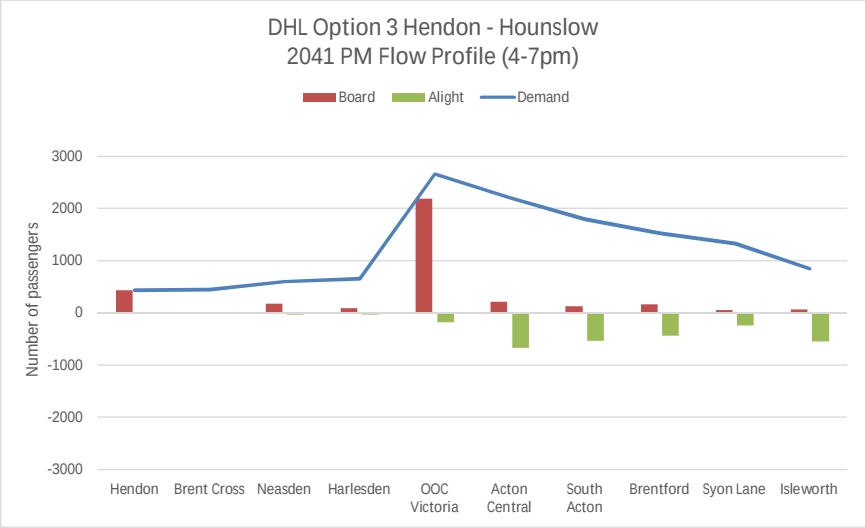
Option 3

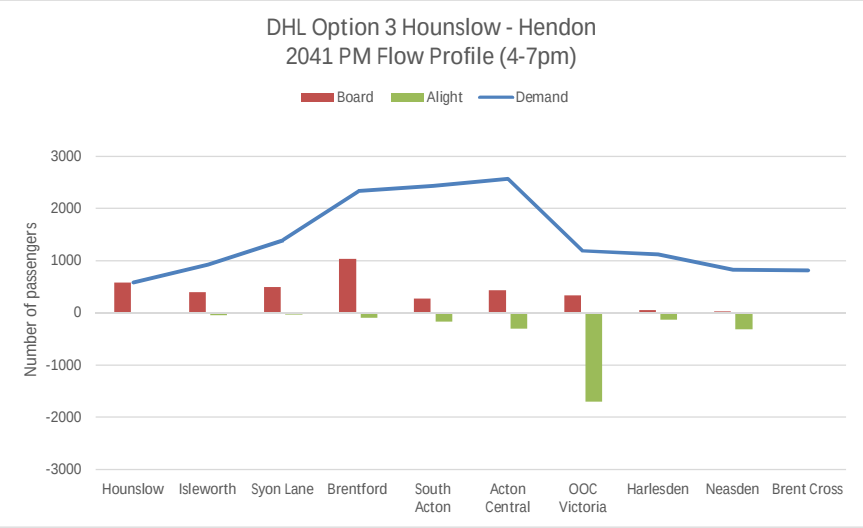
					AM			PM		
Direction	From	To	NAME	LONGNAME	Demand	Board	Alight	Demand	Board	Alight
Southbound	Hendon	Brent Cross	DH001D	HENDON-HOUNSLOW	883	883	0	431	431	0
	Brent Cross	Neasden	DH001D	HENDON-HOUNSLOW	899	16	0	443	12	0
	Neasden	Harlesden	DH001D	HENDON-HOUNSLOW	1171	287	-15	594	179	-27
	Harlesden	OOC Victoria	DH001D	HENDON-HOUNSLOW	1263	133	-40	653	91	-32
	OOC Victoria	Acton Central	DH001D	HENDON-HOUNSLOW	1869	1099	-492	2658	2184	-179
	Acton Central	South Acton	DH001D	HENDON-HOUNSLOW	1784	250	-336	2203	217	-672
	South Acton	Brentford	DH001D	HENDON-HOUNSLOW	1733	159	-210	1796	124	-532
	Brentford	Syon Lane	DH001D	HENDON-HOUNSLOW	1076	52	-708	1523	164	-436
	Syon Lane	Isleworth	DH001D	HENDON-HOUNSLOW	676	13	-413	1330	52	-245
	Isleworth	Hounslow	DH001D	HENDON-HOUNSLOW	369	25	-331	839	62	-553
Northbound	Hounslow	Isleworth	DH002U	HOUNSLOW-HENDON	969	969	0	581	581	0
	Isleworth	Syon Lane	DH002U	HOUNSLOW-HENDON	1434	532	-67	927	395	-49
	Syon Lane	Brentford	DH002U	HOUNSLOW-HENDON	1753	393	-75	1391	492	-28
	Brentford	South Acton	DH002U	HOUNSLOW-HENDON	2200	589	-141	2329	1036	-98
	South Acton	Acton Central	DH002U	HOUNSLOW-HENDON	2564	459	-95	2434	278	-172
	Acton Central	OOC Victoria	DH002U	HOUNSLOW-HENDON	3055	665	-174	2567	438	-305
	OOC Victoria	Harlesden	DH002U	HOUNSLOW-HENDON	462	80	-2673	1186	327	-1707
	Harlesden	Neasden	DH002U	HOUNSLOW-HENDON	420	23	-66	1114	58	-130
	Neasden	Brent Cross	DH002U	HOUNSLOW-HENDON	326	18	-112	825	22	-310
	Brent Cross	Hendon	DH002U	HOUNSLOW-HENDON	316	0	-10	808	0	-18

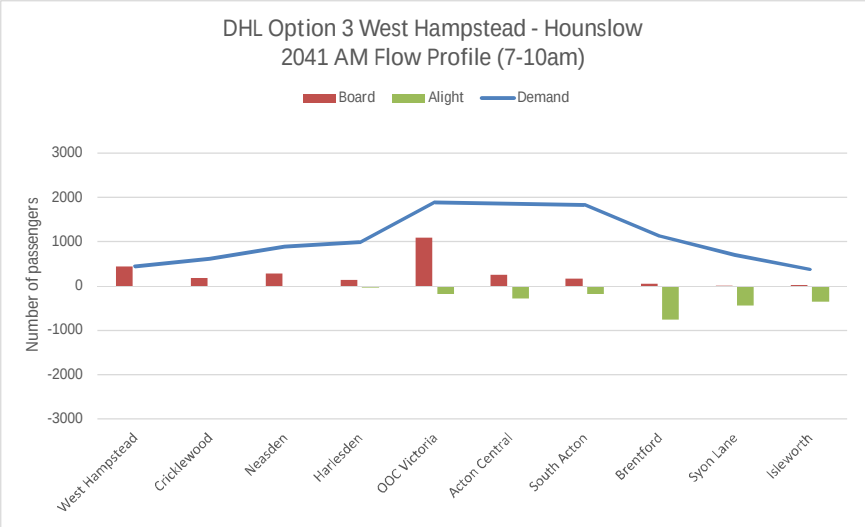
					AM			PM		
Direction	From	To	NAME	LONGNAME	Demand	Board	Alight	Demand	Board	Alight
Southbound	West Hampstead	Cricklewood	DH003D	WESTHAMPSTEAD-HOUNSLOW	440	440	0	249	249	0
	Cricklewood	Neasden	DH003D	WESTHAMPSTEAD-HOUNSLOW	614	177	-3	321	76	-4
	Neasden	Harlesden	DH003D	WESTHAMPSTEAD-HOUNSLOW	889	287	-12	478	179	-22
	Harlesden	OOC Victoria	DH003D	WESTHAMPSTEAD-HOUNSLOW	984	132	-38	553	91	-15
	OOC Victoria	Acton Central	DH003D	WESTHAMPSTEAD-HOUNSLOW	1887	1093	-189	2653	2184	-84
	Acton Central	South Acton	DH003D	WESTHAMPSTEAD-HOUNSLOW	1850	249	-286	2210	217	-660
	South Acton	Brentford	DH003D	WESTHAMPSTEAD-HOUNSLOW	1829	159	-180	1809	124	-525
	Brentford	Syon Lane	DH003D	WESTHAMPSTEAD-HOUNSLOW	1125	52	-756	1534	165	-440
	Syon Lane	Isleworth	DH003D	WESTHAMPSTEAD-HOUNSLOW	702	13	-436	1338	52	-248
	Isleworth	Hounslow	DH003D	WESTHAMPSTEAD-HOUNSLOW	374	25	-353	838	62	-562
Northbound	Hounslow	Isleworth	DH004U	HOUNSLOW-WESTHAMPSTEAD	961	961	0	581	581	0
	Isleworth	Syon Lane	DH004U	HOUNSLOW-WESTHAMPSTEAD	1425	531	-67	933	401	-49
	Syon Lane	Brentford	DH004U	HOUNSLOW-WESTHAMPSTEAD	1745	394	-74	1400	495	-28
	Brentford	South Acton	DH004U	HOUNSLOW-WESTHAMPSTEAD	2198	592	-140	2348	1046	-98
	South Acton	Acton Central	DH004U	HOUNSLOW-WESTHAMPSTEAD	2554	450	-93	2436	258	-170
	Acton Central	OOC Victoria	DH004U	HOUNSLOW-WESTHAMPSTEAD	3034	653	-173	2524	391	-303
	OOC Victoria	Harlesden	DH004U	HOUNSLOW-WESTHAMPSTEAD	437	71	-2668	1064	241	-1701
	Harlesden	Neasden	DH004U	HOUNSLOW-WESTHAMPSTEAD	377	5	-66	962	29	-131
	Neasden	Cricklewood	DH004U	HOUNSLOW-WESTHAMPSTEAD	275	12	-114	660	7	-310
	Cricklewood	West Hampstead	DH004U	HOUNSLOW-WESTHAMPSTEAD	215	3	-64	465	1	-196

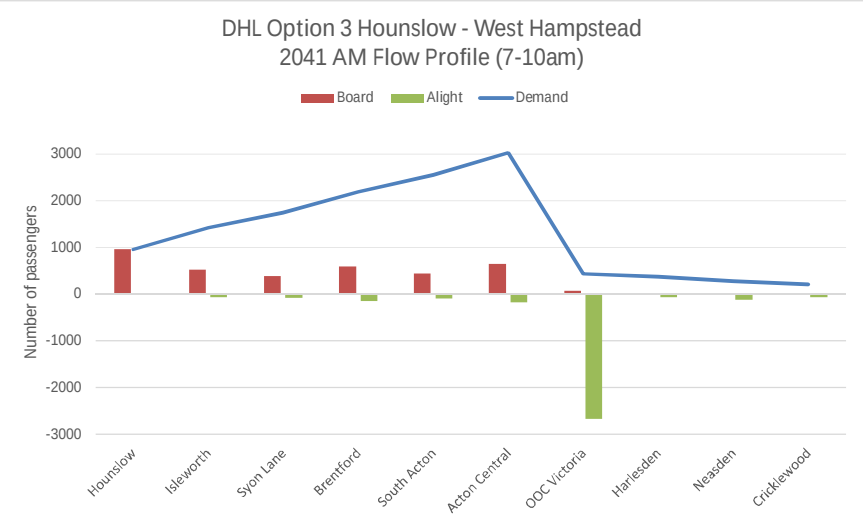

DHL Option 3 Hendon - Hounslow
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hendon
Brent Cross
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth

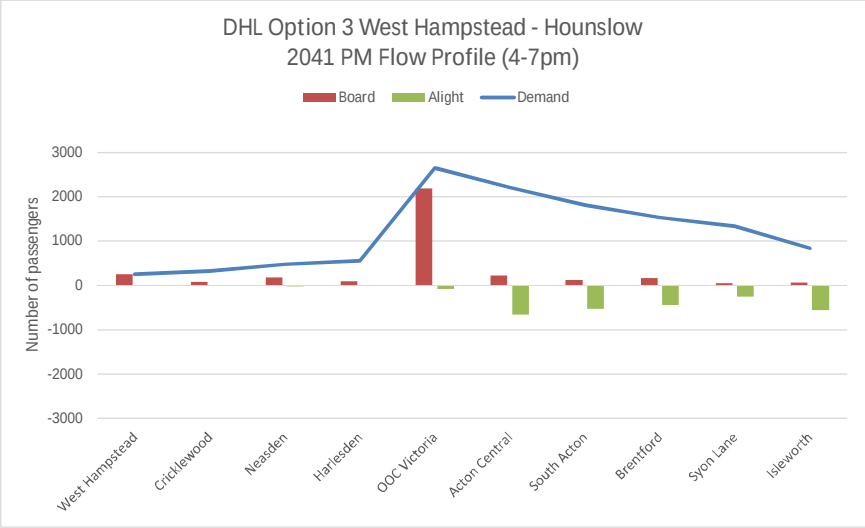

DHL Option 3 Hounslow - Hendon
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Brent Cross

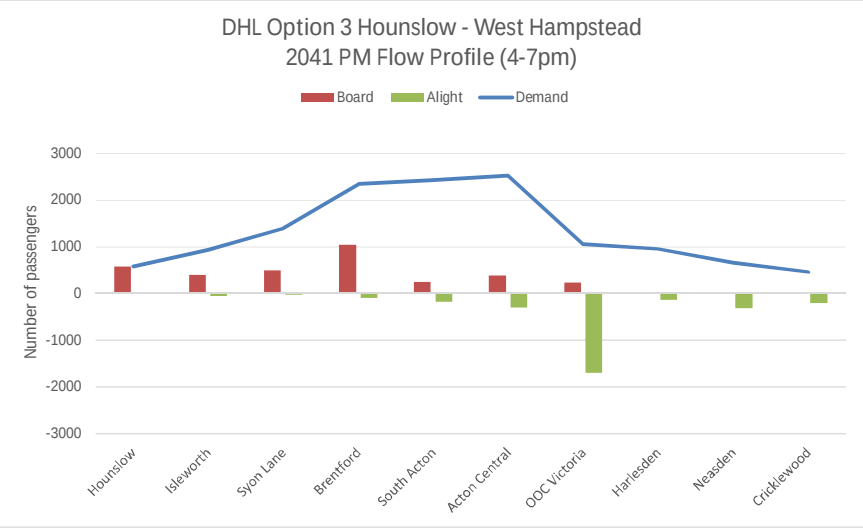

DHL Option 3 Hendon - Hounslow
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hendon
Brent Cross
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth


DHL Option 3 Hounslow - Hendon
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Brent Cross


DHL Option 3 West Hampstead - Hounslow
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
West Hampstead
Cricklewood
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth


DHL Option 3 Hounslow - West Hampstead
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Cricklewood


DHL Option 3 West Hampstead - Hounslow
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
West Hampstead
Cricklewood
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth


DHL Option 3 Hounslow - West Hampstead
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Cricklewood

Appendix B

DEMAND ANALYSIS. PREFERRED OPTION

APPENDIX B-1

GLOBAL STATISTICS

This section presents key model statistics at a global level for each AM Peak and PM Peak scenario modelled, as well as differences in the model statistics between the preferred option scenario and its associated baseline scenario.

Baseline: Standard LTS-PT 2041 Reference Case (A141rc01a)

Mode	Peak	*Description*	*2041 TfL Ref Case*	*Dudding Hill Preferred Option*	*Difference*
		Scenario	A141rc01a	A141DH07a	A141DH07a-A141rc01a
Rail	AM	Passenger Kms	61,984,155	62,033,637	49,482
		Uncrowded Passenger Hrs	57,719,229	57,789,782	70,553
		Crowded Passenger Hrs	77,959,930	78,023,714	63,783
		Passenger Boardings	1,937,480	1,946,854	9,374
	PM	Passenger Kms	63,991,947	64,049,804	57,857
		Uncrowded Passenger Hrs	57,473,633	57,570,553	96,920
		Crowded Passenger Hrs	73,205,216	73,306,027	100,811
		Passenger Boardings	1,996,416	2,005,744	9,327
LUL	AM	Passenger Kms	16,267,356	16,207,276	-60,080
		Uncrowded Passenger Hrs	29,182,762	29,067,435	-115,327
		Crowded Passenger Hrs	43,191,304	42,944,197	-247,107
		Passenger Boardings	2,272,048	2,265,807	-6,241
	PM	Passenger Kms	16,552,743	16,491,977	-60,766
		Uncrowded Passenger Hrs	30,074,167	29,957,067	-117,100
		Crowded Passenger Hrs	41,269,408	41,031,203	-238,205
		Passenger Boardings	2,416,620	2,410,510	-6,110
Bus	AM	Passenger Kms	6,749,006	6,726,693	-22,313
		Uncrowded Passenger Hrs	26,478,568	26,383,592	-94,976
		Crowded Passenger Hrs	30,735,987	30,602,227	-133,759
		Passenger Boardings	1,852,325	1,847,392	-4,932
	PM	Passenger Kms	8,199,665	8,175,750	-23,915
		Uncrowded Passenger Hrs	30,291,568	30,192,596	-98,973
		Crowded Passenger Hrs	36,796,301	36,625,703	-170,598
		Passenger Boardings	2,177,500	2,172,396	-5,104
DLR	AM	Passenger Kms	632,655	632,476	-179
		Uncrowded Passenger Hrs	1,538,078	1,537,703	-375
		Crowded Passenger Hrs	1,899,277	1,898,590	-686
		Passenger Boardings	147,849	147,822	-27
	PM	Passenger Kms	701,112	700,954	-158
		Uncrowded Passenger Hrs	1,695,600	1,695,266	-334
		Crowded Passenger Hrs	2,080,741	2,080,125	-616
		Passenger Boardings	162,406	162,381	-25
Tram	AM	Passenger Kms	162,639	162,632	-7
		Uncrowded Passenger Hrs	430,015	429,997	-19
		Crowded Passenger Hrs	614,341	614,319	-22
		Passenger Boardings	35,061	35,061	0
	PM	Passenger Kms	189,577	189,572	-5
		Uncrowded Passenger Hrs	486,745	486,732	-13
		Crowded Passenger Hrs	756,547	756,508	-39
		Passenger Boardings	38,543	38,543	0
All PT	AM	Passenger Kms	85,795,810	85,762,713	-33,096
		Uncrowded Passenger Hrs	115,348,652	115,208,508	-140,143
		Crowded Passenger Hrs	154,400,839	154,083,047	-317,792
		Passenger Boardings	6,244,762	6,242,936	-1,827
	PM	Passenger Kms	89,635,043	89,608,056	-26,986
		Uncrowded Passenger Hrs	120,021,714	119,902,213	-119,500
		Crowded Passenger Hrs	154,108,212	153,799,566	-308,646
		Passenger Boardings	6,791,486	6,789,573	-1,913

Baseline: 2041 Maximum Growth Scenario without Crossrail 2

Mode	Peak	*Description*	*2041 TfL Max Growth*	*Dudding Hill Preferred Option*	*Difference*
		Scenario	A141rc20a	A141DH08a	A141DH08a-A141rc20a
Rail	AM	Passenger Kms	63,543,061	63,593,894	50,833
		Uncrowded Passenger Hrs	59,261,438	59,348,851	87,413
		Crowded Passenger Hrs	80,539,375	80,605,804	66,429
		Passenger Boardings	2,009,641	2,019,080	9,439
	PM	Passenger Kms	65,808,704	65,869,871	61,166
		Uncrowded Passenger Hrs	59,357,651	59,457,575	99,924
		Crowded Passenger Hrs	76,530,731	76,628,358	97,627
		Passenger Boardings	2,077,290	2,087,085	9,795
LUL	AM	Passenger Kms	16,651,343	16,588,978	-62,364
		Uncrowded Passenger Hrs	29,861,747	29,742,203	-119,544
		Crowded Passenger Hrs	44,507,659	44,251,287	-256,372
		Passenger Boardings	2,334,658	2,328,209	-6,449
	PM	Passenger Kms	17,064,166	16,999,450	-64,716
		Uncrowded Passenger Hrs	30,975,294	30,851,079	-124,216
		Crowded Passenger Hrs	43,170,281	42,911,511	-258,770
		Passenger Boardings	2,493,211	2,486,653	-6,558
Bus	AM	Passenger Kms	7,020,708	6,997,781	-22,927
		Uncrowded Passenger Hrs	27,493,659	27,396,754	-96,905
		Crowded Passenger Hrs	32,489,132	32,309,474	-179,657
		Passenger Boardings	1,927,422	1,922,445	-4,977
	PM	Passenger Kms	8,516,962	8,492,219	-24,743
		Uncrowded Passenger Hrs	31,405,075	31,302,740	-102,335
		Crowded Passenger Hrs	39,115,825	38,926,214	-189,611
		Passenger Boardings	2,263,218	2,257,977	-5,240
DLR	AM	Passenger Kms	772,475	772,331	-144
		Uncrowded Passenger Hrs	1,873,801	1,873,467	-334
		Crowded Passenger Hrs	2,543,780	2,543,076	-703
		Passenger Boardings	178,172	178,149	-23
	PM	Passenger Kms	853,060	852,919	-140
		Uncrowded Passenger Hrs	2,054,730	2,054,430	-300
		Crowded Passenger Hrs	2,754,186	2,753,533	-653
		Passenger Boardings	195,390	195,367	-23
Tram	AM	Passenger Kms	165,161	165,151	-10
		Uncrowded Passenger Hrs	436,538	436,511	-27
		Crowded Passenger Hrs	625,596	625,543	-53
		Passenger Boardings	35,692	35,691	-1
	PM	Passenger Kms	193,122	193,111	-11
		Uncrowded Passenger Hrs	496,620	496,591	-29
		Crowded Passenger Hrs	781,050	780,958	-92
		Passenger Boardings	39,250	39,249	-1
All PT	AM	Passenger Kms	88,152,748	88,118,135	-34,613
		Uncrowded Passenger Hrs	118,927,182	118,797,784	-129,397
		Crowded Passenger Hrs	160,705,541	160,335,185	-370,356
		Passenger Boardings	6,485,584	6,483,574	-2,010
	PM	Passenger Kms	92,436,014	92,407,570	-28,444
		Uncrowded Passenger Hrs	124,289,369	124,162,414	-126,955
		Crowded Passenger Hrs	162,352,074	162,000,575	-351,499
		Passenger Boardings	7,068,359	7,066,331	-2,028

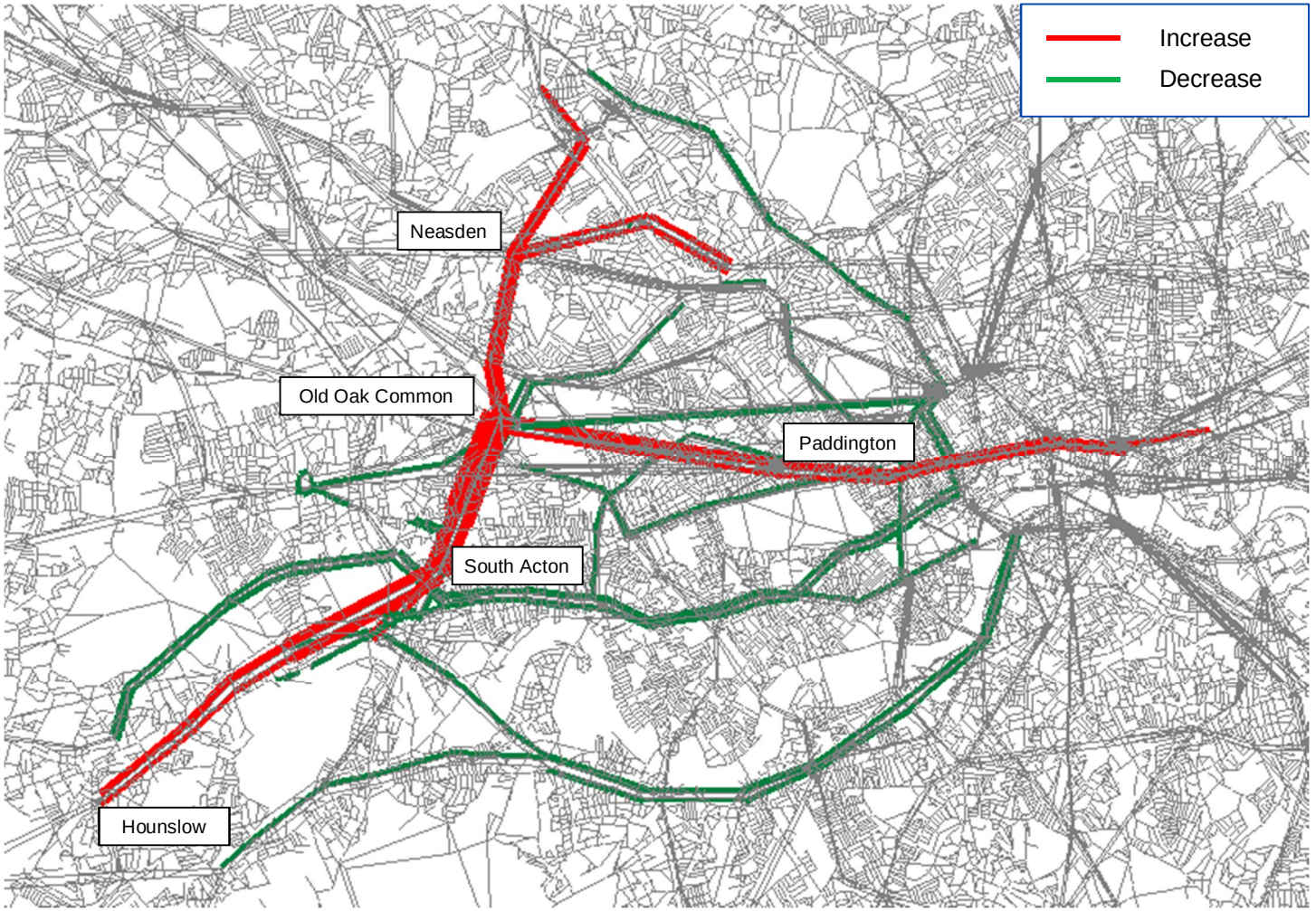
APPENDIX B-2

FLOW DIFFERENCE PLOTS

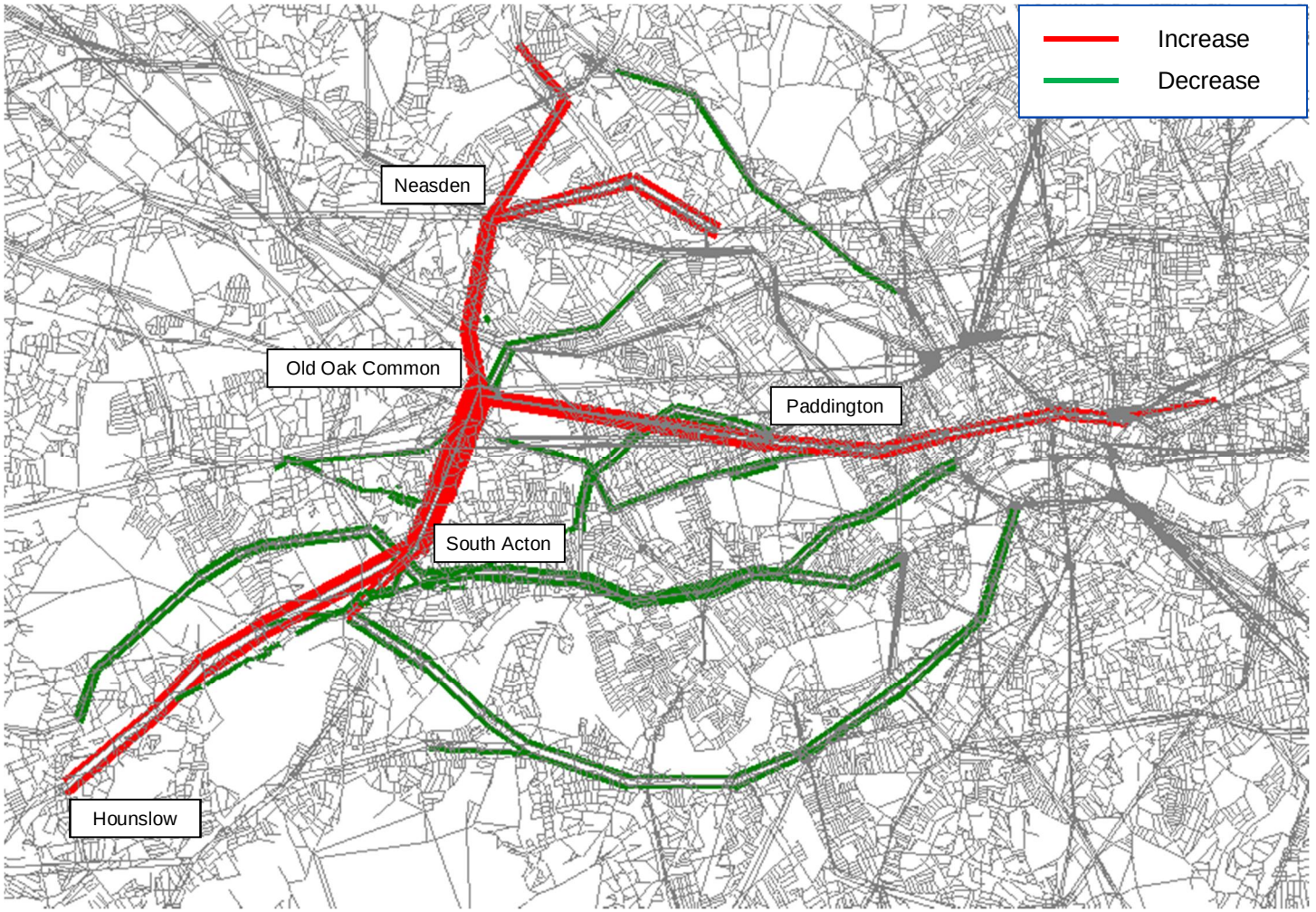
This section displays public transport network plots showing differences in demand on the public transport network in the AM and PM between the preferred option scenario and its associated baseline scenario.

Baseline: **Standard LTS-PT 2041 Reference Case (A141rc01a)**

Passenger flow difference Preferred Option minus Reference Case, AM

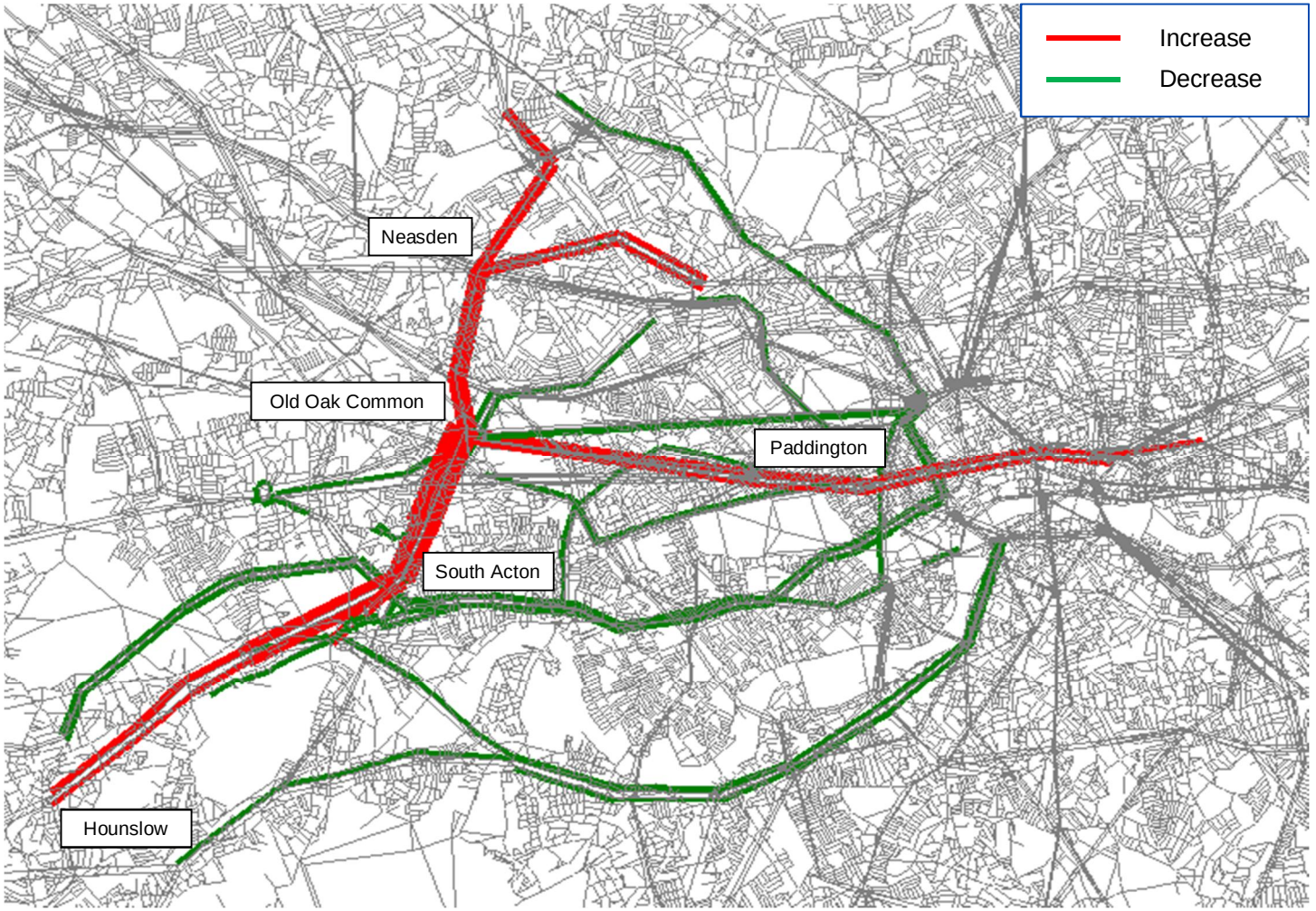


Passenger flow difference Preferred Option minus Reference Case, PM

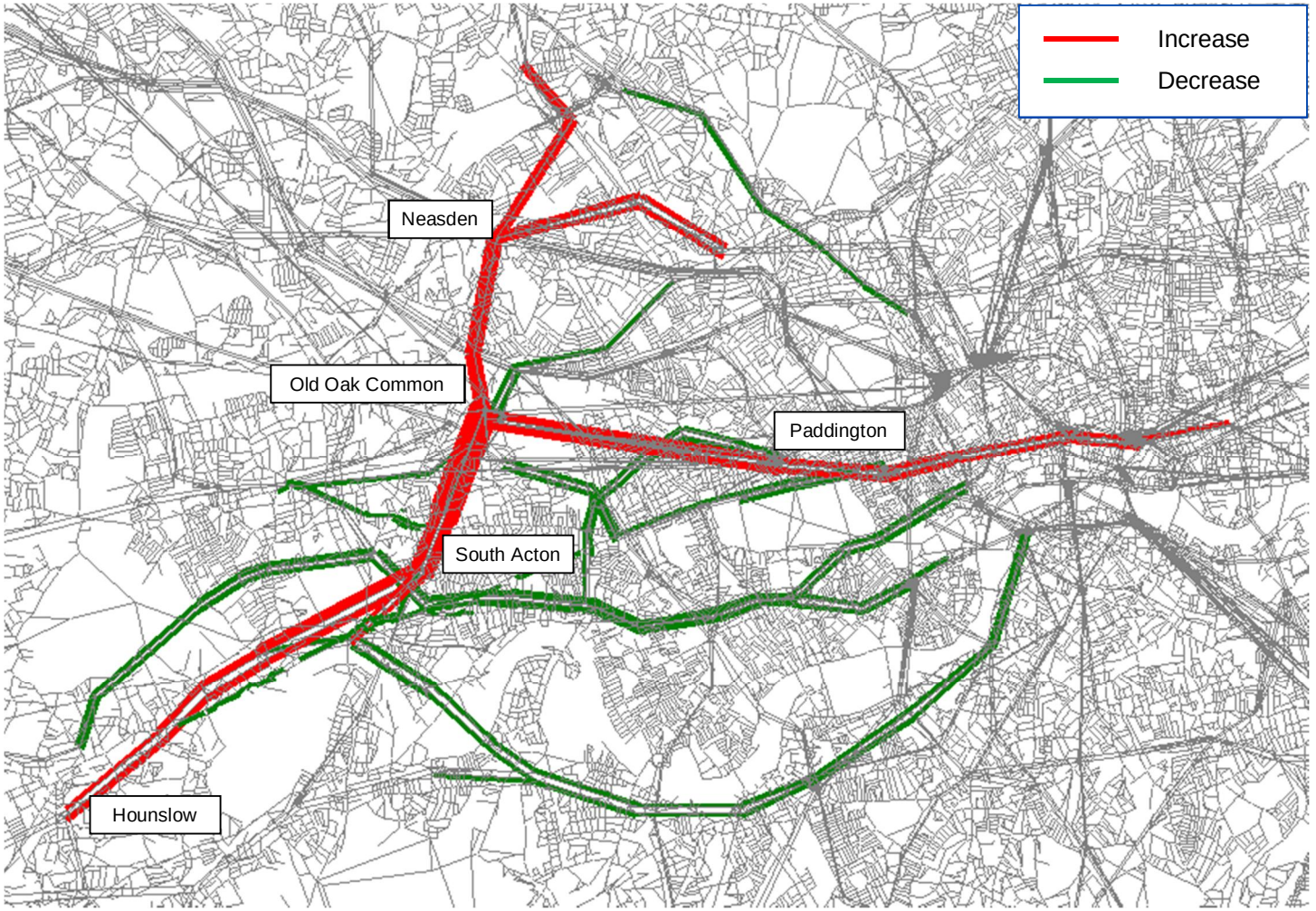


Baseline: **2041 Maximum Growth Scenario without Crossrail 2**

Passenger flow difference Preferred Option minus Maximum Growth Scenario, AM



Passenger flow difference Preferred Option minus Maximum Growth Scenario, PM



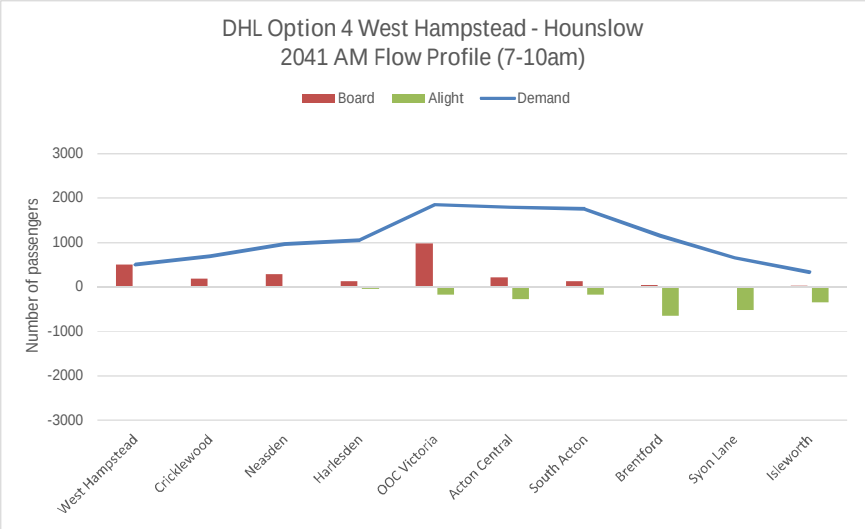
APPENDIX B-3

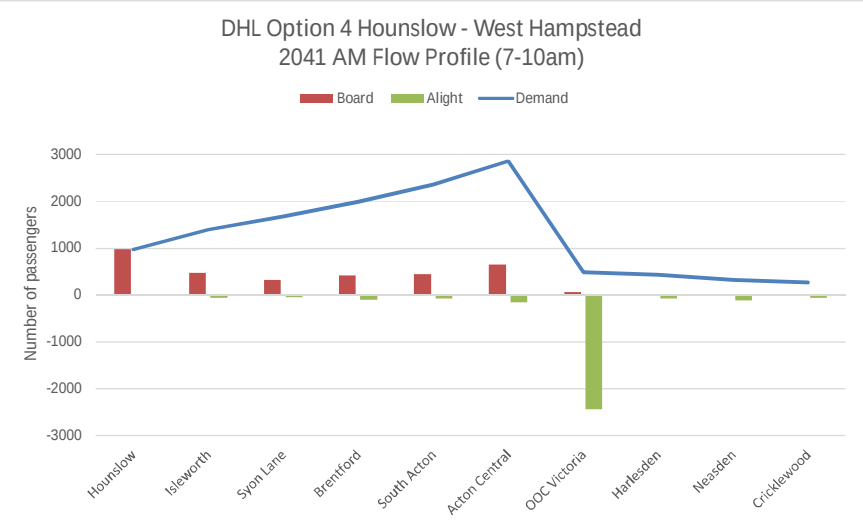
WLO LINE LOADING, BOARDINGS AND ALIGHTINGS

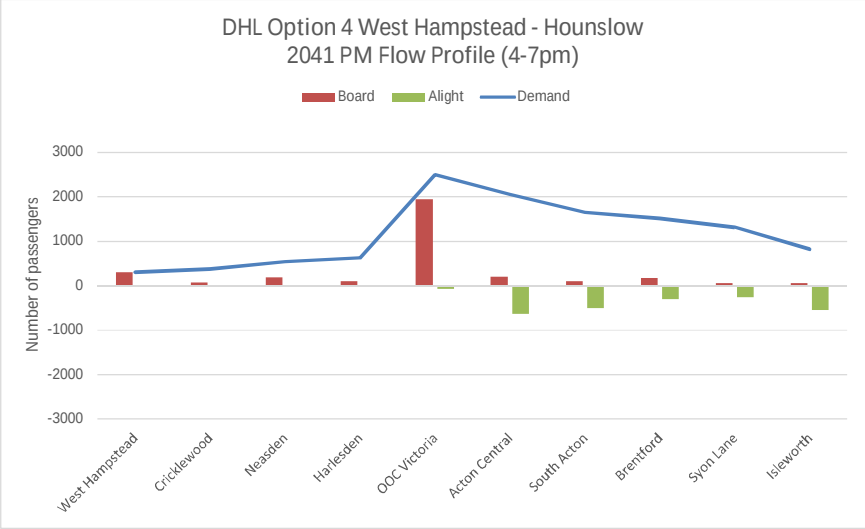
Baseline: **Standard LTS-PT 2041 Reference Case (A141rc01a)**

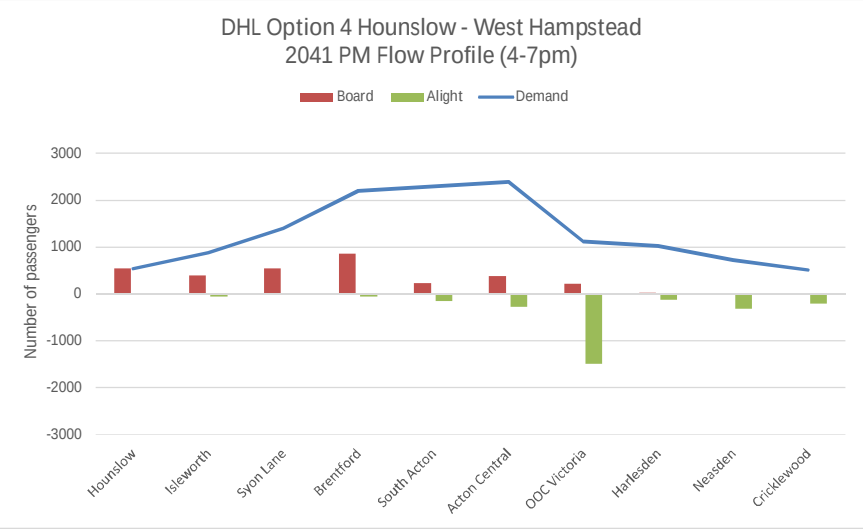
					AM			PM		
Direction	From	To	NAME	LONGNAME	Demand	Board	Alight	Demand	Board	Alight
Southbound	West Hampstead	Cricklewood	DH003D	WESTHAMPSTEAD-HOUNSLOW	502	502	0	299	299	0
	Cricklewood	Neasden	DH003D	WESTHAMPSTEAD-HOUNSLOW	686	188	-3	371	75	-4
	Neasden	Harlesden	DH003D	WESTHAMPSTEAD-HOUNSLOW	960	288	-14	538	188	-21
	Harlesden	OOC Victoria	DH003D	WESTHAMPSTEAD-HOUNSLOW	1052	130	-39	622	97	-13
	OOC Victoria	Acton Central	DH003D	WESTHAMPSTEAD-HOUNSLOW	1849	975	-178	2494	1946	-74
	Acton Central	South Acton	DH003D	WESTHAMPSTEAD-HOUNSLOW	1791	217	-275	2052	197	-638
	South Acton	Brentford	DH003D	WESTHAMPSTEAD-HOUNSLOW	1753	130	-169	1647	97	-502
	Brentford	Syon Lane	DH003D	WESTHAMPSTEAD-HOUNSLOW	1150	45	-648	1515	176	-308
	Syon Lane	Isleworth	DH003D	WESTHAMPSTEAD-HOUNSLOW	652	13	-511	1314	57	-258
	Isleworth	Hounslow	DH003D	WESTHAMPSTEAD-HOUNSLOW	333	23	-342	820	59	-553
Northbound	Hounslow	Isleworth	DH004U	HOUNSLOW-WESTHAMPSTEAD	976	976	0	538	538	0
	Isleworth	Syon Lane	DH004U	HOUNSLOW-WESTHAMPSTEAD	1396	474	-54	882	393	-49
	Syon Lane	Brentford	DH004U	HOUNSLOW-WESTHAMPSTEAD	1679	323	-40	1404	538	-16
	Brentford	South Acton	DH004U	HOUNSLOW-WESTHAMPSTEAD	1998	423	-104	2199	858	-63
	South Acton	Acton Central	DH004U	HOUNSLOW-WESTHAMPSTEAD	2366	443	-76	2290	236	-145
	Acton Central	OOC Victoria	DH004U	HOUNSLOW-WESTHAMPSTEAD	2863	650	-153	2394	375	-271
	OOC Victoria	Harlesden	DH004U	HOUNSLOW-WESTHAMPSTEAD	493	64	-2434	1116	222	-1500
	Harlesden	Neasden	DH004U	HOUNSLOW-WESTHAMPSTEAD	429	5	-69	1022	30	-124
	Neasden	Cricklewood	DH004U	HOUNSLOW-WESTHAMPSTEAD	329	12	-112	722	9	-309
	Cricklewood	West Hampstead	DH004U	HOUNSLOW-WESTHAMPSTEAD	269	3	-63	515	1	-208

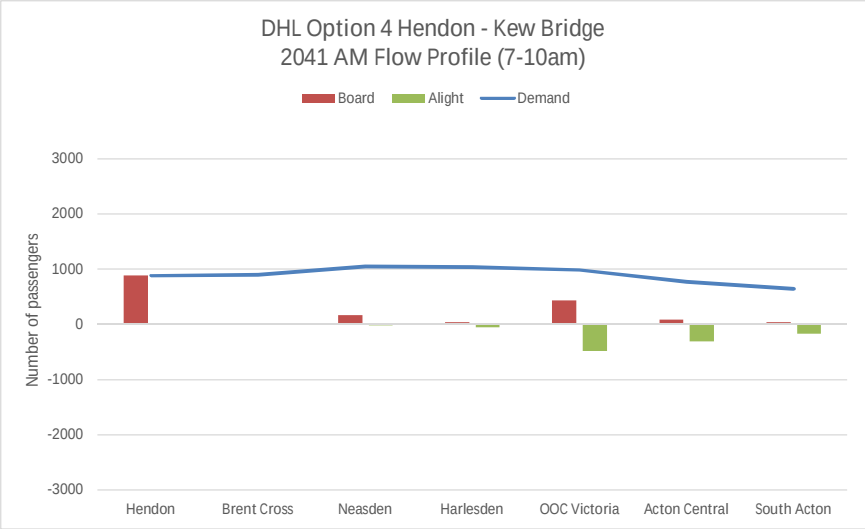
					AM			PM		
Direction	From	To	NAME	LONGNAME	Demand	Board	Alight	Demand	Board	Alight
Southbound	Hendon	Brent Cross	DH005D	HENDON-KEWBRIDGE	883	883	0	356	356	0
	Brent Cross	Neasden	DH005D	HENDON-KEWBRIDGE	896	14	0	365	9	0
	Neasden	Harlesden	DH005D	HENDON-KEWBRIDGE	1047	173	-22	446	109	-28
	Harlesden	OOC Victoria	DH005D	HENDON-KEWBRIDGE	1039	39	-48	455	39	-29
	OOC Victoria	Acton Central	DH005D	HENDON-KEWBRIDGE	987	434	-486	1745	1440	-151
	Acton Central	South Acton	DH005D	HENDON-KEWBRIDGE	768	84	-304	1166	77	-656
	South Acton	Kew Bridge	DH005D	HENDON-KEWBRIDGE	642	40	-166	673	20	-513
Northbound	Kew Bridge	South Acton	DH006U	KEWBRIDGE-HENDON	686	686	0	641	641	0
	South Acton	Acton Central	DH006U	KEWBRIDGE-HENDON	1155	482	-13	879	257	-19
	Acton Central	OOC Victoria	DH006U	KEWBRIDGE-HENDON	1806	685	-35	1247	429	-61
	OOC Victoria	Harlesden	DH006U	KEWBRIDGE-HENDON	306	63	-1563	853	309	-703
	Harlesden	Neasden	DH006U	KEWBRIDGE-HENDON	301	19	-24	879	63	-36
	Neasden	Brent Cross	DH006U	KEWBRIDGE-HENDON	254	17	-64	732	26	-174
	Brent Cross	Hendon	DH006U	KEWBRIDGE-HENDON	248	0	-6	720	0	-13

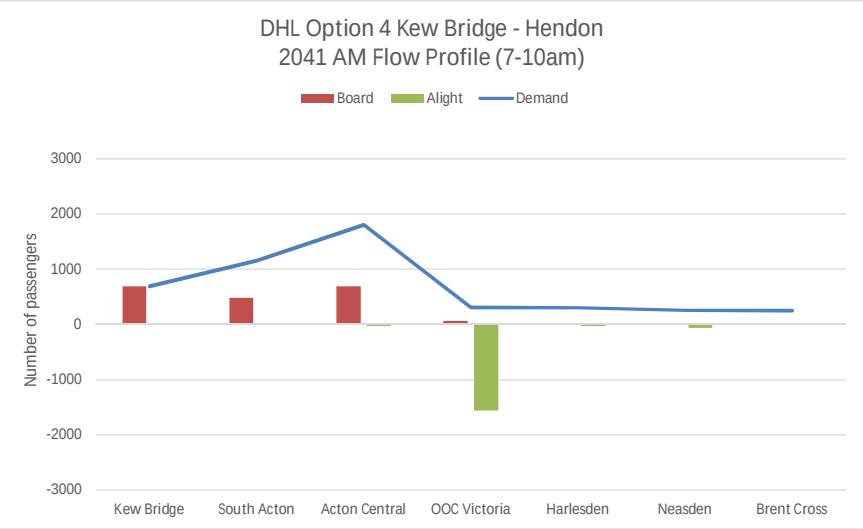

DHL Option 4 West Hampstead - Hounslow
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
West Hampstead
Cricklewood
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth

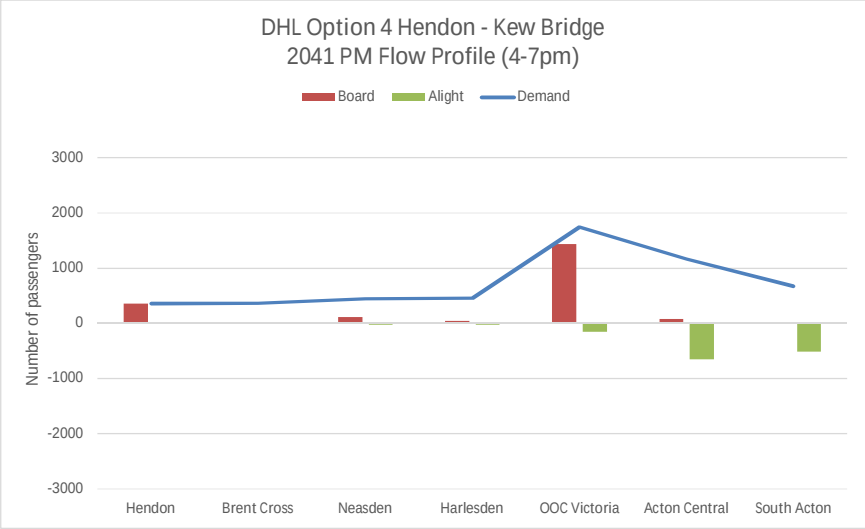

DHL Option 4 Hounslow - West Hampstead
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Cricklewood

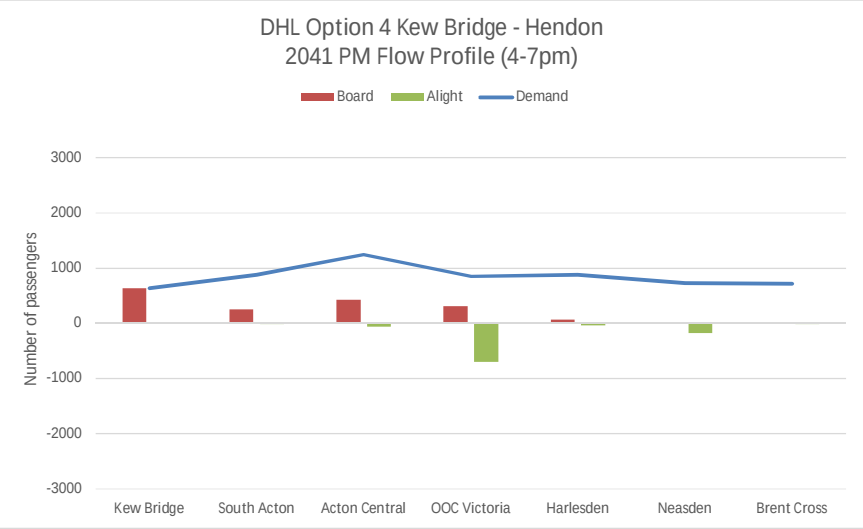

DHL Option 4 West Hampstead - Hounslow
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
West Hampstead
Cricklewood
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth


DHL Option 4 Hounslow - West Hampstead
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Cricklewood


DHL Option 4 Hendon - Kew Bridge
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hendon
Brent Cross
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton


DHL Option 4 Kew Bridge - Hendon
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Kew Bridge
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Brent Cross

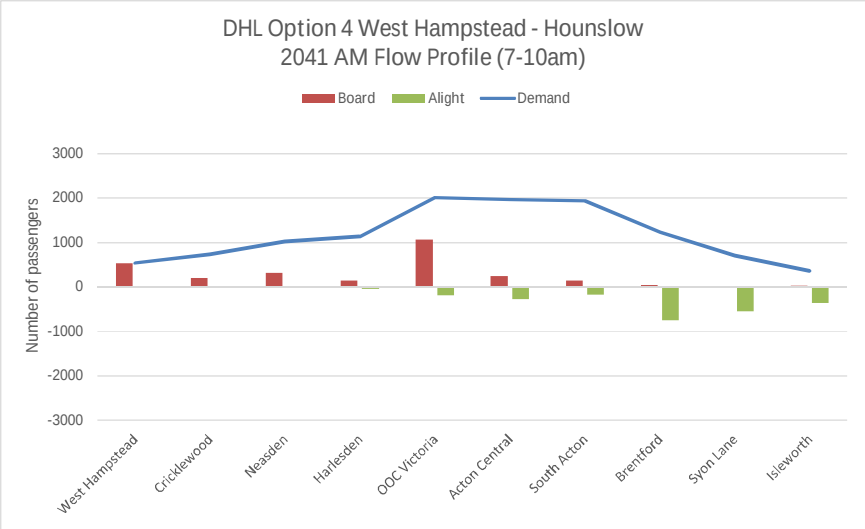

DHL Option 4 Hendon - Kew Bridge
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hendon
Brent Cross
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton


DHL Option 4 Kew Bridge - Hendon
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Kew Bridge
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Brent Cross

Baseline: **2041 Maximum Growth Scenario without Crossrail 2**

					AM			PM		
Direction	From	To	NAME	LONGNAME	Demand	Board	Alight	Demand	Board	Alight
Southbound	West Hampstead	Cricklewood	DH003D	WESTHAMPSTEAD-HOUNSLOW	537	537	0	312	312	0
	Cricklewood	Neasden	DH003D	WESTHAMPSTEAD-HOUNSLOW	732	199	-3	395	87	-4
	Neasden	Harlesden	DH003D	WESTHAMPSTEAD-HOUNSLOW	1026	308	-14	565	193	-22
	Harlesden	OOC Victoria	DH003D	WESTHAMPSTEAD-HOUNSLOW	1138	151	-39	646	96	-16
	OOC Victoria	Acton Central	DH003D	WESTHAMPSTEAD-HOUNSLOW	2007	1061	-191	2475	1914	-85
	Acton Central	South Acton	DH003D	WESTHAMPSTEAD-HOUNSLOW	1965	239	-281	2026	192	-641
	South Acton	Brentford	DH003D	WESTHAMPSTEAD-HOUNSLOW	1933	143	-174	1615	93	-504
	Brentford	Syon Lane	DH003D	WESTHAMPSTEAD-HOUNSLOW	1233	46	-746	1497	185	-303
	Syon Lane	Isleworth	DH003D	WESTHAMPSTEAD-HOUNSLOW	702	13	-543	1303	56	-251
	Isleworth	Hounslow	DH003D	WESTHAMPSTEAD-HOUNSLOW	358	23	-367	818	59	-543
Northbound	Hounslow	Isleworth	DH004U	HOUNSLOW-WESTHAMPSTEAD	957	957	0	576	576	0
	Isleworth	Syon Lane	DH004U	HOUNSLOW-WESTHAMPSTEAD	1362	458	-54	949	422	-49
	Syon Lane	Brentford	DH004U	HOUNSLOW-WESTHAMPSTEAD	1633	311	-39	1501	568	-16
	Brentford	South Acton	DH004U	HOUNSLOW-WESTHAMPSTEAD	1933	409	-108	2422	985	-64
	South Acton	Acton Central	DH004U	HOUNSLOW-WESTHAMPSTEAD	2302	440	-72	2508	243	-157
	Acton Central	OOC Victoria	DH004U	HOUNSLOW-WESTHAMPSTEAD	2801	645	-146	2595	384	-297
	OOC Victoria	Harlesden	DH004U	HOUNSLOW-WESTHAMPSTEAD	504	71	-2368	1215	241	-1622
	Harlesden	Neasden	DH004U	HOUNSLOW-WESTHAMPSTEAD	442	6	-67	1101	30	-144
	Neasden	Cricklewood	DH004U	HOUNSLOW-WESTHAMPSTEAD	341	13	-113	778	9	-332
	Cricklewood	West Hampstead	DH004U	HOUNSLOW-WESTHAMPSTEAD	273	3	-71	556	1	-222

					AM			PM		
Direction	From	To	NAME	LONGNAME	Demand	Board	Alight	Demand	Board	Alight
Southbound	Hendon	Brent Cross	DH005D	HENDON-KEWBRIDGE	913	913	0	414	414	0
	Brent Cross	Neasden	DH005D	HENDON-KEWBRIDGE	928	15	0	423	9	0
	Neasden	Harlesden	DH005D	HENDON-KEWBRIDGE	1092	187	-22	505	112	-30
	Harlesden	OOC Victoria	DH005D	HENDON-KEWBRIDGE	1093	47	-47	510	39	-35
	OOC Victoria	Acton Central	DH005D	HENDON-KEWBRIDGE	1059	469	-503	1751	1426	-184
	Acton Central	South Acton	DH005D	HENDON-KEWBRIDGE	842	93	-310	1165	75	-661
	South Acton	Kew Bridge	DH005D	HENDON-KEWBRIDGE	714	44	-173	671	20	-513
Northbound	Kew Bridge	South Acton	DH006U	KEWBRIDGE-HENDON	675	675	0	749	749	0
	South Acton	Acton Central	DH006U	KEWBRIDGE-HENDON	1140	477	-12	996	268	-21
	Acton Central	OOC Victoria	DH006U	KEWBRIDGE-HENDON	1791	684	-33	1369	442	-69
	OOC Victoria	Harlesden	DH006U	KEWBRIDGE-HENDON	341	81	-1531	926	335	-778
	Harlesden	Neasden	DH006U	KEWBRIDGE-HENDON	341	24	-24	945	62	-43
	Neasden	Brent Cross	DH006U	KEWBRIDGE-HENDON	295	19	-66	782	26	-190
	Brent Cross	Hendon	DH006U	KEWBRIDGE-HENDON	288	0	-6	768	0	-14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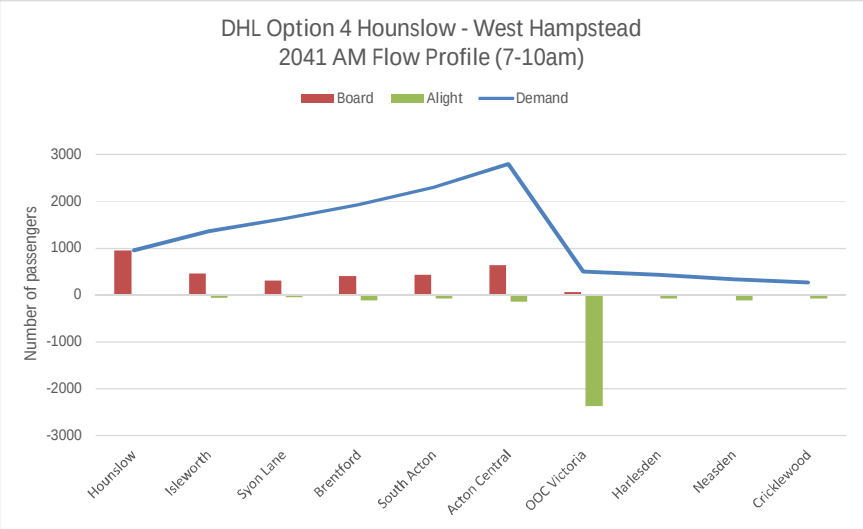
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
West Hampstead
Cricklewood
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth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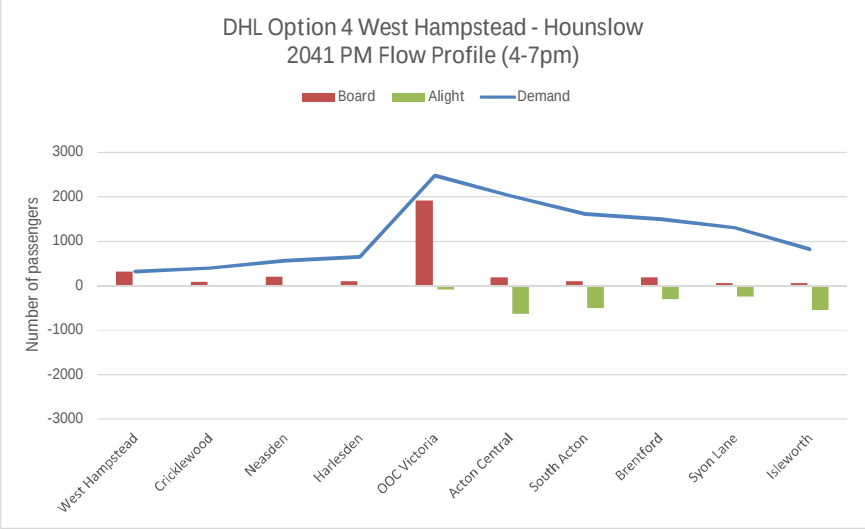
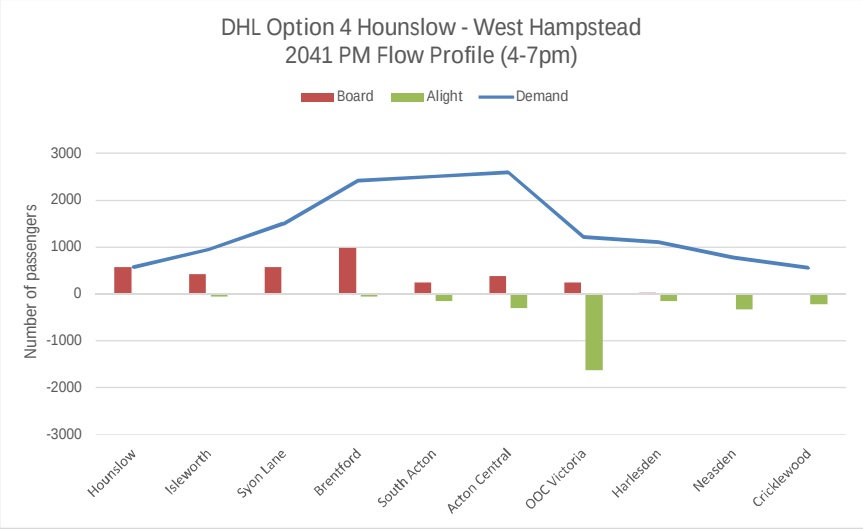
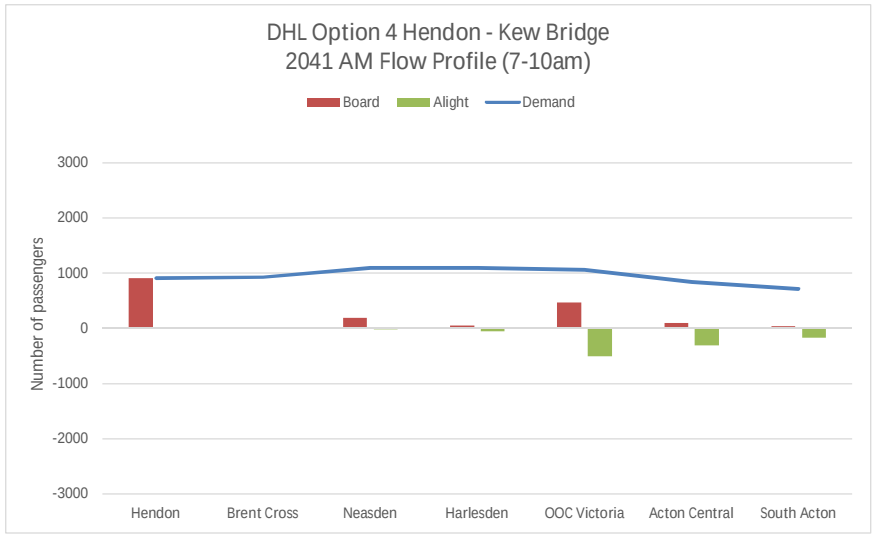
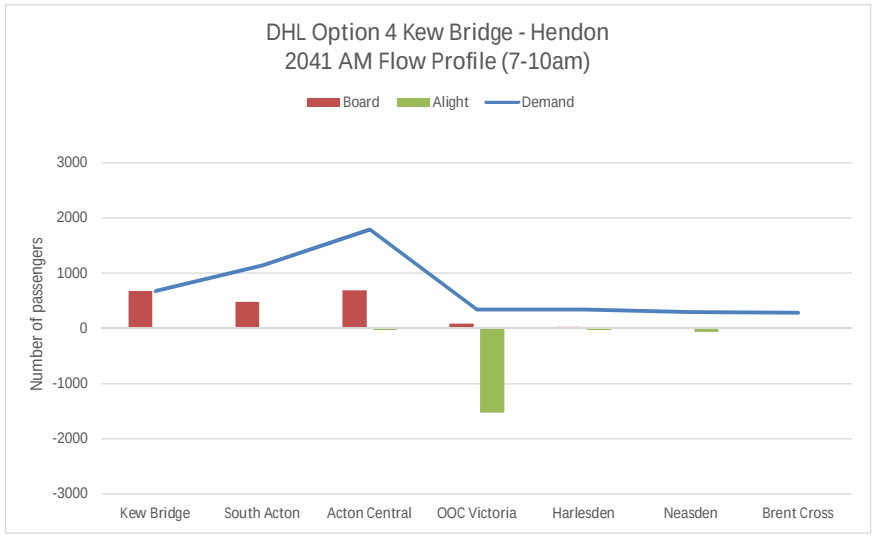
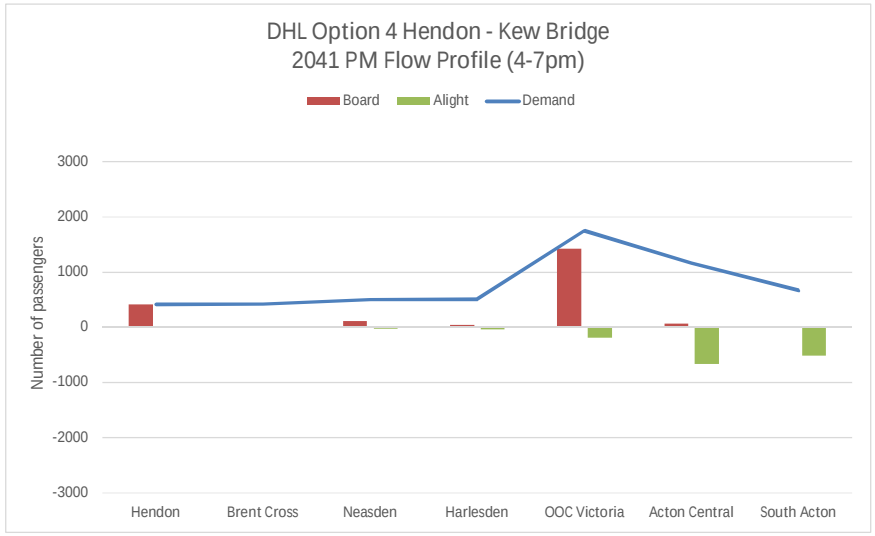
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Cricklewood

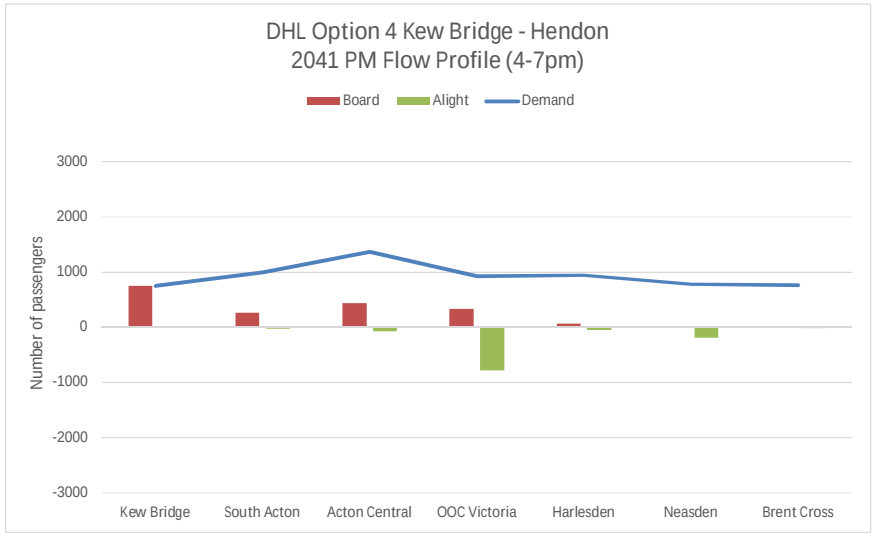

DHL Option 4 West Hampstead - Hounslow
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
West Hampstead
Cricklewood
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton
Brentford
Syon Lane
Isleworth


DHL Option 4 Hounslow - West Hampstead
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hounslow
Isleworth
Syon Lane
Brentford
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Cricklewood


DHL Option 4 Hendon - Kew Bridge
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hendon
Brent Cross
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton


DHL Option 4 Kew Bridge - Hendon
2041 AM Flow Profile (7-10am)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Kew Bridge
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Brent Cross


DHL Option 4 Hendon - Kew Bridge
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Hendon
Brent Cross
Neasden
Harlesden
OOC Victoria
Acton Central
South Acton


DHL Option 4 Kew Bridge - Hendon
2041 PM Flow Profile (4-7pm)
Board
Alight
Demand
Number of passengers
3000
2000
1000
0
-1000
-2000
-3000
Kew Bridge
South Acton
Acton Central
OOC Victoria
Harlesden
Neasden
Brent Cross