Proof of Evidence of The Leeds Railway Station (Southern Entrance) Order

(LSSE.PTE/P/7.1)

Pedestrian Modelling
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1 Introduction

1.1 Qualifications and Experience

1.1.1 My name is John Robertson. I have an Honours Degree in Civil and Transportation Engineering from Edinburgh Napier University, 1993. I am a Chartered Engineer (CEng) and also hold the professional qualification of Transport Planning Professional (TPP). I am a Member of the Chartered Institution of Highways and Transportation and a Fellow of the Chartered Institute of Logistics and Transport. I have 19 years experience in Transport Planning and Engineering working with Halcrow Group Limited for 14 years, and 5 years with Hyder Consulting UK Limited, holding the position of Associate Director.

1.1.2 I specialise in transport planning and pedestrian modelling, and my experience includes undertaking many similar studies throughout the UK, appraising design and potential future passenger congestion levels. My project experience includes St Pancras Olympic Queue Management Study, Channel Tunnel Rail Link Line 2 stations, Crossrail Whitechapel, Manchester Victoria, Bristol Temple Meads, Edinburgh Waverley, and I am current acting as technical advisor on Pedestrian Modelling matters to London Underground Limited for the Bank Station Capacity Upgrade Study.

1.2 Scope of Evidence

1.2.1 In my evidence I demonstrate how the existing and future passenger demand forecasts have been calculated, including the redistribution of passenger movements as a result of the new southern entrance, and how the proposed southern entrance station layout will accommodate these expected future passenger volumes and movement patterns under a variety of operational scenarios.

1.3 Response to Statement of Matters

1.3.1 My evidence relates specifically to the following matter under Items (2) in the Secretary of State's Statement of Matters:

'2 The justification for the particular proposals in the draft TWA Order, including the anticipated transportation, regeneration, environmental and socio-economic benefits of the scheme.'

2 Passenger Demand Forecasts

2.1 Leeds Station Southern Entrance Proposals

2.1.1 The Leeds Station Southern Entrance (LSSE) will comprise a new concourse deck at the current overbridge level, and provide a new ticket gateline, ticket office and ticket machines. The new upper concourse would be connected to a new lower concourse via stairs, escalators and a lift, and extend over the River Aire connecting to both the east and west banks of the river.

2.1.2 The proposed LSSE layout drawings provided by Metro are included in **Appendix A.**

2.2 Methodology

2.2.1 My evidence relates primarily to the Pedestrian Modelling Assessment of the proposed design undertaken by Hyder Consulting in report dated 20 March 2012, appended to this Proof of Evidence.

2.2.2 The analysis within the Pedestrian Modelling Assessment covers the following operational scenarios:

- 2029 'Normal' Operation for AM and PM peak periods;
- Sensitivity Analysis around the AM and PM periods for +10%, +20% and +30% demand scenarios;
- Emergency Evacuation; and
- High Demand Scenario when Leeds United are playing at home.

2.2.3 The agreed methodology for the assessment was to undertake pedestrian modelling based on 'best available' historic survey data.

2.3 'Existing' Passenger Demand Analysis

2.3.1 This section of my evidence describes the process and analysis to derive 'base' or 'existing' passenger volumes and movement patterns. This base data was then used as a platform from which to forecast potential future passenger volumes.

Volumes

2.3.2 A number of historic survey data sets were made available to Hyder when undertaking their assessment. This included the following data sets (taken directly from the Pedestrian Modelling Assessment report.

Table 2.1 – Historic Data Sets

Year	Details	Source	3-Hour AM In/Out Count
2011	Boarding/Alighting data (Tuesday, November 2011)	Northern Rail	16,874
2008	Boarding/Alighting data	Northern Rail	16,874
2008	Manual OUT count, Wednesday October	Jacobs/Count on Us	24,228 (*)
2007	Count on Us gateline Survey (Thursday, June)	Northern Rail	19,727
2006	Gateline Survey (Monday)	Northern Rail	29,372
2006	Gateline Survey (Monday)	Northern Rail	26,074

(*) Note actual survey was exit-only, and returned a figure of 19,382. The two-way count has been calculated using an 80/20 OUT/IN percentage – see following paragraphs

2.3.3 Following a review of the above data Hyder concluded, together with Metro and Network Rail, that the most appropriate baseline data set to use was the manual 2008 station exit count. The reason for this was two-fold. Firstly, the accuracy of some of the other data sets was not known, in terms of their collection method and validity of the day they were carried out, e.g. Monday or Friday which are not considered to reflect 'typical' weekday travel patterns. Also, some of the data sets do not cover passengers from all train services, but comprise counts of only Northern Rail passengers. Secondly, the Jacobs/Count on Us dataset was available to Hyder in raw format, allowing some survey details to be checked including survey locations, and reviewing of the profile of users over the survey period.

2.3.4 It is reported within the Pedestrian Modelling Assessment report that Hyder advised Metro that a full station In/Out count should be undertaken in order to further validate the base passenger volume assumptions. This would allow an up to date (2012) dataset to be used to compare against both the entry/exit ratio, and also total passenger volumes to measure any passenger growth during the four year period.

In / Out Proportions

2.3.5 As the 2008 survey data comprised counts in the exit (alighting trains and leaving the station) it was therefore necessary to derive a factor to calculate the corresponding entry passenger volume (entering the station to board a train). The details of this analysis are presented in the Pedestrian Modelling Assessment report, and summarised as:

- AM peak period (80% OUT, 20% IN);
- PM peak period (25% OUT, 75% IN).

2.3.6 The above percentages are consistent with station survey data available.

5-minute Data Profiles for AM and PM Peak Periods

2.3.7 Section 1.3 of Appendix B of the Pedestrian Modelling Assessment report goes on to describe how the 5-minute data profiles were derived, based on best available information. Figures 1.1 to 1.4 in the same Appendix demonstrate the selection of the profiles used.

2008 AM and PM 'Existing' Flows

2.3.8 Using the data and information described above the total AM and PM passenger flows were therefore concluded as follows.

Table 2.2 – 2008 Base Total Station Entry / Exit Demand

Period	Entry	Exit	Total
AM Peak Period (3 hours)	4,846	19,382	24,228
PM Peak Period (3 hours)	16,269	5,423	21,692

2.4 Passenger Growth

2.4.1 As noted in Section 3.1.2 of the Pedestrian Modelling Assessment report, Hyder were instructed by Metro/Network Rail to use a 'High' growth forecast from the Network Rail Northern Route Utilisation Strategy (RUS) document. There are two growth forecasts in the RUS for Leeds, a 'low growth' peak period growth forecast of 31%, and a 'high growth' forecast of 62%. Adopting the high growth forecast was instructed as this provides the upper limit of forecast passenger growth, thereby factoring in a certain amount of resilience to the modelling and analysis. The high growth forecast equates to an uplift of 62% from 2008 to 2029. The corresponding flows are shown below.

Table 2.3 – 2029 Total Station Entry / Exit Demand

Period	Entry	Exit	Total
AM Peak Period (3 hours)	7,851	31,399	39,250
PM Peak Period (3 hours)	26,356	8,785	35,141

2.5 LSSE Passenger Demand

2.5.1 Metro instructed consultant Aecom to interrogate the Leeds Transport Model to obtain an attraction factor for the potential use of the new station entrance. Aecom maintain and operate the Leeds Transport Model (LTM) which is a multi-modal demand responsive model for the appraisal transport schemes and interventions, and changes in land use development. The following percentages were provided by Metro to Hyder for use in the capacity assessment, taken from the LTM 2031 model scenario.

Table 2.4 – 2029 Percentage of Total Demand Forecast to Use LSSE

Period	Entry	Exit
AM Peak Period (3 hours)	34%	21%
PM Peak Period (3 hours)	22%	39%

(*) Data provided by Metro – original source Leeds Transport Model 2031 scenario.

2.5.2 The following demand was therefore used by Hyder in the capacity assessment of the LSSE design.

Table 2.5 – 2029 LSSE Forecast Demand

Period	Entry	Exit	Total
AM Peak Period (3 hours)	2,669	6,594	9,263
PM Peak Period (3 hours)	5,798	3,426	9,225

(*) Source – Pedestrian Modelling Assessment, appended.

2.6 Demand Forecasting Summary

2.6.1 As explained in paragraph 2.3.3 the 2008 'base' pedestrian volumes have been taken from survey information considered to be 'best available', and fit for purpose. The subsequent passenger growth rate has been taken from the Route Utilisation Strategy **[Core Document LSSE.D12]**, and the 'High' growth scenario was instructed for use, again to ensure a robust approach. Information on the likely attractiveness of the southern entrance has been provided to Hyder for use in the study and, although Hyder did not undertake this analysis independently, it is considered that the Leeds Transport Model is the most appropriate tool available to derive this information as it contains forecasts of the origins and destinations of Leeds Station users for the year 2031, allowing an assessment of the likely percentages for whom the southern entrance would be the preferred point of access/egress. I therefore consider the methodology presented above to be a systematic, transparent and robust methodology to calculate existing (2008) passenger demand at Leeds station, based on 'best available' information, future passenger volumes for 2029, and the potential attractiveness of the new southern entrance to future Leeds Station users.

3 Pedestrian Modelling and Analysis

3.1 Overview

3.1.1 The modelling exercise reported in the Pedestrian Modelling Assessment report was undertaken using LEGION Studio 2006. The software application allows the user to simulate individual pedestrian movements within a defined space. The modelling exercise includes the assessment of 2029 forecast passenger demands for both the AM and PM peak periods.

3.1.2 There are a range of outputs available from LEGION Studio such as Space Utilisation Maps which show the extent to which space within the station is being used and Cumulative Mean Density Maps (CMD) which display the mean level of density registered in an area over a defined period of time.

3.1.3 The CMD plots are based on Fruin Levels of Service (LOS). The LOS system uses the letters A through F:

- A = Free flow;
- B = Reasonably free flow;
- C = Stable flow;
- D = Approaching unstable flow;
- E = Unstable flow; and
- F = Forced or breakdown flow.

3.1.4 The following criteria are acceptable limits for operation, as stated by Network Rail (see **Appendix B**), and therefore were adopted for use in the analysis:

- Queuing for Ticket Facilities/Gateline - Queuing LOS C;
- Passageways (one-way) - Walkways LOS D;
- Passageways (two-way) - Walkways LOS C.

3.2 2029 Normal Operation

3.2.1 The report assesses each area of the station in turn, beginning with the ticket hall on the overbridge. My evidence below summarises the results.

Gateline Analysis

3.2.2 The conclusion was, subject to minor alterations to the gateline design, the proposed layout would operate satisfactorily in both AM and PM peak periods in both the 2029 AM and PM scenarios. See Pedestrian Modelling Assessment report section 3.2.1.

Mezzanine

3.2.3 The report noted that additional ‘run-off’ should be provided given there was only 3.0m between the escalators and the glass windows. In addition, it was recommended that frosted glass should be included to deter passengers waiting in the mezzanine area.

3.2.4 It is my recommendation that these points are addressed during the future detailed design of this scheme.

Ground Floor

3.2.5 The LEGION modelling of the ground floor area shows the layout to operate satisfactorily over the peak 15 minute period, with a Level of Service C. This extended to LoS D for a single 5 minute period, which although slightly exceeding the recommended LoS criteria, is considered acceptable given the duration. The conclusions note that the eastern walkway is approaching capacity and include a proposed mitigation strategy to deal with the eventuality that actual demand on the ground in the future years increases beyond that tested. The mitigation strategy could comprise a one-way system, whereby passengers in the peak direction (e.g. exiting in the AM peak period) used the main passageway adjacent to the lifts, and that the non-peak directional flows used the alternative route adjacent to dark Neville Street.

3.2.6 It is my recommendation that this strategy could be readily implemented should the need arise in those very limited circumstances, together with other recommended design considerations (Pedestrian Modelling Assessment report Section 3.3) as follows:

- CCTV is provided on the Mezzanine level and is monitored during peak times so that staff can control passenger flow if required;
- Provide a number of escalator emergency stop buttons;
- Consideration should be made during detailed design to increase the size of the run-off areas on the Mezzanine level;
- Consideration should be made to open the stairwell in order to link in with the Mezzanine escalators; and
- If required the implementation of a one-way system in the passageways in the peak direction at Ground level.

3.27 Overall, subject to the above the proposals would operate entirely satisfactorily at 2029.

3.3 Sensitivity Analysis

3.3.1 The Pedestrian Modelling Analysis included a number of sensitivity tests comprising a blanket uplift to the 2029 LSSE passenger demands. The uplifts were as follows:

- +10%;
- +20%; and
- +30%.

3.3.2 The results of the 2029 ‘Normal’ operation indicate that the eastern bridge link is close to capacity during the AM period based on the passenger demand assumptions as agreed for 2029 passenger levels.

3.3.3 The results from the sensitivity analysis indicate that an increase in total volume of passengers by circa 20%, over and above the calculated 2029 forecasts, may result in the requirement for some form of management intervention, during at least part of the AM peak period. The circumstances where the number of passengers could increase (over and above what has been assumed for the 2029 scenario) are summarised in the document as follows:

- Higher overall station demand;
- Higher percentage of station demand heading south;

- Higher percentage of southern passengers using eastern link; and
- Lesser number of southern passengers using the Dark Neville Street link.

3.3.4 It is my view, therefore, that an appropriate mitigation strategy be developed in the event that it is necessary to manage passenger movements during busy peak periods. Chapter 3 of the Pedestrian Modelling Assessment report identifies potential mitigation measures that I consider to be valid for further consideration. For exiting passengers, during the AM period, this could include the management of passengers at the upper level via a segregated approach to the gateline, and the introduction of a one-way system at ground level to relieve any pressure on the east (or west) bridge links. During the PM peak passengers could be managed on approach to the station entrance, both in terms of their direction and volumes. This would also help mitigate any conflict on the approach to the escalators at ground level. Such measures would be readily capable of being implemented and thereby mitigating any short term issues which might arise.

3.4 Emergency Evacuation

3.4.1 A further consideration as noted in the Pedestrian Modelling Assessment report is the impact of the LSSE during an emergency evacuation analysis. The report provides calculations that identify the capacity of the LSSE for use in an emergency evacuation, and concludes that circa 2,000 passengers could be evacuated to assist in the existing evacuation strategy for the station.

3.4.2 I concur with the view that the additional exit will provide additional capacity during any need for station evacuation, and that the potential capacity of the new exit should be included in an updated station evacuation strategy.

3.5 'High Demand' Scenario

3.5.1 Chapter 6 of the Pedestrian Modelling Assessment report identifies certain periods where there could be significantly higher passenger demand using Leeds Station, notably when Leeds Football Club have a home match.

3.5.2 The report then goes on to identify the types of management intervention that may be appropriate. For example, pre-match alighting passengers may choose to exit via the LSSE, and there would be a risk of congestion as a result. The introduction of a passenger 'holding area' on the approach to the ticket gateline at bridge level is suggested, the analysis estimating that this could accommodate up to 300 passengers at any one time. Other alternatives could include one-way operation, or having the southern entrance out-only for a certain period of time. Similarly, after the match has concluded, fans may want to enter through LSSE and that during this time management may be required at the lower level to regulate the flow of arriving passengers to the escalators at the lower level.

3.5.3 I would agree that there may be a requirement to manage passengers during very busy times, and the methods noted should be discussed further with stations operations staff as to how best to manage the passenger flows for various different events. Ultimately the new entrance will create additional capacity both for entering and exiting passengers, and it is therefore essential that the strategies to manage these occasions are developed further and tested.

4 Conclusions

4.1.1 This proof of evidence sets out the appraisal of the proposed Leeds Station Southern entrance in terms of the increased capacity it will provide and the potential demand by passengers.

4.1.2 The evidence sets out the methodology to calculate the future passenger volumes and movement patterns and concludes the method adopted is transparent and robust. I have also noted that the assessment was based on best available information at the time of analysis and it is my view that the data used is the most fit-for-purpose data available at the time. It is on this data that the subsequent analysis has been founded.

4.1.3 The capacity assessment has been undertaken using LEGION Studio, and utilising industry standard modelling analysis techniques. The results of the analysis support the design, noting that there may be occasions (single period of 5 minutes) where one element of the design experiences LoS D against a recommended capacity threshold of LoS C. It is my conclusion that the design would be fit-for-purpose based on the assumptions developed for the tests undertaken.

4.1.4 Sensitivity tests have highlighted the potential need to introduce passenger management strategies during certain periods, particularly at the approach to the gateline at the overbridge level, and the approach to the entrances at ground level. The strategies noted within this document would help alleviate potential congestion and my view is they would be appropriate and should be developed further with stations operation and management staff.

4.1.5 In summary, my evidence supports the proposed LSSE design in terms of the capacity it would provide and the demand expected. The results are based on best available data at the time of assessment, and it is recommended that this data be updated whenever possible, to keep abreast of actual changes in passenger flow volumes and movement patterns at Leeds Station, and feed any new information into the design process as required.