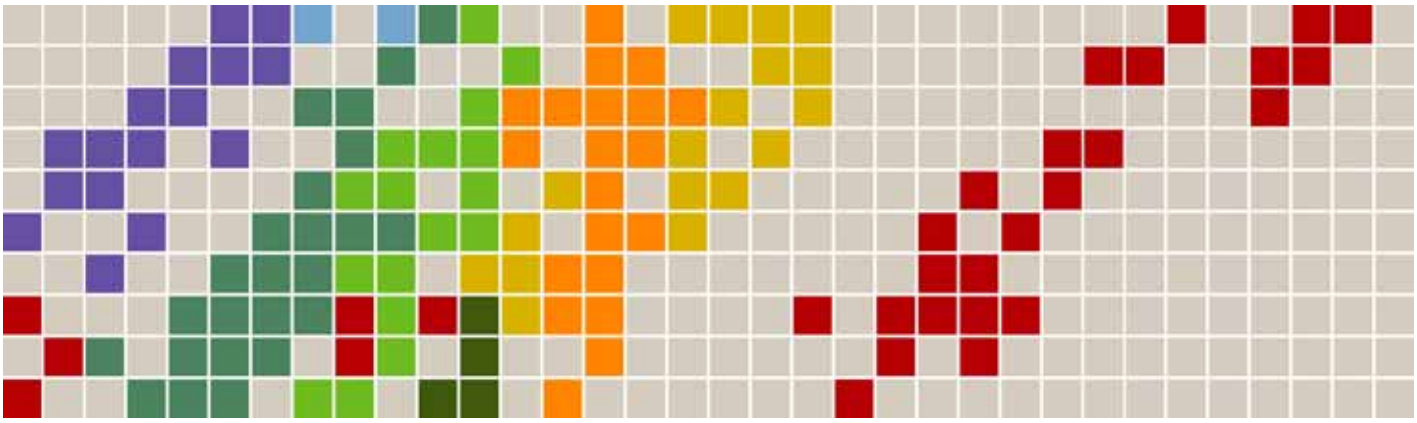


Application for the Proposed Victoria Station Upgrade

Victoria Palace Theatre
OBJ21/P7

Proof of Evidence
Mr Paul Speirs

Contents

Contents

Tables

List of Figures

1 Introduction

1.1 PROFESSIONAL QUALIFICATIONS

1.1.1 My name is Paul Speirs. I am an Associate Director of WSP, one of Europe's largest multi-disciplinary consultancies, offering an integrated design, consultancy and facilities management service in the property, transport and construction sector.

1.1.2 My qualifications and experience of relevance to this case are:

- An Honours degree in Civil and Transportation Engineering from Napier University, Edinburgh.
- 14 years of professional experience as a Transport Planner specialising in Transport Planning and Transport Modelling issues, providing advice to public and private sector clients on schemes at all stages from identification of concepts to feasibility studies, design and implementation.
- A wide ranging experience in pedestrian flow modelling including major public transport interchanges.

1.1.3 I am familiar with the local area and have advised public and private sector clients on similar major interchange developments served by the London Underground.

2 Scope of Evidence

2.1 BACKGROUND

2.1.1 The evidence that I have prepared concerns the flow of pedestrians through the Victoria Station Upgrade (VSU) as proposed by London Underground Limited (LUL).

2.1.2 Victoria Palace Theatre are objecting to LUL's proposals for a number of reasons during and post construction as summarised here:

During construction:

- Structural damage due to settlement which I believe has not been adequately assessed by LUL. The evidence of Mr Wilson OBJ21/P10 and Mr Chapman OBJ3/P3 cover this aspect.
- Noise and vibration as explained in Mr Greer's evidence OBJ21/P4
- Disruption of access and transportation covered in Mr Loveday's evidence OBJ21/P5

Following construction

2.1.3 Assuming that the effects during construction leave the VPT as a working theatre the concerns following construction are:

- Noise and vibration. The VSU as it stands includes elements that have a detrimental impact on the Victoria Palace Theatre (VPT) and threatens its sole reason for existence, that of being a first class West End Theatre. The VSU elements I refer to are the proposed Northern Escalators and the Paid Area Link (PAL). Both of these elements are located underneath and/or very close to the VPT footprint. If these elements are constructed using the methods as described in Robert Essler's evidence LUL.P4 they will create a physical link between the VPT and the Victoria underground station thereby increasing the groundbourne vibration felt within the theatre. The subject of groundbourne vibration is explained in Mr Greer's evidence (OBJ21/P4, paragraph 3.5).

- Compromising future development of the VPT. The location of the northern escalators will also prohibit or, at the very least make it difficult for the VPT, to extend in this area. This is a current aspiration and is presented in more detail in Mr Wilsons's evidence OBJ21/P10, Mr Satow's evidence OBJ21/P6 and Mr Edge's evidence OBJ21/P3. From the VPT's perspective the theatre had no choice but to object to the planning application as it stands.
- Possible harm on visual impact due to setting as discussed in Mr Earl's evidence OBJ21/P2 and Mr Edge's evidence OBJ21/P3
- Prejudice to the viability of the VPT as a working theatre.

2.1.4 The objection held by the VPT is not against the VSU in principle. Indeed, the VPT would support any upgrade as the underground station clearly operates beyond its capacity at peak times and some form of upgrade would be of benefit not only to LUL but to patrons of the VPT. However, the location of the northern escalators and the alignment of the PAL and the construction methods clearly do not take into consideration the obvious impacts they will have on the VPT.

2.1.5 The purpose, therefore, of my evidence is to identify an alternative proposal that will still allow LUL to achieve its objectives whilst at the same time remove the reasons for the VPT's objections to the location of the northern escalators and the alignment of the PAL.

2.1.6 In preparing this evidence I have drawn on information presented in the Environmental Statement VSU.A13, the Supplementary Environmental Statement VSU.A31, the Scheme Needs & Benefits LUL.P1 and the Background Report for Transport and Works Act Submission VSU.B36. The remainder of my evidence is structured as follows

- Section 3.0 outlines LUL's objectives, highlights the impact on the theatre and assesses whether the proposal meets the core objectives or not.
- Section 4.0 will review the appraisal process methodology focusing on the journey time assessment and the identification of alternative options.

- Section 5.0 will present a review of the requirements of and for the Escalators.
- Section 6.0 will provide my recommendations of the submitted evidence.

3 London Underground Ltd's Proposal

3.1 INTRODUCTION

3.1.1 This section of my evidence summarises the key drivers behind the development of the LUL preferred proposal, referred to by LUL as Option 6 (Alan Finch's POE, LUL.P3, paragraph 5.1). This section also examines whether the proposal delivers the core objectives. It is broken down into the following headings:

- Existing Station Layout
- Causes of congestion
- Platform Capacity
- Principle and Supporting Objectives of the VSU scheme
- LUL's Proposal
- Does the LUL proposal deliver?

3.2 EXISTING STATION LAYOUT

3.2.1 The Victoria underground station currently consists of two ticket halls; the Victoria Ticket Hall serving the Victoria Line and the District & Circle Ticket Hall serving the District & Circle (D&C) Line. These two ticket halls are connected by a two way passageway. Both have access to street level and the Victoria bus station. The Victoria Ticket Hall also provides access to the Victoria mainline railway station. The two ticket halls are collectively know as the Southern Ticket Hall (STH) in the LUL proposal.

3.2.2 Current access to the Victoria Line is via a set of three escalators from the Victoria ticket hall providing a direct link to the southern end of the Victoria Line platforms. The existing Victoria Line escalators are labelled 1, 2 and 3 in the LUL proposals. They currently run a one down-two up configuration.

3.2.3 Current access to the westbound D&C platforms is via steps down from the D&C ticket hall.

3.2.4 Interchange between the two underground lines is possible via the interchange concourse. This is reached from the D&C platforms via steps down to the concourse. From here a set of three escalators leads down to approximately half way along the Victoria Line platforms. These three escalators are labelled 4, 5

and 6 in the planning application and are configured one down–two up. The interchange concourse allows for a two way interchange between the two underground lines.

3.3 CAUSES OF CONGESTION

3.3.1 LUL have identified three causes of congestion, as described in Philip McKenna's Proof of Evidence, Scheme Needs and Benefits (Document LUL.P01) section 8.7.6 to 8.7.8. These refer to the performance of the Victoria Line in particular and are described in summary as follows:

- **One** Delayed services; if the interval between trains is significantly longer than scheduled many passengers cannot board and are left behind to wait for the next train. As more passengers arrive on the platform the platform could become full to the extent that passengers coming in on the next train do not have sufficient space to alight.
- **Two** Platform crowding; because of the disposition of escalators at the south end and middle of the platforms the south end of the platforms becomes full before the north end so the full capacity of the platform cannot be exploited.
- **Three** Escalator capacity; the escalators have a maximum flow capacity of 100 passengers per minute or 6000 per hour. In the AM peak in 2006 around 8700 came in.

3.4 PLATFORM CAPACITY

3.4.1 Section 12.4 of McKenna's POE discusses platform capacity and various approaches on how platform congestion can be eased. The approach favoured by LUL is to provide an additional connection to the north end of the platform so that the current bias of boarding and alighting towards the south end of the platform is reduced and the spare capacity at the north end of the platform is more fully utilised.

3.5 PRINCIPLE AND SUPPORTING OBJECTIVES OF THE VSU SCHEME

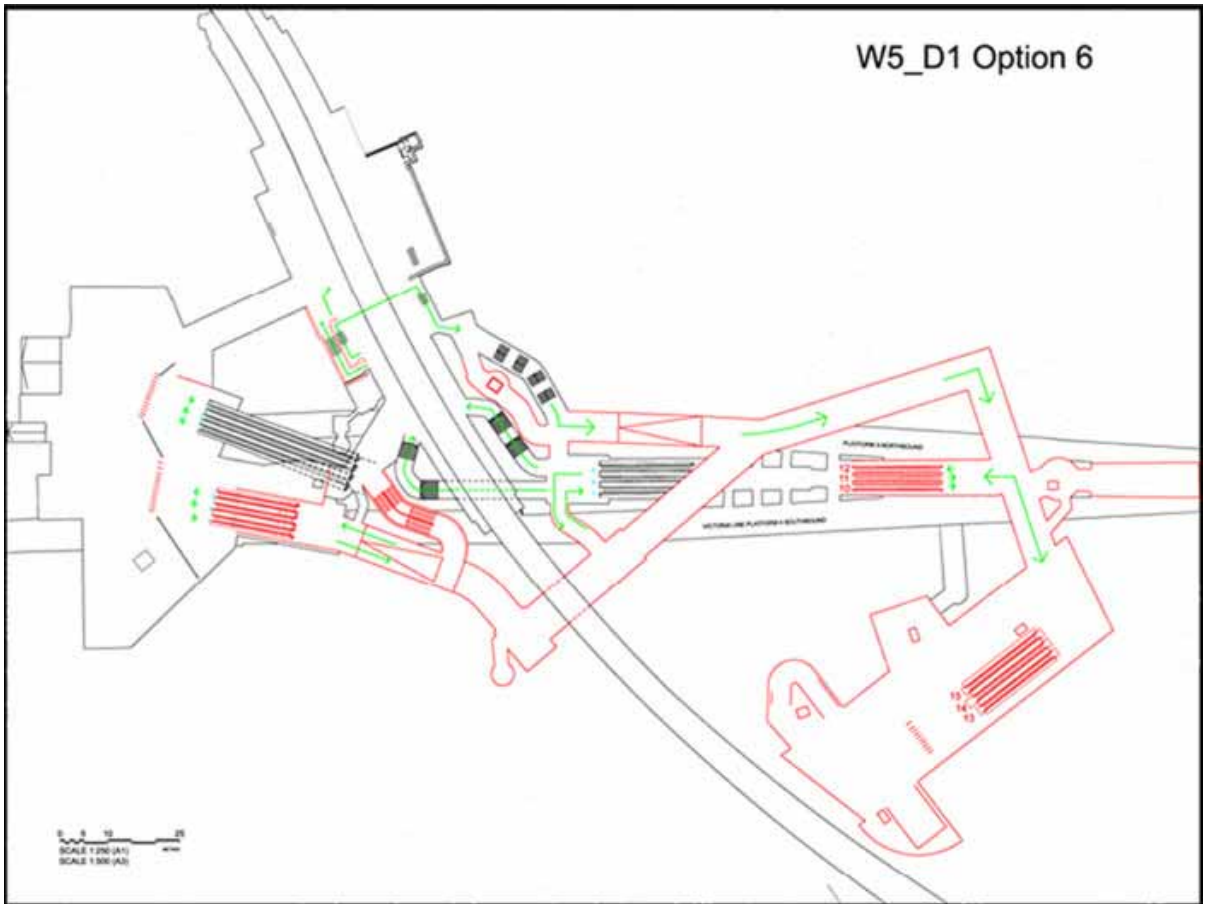
3.5.1 The principle and supporting objectives are described in Section 9 of McKenna's POE (LUL.P1). Those relevant to my evidence are summarised as:

- Increase the capacity of the Victoria Underground Station so that it is fit for purpose for handling forecast demand
- A 50% increase in escalator capacity to/from the Victoria Line
- A new station entrance near the Victoria Street / Bressenden Place junction
- Minimise journey times

3.6 LUL'S PROPOSAL

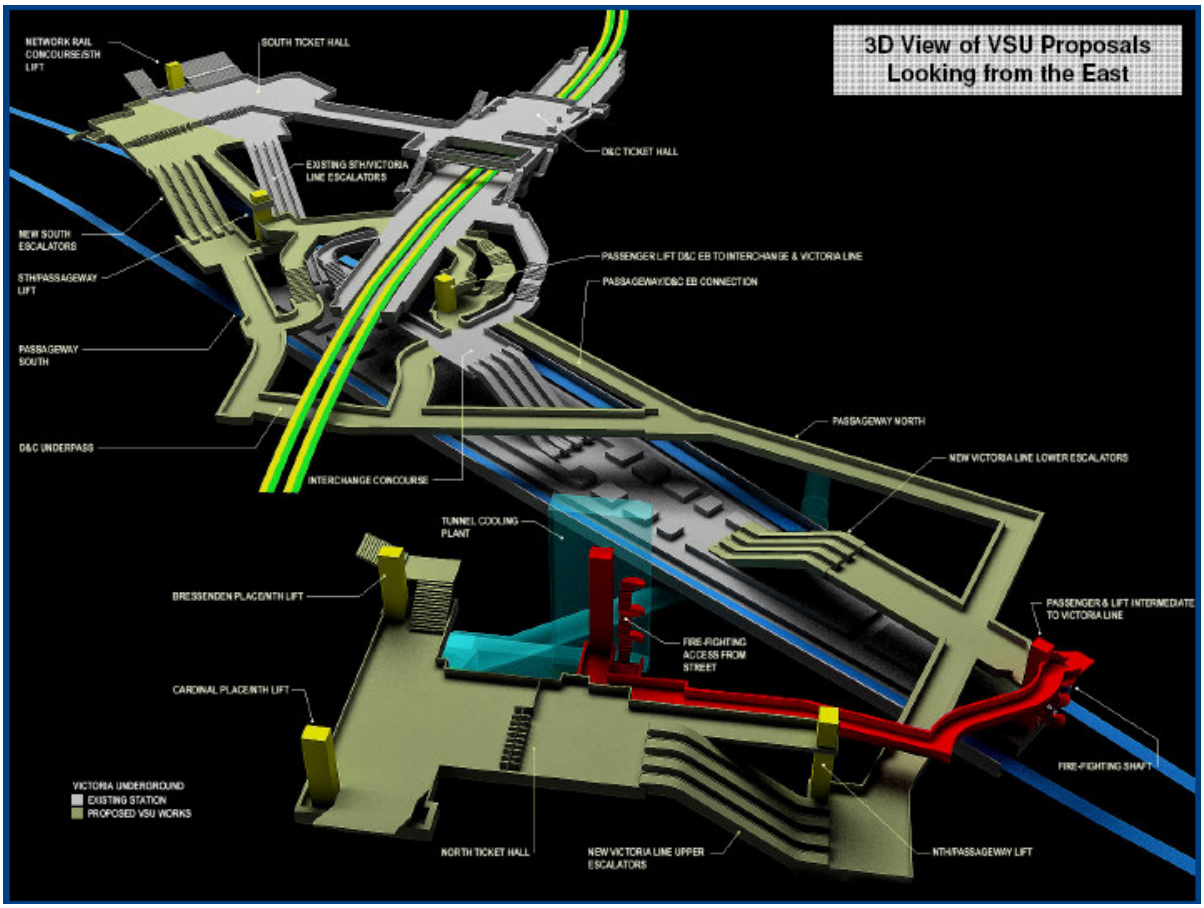
3.6.1 LUL's preferred proposal is Option 6. This layout is presented in Figure 3.1.

Figure 3.1 – LUL's Preferred Layout - Plan



Taken from the Supplementary Environmental Statement, Technical Annexes - Appendix B

Figure 3.2 – LUL's Preferred Layout – 3D View



Taken from The Environmental Statement supporting document – Design and Access Statement

3.6.2 The D&C ticket hall and access to the D&C platforms from the D&C ticket hall remain unchanged in the VSU. The links from the D&C platforms to the interchange concourse also remain unaltered in the VSU proposal, although governance over the direction of pedestrian flow on these links may change with the addition of a new link. The VSU proposal includes the following new elements:

- New STH Escalators, labelled in LUL's proposal as 7, 8 and 9. The assumed configuration is one down-two up.
- Northern Escalators, labelled in LUL's proposal as 10, 11 and 12. The assumed configuration is two down-one up.
- Northern Ticket Hall
- Paid Area Link

SOUTHERN TICKET HALL ESCALATORS

3.6.3 The proposed STH escalators comprise three escalators (7, 8 and 9). These compliment the existing three escalators (1, 2 and 3) and are intended to provide much relief to pedestrian crowding in this part of the underground station. The new STH escalators provide a link from the STH to the southern end of the PAL..

NORTHERN ESCALATORS

3.6.4 The proposed Northern Escalators are located at the northern end of the Victoria Line platforms. They provide a link between the Victoria Line platforms and the Northern Ticket Hall for Victoria Line passengers.

NORTHERN TICKET HALL

3.6.5 The proposed Northern Ticket Hall, located on the north side of Victoria Street is positioned to provide direct access between the Victoria Line platforms and the streets to the north of Victoria mainline station. The primary purpose of this ticket hall is to lighten the pedestrian demand in the STH. The proposal includes a pedestrian link from the Northern Ticket Hall to the Victoria Line platforms via the Northern Escalators.

3.6.6 The PAL also links into the Northern Ticket Hall and is a one way from the D&C and the new STH escalators. It is not possible to walk from the Northern Ticket Hall to the D&C using the PAL. However it would be possible to walk from the Northern Ticket Hall to the D&C by following a route via the Northern Escalators, the Victoria Line platforms and the interchange concourse.

3.6.7 SES Technical Appendix C, Option 6 VSU.A31 states that

> *there is no assumed movement between the Northern Ticket Hall and the D&C platforms/ticket hall.*

3.6.8 It is not made explicitly clear in the ES or SES, but my deduction is that the Northern Ticket Hall serves only Victoria Line passengers.

PAID AREA LINK

3.6.9 The PAL runs from the new Southern Ticket Hall escalators, past a short link connecting the PAL to the D&C westbound platform and past another short link connecting to the interchange concourse. This section is assumed to be two way based upon the layout shown in Figure 3.1. Passengers would be able to easily move between the Southern Ticket Hall and the interchange concourse therefore providing links from the Southern Ticket Hall to the D&C and Victoria Line. Beyond the interchange concourse the PAL continues as a one way link towards the Northern Escalators and the Northern Ticket Hall.

3.6.10 The PAL also has a western link that runs from the D&C eastbound platform in one direction towards the Northern Ticket Hall. The eastern section of the PAL from the new Southern Ticket Hall escalators merges with the western D&C section on route to the Northern Escalators and the Northern Ticket Hall.

3.6.11 SES Technical Appendix C, Option 6 VSU.A31 states that

> *The new west link corridor is one way and serves all passengers from the D&C platforms/D&C ticket hall to the Victoria Line platforms*

3.6.12 The statement implies that all interchange movements from the D&C to the Victoria Line will use the new west link and not the existing interchange concourse. Technical Appendix C, Option 6 VSU.A31 also states that

> *All interchangers going from the Victoria Line to D&C platforms use the existing interchange escalator shaft.*

3.6.13 These two statements imply that a one way system is in place with the western PAL linking the D&C to the Victoria Line and the existing interchange concourse linking the Victoria Line to the D&C.

3.7 DOES THE LUL PROPOSAL DELIVER?

3.7.1 LUL's core objective is to create a station that is fit for purpose for handling forecast demand. McKenna's evidence refers to the platform capacity being the cause of congestion (section 8.8) and that staff intervene if the platforms become unsafe or inoperable. This intervention takes the form of closing the ticket gates

leading to the Victoria Line followed by closing the entrances to the ticket hall if crowding conditions do not improve.

3.7.2 The proposed solution to the platform congestion is formed around spreading the passengers more evenly along the platforms by introducing the northern escalators and an alternative access to street level via the NTH.

3.7.3 The best way to demonstrate the success of this initiative is to examine the Passenger Densities as shown in the Appendices to the POE of Philip McKenna (Document LUL.P1A Volume 2 of 2). The busiest time periods appear to be 0845 to 0900 quarter hour period. Figures 10b and 11b from LUL.P1A are reproduced here.

Figure 3.3 – Passenger Densities Scheme Layout 2016: 0845-0900 hrs (Figure 10b)

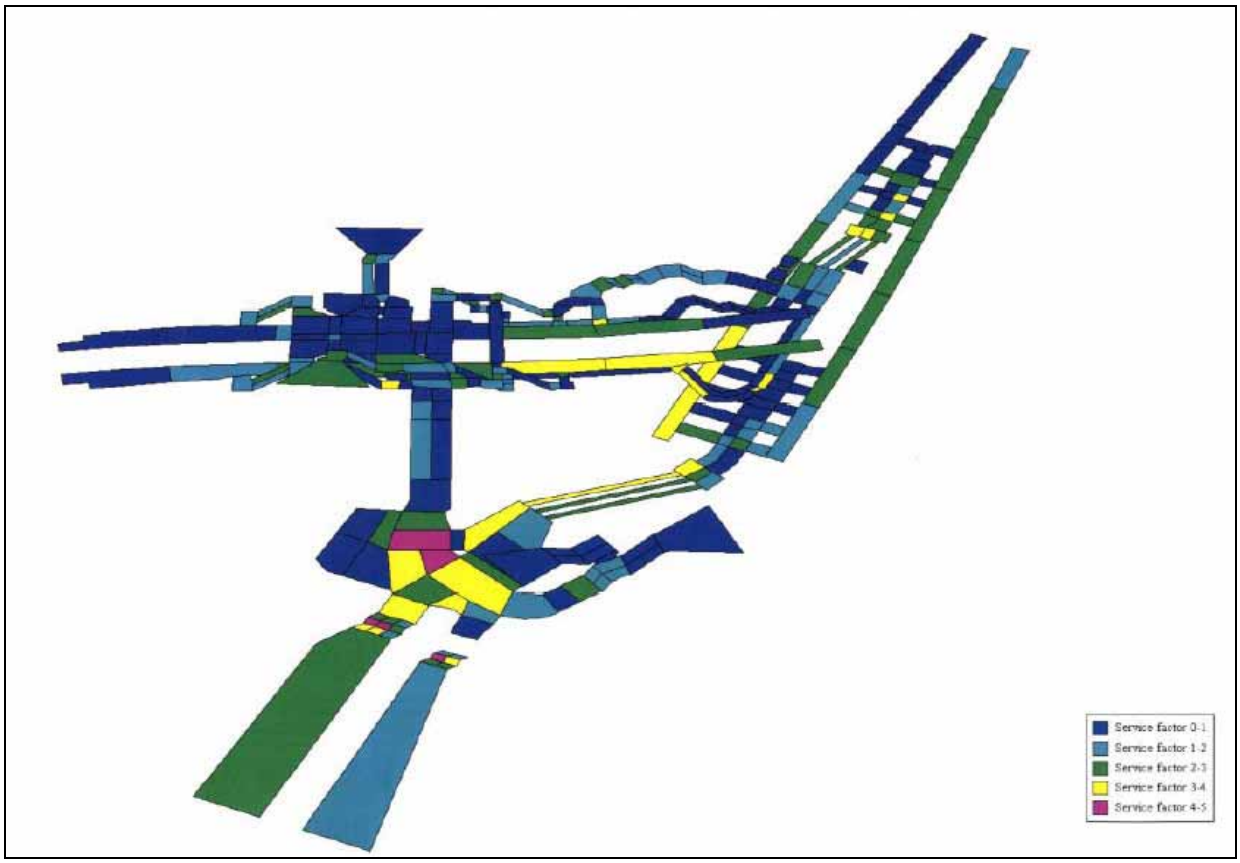
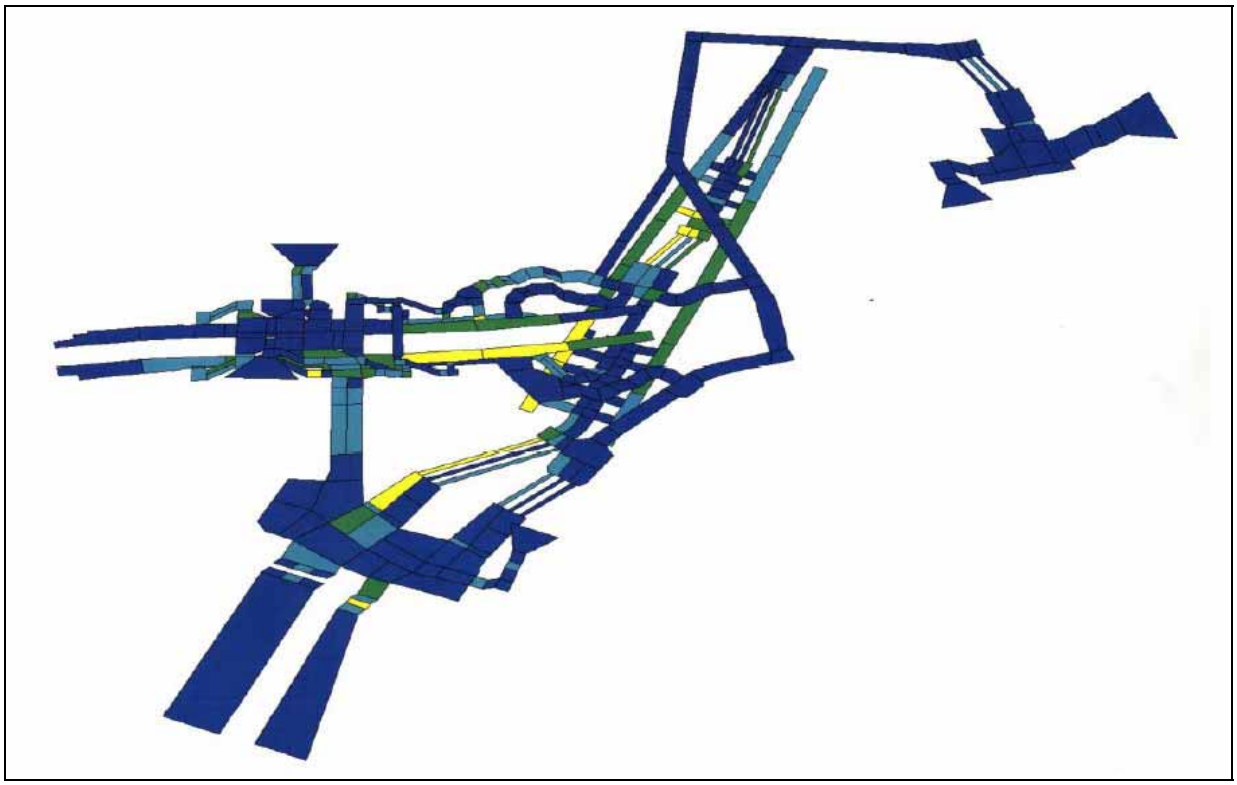
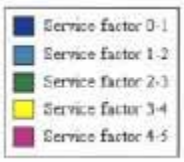


Figure 3.4 – Passenger Densities Scheme Layout 2016: 0845-0900 hrs (Figure 11b)



3.7.4 The images are taken from a PEDROUTE analysis of the station. Figure 10b shows the densities as forecast in 2016 and Figure 11b shows the densities under the proposed scheme. PEDROUTE is a bespoke pedestrian modelling software traditionally used by London Underground to assess the levels of service in their stations. The station is assessed by breaking the station elements down into small blocks where the pedestrian activity and hence density can be measured. The level of service is shown in the colour coded format as used by LUL below.



3.7.5 In Figure 10b the worst Level of Service forecast for 2016, shown in red, is at the top of the STH escalators. The second worst Level of Service, shown in yellow, is frequently forecast throughout the station including:

- Parts of the STH
- The STH down escalator
- The eastern end of the WB D&C platform

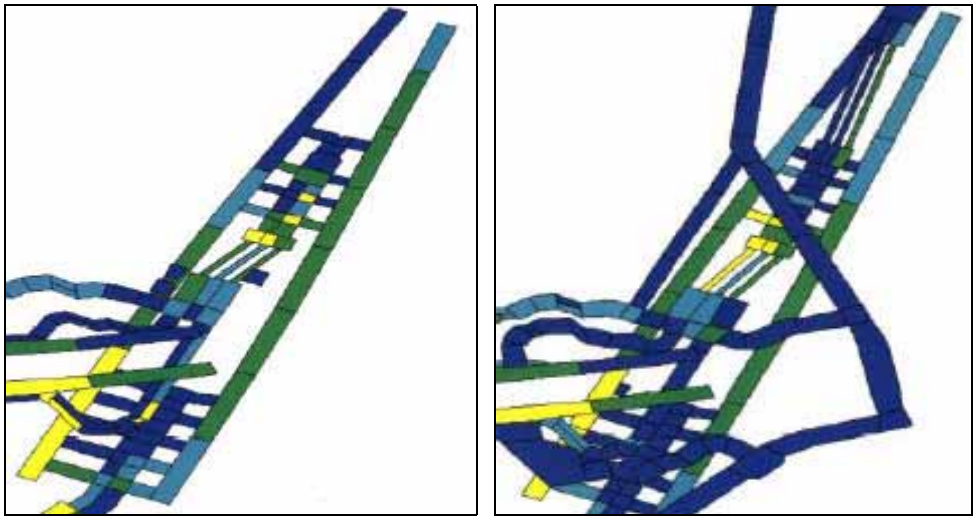
- The southern end of the NB Victoria Line platform
- The bottom of the interchange concourse escalators

3.7.6 In Figure 11b there are no red areas, i.e. the worst Level of Service is not experienced. However there are still pockets of yellow:

- The existing STH down escalator
- The eastern end of the WB D&C platform
- The southern end of the NB Victoria Line platform
- The interchange down escalator

3.7.7 The core objective was to address the congestion on the platform. Comparing the densities of the platforms with and without the proposal sheds some light on the success of the proposal.

Existing 2016 **Proposed 2016**



3.7.8 In both instances the density at the southern end of the NB Victoria Line platform remains in the same Level of Service band (yellow). The central section of the NB platform is also denser with the proposal. The density on the interchange down escalator is worsened under the proposal.

3.7.9 The images above do not demonstrate that the core objective of freeing up platform capacity has worked as congestion at the southern end of the NB platform still remains. One could venture by saying that the platform capacity is dictated by the quality of the train services rather than the platform access/egress

arrangements and that no amount of improvements will deliver on the objective if the services themselves cannot handle the demand.

4 Option Selection

4.1 ALTERNATIVE OPTION – OPTION 2B/C

4.1.1 In seeking alternatives to the alignment of the PAL the most obvious place to start was those schemes rejected during the option selection process. Of those schemes rejected there was one that offered a more favourable alignment of the PAL compared to that in the planning application. The rejected option is referred to as Option 2B/C. VSU.A31

4.1.2 In Option 2B/C the alignment of the PAL is parallel and to the south of the D&C rail tracks. This alignment almost completely avoids the theatre's footprint and therefore becomes an attractive alternative to the current proposal. The option was rejected during Phase 2 VSU.A31, page 16 with the main reasons cited as being:

- Journey Time: Increased passenger walk time.
- Buildability: Increased construction risk; potential for undermining D&C tunnel due to PAL alignment immediately adjacent.
- Stakeholder impacts: Construction impacts on the Saudi building on south side of Victoria Street.

4.1.3 My evidence and expertise considers only the journey time aspect of the option's rejection.

4.1.4 The Journey Time calculation process is described in VSU.A31, Technical Appendix D. Whilst this is clear, the actual calculations themselves are not evident in the ES or the SES. However, it is the results of the journey time calculations that were used to aid the selection process of the design options. The qualitative description for each option is provided against each option in the assessment framework detailed in the SES VSU.A31, pages 33-39. A quantitative summary is also provided which identifies the total number of pedestrian hours for several options including Option 2B/C and Option 6. The results of each option are compared against each other with Option 6 performing the best of those presented. This, in part, led to Option 6 being taken forward.

4.1.5 The journey times were calculated by multiplying the number of passengers on each route by the distance walked, and then factoring by an assumed walk speed

governed by the terrain walked over (e.g. walkways, stairs and escalators). No account was taken of congestion and any resultant reduced walking speeds. The journey time calculations were restricted to the confines of the underground station and do not include interchange distances between the mainline rail platforms or the streets around Victoria station.

4.1.6 Journey Times were one of the key indicators used to select the options. On a number of occasions various options were marked as having longer journey times and distances than the preferred option. By way of example, using the figures presented in the SES the following analysis is presented to demonstrate the time savings.

Table 5.1 – Journey Time Comparisons (AM peak 0700-1000)

	Option 2B/C	Option 6	Saving
Passenger Hours	3989	3838	151
Passenger Minutes	239340	230280	9060
Total PAX (2016+20%)	100800	100800	
Average Journey Time (Mins)	2.37	2.28	0.09
Average Walk Speed	1.34	1.34	1.34
Average Distance Travelled (m)	106	102	4

4.1.7 Using the rejected Option 2B/C as a benchmark against LUL's preferred Option 6, the number of passenger hours are converted into passenger minutes. The average journey time per passenger is then calculated in minutes per passenger journey. This is converted into a distance using the average free flow walk speed adopted by LUL. In this example, Option 2B/C has an average walk distance increase of 4m compared to Option 6. In the option appraisal framework, a primary reason cited for rejecting Option 2B/C was an *"Increased walking distance"*.

4.1.8 This distance is negligible at an individual's perception and therefore would, in reality, have little or no effect on travel behaviour choices. This 4m extended journey is in comparison to an average journey through the underground station of approximately 100m.

4.1.9 It is noted that the assessment does not include walk distances beyond the extent of the underground station and in particular the distances from the Victoria

mainline rail station. The underground and the mainline station are one public transport interchange, and I feel that pedestrian journey times and benefits should be considered in the context of the interchange and not just focused on one small part of the journey within the interchange.

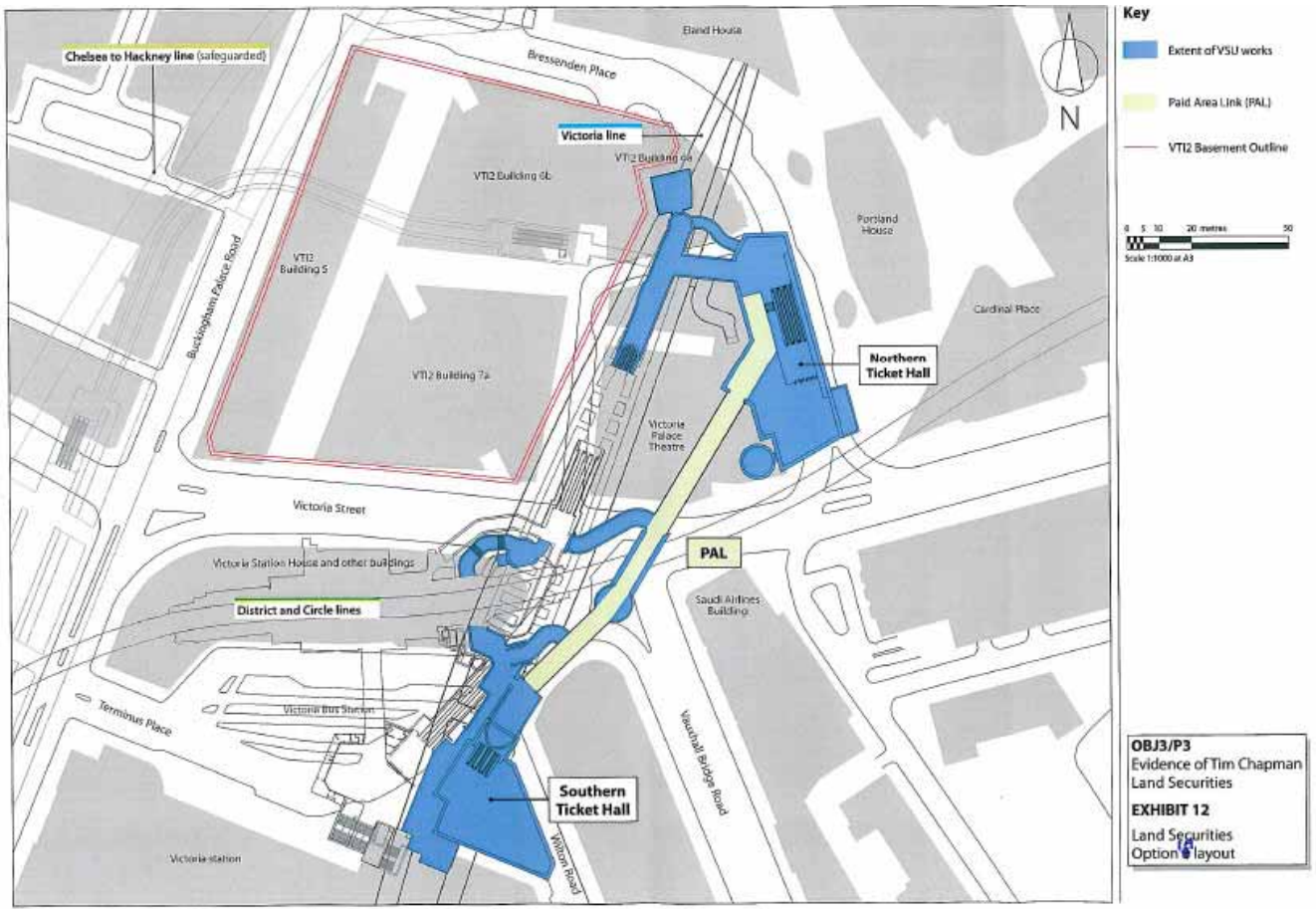
4.1.10 It may be, therefore, that a number of options have been discredited for very minor theoretical impacts at an individual level. In reality these impacts just simply would not be noticed.

4.1.11 In this respect, the rejection of Option 2B/C on the grounds of increased journey times is misleading and practically irrelevant.

4.2 ALTERNATIVE OPTION – LAND SECURITIES OPTION 1A

4.2.1 Land Securities have developed an alternative proposal, known as Land Securities Option 1a OBJ3/2/8A, that better serves their needs. This is illustrated in Figure 4.1.

Figure 4.1 – Land Securities Option 1a



4.2.2 This option maintains a PAL that links directly with the NTH from the bottom of the new STH escalators. The link from the PAL to the interchange concourse remains. The new west link connection from the D&C to the Victoria Line is not included, thus leaving interchange passengers to make their connections via the same infrastructure as existing.

4.2.3 This option preserves almost all of LUL's objectives, platform capacity not withstanding, and given the construction techniques proposed by Land Securities for the PAL, is also an acceptable solution to the VPT even though it runs directly underneath the theatre.

5 Northern Escalator Review

5.1 THE REQUIREMENT FOR THREE NORTHERN ESCALATORS

5.1.1 LUL's preferred scheme proposal includes a new bank of three escalators at the northern end of the Victoria Line platforms. The northern escalator shaft is partially underneath the Theatre and its construction technique will create a physical link between the rail tracks on the Victoria Line with the Theatre's foundations. This will increase the magnitude of groundbourne vibration that would be felt and heard within the Theatre thereby threatening its very existence as a theatre able to put on the high quality of shows that it currently does.

5.1.2 The construction techniques proposed by LUL do not fully consider the impacts of ground settlement and the inherent risks to the structure of the VPT. This aspect is covered in detail in Mr Wlison's evidence (OBJ21/P10).

5.1.3 This section of my evidence explores the need and requirement for three northern escalators against my proposal for just two escalators thus creating the opportunity to move the escalators further north. My evidence is drawn largely from four submitted documents:

- VSU.B36 Background Report for Transport and Works Act Submission
- LUL.P1 – Scheme Need & Benefits, Proof of Evidence of Philip McKenna
- VSU.A13 – Environmental Statement
- VSU.A31 – Supplementary Environmental Statement

5.2 PREVIOUS LOCATION OF THE NORTHERN ESCALATOR

5.2.1 In previous options the location of the northern escalators was further north away from the theatre. This is presented in greater detail in Jon Satow's evidence OBJ21/P6 in Section 4.3 with supporting illustrations in Appendix H OBJ21/P6A. The current proposed position is some 5m further south than these earlier options.

5.2.2 There appear to be two possible reasons why the escalators cannot be moved further north.

5.2.3 Firstly the location of Signal Equipment Room (SER) would have to be moved or relocated if the escalators were to be moved north. It is noted that the VSU proposals do propose a new SER in an alternative location. If this is the case then this removes this reason for not being able to move the escalators further north.

5.2.4 Secondly, the proposed positioning of the northern escalators is dictated by its proximity to the Victoria Line running tracks. This explanation would appear to conflict with the previously proposed positioning shown in Jon Satow's evidence OBJ21/P6A, Appendix H. The northbound and southbound running tracks sit either side of the Victoria Line platforms and at the northern end the platforms begin to taper and merge towards each other. Beyond the north end of the platforms the running tracks converge together to sit side by side. The positioning of the northern escalator shaft is above the section where the running tracks begin to converge, so at some point the shaft will be immediately above the tracks. It is understood that the converging tracks that dictate the location of the shaft meaning that it cannot be moved further north if the minimum headroom above the tracks is to be maintained. A wider shaft will overlap the alignment of the running tracks before a narrower shaft. It therefore stands to reason that if the shaft could be narrowed then it could be located further north than its proposed location whilst still maintaining the minimum headroom above the tracks.

5.3 TRANSPORT FOR LONDON GUIDANCE

5.3.1 The Station Planning Standards & Guidance (SPSG), a Good Practice Guide 5th Edition (VSU.B31) is quoted in various parts of LUL's evidence.

5.3.2 The following is an extract from SPSG.

The number of escalators required for any one direction is as follows:

$$\textit{number of escalators} = \left\{ \frac{\textit{peak minute one-way flow}}{100} \right\}$$

where peak minute flow is as in the earlier section on passenger flows and based on escalator capacity of 100 passengers per minute. The calculated number of escalators shall be rounded-up to the next whole number if the first number after the decimal point is ≥ than 0.2, and

rounded down otherwise; e.g., 2.2 escalators would be rounded-up to 3, 2.1 escalators would be rounded down to 2.

Escalator shafts shall be constructed to be capable of accommodating a minimum of three escalators even if fewer than that number are installed initially.

5.3.3 This statement advises that the escalator shaft should be wide enough to accommodate three escalators. However, there are a number of precedents in many stations around London where there are only two escalators in the same shaft.

5.3.4 The Technical Appendix C, Option 6 of the SES VSU.A31 indicates that the northern escalator one minute peak demand for both directions is 235 pedestrians. Using the LUL design standards, 2.35 escalators are required. This is rounded up to three. However, if this one minute demand were reduced to 219 pedestrians then only two escalators would be required. To achieve this a reduction in the one minute peak demand of just 16 pedestrians would be required. With this small reduction in mind I go on to discuss the pedestrian demand in more detail.

5.4 PEDESTRIAN DEMAND OVERVIEW

Railplan

5.4.1 LUL's assessment of the station's operating conditions is based upon forecasts for 2016. The forecast pedestrian demand is taken by adding the growth as forecast by Railplan between 2006 and 2016 to an observed base taken from 2006. Railplan is best described quoting VSU.B36, page 16, section 4.4.2.

Railplan is a model of the whole public transport network in London and the surrounding area which can be used to estimate flows on individual lines and routes as demand or service changes.

5.4.2 Railplan is a strategic demand tool and does not include detailed origin / destination movements through the underground station such as between platforms and the different street entrances. LUL have expanded the Railplan matrices so as better to reflect the detailed movements through the underground station. I have not assessed this part of the demand process in my evidence.

5.4.3 Railplan, and therefore the derived forecasts for 2016, are initially prepared as three hour demand matrices covering the AM peak (0700 to 1000). Page 17 of VSU.B36 states;

Railplan is only set up for the AM peak

5.4.4 It is not clear from LUL's evidence how the PM peak forecasts are derived if Railplan is not set up for the PM peak. In any event, the three hour PM peak period is 1600 to 1900.

Peak Minute Demand

5.4.5 The key determining measurement used to calculate elements such as corridor widths, number of ticket gates and number of escalators is the peak minute demand. This is calculated by factoring the three hour demand down to a 15 minute timeslice using either observed quarter hour profiles or if not available factors taken from the Station Planning and Standards Guidance VSU.B31, page 8. For Victoria Underground Station (a zone 1 station), the conversion factor from three hours to peak minute is 0.081 and 0.071 for the AM and PM peaks respectively.

5.4.6 The LUL assessment has been prepared using peak minute flows. VSU.B36 section 4.4.2 (page 23) describes the process as breaking the three hour demand into 15 minute timeslices using profiles shown in VSU.B36 Table 11 (page 23). The same paragraph goes onto say

Implicitly, within each 15 minute period demand levels are treated as flat.

5.4.7 It is assumed this means the peak minute demand is calculated by dividing the 15 minute demand by 15. This is consistent with the calculation described above and in VSU.B31 page 8.

5.4.8 The busiest 15 minute profiles are taken as Quarter Hour Starting at 08:30 (AM) and 17:45 (PM) as shown in VSU.B36 Table 11. In summary the busiest 15 minute peak as a proportion of the peak hour is reproduced here.

Table 5.1 – Busiest 15 Minute Profile (as a proportion of 3 hour peak)

Quarter Hour	Entries	Exits	Interchange
0830 - 0845	11.6%	11.2%	12.3%
1745 - 1800	10.4%	10.4%	10.4%

5.4.9 These proportions are greater than the default factors calculated in VSU.B31 so will produce larger peak minute flows.

Relevant Pedestrian Demand

5.4.10 The pedestrian demand relevant to my evidence is any that uses the escalators to access/egress the Victoria Line platforms. The pedestrian demand, based upon where pedestrians start and end their journey, is broken down into the following sectors.

Table 5.2 – Victoria Underground Station Sectors

Platforms	D&C WB D&C EB Victoria NB Victoria SB
D&C Ticket Hall	Victoria Street Terminus Place

Southern Ticket Hall	Wilton Road Mainline Entry Mainline East
Northern Ticket Hall	Bressenden Road Vic St North

5.4.11 Movements between the following sectors do not interfere with any of the escalator banks in the LUL proposal, so the demand is not considered in my calculations.

- Between the D&C platforms and the D&C ticket hall entrances
- Between the D&C platforms and the STH entrances

5.4.12 The first assumption is logical; the second assumption is qualified by the statements in VSU.A31 Technical Appendix C, Option 6:

> *People travelling between the D&C westbound /eastbound platform and south ticket hall are assumed to use the conventional route via the D&C ticket hall.*

5.4.13 A second statement taken from the same source is:

> *People from the Victoria line platforms exiting at the D&C ticket hall are assumed to exit via the interchange concourse and the eastbound D&C platform.*

5.4.14 These pedestrians are therefore included in my calculations. There is no reference made to pedestrians moving in the reverse direction, so I have assumed that pedestrians travelling from the D&C ticket hall to the Victoria Line will also use the D&C eastbound platform and the interchange concourse.

5.5 2016+20% FORECASTS

5.5.1 It is standard LUL practice for the forecast scenarios to be uplifted by 20% to account for growth beyond the forecast year, therefore, in the interests of examining worst case scenarios I have prepared my evidence based upon the greatest forecast demand for 2016 available in other evidence documents. There are references to the 2016 forecast demand in at least three other evidence documents.

5.5.2 Firstly, paragraph 12.5.9 of LUL.P1 (page 25) refers to forecast demand and allowing for 20% further growth in the long term, however, paragraph 16.2.25 of LUL.P1 (page 53), under the heading Congestion Relief Appraisal, notes that

> *for appraisal purposes demand at the 2016 reference year has been used for both peaks and demand 5% and 10% above for the evening peak. The 5% and 10% levels for the morning peak were not included in the project appraisal. This is because at this level of demand the modelling suggests the existing station experiences very long delays, and may lock up. This makes the model results less reliable for higher levels of demand.*

5.5.3 Paragraph 16.2.17 of LUL.P1 (page 52) suggests that the proposed station has been modelled with a 20% uplift in demand.

5.5.4 Secondly, the demand quoted in VSU.B31 (page 72), representing the three hour 2016 AM peak period is for 81,404 pedestrians. With an additional 20% uplift, this rises to 97,687 pedestrians.

5.5.5 Thirdly, the Environmental Statement VSU.A13, Table 2-1 (page 2-2) states that;

> *Design year forecasts represent demand levels in 2016 plus an additional 20% (100,800).*

5.5.6 This is a three hour AM peak demand.

5.5.7 Page 26 (the last page) of OBJ3/P4/A13 (Appendix 13 to Roy McGowan's proof) details an interchange demand matrix provided by LUL to Land Securities. Whilst this source of information does not state whether it represents the AM or PM peak it is consistent with the three hour AM peak demand of 100,800 as quoted in the ES. As this represents the highest forecast demand I have assumed this demand in assessing the AM peak minute demand for the 2016+20% scenario. This is a higher forecast than that presented in VSU.B36.

5.5.8 The only PM peak demand available for assessment is that contained in VSU.B36 (page 92). This represents 2016, so I have globally uplifted this demand by 20% to produce 2016+20% demand levels.

5.5.9 The three hour AM and PM peak 2016+20% demand is presented, for the relevant pedestrian movements, in Table 5.3 and Table 5.4 respectively.

Table 5.3 – AM Peak (0700-1000) 2016+20% Scheme Design Scenario Pedestrian Demand

		Platforms				D&C			STH		NTH		Total
		D&C WB	D&C EB	Vic NB	Vic SB	Victoria Street	Terminus Place	Wilton Road	Sussex	Kent	Bressenden Road	Vic St North	
Platforms	D&C WB			452	1205								1657
	D&C EB			4001	1576								5577
	Vic NB	4458	2363			431	163	183	853	341	1673	126	10591
	Vic SB	4991	2374			2007	758	856	3972	1585	7787	586	24916
D&C	Victoria Street			239	17								256
	Terminus Place			671	48								719
STH	Wilton Road			588	35								623
	Mainline Entry			13068	781								13849
	Mainline East			7860	469								8329
NTH	Bressenden Road			1213	73								1286
	Vic St North			92	5								97
	Total	9449	4737	28184	4209	2438	921	1039	4825	1926	9460	712	67900

Sector Movement Summary	Pedestrians	Proportions
Vic to/from NTH	11555	17%
Vic to/from STH (Existing)	17731	26%
Vic to/from STH (New)	11821	17%
Interchangers	26793	39%
	67900	100%

Small rounding errors may be present in row and column totals

Table 5.4 - PM Peak (1600-1900) 2016+20% Scheme Design Scenario Pedestrian Demand

		Platforms				D&C			STH		NTH		Total
		D&C WB	D&C EB	Vic NB	Vic SB	Victoria Street	Terminus Place	Wilton Road	Sussex	Kent	Bressenden Road	Vic St North	
Platforms	D&C WB			1920	1507								3427
	D&C EB			5216	3176								8393
	Vic NB	2130	1356			56	50	59	823	496	151	11	5132
	Vic SB	3853	691			818	719	845	11828	7114	2170	163	28201
D&C	Victoria Street			1804	384								2188
	Terminus Place			725	154								878
STH	Wilton Road			1987	308								2296
	Mainline Entry			3808	590								4398
	Mainline East			1519	235								1754
NTH	Bressenden Road			9196	1427								10622
	Vic St North			692	107								799
	Total	5983	2047	26867	7889	875	769	904	12652	7609	2321	174	68089

Sector Movement Summary	Pedestrians	Proportions
Vic to/from NTH	13916	20%
Vic to/from STH (Existing)	17225	25%
Vic to/from STH (New)	11484	17%
Interchangers	25464	37%
	68089	100%

Small rounding errors may be present in row and column totals

5.5.10 I have calculated the peak minute demand in the same manner as previously described, by applying the 15 minute profiles in Table 5.1 to the three hour demand and dividing through by 15. This produces the AM and PM peak minute demand shown in Table 5.5 and Table 5.6 below.

Table 5.5 – 2016+20% AM Peak, Peak Minute Pedestrian Demand

		Platforms				D&C			STH		NTH		Total
		D&C WB	D&C EB	Vic NB	Vic SB	Victoria Street	Terminus Place	Wilton Road	Sussex	Kent	Bressenden Road	Vic St North	
Platforms	D&C WB			4	10								14
	D&C EB			33	13								46
	Vic NB	37	19			3	1	1	7	3	13	1	85
	Vic SB	41	19			16	6	7	31	12	60	5	196
D&C	Victoria Street			2	0								2
	Terminus Place			5	0								5
STH	Wilton Road			4	0								5
	Mainline Entry			98	6								103
	Mainline East			59	4								62
NTH	Bressenden Road			9	1								10
	Vic St North			1	0								1
	Total	77	39	214	33	19	7	8	37	15	73	6	528

Sector Movement Summary	Pedestrians	Proportions
Vic to/from NTH	89	17%
Vic to/from STH (Existing)	133	25%
Vic to/from STH (New)	89	17%
Interchangers	217	41%
	528	100%

Table 5.6 – 2016+20% PM Peak, Peak Minute Pedestrian Demand

		Platforms				D&C			STH		NTH		Total
		D&C WB	D&C EB	Vic NB	Vic SB	Victoria Street	Terminus Place	Wilton Road	Sussex	Kent	Bressenden Road	Vic St North	
Platforms	D&C WB			13	10	0	0	0	0	0			24
	D&C EB			36	22	0	0	0	0	0			58
	Vic NB	15	9			0	0	0	6	3	1	0	36
	Vic SB	27	5			6	5	6	82	49	15	1	196
D&C	Victoria Street	0	0	13	3								15
	Terminus Place	0	0	5	1								6
STH	Wilton Road	0	0	14	2								16
	Mainline Entry	0	0	26	4								30
	Mainline East	0	0	11	2								12
NTH	Bressenden Road			64	10								74
	Vic St North			5	1								6
Total		41	14	186	55	6	5	6	88	53	16	1	472

Sector Movement Summary	Pedestrians	Proportions
Vic to/from NTH	96	20%
Vic to/from STH (Existing)	119	25%
Vic to/from STH (New)	80	17%
Interchangers	177	37%
	472	100%

5.6 ROUTING ASSUMPTIONS

5.6.1 To help understand the routings the escalator numbering system and direction of flow is reproduced from LUL.P1 Table 4 (page 45).

Table 5.7 – Escalator Directions (up to 10% above 2016 demand)

Escalator	Escalator Number	Direction
Victoria Line TH Existing escalators	1	UP
	2	UP
	3	DOWN
Interchange Concourse	4	UP
	5	UP
	6	DOWN
Victoria Line TH (new escalators)	7	UP
	8	UP
	9	DOWN
Victoria North End escalators	10	UP
	11	DOWN
	12	DOWN
North Ticket Hall	13	UP
	14	UP
	15	DOWN

5.6.2 To evaluate the escalator demand the above peak minute demand matrices need to be apportioned based upon some basic routing assumptions.

5.6.3 Section 15.8 and paragraph 15.8.1 of LUL.P1 (page 44/45) in particular explains the routing and the triggers for a change in routing.

> *At low levels of demand, off peak and in the shoulders of the peak, passengers from the mainline station going to the Victoria Line can go via the existing escalators. As demand builds up passengers need to split between the existing and new escalators. Those that come down the new escalator would use the interchange concourse until the interchange concourse becomes too busy with the cross flows from the exiting and interchange passengers. At this point, the traffic from escalator 9 would be routed via escalators 11 & 12 at the north end of the station.*

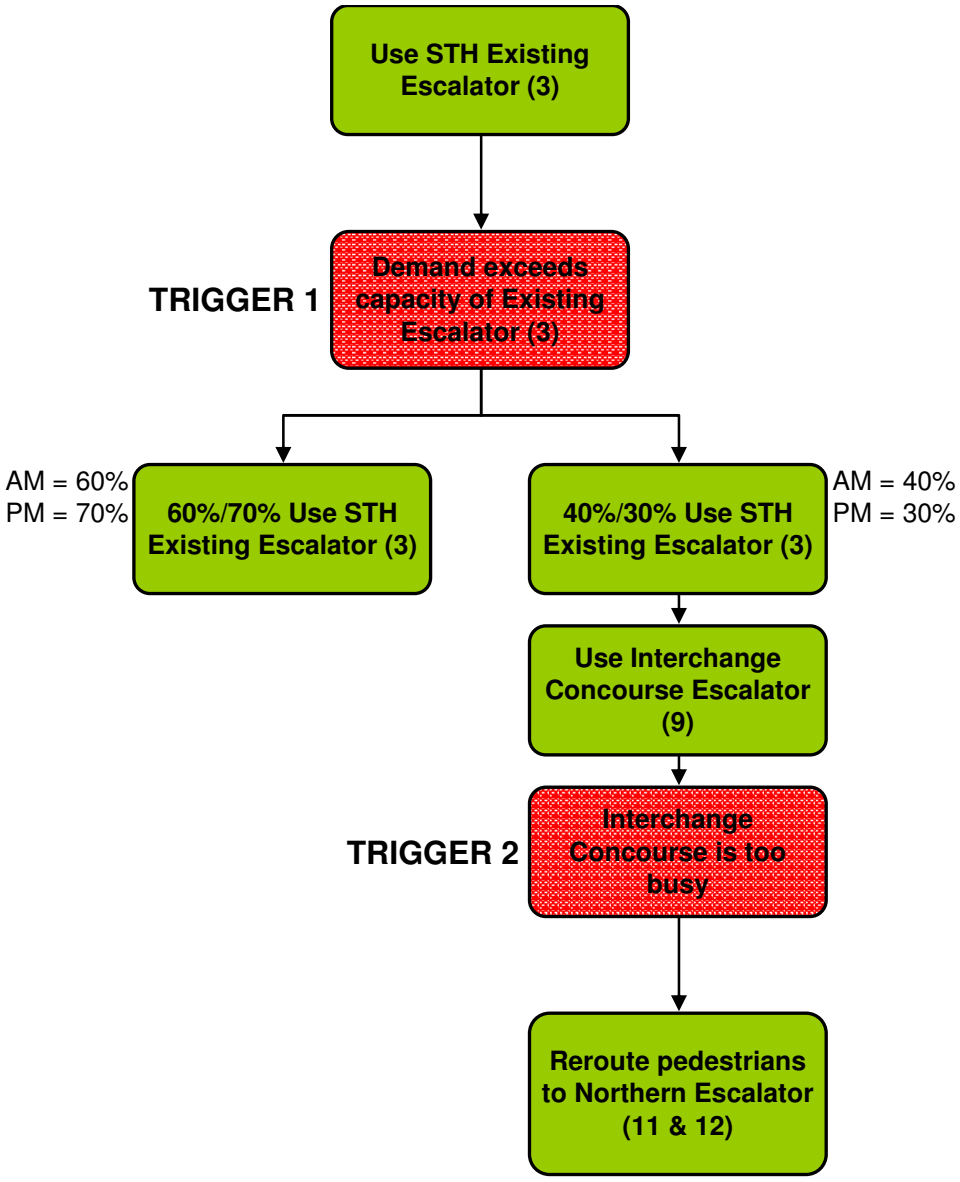
5.6.4 Paragraph 15.8.4 of LUL.P1 (page 45) explains the proportional split between the existing and new STH escalators.

> *For modelling purposes 60% of passengers have been allocated to escalator 3 and 40% to escalator 9 in the AM peak and 70% to escalator 3 in the PM peak.*

5.6.5 These splits appear arbitrary.

5.6.6 To summarise, this means that two triggers are anticipated that will result in a change of routing. The routings and triggers are illustrated in Figure 5.1.

Figure 5.1 – LUL Routing Decisions & Triggers



5.6.7 To put this regime to the test I have calculated the peak minute demand from the STH to the VL starting from free flow conditions at the existing escalator. Following the regime and the trigger points the escalator demand throughout can be seen. The AM peak analysis is presented below.

Table 5.8 – AM Peak Minute Escalator Demand, 2016+20%

Conditions	Escalators in Use	Location	Direction	No. Escalators	Users	Peak Minute Demand	Escalators Required	Demand Exceeded?
STH to Victoria Line								
Free Flow	3	STH Existing	Down	1	STH to VL	170	2	Yes
Trigger 1	3	STH Existing	Down	1	STH to VL	102	1	No
	9	STH New	Down	1	STH to VL	68	1	No
Interchange Concourse to Victoria Line								
Free Flow	6	IC	Down	1	STH to VL	67	1	No
Trigger 1	6	IC	Down	1	STH to VL D&C to VL	135	2	Yes
Trigger 2	11 & 12	NTH	Down	2	STH to VL NTH to VL	78	1	No

5.6.8 Under free flow conditions the demand for the existing escalator is exceeded (170 pedestrians). This calls in Trigger 1; so the STH to VL demand is split 60/40 between the existing and new escalators. The demand for these two down escalators is now within the escalator capacity.

5.6.9 With Trigger 1 kicking in additional demand is sent to the interchange concourse and escalator 6. This adds to the interchanging passengers already using this escalator and at this point the escalator demand exceeds the capacity, so Trigger 2 kicks in. The demand rerouted from escalator 3 after Trigger 1 is now rerouted a second time to the northern escalators to join the NTH to VL pedestrians. This combined demand (78 pedestrians) is within the capacity of one escalator.

5.6.10 **Therefore, in the AM peak, only one down escalator is required at the northern end of the Victoria Line platform. LUL are proposing two.**

5.6.11 The PM peak analysis is presented in .

Table 5.9 – PM Peak Minute Escalator Demand, 2016+20%

Conditions	Escalators in Use	Location	Direction	No. Escalators	Users	Peak Minute Demand	Escalators Required	Demand Exceeded?
STH to Victoria Line								
Free Flow	3	STH Existing	Down	1	STH to VL	59	1	No
Trigger 1 Not Required	3 9	STH Existing STH New	Down Down	1 1	STH to VL STH to VL	59 0	1 0	
Interchange Concourse to Victoria Line								
Free Flow	6	IC	Down	1	STH to VL	67	1	No
Trigger 1 Not Required	6	IC	Down	1	STH to VL D&C to VL	67	1	
Trigger 2 Not Required	11 & 12	NTH	Down	2	STH to VL NTH to VL	78	1	

5.6.12 Under free flow conditions the demand for the existing escalator is never exceeded (59 pedestrians). Therefore the routing triggers are not required.

5.6.13 **Therefore, in the PM peak, only one down escalator is required at the northern end of the Victoria Line platform. LUL are proposing two.**

5.6.14 In support of reducing the total number of escalators serving the Victoria Line platforms from 9 down to 8, paragraph 15.7.1 of LUL.P1 simply states

> *Whilst 9 escalators (Nos 1, 2, 3, 4, 5, 6, 10, 11 and 12) would be installed that link into the Victoria Line level the station should work reasonably comfortably well with 8.*

Alternative Options

5.6.15 In Option 2B/C the trigger routing would send pedestrians straight to the northern escalators from the STH, rather than the intermediary interchange concourse.

5.6.16 The same routings as proposed by LUL could be managed if the crowding triggers were to occur in the Land Securities Option 1a arrangement.

5.7 EGRESS ESCALATORS

5.7.1 The number of UP escalators remains unchanged at five so I have not assessed the allocation, demand for or capacity of the egress, or UP, escalators. The peak minute demand for pedestrians alighting the Victoria line, i.e. egress pedestrians, is lower than the number boarding in the AM and slightly higher in the PM. It has been proven that three DOWN escalators can accommodate the boarding demand, so it is highly likely that the five UP escalators will accommodate the alighting passenger demand.

5.8 DEMAND PEAKS & SURGES

5.8.1 Paragraph 15.8.8 of LUL.P1 (page 46) discusses arrival surges, notably the surge in pedestrians if two trains were to arrive at the same time.

5.8.2 The number of UP escalators remains unchanged at five from the platforms, so I have not prepared an assessment of the ability to absorb surges alighting from the trains.

5.9 RESILIENCE FOR ESCALATOR REPAIR

5.9.1 Paragraph 15.7.1 of LUL.P1 (page 44) considers the resilience for Escalator repair. It concludes that whilst the Victoria Line platform has 9 escalators facilitating access and aggress it could comfortably handle the demand with 8 escalators.

5.9.2 I am proposing that the Victoria Line platforms are serviced with 8 escalators. With one under repair this would leave 7 remaining.

5.9.3 Based upon the peak minute demand provided in Table 5.5 and Table 5.6 for the AM and PM peak, an assessment of the total UP/DOWN demand is presented.

Table 5.10 – Resilience, Escalator Peak Minute Demand

Direction	No Escalators In Place	AM	PM	No. Escalators Required
Demand Taken from Table 5.5 and 5.6				
UP	5	281	231	3
DOWN	3	247	241	3
Total	8	528	472	**6**
Demand taken from VSU.A31 Technical Appendix C, Option 6				
Two Way	8	636		**7**

5.9.4 The required number of escalators is demonstrated to be a minimum of 6 based upon the peak minute demand. For robustness, the peak minute demand taken from VSU.A31 Technical Appendix C, Option 6 is also assessed and this demonstrates that 7 escalators are required.

5.9.5 Therefore, resilience in the system is retained even if the number of escalators serving the Victoria Line platform is reduced to 7 in total. The continued connectivity in Land Securities Option 1a ensures that pedestrians can be shepherded around the station if one escalator is removed from service.

5.10 LUL ESCALATOR DEMAND & ROUTING INCONSISTENCY

LUL Demand in the SES

5.10.1 VSU.A31, Technical Appendix C, Option 6 details the peak minute demand for the escalators and the various passageways. The escalator peak is expressed as total peak flow for both directions. I have found these flows difficult to reproduce based on the demand and methodology evidence in other parts of LUL's submitted documents. It is also not clear from the Table if the demand is AM, PM or a combination of both time periods.

LUL Routing as Defined in the SES

5.10.2 The routing decisions also appear to be either illogical or impossible to control based on the VSU.A31, Technical Appendix C, Option 6 Table. For instance, the two way demand on the new STH escalators (7-9) is 98 pedestrians. The demand on the PAL Centre IC Connection is also 98 pedestrians. It is reasonable to assume that these are the same 98 pedestrians and represent pedestrians moving

between the STH and the Victoria Line platforms via the interchange concourse. This is supported in the footnote to the Table that states:

> *A 60% to 40% split is assumed for the boarders and alighters travelling between the STH and the Victoria line platforms. 60% of people are assumed to use the current escalators and 40% are assumed to use the new link (escalators 4-6 and 7-9).*

5.10.3 The D&C WB PAL Interchange Corridor and Stairs have a demand of 32 pedestrians. These pedestrians are moving between the D&C WB platform and the Victoria Line. The PAL Centre also has 32 pedestrians. Bearing in mind the above assumption, by deduction these pedestrians must be the same individuals.

5.10.4 This means that for a short section of the PAL, between the D&C WB Interchange Corridor and the PAL Centre IC Connection the 98 and the 32 pedestrians are merged. They then neatly and precisely diverge at the PAL Centre IC Connection to continue on their separate routes to the Victoria Line.

5.10.5 In reality this simply would not happen and also the routing patterns are inconsistent with those described in Section 15.8 and paragraph 15.8.1 of LUL.P1 (page 44/45).

5.10.6 It is therefore difficult to take confidence either from the figures presented in this Table or from the emanating escalator requirements.

6 Recommendations

6.1.1 One of the core objectives of the VSU is to reduce crowding on the platforms, something that is a key trigger to delays experienced at the station today. Yet evidence from the PEDROUTE plots suggests that the same degree of congestions is experienced on the southern end of the Northbound platform in the AM peak. In this sense, the scheme has failed to meet one of its core objectives.

6.1.2 The option selection process appears to be misleading based upon the case of Option 2B/C where the journey times are regarded as a primary reason for rejection, yet it has been demonstrated that the average increase in journey distance is just 4m per pedestrian.

6.1.3 My evidence clearly demonstrates the pedestrian demand around the station to be lower than that presented in LUL's evidence documents. I have used LUL's worst case demand data and their agreed methodologies to develop the peak minute demand from which my calculations and assessments are based.

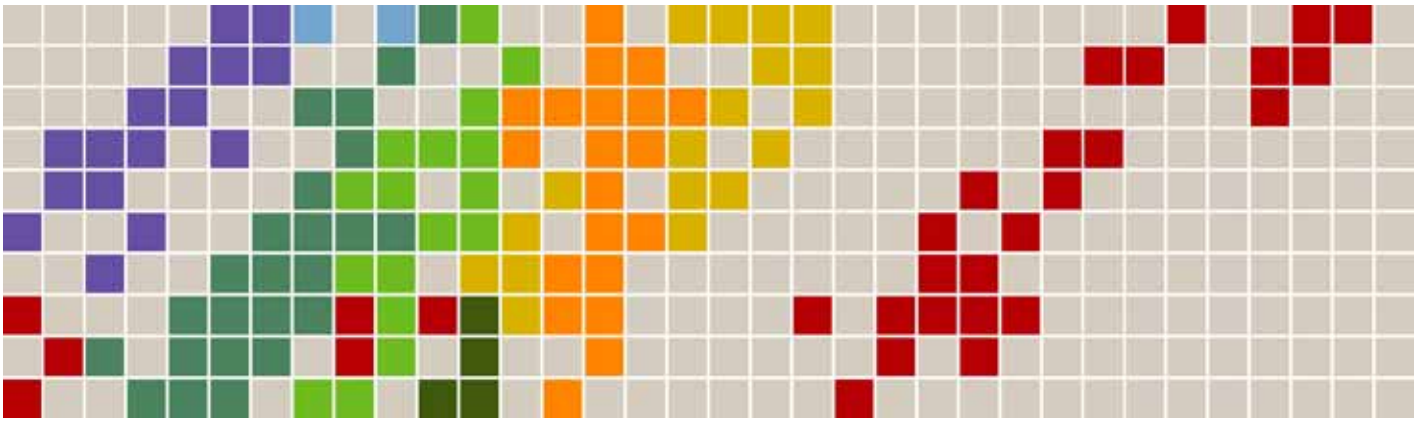
6.1.4 The current LUL proposal appears heavyweight and over engineered considering the light flows on the passageways connecting the STH and the NTH and notably the lack of any routing triggers in the PM peak period. The awkward alignment of the PAL and the location of the northern escalators have a serious detrimental impact upon the continued operation of the Victoria Palace Theatre.

6.1.5 On these grounds and the fact I have demonstrated that a reduced proposal could accommodate the 2016+20% demand LUL's proposal as they stand should be refused. A revised proposal that better considers the serious impacts on the Victoria Palace Theatre would eliminate VPT concerns.

6.1.6 It should be noted that the VPT are not objecting to the VSU proposal in principle. In fact they welcome the upgrade. In my view, the LUL core objectives can still be achieved by amending their proposal. My evidence leads me to make the following recommendation:

- If the original configuration of the escalators which I have described in paragraphs 5.2.1 and 5.2.3 is not adopted then I propose to reduce the number of northern escalators from three down to two so that a narrower shaft can be built. A narrower shaft will provide an opportunity to relocate the escalator shaft

further north, thus taking it further away from the Victoria Palace Theatre foundations.



Application for the Proposed Victoria Station Upgrade

Victoria Palace Theatre
OBJ21/P7

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