Transport for London

Business Case Development Manual

Issued by

TfL Programme Management Office

May 2013

V101.2013.05

MAYOR OF LONDON

Transport for London

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MAYOR OF LONDON

Preface

This manual explains the steps and methods used to make a Business Case. A Business Case must be made for any proposal for change. But how do such proposals arise? Transport for London is charged with ensuring that best use is made of the limited funds available. There is a continuous process of review, intended to identify valuable opportunities for change. The checklist below sets out the possible grounds for change. Most proposals are based on a combination of these, but an understanding of the prime motivator for a proposal may help the appraiser to identify and quantify the appropriate items when making a Business Case.

Why Spend? - Checklist

1. Compulsion
   - meet statutory requirements
2. Cost effectiveness
   - avoid age related costs
   - introduce new, cheaper to run alternative
3. Risk avoidance
   - reduce potential service disruption/worsening
   - reduce safety/accident risk
4. Enhancement of primary services
   - benefit customers, staff or stakeholders
   - generation of added demand and revenue
5. Generation of secondary income
   - vending, advertising etc.

As we demonstrate in the manual, it is not enough to show simply that a proposal can be justified by making a case for it against any one of these headings. It is also necessary to estimate the size of the net benefit by assessing the total impact on areas 2 to 5, and to investigate options to show that none of the possible alternatives gives better overall value than the one proposed.

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1 INTRODUCTION

1.1 Purpose of the Manual

The aim of the Business Case Development Manual is to provide a uniform framework for the evaluation and presentation of business cases across Transport for London (TfL) as a whole, including corporate units as well as subsidiaries. This will enable authorising bodies within Transport for London and its subsidiaries, and the Department for Transport (DfT), to make informed decisions on whether to approve proposals for change. Business case appraisal is an essential part of all stages of expenditure planning throughout TfL and all its subsidiaries.

All business cases involving capital expenditure, changes in day to day operating expenditure, and the setting and revision of engineering and other standards should be prepared according to the requirements of this manual.

However, major strategic changes (such as railway extensions and intermediate mode schemes) will require more sophisticated demand modelling than is described in this manual. In addition, major projects which have a potentially wider network effect such as line extensions or large-scale interchange schemes are likely to require the DfT's New Approach to Transport Appraisal (NATA) format to be produced (see Appendix I).

The Public Service (Social Value) Act 2012 requires a contracting public authority to consider how a proposed procurement might improve the social, economic and environmental well-being of its area. Following the processes and procedures set out in this manual will ensure that the business case is compliant with this Act.

A step-by-step guide to business case appraisals is given in 4.6, with references to sections where further help can be found.

1.2 How to use the Manual

Section 2 on the concepts and principles of appraisals is intended to help managers determine the framework for the appraisal of their projects.

Sections 3 and 4 are for anyone responsible for undertaking an appraisal. They describe the quantitative techniques to be used in establishing costs and revenues, and the methods of cost benefit appraisal.

Section 5 describes, for those who are preparing a case for appraisal, the way the case should be presented.

Much of the basic data required is summarised in Appendices. Some data sources are however too voluminous to list, and contacts for further information are provided.

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2 CONCEPTS AND PRINCIPLES OF APPRAISAL

2.1 The Purpose of Appraisals

The purpose of an appraisal is to identify the effect that a course of action will have both on the finances of TfL and on "securing efficiency, economy and safety of operation in ... transport services" [Greater London Authority Act 1999]. The achievement of efficiency is interpreted here as the following business objective:

to maximise net social benefit within available funds.

The objectives of a project must be stated as precisely as possible, referring to specific outputs against which the project can subsequently be monitored. Where appropriate, these objectives should be related to those of the relevant part of the business, those of TfL overall, and those set by the Government. For example, TfL is under a statutory obligation under Health & Safety legislation to reduce safety risks to a level which is as low as reasonably practicable (the ALARP principle). Another example (from DfT's appraisal guidance) is that, wherever appropriate, the intended level of accessibility for people with mobility handicaps should be indicated.

The substantive provisions of the Social Value Act 2012 require that TfL considers:

- How what is being procured might improve the economic, social and environmental well-being of its area (by producing a TfL business case this is addressed)
- How that improvement might be secured (the business case and benefit realisation strategy should be robust)
- Whether TfL needs to consult on the potential improvements themselves or how they might be secured (See Sponsorship and Requirements Handbook and Stakeholder Engagement Plan)

Note that by producing a TfL compliant business case, the first two requirements are being satisfied.

Project development must ensure that an appropriate range of options is considered so as to enable TfL to meet its statutory responsibilities with due regard to efficiency, economy and safety. One of these options will be a base case which might be to continue to operate as now or to minimise the potential consequences of asset deterioration, and the other options will be to implement a change which will benefit TfL by ensuring that total benefits exceed costs. Where the project has an impact on safety, the appraisal needs to identify whether the base case can be demonstrated to be ALARP, or if not which option would be required to satisfy this principle (see Section 3.5.2 and Appendix F).

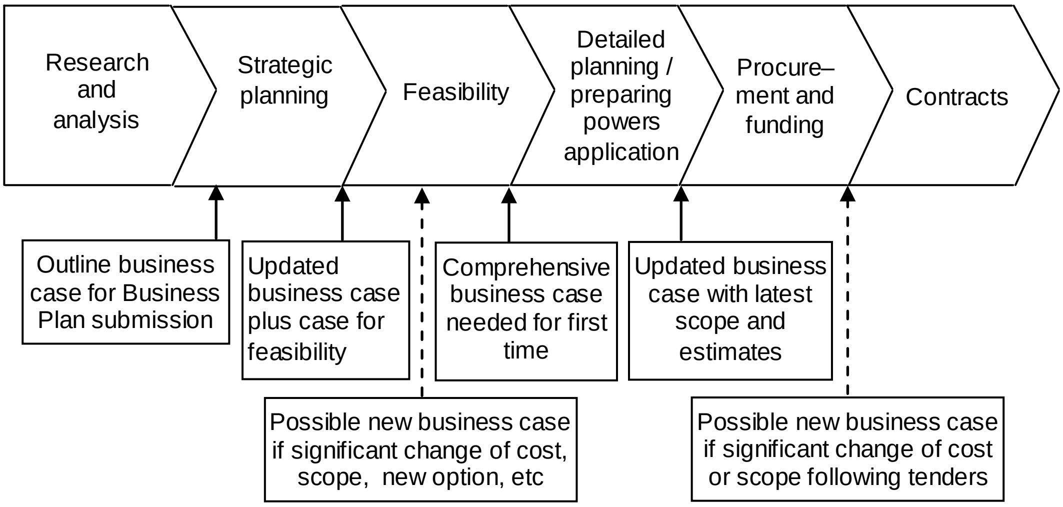
Appraisals should be used not only to select the best projects, but also to identify the best operating procedure (for example trading off maintenance levels against failure rates and service availability). For proposals in both categories, those with the best benefit:cost ratios should be selected for implementation, until all available funds are exhausted. (Benefit/Cost Ratios are described in Section 2.6.7). Where this investment prioritisation process excludes projects which have been identified as necessary to ensure that safety risks are ALARP, priority should be given to such projects unless a case can be made for programming implementation at a later stage.

The appraisal process requires the following steps:

- define objectives, and outputs against which project can be monitored
- define a base case
- develop options
- identify all costs and benefits
- quantify costs and benefits at current prices
- carry out appraisal

The resources committed to an appraisal should at all times be commensurate with the cost of a project and potential usefulness of the results of the appraisal. In the case of minor projects, the cost and/or time of carrying out a formal appraisal may not be warranted, but the principle would be that benefits clearly outweigh the costs and therefore a business case could be demonstrated if necessary. In the case of large projects where the costs, benefits, and indeed the scope of a project may be very unclear at the outset, it would not be appropriate to commit substantial resources to an appraisal which could only yield estimates within a wide range. (Nevertheless, using more modest resources, it is important to obtain a reasonable estimate of the maximum cost and order of magnitude of benefits at an early stage, as an aid to investment planning.)

Expenditure thresholds for requiring formal business cases to accompany submissions for inclusion in the Business Plan, or for implementation, may vary from time to time, and similarly the procedures adopted for approval may vary, but the points at which business cases are likely to be needed are generally as follows:



Note that the Feasibility stage might be carried out over a long period, and although there may not be a formal requirement to obtain new authorisation, if a significant change occurs from the project as defined at the previous authorisation, it will be important to update the business case accordingly.

Where necessary seek advice from Business Case Development –contact Ryan Taylor, [redacted]

2.2 Definition of a Base Case

In appraising a project, the effects of doing it must be compared with the effects of not doing it. Often this involves literally comparing the results of the project options with the results of doing nothing or continuing as now (e.g. maintaining an old asset). However, in some cases doing nothing may not be the most sensible base (for example if a decision needs to be taken on the closure of a station or a line). In such cases an alternative base case may be appropriate such as:

- replacing like for like (if still available)
- replacing with a modern equivalent
- delay replacement by one year (if the only question is when to replace)
- closing a facility down

Essentially the requirement is to define the minimum realistic alternative to the proposed course of action. If this is not "do nothing" an explanation will be needed. The definition of the base scenario may take account of:

- LUL Development Plans affecting the assets (where these have already established a business case for a certain level of spend)
- the achievement of required standards (again, where a business case for a certain level of spend has already been established)
- legislative requirements

2.3 Development of Options

2.3.1 Generation of options

In order to give decision makers confidence that a particular project is the best way to achieve an objective, a range of alternative options with similar objectives needs to be defined and appraised in a consistent way. To give real confidence these options must be *realistic* practical ways of achieving the objective; they must cover all the *reasonable* alternatives available, whilst at the same time being limited to a *manageable* number. Options must also take account of any commitments, which may have been expressed in Environmental Reviews of the investment programme, to consider specific environmental issues.

Options may represent either an enhancement or a downgrading compared to the base, or they may involve a re-scheduling of the base programme.

Other factors which should be considered when assembling options include the following:

- timing: deferring or bringing forward implementation dates
- scope: cutting back on full implementation
- standards: enhancing or reducing specification
- synergy: in combination with other projects some options may score particularly well or, alternatively, simultaneous

implementation at a site could create problems. Business plans can help identify the opportunities for synergy
- corporate image and the value of company-wide or corporation-wide consistency.

2.3.2 Treatment of options

For many appraisals an incremental approach to option selection is essential. Thus in appraising a proposal to provide new lifts at a station it is important to consider the incremental costs and benefits of providing one, two, three or four lifts. The four lift option appraisal as a total project may have a benefit/cost ratio greater than the passmark, but the incremental investment in the fourth lift compared with the third may have a ratio less than the passmark. In this way the appraisal can identify the optimum level of investment in new facilities.

Where there are a large number of options, a matrix showing the ‘score’ of each option against a variety of criteria could be useful in eliminating and shortlisting. The following factors should be considered when using this approach.

If the scores are to be aggregated, try to arrange the ‘levels’ (e.g. low, high, poor, good, etc.) of each criterion in such a way that a given score for one criterion indicates the same order of importance as the same score for another. An alternative approach is to use different weightings for the criteria. Such assessments are inevitably subjective, and the robustness of the assessment system will be improved if several people (with the relevant specialist knowledge) contribute to the process. To the extent that a number of independent judgements about the suitable levels/weightings are reasonably consistent, the assessment system will have improved credibility. Similarly, when the system is actually used to compare options, it will make the case for choosing the preferred option(s) stronger if a number of independent assessments tend to coincide.

- Try to avoid overlaps, i.e. where one criterion duplicates part of another.
- Sometimes a high aggregate score for an option would be misleading, if perhaps a zero for one criterion rules it out completely. It might be helpful to highlight those items where a zero score would virtually rule out the option.
- It should be emphasised that such a matrix, whilst being useful for sifting through options and for providing background information to go with the business case, is NOT a substitute for a business case; in assessing the advantages and disadvantages of a short list of options, the usual costs and benefits must be calculated.

2.3.3 Options with enhanced standards of urban design

Options exhibiting high quality urban designs should be carefully considered, especially in the context of the public spaces initiative led by the GLA’s Architecture and Urbanism Unit (AUU). The following excerpts from ‘100 public spaces’ (AUU, July 2002) stress the value of improvements to London’s public spaces:

"Cities have always been places where people gather – to talk, to argue, to rest, to trade. Squares and streets, parks and other green spaces, foyers and public buildings form a city's public realm, the place where encounters – chance and planned – can occur. London's parks and open spaces are among the greatest assets we have. At their best, they mark out London as one of the world's most civilised cities. But shoddy design and pared-back maintenance are letting too many of our spaces – from squares to streets, and from parks to less formal open ground – fall into neglect, even as London's economy (and the quality of much private development) has boomed … Improving the quality of public space makes … a sustainable city, where walking and cycling are as pleasant, safe, and as easy as driving."

Contributions to improved urban design should be considered in the Strategic Assessment Framework, under 'Enhancing the built and natural environment' (see 2.8 and Appendix H3). An indication of the townscape appearance both before and after the proposed scheme should be provided, and the strength of public support for the design should be verified.

2.4 Identifying Costs and Benefits

2.4.1 Financial costs and savings

For projects, costs must be calculated for the whole life of the assets involved in the project. For operating changes, a single year may be adequate if there are no "up-front" costs. Costs should include:

- One-off costs e.g. construction costs, purchase cost etc.
- Part life costs e.g. main overhauls, renewals etc.
- On-going costs e.g. annual maintenance, fuel, staff, energy, overheads etc.
- Reductions in fares revenue (including during construction)
- Reductions in other revenue (e.g. advertising, vending machines)
- Cost increases in other TfL areas
- Compensation to landowners etc.
- Redundancy payments
- Professional services – design, legal, management etc.
- TfL support costs – IT, HR, Property and Facilities (see Appendix M5 for the Support Services Rate Card).

Savings and other financial benefits must also cover the whole life of the assets and should include:

- Avoidance of one-off costs e.g. savings in redundancy costs
- Avoidance of part life costs
- On-going savings in operating costs
- Increases in fares revenue to public transport as a whole
- Increases in other revenues (e.g. advertising, vending machines)
- Cost savings in other TfL areas
- External contributions e.g. by developer
- Residual value of assets at end of project life

Other important, but more difficult to quantify, financial savings include organisational benefits such as:

- better management information
- improved corporate image.

2.4.2 Benefits/disbenefits

Monetised social benefits include

- changes in time for all components of passengers' journeys:
  - travelling time
  - waiting time
  - access times
  - interchange times

- "ambience" benefits/disbenefits:
  - appearance
  - ride
  - noise
  - perceived security

- pollution – greenhouse gases CO2, and local air quality NoX and PM10
- health benefits from physical activity
- accessibility benefits/disbenefits for people whose mobility is impaired
- and safety benefits/disbenefits.

2.4.3 Wider benefits

Wider social or external benefits, for example

- regeneration benefits
- social inclusion benefits

should also be quantified or described if the effects are significant. See Appendix L for further information.

Any social benefits and disbenefits during implementation shall be quantified, including any specific external effects (e.g. effects on local traffic and businesses).

2.5 Quantifying Costs and Benefits at Current Prices

For all options, costs and benefits shall be calculated in comparison with the base option at constant prices. Costs and benefit streams over the life of the project shall then be discounted to give *present values* in the *base financial year* over the whole *appraisal period*. For definitions see Section 2.6 below.

Methods of calculating costs and benefits are given in Section 3.

2.6 Carrying Out an Appraisal

2.6.1 Appraisal period

For projects where assets are procured, appraisals must cover the whole life of the proposed assets (including disbenefits during construction). This is to ensure that all the attendant costs of assets e.g. half life overhauls, and annual maintenance costs etc. are included, and that incorrect evaluations do not result from different phasing of these costs between the alternative options. All options must be evaluated *over the same appraisal period*, and accordingly, a longer rather than a shorter appraisal period shall be used. A list of selected asset lives is given below.

The nature of the discounting process (described below) means that the contribution to present values decreases for the later years, so the importance of using very detailed forecasts decreases for the later years of the appraisal period. However, these forecasts must still be made and recorded in the appraisal. The likely increase in annual maintenance costs as an asset gets older must be reflected in the costs and then compared with the option of earlier replacement with new assets.

It is not always possible to pre-determine the economic life of an asset. That may depend upon the later costs of continuing to maintain the asset in comparison with savings arising from replacement - see Section 3.5.1 on the appraisal of renewal options. The following asset "lives" are therefore offered only as guidance in deciding an appropriate appraisal period. When in doubt, make the period longer rather than shorter. It should be noted that extending the appraisal period does not affect the "life" of the asset.

Rail Cars		35 - 40 years
Buses		3 (RMs) - 10
Bus shelters		10
Bus electrical	eg. ticket machines, depot readers, security systems etc	7
Underground electricity supply equipment		25 - 40
Escalators	(Underground stations)	40
	(Bus stations)	20
Lifts	(Underground stations)	40
	(Bus stations)	20
Plant, Machinery and equipment		10 - 30
Computers	- Hardware	3 - 10
	- Software	5
Radio, TV, and office equipment		10
Road vehicles		3 - 10

Other LUL asset lives can be found in the VIM-BC User Guide - contact Sandra Weddell, 44591.

In some projects there may be options with economic lives of different lengths. For these appraisals it may be appropriate to use an equivalent annual cost methodology (see Appendix K3).

2.6.2 Constant prices

All costs, revenues and benefits used in the evaluations must be computed at constant prices for the *base price year*. This is normally taken as the year in which the appraisal is undertaken. All costs, revenues, and benefits must then be computed at that year's prices to remove any effects due to price inflation. Note that where unit costs and benefits are likely to rise at a different rate than the general level of inflation (for example staff costs), then any *real* increases shall be reflected in the costs and benefits over the appraisal period. Only the effect of general price rises as measured by the GDP Deflator series shall be removed from the calculations.

2.6.3 Discounting costs and benefits

The purpose of discounting costs and benefits to a base financial year (see below) is to bring all options to a common basis regardless of the timing of their costs and benefits. To do this the real cost of capital as expressed by the discount rate must be used. At a discount rate of 3.5% then £100 which is not spent this year will, with interest, be worth £103.50 next year. Similarly, if we need to spend £100 in a years time then that is equivalent to an expenditure of just £96.62 now i.e. 100/(1+3.5/100). Thus the present value (PV) of an expenditure of £100 in one years time at a discount rate of 3.5% is £96.62. Similarly, the PV of an expenditure of £100 in three years time at a discount rate of 3.5% is £90.19 ($100/(1+3.5/100)^3$).

So all costs and benefits over the appraisal period must be calculated in *present value* terms for the *base financial year*. When this has been done it is possible to compare options which have different timings of costs and benefits. This is known as *discounting* all costs and benefits back to their present value in the base financial year. In financial calculations the discount rate reflects the real (net of inflation) cost of capital. As all investment in TfL projects is underwritten by the Government so all appraisals use the Department of Transport *required rate of return*.

The discount rate currently used and the relevant discount factors are shown in Appendix G.

The *base financial year* is normally taken as the first year in which cash flows will be affected by any of the options under evaluation. All costs incurred or benefits which accrue in future years should be *discounted* to their *present value* in the base financial year (year 0).

2.6.4 The effects on revenue

Many projects will alter the demand for TfL services, and hence the revenue received. Improvements to station lighting, for example, can make the service more attractive to passengers and hence increase the revenue generated. The effects of proposals on passenger demand and revenues need to be calculated using consistent assumptions, which are discussed in 3.4 below.

2.6.5 Financial effects

Having calculated the present value of all cash flows, the financial effects of the proposal can now be calculated.

The *Net Financial Effect* is the sum of the present values of the cash flows (positive and negative). That is, PV of cost savings plus revenues less PV of implementation and other cost increases.

If the Net Financial Effect is positive (i.e. there is a positive financial return) and there are no passenger disbenefits (see 2.6.6) then the option passes the value for money test on financial grounds alone. However, any passenger benefits, if present, should still be quantified so that the contribution to the TfL objectives can be calculated. This is particularly important where there are winners and losers in the appraisal and the breakdown between different parties should be shown. The number of years after which the project becomes financially positive shall be stated.

If the Net Financial Effect is negative, the benefit:cost ratio (see 2.6.7 below) shall be used to judge whether the social benefit justifies the net cost. If there are negative social benefits and a negative Net Financial Effect, then the scheme does not show good value for money using monetised cost benefit analysis and the reason for pursuing the project should be expressed. A breakdown of the winners and losers should be shown.

2.6.6 Passenger Benefits

In addition to financial cash flows, TfL also considers the benefits or disbenefits which the options will give to customers -benefits which are not necessarily recovered from fares. If the Net Financial Effect as calculated in 2.6.5 is negative (i.e. there is a net cost), the value of these benefits shall be compared with the net financial costs of the options in a *cost benefit appraisal*.

Such benefits include benefits to passengers such as time savings, improvements to trip quality, and improved safety and security. Any passenger disbenefits during implementation shall be taken into account.

2.6.7 Benefit to cost ratios

The present value of costs, revenues and benefits for all options in comparison to the base option should now be presented to decision makers along with a recommendation on the proposed course of action.

Decision makers will then have to determine the priority of each project's claim to the scarce resources available in the light of other competing projects. To do this they will need to know the *benefit to cost* ratio of each of the options. This is calculated by dividing the Net Present Value of passenger benefits by the Net Financial Effect (see Section 4.3).

Authorising bodies will expect the benefit to cost ratio to be greater than one. Since most expenditure is capable of being funded by fares increases, the potential benefit per net pound of project expenditure should exceed the disbenefit per net pound of revenue gain from raising fares. When the effects of raising Underground and bus fares are compared, a higher elasticity for buses means that more passengers are deterred from travelling by a given fares increase. A fares increase on the buses therefore has a worse effect.

If fare levels could be set independently for LUL and LB, then separate passmarks would be appropriate: the LUL passmark would be 1.4:1 and the LB passmark 1.7:1. In practice LUL and LB fares have tended to move in parallel, and in particular are linked through Travelcard. The use of a weighted average of 1.5:1 is therefore recommended. This has the added advantage that it can be used for projects affecting both modes and for projects involving intermediate modes.

A higher target may sometimes be set to avoid frequent changes in plans; e.g. in bus service planning, ratios higher than the passmark have been used to ensure that service levels are not increased and then decreased with short-term fluctuations in demand. On the other hand, lower targets may also be appropriate if a project provides benefits to the wider community (see 5.2.2).

The passmark can be academic when funding levels are limited, as at present, since much higher benefit to cost ratios may be required for a project to be included in the investment programme.

2.6.8 Incremental benefit:cost ratio

An incremental benefit:cost ratio should be used to assess the extra benefit achieved by the extra cost of implementing a more expensive option (or a more expensive project, where different projects are being compared). The assessment is carried out in the same way as described in the previous section, i.e. dividing the increase in benefits by the increase in Net Financial Effect (both expressed in terms of Present Value). At one extreme a low incremental ratio could illustrate an increment in scope which is not justified, even though the project with this extra scope included has a satisfactory benefit:cost ratio. At the other extreme a high incremental ratio could justify the increment in scope, even though the project without this extra scope added would have a higher benefit:cost ratio –the justification consists in the increment itself potentially having better value than many other projects in TfL's programme. However, note that the overall benefit:cost ratio of the preferred option against the base option will be the one that represents the project's value.

2.7 Measures of success

2.7.1 Characteristics of Measures of Success

This manual describes the quantification of benefits using standard methodologies. However, it is also important for a business case to identify measures of success specific to that project, so that the outcome of implementation can be evaluated. When reviewing the success of a project it is sometimes difficult to separate the project's impact from that of others completed during the same era. In these circumstances project-specific measures can be used to establish whether or not the intended effects have been achieved. Characteristics of useful measures of success would include:

- wide coverage of the areas of benefit which have been claimed, for example in a train refurbishment (see 2.7.2 below) the effect on door delays would cover only one aspect -additional measures would be needed here to give a fuller picture of the outcome
- not being influenced by factors other than the project
- being as close to formal business indicators as possible, e.g. MSS scores where applicable, otherwise being simple / inexpensive to provide
- statistics measured over a sufficiently long period to mitigate the effects of random variation.

2.7.2 Examples of Measures of Success

Some examples of measures of success (there would usually be more than one measure per project) which a business case could plan for, to confirm that the claimed benefits are being achieved after implementation, are shown below.

Train refurbishment:	Measured over year following project, door-related delays reduce from (current) 50 per period to average of 35 per period
New computer system:	When system has been running for six months, average response time to standard query is less than 15 seconds (where performance of local network is not a significant factor)
Station congestion relief:	Average time from leaving train to reaching UTS gates reduces by 45 seconds -use median of 100 trips between 8.30 and 9.30 am. distributed over 5 different days
Staff training scheme:	MSS score for "Staff willingness to help" increases by 15 points at stations where staff have participated in the training

2.7.3 Feasibility studies

Measures of success are particularly relevant when developing proposals for feasibility studies. Often, the benefits and costs of eventual implementation are only very broad estimates at this stage. One of the measures of success (or "deliverables", in this context) of the feasibility study itself could be a detailed business case. Others could include:

- review of options, looking at incremental approaches, phasing, etc. and eliminating any options where further investigation is likely to be fruitless
- establishing realistic demand scenarios
- quantifying safety risk

- quantifying risk of project overspend.

In each case, the deliverable should be as specific as possible, e.g. instead of "investigation of demand scenarios", the deliverable could be "provision of demand forecasts to 2016 with/without Crossrail 1 and with/without Thameslink 2000".

2.8 TfL Strategic Assessment Framework

TfL has developed a Strategic Assessment Framework (SAF) multi-criteria analysis tool to help specify contributions made to the delivery of the Mayor's Transport Strategy (MTS) goals, challenges and outcomes. The SAF is intended to ensure that option choices and funding decisions are informed by an assessment of the strategic impact of interventions against the MTS.

A fundamental principle of the methodology is that the assessment is intended to provide evidence to help inform decision making, but should not be used in a mechanistic way to determine "the answer". The SAF will reflect the latest information available, and where there is limited quantitative data available to inform an assessed score for a particular item, a more qualitative judgement will be made.

The template used for the summary assessment of contributions to MTS challenges and outcomes is shown in Appendix H3, and full information on the SAF is available at:

http://source.tfl/docs/Strategic_Assessment_Framework.xlsm

For more information on the Strategic Assessment Framework please contact Elaine Seagriff on 64083.

For Business Cases SAF can be of particular help in illustrating the strategic drivers and rationale for a project. A business case should show the problem or opportunity and explore the strategic outcomes that are expected as a result of intervention ***before*** analysing options in much detail. In this way the scope is defined based on the objectives that the project is trying to achieve. This process can help to reduce the number of options being taken forward from a long to a short list.

It is recommended that a SAF is undertaken in the very early stages of a project and kept updated as the project evolves.

Other multi-criteria products and processes also exist that can help define a project such as:

- Surface Strategic Outcomes (which are linked at a higher level to the MTS objectives within SAF)

For more information on Surface Strategic Outcomes contact Tanya Durlen on [redacted]

- Sustainability Assessment

  http://onelink.tfl.gov.uk/sites/ptpm/TfL%20Pathway/Pages/TfL%20Pathway%20Home.aspx

  Follow the link from the Pathway Product Matrix

For more information on Sustainability Assessment contact Helen Woolston [redacted]

It is acceptable that any level of strategic driver could be captured to illustrate why a project is needed. These can be global, national, Government departmental, mayoral (SAF), organisational (SAF), modal, or departmental or any other level necessary. It is helpful if from the organisational level and above that analysis is undertaken in a consistent form using SAF as this helps validate the credibility.

We are currently working towards an updated SAF that will incorporate approaches within Surface that examine contributions to Surface objectives.

2.9 Social inclusion (and distributional impacts)

The Treasury's Green Book revision (2003) highlights the need to consider distributional issues – how benefits and disbenefits are apportioned amongst different groups – in appraisals.

In transport appraisals, it may not always be possible to distinguish impacts on different income groups. Nevertheless, some groups, e.g. bus passengers, are known to have lower than average incomes. Another example where different impacts can be distinguished would be where high level modelling enables particular journey time savings to be related to geographical areas whose populations have different levels of deprivation. Where such analysis is available, the appraiser should quantify and draw attention to any differential impacts of a proposal.

The 'Transport opportunities' entry in the Strategic Assessment Framework (see Appendix H3) allows differential impacts to be assessed, not only with respect to the deprivation categories listed in the note below, but also regarding gender, race, etc.

In particular, any benefits favouring – or disbenefits further disadvantaging – groups which are socially excluded, should be highlighted.

Note. The Government's Index of Multiple Deprivation (2004) provides a guide to the extent of various types of deprivation within areas (though does not reveal to what extent individual households are subject to multiple deprivation). The IMD uses indicators under seven broad headings ('domains') which are weighted as follows:

income	22.5%
employment	22.5%
health & disability	13.5%
education, skills & training	13.5%
housing	9.3%
living environment	9.3%
crime	9.3%

Each ward is given an overall IMD score, which is the sum of its weighted domain scores.

2.10 Business Cases and Project and Programme Lifecycle

The level of detail depends on the lifecycle stage. There are four main stages of a business case:

- **Strategic Outline Case** – confirms the strategic context and makes a case for change (without committing to a preferred option). Maps onto gates: OGC 1, CGAP A, Pathway 1. Note this is currently called an **Outline Business Case in TfL** as the traditional Business Case elements of Strategic / Economic cases should make a robust case for change without identifying a preferred option.

- **Outline Business Case** – The purpose is to identify a preferred option, a robust single option selection should be demonstrated. Maps onto gates: OGC 2, CGAP B, Pathway 2. Note this is currently called a **Full Business Case in TfL** as the traditional Business Case elements of Strategic / Economic Cases should be largely defined.

- **Full Business Case** – Outline Business Case is updated following procurement negotiations, demonstrating an affordable solution that optimises value for money with the recommended supplier. Maps onto gates: OGC 3, CGAP D, Pathway 4. Note that this is a development of the Outline Business Case above but focusing on the preferred option with revised costs and benefits following any changes during procurement or from detailed design.

- **Outturn Business Case** – updated post delivery with actual costs and any known changes to likely or actual benefits using indicative statistics as identified in the Benefits Management Process or that has arisen through design changes. Maps onto gates CGAP E, Pathway 6 and beyond. A benefit realisation exercise should be taken after benefits have had time to bed in (currently ungated in CGAP and Pathway). This could be two years after practical completion, be an update of the outturn business case and focus on the Benefits Management Plan. The importance of this is that it feeds back lessons learnt to future business cases and it demonstrates the actual benefits of projects as delivered rather than being based on prediction.

Business cases should be locked down and version controlled as they develop and the version at each key stage identified. Business cases should be updated as revised information becomes apparent, perhaps from more detailed modelling of benefits or more robust cost estimates and be presented in advance of the appropriate Gate.

The expectations at the different gateways are set out below:

- CGAP A, Pathway 1 – Feasibility. An outline (TfL terminology) case is made, with a likely or range of benefit to cost ratios presented and the strategic reasons for intervention. The range of options should not be unduly restricted.

- CGAP B, Pathway 2 – Single Option Selection. The options are narrowed down to a shortlist and the case for each assessed to show the preferred single option recommended to be taken forward. A Quantified Risk Assessment (QRA) should have been undertaken to help give confidence to the cost estimates. Measures of success should be identified but not yet baselined. This is the most important business case as it is upon this that the decision to implement is made and a robust case for the preferred option should be presented.

- CGAP C, Pathway 3 – Begin Procurement. The single option business case should be developed to focus on the preferred option and the preferred case should be updated with any revisions to costs and benefits as a result of detailed design or other developments.
- CGAP D, Pathway 4 – Delivery. The business case should be updated with costs as expected or agreed as a result of procurement. Benefits should be updated with any agreed scope changes. Benefits should have baseline measures of success.
- Pathway 5 – Practical Completion. Updated with expected outturn costs.
- CGAP E, Pathway 6 – Financial Close. Updated with final outturn costs and any expected changes in benefits.
- Ungated – Benefit Realisation. The business case should be updated with realised benefits by factoring any original modelled results with the outturned position. Analysis should describe the changes over the project lifecycle and measures of success should be compared to prediction. Other benefits should be described and where possible quantified. Business Case lessons learnt and conclusions should be drawn. This should provide feedback to future business case development and provide evidence to make the case for future investment.

A change log should be maintained throughout, so that if staff changes occur, knowledge will not be lost on the changes that have been made.

The table below summarises the various business case names, with lifecycle stages and Pathway / CGAP stages.

Lifecycle Stage	Five-Case Name	TfL Name	Pathway	CGAP
Outcome Definition	Strategic Outline Case	Outline Business Case	1	A
Single Option Selection	Outline Business Case	Full Business Case	2	B
Concept Design	"	"	3	C
Detailed Design	Full Business Case	"	4	D
Physical Completion	Outturn Business Case	Outturn Business Case	5	
Financial Close	"	"	6	E
Benefit Realisation	"	"	No stage	No stage

2.11 Delivery Portfolio Business Cases

Business cases for Delivery Portfolios (formerly Annualised Programmes) that are aiming to **maintain a group of assets** with a stable condition profile (and hence no new or lost passenger benefits), existing narrative from asset strategies or plans (such as Annual Asset Maintenance Plans (AAMP)) can be used so long as it includes the following:

- An explanation of the ideal lifecycle replacement – why is 18 years (for example) an optimal replacement cycle?
- An explanation of the overall estate asset condition profile (including what the impact would be if the funding was increased or decreased) – show the asset condition profile and set out the impact on this with investment levels that vary around the preferred option. Business Planning scenarios should have already been required for this or they will be needed.
- An explanation of the prioritisation process – what determines the particular work bank composition? What factors are important? What prioritisation model has been used and have any manual overrides been used (such as to for efficient delivery of nearby assets at the same time)? Does this work bank align to the funding required?
- An explanation of why that replacement process offers optimal value for money (consider other technologies, other replacement cycles, other efficiencies and dependencies).

This should be provided in a single existing document such as an AMP Justification that is used to justify the size and composition of the portfolio rather than using the standard Business Case template. Different templates for this currently exist around the business and these should continue to be used but with a check that they contain the information listed above. If this information does not exist then an addendum note should be produced.

For Delivery Portfolios (Annualised Programmes) where the replacement rate **improves or declines the overall estate asset condition profile** (results in new or lost customer benefits) then a standard business case should be produced with a benefit to cost ratio.

For Delivery Portfolios that are **collections of projects grouped together for managerial convenience**, an overarching summary business case should be produced but justification for each individual project should also be obtained at an appropriate level. The standard business case template should be used following guidance within the template on appropriate scaling.

3 METHODS OF QUANTIFICATION

3.1 THE NEED FOR QUANTIFICATION

Whilst every business case must be justified on the basis of a rational and convincing narrative, the quantification of benefits demonstrates rigour and robustness in the consideration, and allows the business to more easily prioritise investment decisions.

All benefits should be quantified as far as is possible. Where benefits can be monetised, a direct comparison of the monetary equivalence to the investment costs can be made. This is termed the Benefit to Cost Ratio (BCR). Although the methods of calculation will vary from case to case, there are a number of standard methods which should be followed. This section describes those most commonly required for TfL appraisals, including those covering non-investment decisions such as train and bus service changes, closures of secondary entrances or booking offices, changes in station opening hours etc.

In all cases it is helpful to lay out the calculations in the form of a computer spreadsheet so that it is easy to change data and test sensitivity. Appendix A gives examples of appraisals including a station improvement scheme, train refurbishment, a bus shelter project, and bus service changes.

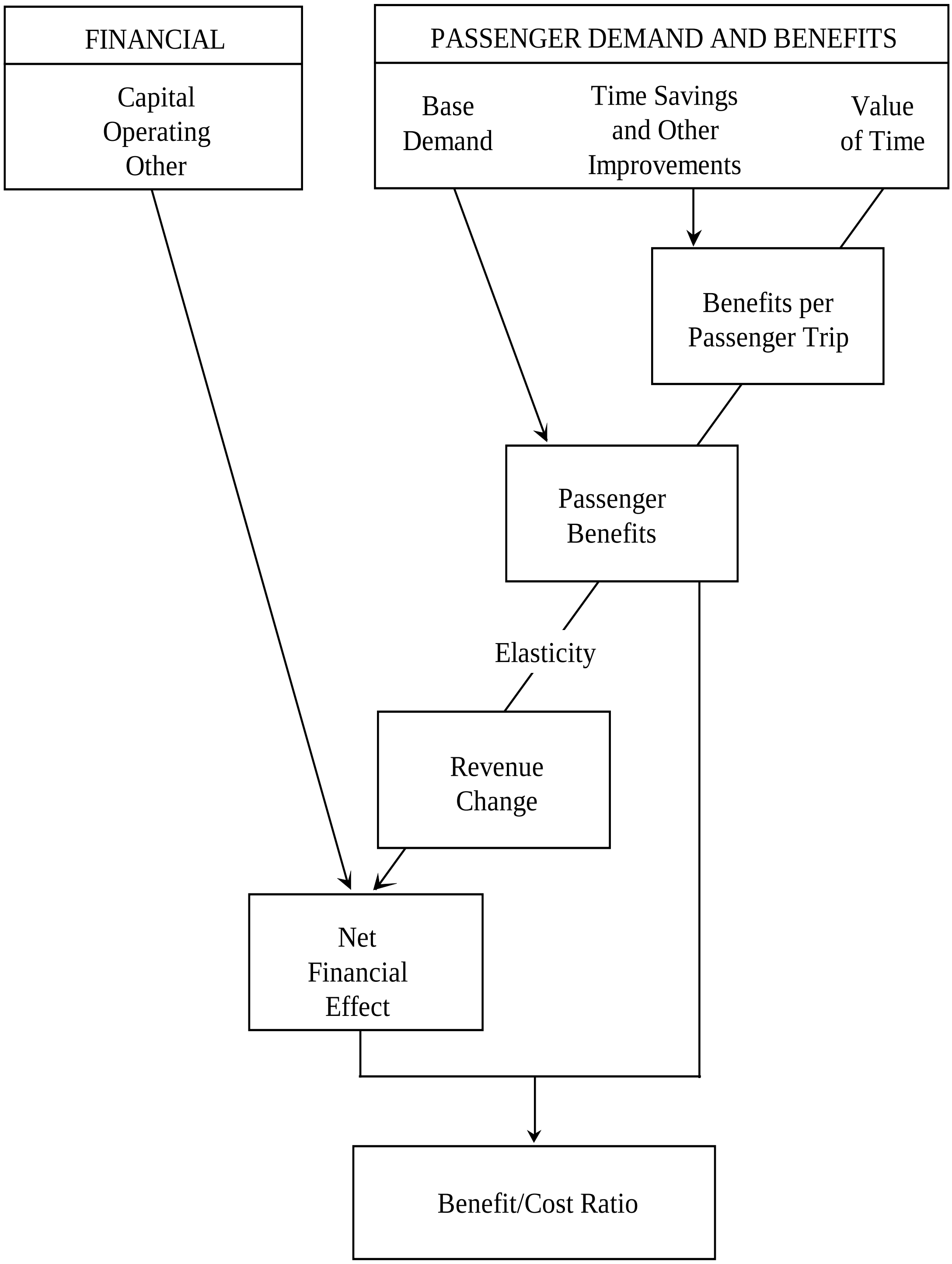
For any project which affects passenger benefits, Figure 3.1 indicates the quantification that is required and the logic of the steps to be used in preparing the analysis.

However, not all projects have a direct effect on passenger benefits. For example, a proposal to improve office productivity by implementing an IT system may have a number of effects on costs but will have no direct effect on passenger benefits, so only the financial effects analyses shown to the left of Figure 3.1 and described in Section 3.2 will need to be undertaken. (There is a detailed example of this kind of appraisal in Appendix A8.)

Research into new methods is on-going, and advice on methodology can be obtained from TfL Business Case Development.

Ryan Taylor, [redacted]

Figure 3-1: The Appraisal Process Stages of Quantification



3.2 FINANCIAL EFFECTS

All cash flows (costs, cost savings, revenues and revenue losses) must be estimated for the whole appraisal period (i.e. for the life of the main assets involved). They must all be at constant prices, preferably in the base price year and they must all be discounted to give present values in the base financial year. For a change in operating costs only one year's effects on costs and savings is needed if there are no "up-front" costs (such as redundancy payments).

Where costs or revenues are likely to change in real terms over the life of the project, i.e. differently from the GDP Deflator standard measure of inflation (Appendix C5), then specific indices must be used to estimate this effect. Staff costs are a good example. Historically, earnings have risen at a higher rate than the GDP Deflator. This needs to be reflected in the calculation of future costs by using the likely real growth of earnings.

3.2.1 Staff costs and savings

Unless there are specific reasons for doing otherwise, then it shall be assumed that staff costs will change in the same way as average earnings in the economy as a whole. The recent history of the earnings index is shown in Appendix C6 along with the current forecast.

The real increases in earnings that this implies must be reflected in future staff costs and savings.

Appendix M provides guidance on the estimation of staffing on-costs, e.g. pension, National Insurance, etc.

3.2.2 Material and other costs

If material and other costs are expected to change in real terms over the appraisal period then these must be adjusted before discounting is applied. The use of these indices must be agreed with TfL Business Case Functional Lead.

For more information on non standard inflation indices contact Ryan Taylor, [redacted]

3.2.3 Non-Fares Income

Extra revenue arising from passenger service improvements will be considered in Section 3.4. Appraisals must, however, include any other changes in TfL income e.g. vending machines sales, and advertising. Once again these need to be forecast for the period of the appraisal and present values calculated.

3.3 PRINCIPLES OF PASSENGER BENEFIT QUANTIFICATION

The quantification of passenger benefits is based on the concept of "willingness to pay" - that passengers would be prepared to pay for improvements to the service offered – which in turn enables a value to be placed on improvements.

There are three quantification methods covering:

- Time savings
- Trip related factors
- Other more global factors

Each type of benefit should be fully explained, and in particular where benefits are monetised, the elements contributing to the calculation of annual benefit should be detailed (see Appendix H1).

3.3.1 Time savings

Quantifications of time savings are based on behavioural values of time which are derived from observation of passenger trade-offs between saving time and spending money. Values are based on research by TfL and the DfT. The current values are given in Table E1.

Passengers value time for the various stages of a journey (e.g. walking, waiting, travelling) differently and so weighting factors are applied to the component elements of the trip to reflect the extent to which passengers like or dislike particular stages of a journey. Weighting factors are defined in Section E3.

The weighted time saving per passenger is then multiplied by the number of passengers and the value of time to calculate the total benefit (expressed in £s).

Most calculations of this nature will use computer models to calculate journey times, congestion etc. (see **Error! Reference source not found.**).

In addition to changes in mean journey time, changes in reliability, as measured by standard deviation, may be monetised. A reduction in the standard deviation of in-vehicle journey time for a public transport mode is valued as if it were a reduction in the mean journey time. (In the case of waiting time, a reduction in standard deviation would be weighted in the same way as for mean journey time –see Appendix E as mentioned above.) For private transport, a reduction in standard deviation of journey time is valued at 0.8 times the same reduction in mean journey time.

3.3.2 Trip related factors

These relate to improvements to the environment of journeys, and valuations are based upon market research into how much per trip a passenger is willing to pay for improvements. The factors for which customer valuation data are available are listed in Appendix E4.

Note carefully the different usage data required. For example, in Underground projects the appraisal of improvements to ticket halls relates to station entries alone, whereas for "access" areas improvements are relevant to both entries and exits.

(There is no comparable body of research regarding movements in Customer Satisfaction Scores equivalent to that for Customer Priorities; the practice of forecasting changes in CSS and placing values on these predicted changes is therefore to be avoided.)

3.3.3 Global factors

Some travel attributes are not related either to the time taken or the number of trips made. For example, safety benefits are calculated in terms of the number of incidents per annum which are avoided by improvements to sections of the system. The ways of calculating such benefits are given in Section 3.5.

3.3.4 Usage data

Station and line usage data, and bus demand data, are available from LU Transport Planning and from the Customer Experience Directorate. The volume of such data is very large and only examples can be given in this manual (Appendix B).

Contact Sarah Scott [redacted] (Underground demand)

Contact Tony Richardson [redacted] (Bus demand)

3.3.5 Forecasts of value of time

The value of time during work time is based on earnings. For forecasting purposes, this value is assumed to grow in line with real increases in GDP per capita. Research looking at changes in the value of non-working time over a long period suggests that annual value of time increases are at about 0.8 times the rate of real increases in earnings; i.e. if real earnings (or as a proxy, GDP per capita) increase by 2% p.a., then the value of non-working time increases in real terms by 1.6% p.a. For further information, see Appendix C3.2.

For VoT growth contact Ryan Taylor, [redacted]

3.4 COMMONLY USED MODELS

Understanding the benefits (and disbenefits) that arise due to changes to the congested London network may require complex and extensive calculations that often cannot be carried out manually. Various modelling tools have been developed to assist with these analyses.

Developing models to a correct standard, and using these models to inform the appraisal process requires expertise and experience that should not be underestimated. In promoting an investment proposal, it should be considered whether analysis of existing data and market research could provide an adequate, and more cost effective, insight.

The following paragraphs are intended as a basic guide to the models commonly used across the organisation to quantify non-financial benefits. Further detail and support in the use of the models should be sought from the named contacts.

3.4.1 Modelling Principles - the 4 Stage Process

Modelling is used in a series of steps to produce a picture of changed or future year travel. These steps were traditionally known as the '4 stage process', although for business case purposes may more accurately be considered as 5 levels:

i) Trip Generation – How many trips will be made?
Population forecasts, economic forecasts and land use patterns are needed as inputs to this stage. Trip rates for given circumstances are derived from historical information such as surveys and census data, and the calculations are made for a number of trip purposes. The output of this stage is known as 'trips ends' – the number that start or end in a particular geographical area (zone).

ii) Trip Distribution – Where will the trips be?
Travel analysis requires a full origin-destination pattern, therefore the trip ends must be linked to produce an Origin to Destination (O-D) matrix. Trip distribution calculations are generally based on distance or travel time and number of trip ends by purpose – called gravity modelling

iii) Mode Split – How will people travel?
Due to complexity, assignment modelling is usually carried out separately for public and private modes. It is therefore necessary to separate the overall demand into highway and public transport users. The mode split calculation takes account of travel times (weighted to reflect the relevant inconvenience of each element of the journey), cost / fares, availability of a car for use, and mode 'bias' factors to represent real or perceived characteristics such as privacy, comfort and flexibility.

iv) Assignment – What routes will be used?
Assignment models take the demand matrices from the previous step and work out how those trips will use the network available to them. This is an iterative process, as the volumes on each route affect the absolute travel times, and also the conditions (crowding on public transport). The simulation should run through multiple loops until an equilibrium position is reached.

v) Impact analysis – What will be the effects of these travel patterns?
Output from the assignment stage can be used to determine benefits quantified in business cases. However, more detailed localised analysis may also be needed – e.g. to optimise signal timings or quantify crowding levels within a station. These local models will cover a much smaller geographical area than the assignment models, and may have fixed routing, determined (partially or fully) by outputs from the assignment models.

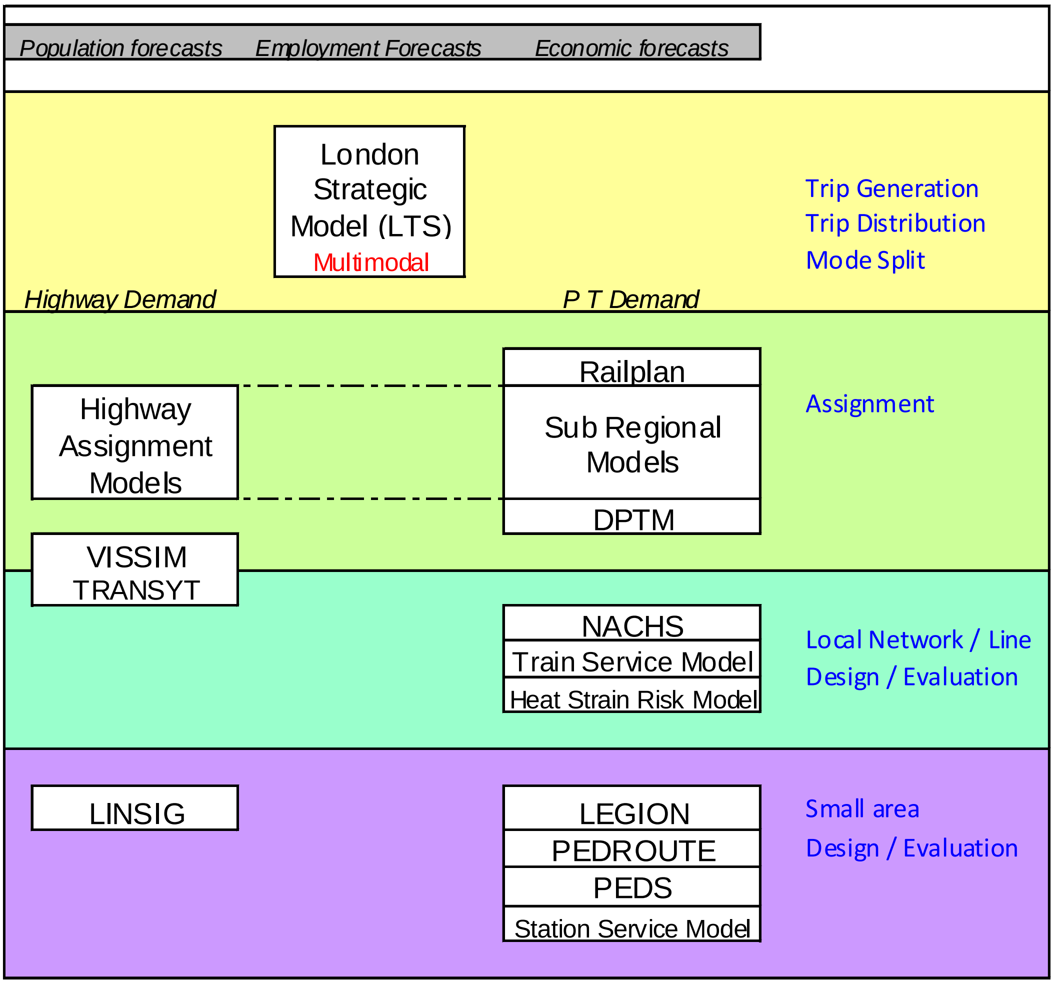
Ideally, the stages should be iterated as the output of subsequent stages impacts the assumptions used in previous ones. However, time and resource constraints limit the extent to which this can be realistically achieved.

3.4.2 Hierarchy of Modelling

Within TfL, a hierarchy of modelling tools, from the strategic through to highly localised, are needed to ensure an appropriate level of understanding of the benefits being valued. In general terms, models can only fully reflect changes that are within their boundaries, and have an implicit assumption that conditions beyond their boundary remain constant. A hierarchy of models therefore allows progression to an appropriate level of detail within the context of the wider picture.

The models most commonly used across TfL are described in the diagram below, and in the following sections.

Figure 3-2: Hierarchy of Models Commonly used to Generate Business Case Inputs



3.4.3 Demand Generation and Mode Split

LONDON STRATEGIC MODEL (LTS)

Overview: LTS is the foundation for the strategic modelling carried out within TFL. It is a strategic multi-modal simulator for London, and it extends to cover all of the UK. Its principal relevance to TfL is in creating a complete picture of current and future year public transport and highway travel demand matrices.

Inputs / Outputs: LTS requires forecasts of population and employment by geographical area. These are based on historical census information for current year, and primarily the London Plan for future levels. The London Plan sets out a fully integrated economic, environmental, transport and social framework for the development of the capital to 2031, and is produced by the GLA. From these inputs, LTS produces forecasts of the number of trips that will be made (trip generation) and from where to where these trips will occur (trip distribution).

LTS also features a mode split module. This requires a representation of the public and private transport networks, which allow travel times by each mode to be calculated. Based on these comparable travel times, and consideration of car availability, the model determines what proportion of the total demand will travel by each mode. Trip ends, distribution and modal split are calibrated against 'observed' data – such as household surveys – to ensure results are realistic.

Although LTS also produces trip assignment results, these are not generally used within TfL as LTS is not sufficiently detailed to give the levels of accuracy required. The generated demand matrices are taken forwards to Railplan and Highway Assignment Models described in the following paragraphs. However, for testing major strategic schemes, it is necessary to include the new scheme within the LTS network representation, in order for that travel opportunity to be reflected in both the distribution of trips and in the public / private mode split.

Be aware: LTS is generally run externally to TFL, and is time consuming and resource hungry, so the number of scenarios tested should be limited.

Custodian: (Group) Planning, Strategic Modelling and Analysis. Contact Chris Hyde on [redacted]

<u>LONLUTI</u>

Overview: TfL has begun developing a proxy for LTS that can be run internally, allowing easier access, quicker turn around times for analysis, and easier interface with the travel times generated by Railplan and the Highway models.

Inputs / Outputs: It contains a slightly coarser zone system than LTS, but requires the same inputs of population and employment levels, producing forecasts of current and future year demand by public / private transport

Be aware: Currently LonLUTI is not used for producing Railplan demand matrices, but operates in parallel, offering a comparator / sense check to LTS outputs.

Custodian: (Group) Planning, Strategic Modelling and Analysis. Contact Chris Hyde on [redacted]

3.4.4 Public Transport – Strategic

<u>RAILPLAN</u>

Overview: Railplan is TfL's own public transport assignment model. The geographic coverage extends to all of the UK but is detailed within the M25, and it includes all public transport modes (including National Rail), as well as partial walking routes. With London's complex and congested network, it is almost impossible to predict the impacts of even localised changes without using Railplan.

The Regional models (of which there are 5) are more detailed in their respective geographical areas (Central, Western, Eastern, Northern, Southern). They were developed to supersede bespoke variations of

Railplan that were built for specific project analyses, where the strategic model was found to lack sufficient detail.

The Docklands Public Transport Model (DPTM) is another variant of Railplan that is focused on the Docklands development areas. It was originally developed to support planning and appraisal for the early development of London Docklands, and in that area has a zone system that is quite different from LTS. Demand matrices are supplemented by a local land use model which generates trips relating to the development areas (LUTE).

Railplan was initially developed to simulate the morning peak period. However evening and inter-peak versions are now available.

Inputs Demand matrices – predominantly derived from LTS. All versions of Railplan have more zones than LTS, so the LTS outputs must be processed to split the larger zone values. Network – representation of bus routes, rail links and walk network. Services – representation of individual rail and bus services including speeds, stopping patterns, frequencies and capacities.

Outputs: Railplan assigns demand across all modes over the whole network. It is possible to extract a great deal of information which can be fundamental to making the business case. The most common statistics used for monetised benefits are the differences in total travel times – often subdivided by mode and by travelling conditions (crowded / uncrowded). These outputs need to be multiplied by the appropriate values of time to generate inputs to the economic appraisal (Business Case Assistant).

Railplan can also generate diagrams that can support the narrative of the business case – such as plots of links where the greatest crowding relief occurs, or origins/ destinations of trips which experience the greatest travel time changes.

Outputs from Railplan can also be used as inputs to other models – such as station congestion simulations

Be aware: Where demand matrices diverge from the pure LTS outputs, there can be significant differences in modelled passenger flows. This can be material where a scheme lies outside the area of focus of the model.

Railplan is a strategic model and caution is needed in using outputs to feed more localised models – such as station congestion analysis.

Setting up and running the model(s) is time consuming and requires experienced specialist resource.

Evening and inter-peak validation may not be as robust as for the morning period.

Custodian: (Group) Planning, Strategic Modelling and Analysis. Contact Chris Hyde on [redacted]

<u>*OTHER MODELS*</u>

Other strategic / assignment simulations are sometimes used within TfL – e.g. MOIRA, a National Rail model.

3.4.5 London Underground Models

<u>TRAIN SERVICE MODEL (TSM)</u>

Overview: The TSM simulates railway operations on individual Underground lines with fixed passenger demand. It is used to evaluate how the service would respond to both infrastructure and train service changes, and to quantify the journey time benefits that can be achieved through such changes.

Use: The TSM simulates the running of the railway for a given schedule and level of demand, modelling the interaction between individual trains and the boarding / alighting passengers, and the consequent impacts on the timetabled service over the modelled period. Each LUL line has a separate TSM model, with the exception of the Sub-Surface Railway, (District, Metropolitan, Hammersmith & City, and Circle), and the Piccadilly line, all of which are contained within one model due to the level of interaction between these lines. It can also be used to analyse the impact of non-timetabled events – such as a train taken out of service.

Inputs Most of the features of the railway that define its capacity concern the time required for passengers or trains to perform certain tasks. As such, the TSM is populated with information about the time taken for certain 'events' to complete (e.g. the time for a train to run from one station to the next). *Outputs*: A wide range of information can be extracted from the TSM, including customer journey time.

Be Aware: Does not model the impact of infrastructure changes on passenger demand – an assignment model such as Railplan would be needed to determine this.

Custodian: LU Transport Planning. Contact Neil Bichard on [redacted]

<u>NACHS (NOMINALLY ACCUMULATED CUSTOMER HOURS) SYSTEM</u>

Overview: This is a database of incident types and the resultant impact on LUL's lines and passenger journey times. It is derived from output from the Train Service Model, the Network Model and pedestrian simulation models. It was originally constructed to support the penalty payment mechanism under the PPP contract but has since evolved for extensive general use.

Use / Output: Provides quantified estimates of journey time changes due to service reliability (benefits and disbenefits) without resort to specialist models. It is openly available but the Transport Planning Team can provide guidance and interpretation and it is recommended that they are consulted about figures used in building business cases.

Input: Details of the change that will be made – line(s) affected, time period etc

Be aware: The database is founded on the existing network and its validity therefore decreases with substantive network changes. Caution should also be exercised when multiple impacts are occurring simultaneously. (as an example, impacts will be different if another line is closed for engineering works).

Custodian: (London Underground) Transport Planning. Contact Sandra Weddell on [redacted] or Dave Hughes on [redacted]

JOURNEY TIME CAPABILITY MODEL (JTC)

Overview: The model was originally developed as part of the payment mechanism between LU and the Infracos for the PPP contracts. It evaluates the infrastructure that is provided – track, signalling, rolling stock characteristics etc – in terms of the service that could be provided with these assets

Use / Input: This is a spreadsheet model, which is quick to run. Data fields describing the characteristics of the assets can be readily changed. Because it is quick and easy to run, this model can be helpful to generate preliminary estimates of benefits or to compare alternative upgrade proposals. It could therefore form part of the method for narrowing down a wide range of options to a shortlist for full appraisal.

Outputs: the model generates a single figure – the Journey Time Capability - for the LU network. This is an average weighted journey time. This figure has meaning only in relation to the payment mechanism (now defunct) or to other comparative scenarios from the model.

Be aware: As it does not model changing passenger numbers it does not provide monetisable benefit suitable for deriving a benefit to cost ratio.

Custodian: (London Underground) Transport Planning. Contact Dave Hughes on [redacted]

STATION SERVICE MODEL

Overview: This is a spreadsheet model to simulate ticket purchase activities within stations.

Use / Inputs: The model is based on static spreadsheets which contain data about the facilities available and demand levels, and is essentially a queue simulator. With training, the model is straightforward to use.

Outputs: Passenger queuing times and staff costs.

Be aware: does not include consideration of fraudulent ridership.

Custodian: London Underground Transport Planning. Contact Dave Hughes on [redacted]

THE ROLLING ORIGIN AND DESTINATION SURVEY (RODS)

Overview: This is not a model, but a database of entry and exit numbers to the Underground system. It can therefore provide information to analyses used to generate quantified benefits in business cases. Data is obtained by handing out self-completion questionnaires to passengers entering LU stations, with topics including start and end of journey, journey purpose, ticket type and car ownership level.

Use / Outputs: The data is freely available via the LU Sharepoint site.

Be aware: As the survey is conducted on a rolling basis it can take time for major infrastructure changes to be fully reflected in the data.

Custodian: Please contact Howard Wong [redacted] for any data queries or Kathryn Jones [redacted] about survey management.

RELATE

Overview: This is another dataset containing ticket gate usage information. Raw data is corrected for data gaps (such as gates left open when gatelines are not manned). Information is gateline specific – so provides useful disaggregation where a station has multiple entrances - and also differentiated by ticket type.

Custodian: London Underground Transport Planning. Contact Dave Hughes on [redacted]

HEAT STRAIN RISK TOOL (HSRT)

Overview: The Heat Strain Risk Model (HSRT) has been developed to give a monetary value to the impacts on passengers arising from changes in temperature. These impacts are in terms of both thermal comfort (based on willingness to pay data and customer priority surveys).and safety – risk of fainting and/or becoming unwell (based on number of passengers per annum likely to experience heat illness).

Use / Output: The calculation is repeated each year for a forty year appraisal period allowing changes in passenger numbers, line upgrades and external climate to be accounted for. Outputs can be provided by link and then grouped per station, line and network. The model includes the capability to discount the outputs to provide a self contained economic appraisal, or the values of the benefits can be used in the Business Case Assistant.

Input: The HSRT takes baseline temperatures for the network - seasonal, tunnel, station and train - and allows changes in temperature from such factors as line upgrades or cooling infrastructure to be analysed. (The changes in temperature are derived separately, normally from Tunnel Ventilation Models). Travel time and passenger numbers are also needed, and the safety calculations require crowding levels and the probability of stalled train events of differing durations.

Be aware: This is a complex model which needs full understanding of the input data and therefore should be run only with the full support of the custodian.

The model applies to the deep tube lines only, SSR is excluded.

Custodian: Tony Lightfoot, Engineering Railway Systems, London Underground, [redacted]

3.4.6 Pedestrian Modelling

A number of tools are available to analyse pedestrian movement through stations, both in normal conditions and for emergency evacuations. The Station Capacity Analysis Team has the role of ensuring the best use of the existing and proposed space within stations for meeting passengers' needs, including that they have a quick and congestion free flow through from entrance to platform. Two key approaches are applied:

- Setting Standards and Best Practice Guidance
- Analysing the impact of changes to demand and/or the station layout on passenger flows.

Analysis of pedestrian modelling forms an integral part of the design for schemes aimed to reduce congestion at stations. The modelling can demonstrate the effectiveness and longevity of the scheme, whilst also providing social costs to feed into the necessary business cases. Modelling is specifically used for:

- Optioneering: Models used to assess and compare journey times between schemes to quantify in terms of social benefit (CRS/SFA);
- Station control: Models used to control the use of the station so to improve passenger level of congestion and safety (operational support);
- Asset Maintenance: Models used to assess impact of asset's works and identify operational changes to guarantee a safe service (operational support);
- Special Event Planning (e.g. Olympics 2012).

There are a number of 'static' and 'dynamic' tools employed: STATIC TOOLKIT, PEDS, PEDROUTE, and LEGION. The two former tools have been developed in-house to help understand journey time, capacity and congestion impacts from changes to the station design or demand levels. All differ in terms of turnaround speed and level of detailed input/output that is required/ produced. Each can be applied in isolation, or a combination may be applied to a particular project at different stages of its lifecycle. Application is best discussed with the Station Capacity Analysis Team (stationcapacityanalysis@tfl.gov.uk).

STATIC TOOLKIT

Overview: The Static toolkit is a spreadsheet based analytical tool that rapidly applies Station Standards to the proposed design. It works within Excel. Each element in the model is treated separately and they are joined together for presentation purposes. It has a very fast run time and depending on the complexity of the station the development time is very short (days). It is best used for quick analysis of initial proposals for potential design, ensuring that any options that make it through to the shortlist address some potential high level station design concerns. About 20 stations are currently covered, but development time for new ones is very short.

Use/Output: It provides Level of Service (LoS) plots and free flow journey time analysis, in the form of block diagrams of station layouts with demand coded in relation to supply for each element. It provides an indication of whether they pass or fail Standards in the scenario under consideration.

Input: Each element of the station (gateline, passageways, escalators, stairs, lifts, platforms etc.) is defined by their space characteristics and hence their capacity (using Station Planning Standards). Demand is derived, usually from RODS, and any assumptions about routing options are applied. Train service, in the form of TPH is also an input.

Be aware: It does not assess delays, queuing and social cost benefits. It does not involve dynamic modelling and the impact of individuals' movement on other individuals.

Custodian: Station Capacity Analysis Team
(stationcapacityanalysis@tfl.gov.uk)

PEDS (PEDROUTE STRATEGIC)

Overview: PEDS is a statistical model of the entire network. It covers all stations but it has a coarse detail in station layout and it does not model the link between stations. It has a very fast run time and depending on the size of the project the development time is very short (days/weeks).

Use/output: It assesses delay and congestion in all stations in the LU network and it can analyse line-level changes and station-level changes. It handles multiple closure scenarios and supports analysis of performance measures, but does not assess queuing time. It is a useful first indicator of the station impacts of more strategic (line or network wide) interventions.

Input: Coarse station elements (in block form), train service levels.

Be aware: Detail is course and further investigation at a station level (with other tools) may be required.

Custodian: Station Capacity Analysis Team
(stationcapacityanalysis@tfl.gov.uk)

PEDROUTE

Overview: About 50 stations are currently covered by Pedroute models.

Use/output: Social cost/benefit, congestion levels (average delay)(on a block by block basis), and comparison against station standards.

Input: CADs, survey data, station operational arrangements

Be aware: Validated base year. sensitivities

Custodian: Station Capacity Analysis Team
(stationcapacityanalysis@tfl.gov.uk)

LEGION

Overview: Legion is one of the commercially available software packages which assigns individual pedestrian movement within the confines of a modelled environment. It shows the individual routes that passengers take through a station based on a vast array of data to develop accurate computational algorithms, calibrated and validated from observations. Given the micro-level modelling provided, Legion models can require a long development time (possibly months). About 50 stations are currently covered by existing Legion models...

Use/output: Legion can provide detailed graphical outputs, such as Level of Service (LoS) maps, utilisation maps and 2D videos. It can also provide detailed numerical output used to calculated journey time, social cost, passenger flow numbers and rates, and platforms clearing times. Future scenarios are compared against one-another, and against a validated current, or a future year, base case.

Weekday AM peak (07.00 – 10.00) and PM peak (16.00 – 19.00), are the usual modelled periods, although others can be (subject to input data/assumptions). The model works on a second by second basis, but reporting is usually agglomerated into 15 min periods, or the busiest 15 mins in each peak.

Input: Up-to-date station CADs (existing and planned) as well as actual station operational plans, and signage are the building block of supply. The latest RODS, additional ad-hoc surveys to validate overall numbers and define routing choices, Railplan, (or in some instances LTS to produce revised Railplan forecasts) are the contributors to inputs on the demand side. Detailed train service timetabling and train capacities are also inputs. For future year demand, trends, assumptions and Railplan may be used in varying combinations.

Be aware: If a model doesn't already exist, complex stations can take weeks to prepare and months between inception and completed reporting.

Some Legion models are a little old, and some have been produced by outside parties. In all cases models would need to be audited to ensure appropriateness to the task in-hand.

Forecasting future demand numbers is both a science and an art. These would be agreed with the client and possibly include some sensitivity testing.

Sometimes, options being looked at may not complete a model run due to blocking (congestion), and tweaking with further model runs may be required.

Sometimes modelling reflects an element of poor design, and the design may subsequently need to be revised and tested again. As far as possible, it would be wise to eradicate any obvious design flaws before abortive modelling takes place.

Custodian: Station Capacity Analysis Team
(stationcapacityanalysis@tfl.gov.uk)

3.4.7 Strategic Highway Modelling

HIGHWAY ASSIGNMENT MODELS (HAMS)

Overview: TfL have developed a suite of SATURN models, which assign the highway demand generated by the LTS mode split process to the road network. Each of the models is focussed on a geographical region of London.

Inputs: Network - Representation of the road network, including link lengths, capacities, and junction information. Demand – output from LTS must be processed to match the model's individual zoning system.

Outputs: Flows on each road link over the modelled period (including diagrammatic representations). Total or specific route journey times (free flow and queuing).

Be aware: Traffic conditions, and the impact of a proposed change can vary greatly by time of day. Analyses should be based on consideration of all appropriate time periods.

Custodian: (Group) Planning, Strategic Modelling and Analysis. Contact Chris Hyde on [redacted]

3.4.8 Highway – Other

The TfL Streets Traffic Directorate have produced the Traffic Modelling Guidelines - a very comprehensive guide covering all aspects of highway modelling. This should be the primary reference point for anyone evaluating benefits accruing on the road network.

All of the following models are operated by the Surface Transport Traffic Directorate. Contact Glynn Barton in the first instance.

LINSIG

Overview: LinSig is a detailed junction design tool which can be used to assess the performance of a signalised junction. It combines geometric layout, traffic and controller modelling to accurately reflect the way the junction operates.

Input / Use: LinSig is best used for the design and assessment of isolated signalised junctions. It is a useful tool in optimising the signal timings for a changed junction layout – either to maximise capacity or to minimise total delay. Required input information includes the geometry of the layout, and traffic flow by turning movement.

Output: is highly customisable and can display data by road link or by junction as a whole, tabular or graphical, flows, capacity, delays and queue build up.

Be aware: Within TfL, LinSig is not used for larger networks.

LinSig is more appropriate when the junction design is well advanced as detailed geometry is required.

There is potential for unrealistic representation of driver behaviour when queues are moving off.

TRANSYT

Overview: TRANSYT is used to produce timing plans for a network of signal-controlled junctions and is particularly useful where benefits accrue if sequential junctions' signal timings are linked to minimise delays.

Input / Use: Used for developing optimum signal settings for representative traffic conditions, and therefore can forecast timings for a proposed change to the network. Requires average traffic data to be collected (or projected) and analysed for each modelled period, in addition to data describing the physical layout of the network.

Outputs: TRANSYT can deliver a variety of outputs. It is possible to define specific routes through a TRANSYT network to examine performance statistics for a particular pathway or vehicle type, or for the modelled area / demand as a whole. Outputs can include travel times, queuing time etc. Coloured graphs can also be produced – e.g. of queue build up per cycle

Be aware: TRANSYT does not model individual vehicles and therefore can only approximate actual traffic behaviour. This is adequate for business cases but the signal timing output is never directly applied onto the street.

TRANSYT cannot automatically simulate the effect of a queue building up to the extent where it blocks back to an upstream junction – user intervention is required to adjust the parameters to approximate this.

VISSIM

Overview: VISSIM is a more complex and powerful tool, capable of modelling several groups of linked junctions and can complement analyses provided by traditional traffic optimisation and design tools such as TRANSYT and LinSig. Some examples of where VISSIM is particularly useful include:

- Where over-saturated conditions exist, and particularly where exit-blocking occurs, or where queues interact with other facilities;
- Where network infrastructure changes dynamically throughout the modelled period (e.g. SCOOT signal control, demand-dependency, bus priority at signals);
- Where accurate journey time prediction is important as an improvement measure (e.g. bus priority scheme); and
- Where it is necessary to visually demonstrate the operation of a scheme, for use in a stakeholder consultation or Public Inquiry.

Input: Representation of the network area, including signal timings, bus frequencies, location of bus stops and pedestrian crossings.

Output: All aspects of network performance, in aggregate of for individual links or even vehicles. Also, visual dynamic representation of the operation of the modelled network.

Be aware: Complex and time consuming to set up the model.

3.4.9 Analytics

Overview: Analytics, Customer Experience is the custodian of TfL's ticketing and journey data. Customer transactions are recorded on a central system, which can be interrogated to provide historical records of Oyster and magnetic ticket sales, discount card usage, Oyster card credit, journey patterns, station and bus route demand, and various other metrics. Although Analytics does not provide a modelling service as such, the data available can support scenario modelling by demonstrating what actually happened when the same or similar scenarios occurred in the past. For example, by tracking passenger movements over time using Oyster data (which accounts for over 80 per cent of trips), it is possible to show the effect of delays, diversions and other interventions on customer demand and behaviour.

Input / Use: In broad terms, queries need to specify the type of data sought (e.g. journeys, ticket sales, etc.), the time period required (e.g. daily figures, over the course of a month), and any additional parameters (e.g. between particular stations, using specific ticket types, etc.) .

Output: Historical sales and journey analysis.

Be aware: Full sales and journey data is only held for a period of 8 weeks, with some degree of summarisation after this. For sales, after 8 weeks the exact time of transaction is replaced with the day of transaction, while for journeys, after 8 weeks the data is aggregated and cannot be linked to individual cards. To illustrate this, an analysis of data from the past 8 weeks could show, for example, how the users of a particular station changed their travel patterns in response to a closure of the station; whereas an analysis of data from more than 8 weeks ago could only show the total demand for surrounding stations or bus routes without being able to pinpoint the users of the closed station.

Also note that because customers are not required to 'tap off' buses, actual bus journeys are not recorded. However, Analytics has developed a tool called Origin Destination Interchange (ODX), which predicts bus journey behaviour based on interchange taps at stations and on other buses. ODX can be used to estimate route loadings, bus stop usage and patterns of multi-modal travel.

Custodian: Contact Customer Experience Analytics Managers at customerexperien2@tfl.gov.uk

3.5 CALCULATION OF REVENUE EFFECTS

If passengers are given benefits which are not specifically recovered from fare increases then the demand for travel will grow, and revenue will increase. The extent of revenue increase can be calculated by multiplying the passenger benefit by an elasticity.

Elasticities are usually calculated by reference to the effects of fare changes. For example, a fares elasticity of -0.28 implies that a 10% increase in fares results in a 2.8% loss in passengers. As the benefits that passengers receive from improvements are measured in monetary terms it is now possible to use the same elasticity (without the minus sign) to indicate the extra revenue that will arise from passenger benefits.

Since the DfT currently subsidises most services on the national railway network, in addition to providing grants to LB and LUL, for appraisal purposes only the overall changes in revenue for all public transport modes should be included. For example, revenue gained by LUL resulting from transfers from bus and rail is subtracted from the total gain. To calculate the "new to public transport" revenue, conditional elasticities are used. These are given in Appendix E2.

This elasticity approximation is satisfactory for small changes to services but needs to be supported by further evidence where larger changes are implemented. A cap is placed on the forecast of extra revenue due to a service improvement, such that the implied increase in demand does not exceed 10% of the existing number of passengers who experience the service improvement. Beyond this cap, further increases in forecast revenue due to the improvement will require additional supporting evidence.

A notable example of likely exceedence of the limits of elasticity approximation occurs with LUL congestion relief projects where value derives from avoiding a significant worsening of congestion at a station. In extreme cases congestion delays can be forecast to build up exponentially beyond the point where they can plausibly be modelled. In this Do Nothing scenario, delays should be estimated in two steps. The first step is to model up to a suitable point where the level of delays to passengers still remains plausible. The second step is to extrapolate this worst plausible level of delay to passengers in the remaining part of the peak with the heaviest demand. Following this, the Do Something scenario should best be regarded not as generating extra demand, but avoiding the loss of passengers who could be deterred by the high levels of delay if no congestion relief measures are implemented. The cap described above will then apply to the proportion of forecast passengers who could be deterred.

For LUL, observation of demand build up following train service frequency changes has revealed that new demand from a project is not generated immediately but builds up over a period of time. The observed build up of demand is as follows:

- 35% in the 1st year of operation
- 75% in the 2nd year
- 90% in the 3rd year
- 100% in the 4th year and thereafter.

These factors must be applied to the revenue generated due to any passenger time savings or ambience improvements.

No comparable “build-down” following a reduction in passenger benefits should be used. There could be some interval before a service reduction is interpreted as a permanent, rather than a temporary, change; but basically it is “experienced” immediately by existing passengers. By contrast, the attraction of new passengers depends crucially upon them finding out about the change.

Note too that the passenger time (or other) benefits are realised immediately the project is implemented. Thus for a project implemented during Year 0 with a passenger benefit of £80,000 pa, the eventual revenue gain will be £22,400 pa (using an elasticity of 0.28). The entries in the DCF spreadsheet (to the nearest £1,000) will be:

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue	0	8	16	19	22	22
Passenger Social Benefit	0	80	80	80	80	80

It should be noted that after closure of a station or section of line for a prolonged period (say greater than one month), the build up in revenue will be gradual.

Contact Ryan Taylor, [redacted] *for further information on estimating the probable rate of build up.*

For LB, the realisation of capital project revenue generation (including changes in fraud levels) will build up over a number of years of a project's life. The profile varies according to the split of net and gross cost contracts (NCC and GCC) over the years following project implementation. A simple approximation is used in appraisals such that there is no demand increase in Year 1 (the year after implementation) and 100% of the forecast increase from Year 2 onwards.

3.6 SOME SPECIFIC ISSUES OF QUANTIFICATION

3.6.1 The appraisal of renewals

The renewal of assets is a major part of the project expenditure of LUL. The following decisions need to be made:

- should the asset be renewed, and if so
- when should it be renewed and to what standard or quality

In many cases the answer to the first will be "yes" if the alternative is the closure of a major part of the system. Clearly Metropolitan Line trains must be renewed at some time as the only alternative option in due course would be closure of the line. In other cases the decision may not be so clear; for example, the renewal of Aldwych station lifts when the alternative of station closure was feasible (and was implemented).

Having decided that an asset must be renewed, then the timing of renewal must be determined. As an asset nears the end of its economic life its performance deteriorates and the cost of keeping it in service (or the disbenefit of longer periods out of service) increase. The renewal may also give the opportunity to exploit the increased benefits of a modern asset.

The economic life of an asset is ascertained by comparing the NPV of future cash and passenger benefit flows, assuming replacement of the asset now, against the NPV assuming deferment of replacement by one or more years, taking into account increased maintenance costs and risks of failure. The cash flows will take into account changes in operating costs and passenger benefits as the existing asset ages, and the benefits of replacement by a new asset. Delay in replacement by a new asset will usually imply delay in the subsequent replacement of that new asset when it reaches the end of its economic life and this should also be taken into account in the cash flows. This is a version of "whole life costing" which includes, where relevant, passenger benefit.

For a very long lived asset (e.g. an escalator), the discounted cost of the next replacement will be low because it will occur a long time into the future, and the asset will simply be assessed to have reached the end of its economic life when the annual operating savings and passenger benefits resulting from the renewal, including any enhancements, outweigh the financial advantage of deferring the capital expenditure by one year. Note that there may be a trade-off between higher maintenance to sustain asset performance and replacement by a new asset.

Such calculations should adopt the methods defined in this manual to calculate cash and passenger benefit flows, and use the appropriate benefit/cost "passmark".

All renewals can theoretically be appraised by the above methods. However, for some asset replacement programmes involving the replacement of a large number of individual assets (e.g. the LUL Pump Replacement Programme), data may not be available for each individual asset.

In such cases, plans should be formulated which review the replacement programmes as a whole and ascertain the optimum replacement rate (and by implication the asset life).

Appendix K discusses four techniques which are applicable to various aspects of renewal appraisals:

- K1 Overview of asset degradation
- K2 Appraising the effect of bringing forward renewal by one year
- K3 Equivalent annual cost (for options with life-cycles of different lengths)
- K4 Methodology for scenarios in which risk accelerates in the “Do Nothing” option.

3.6.2 Safety

The LUL safety management system includes various directives and standards which are important points of reference. These include:

a) Safety Review and Change Control

This directive requires that changes are checked for safety significance. Where there could be a significant impact, it requires that a ‘safety case’ is made, demonstrating that safety will not be degraded and/or that the proposed option is that which will reduce risks to as low as reasonably practicable (ALARP).

b) Change Control and Implementation

This standard provides guidance on the categorisation of changes, indicating categories of safety significance and appropriate levels of authorisation. It is also designed to ensure that the necessary safety controls are maintained during implementation of the change.

c) Safety Justification and ALARP

This standard provides guidance on the structure of safety case papers, and describes the basis for demonstrating that risks are ALARP.

The safety case should clearly identify the requirements for any safety controls and their management during and following implementation of change. Assessment of the safety implications of change should be undertaken at an early stage in the development of options so that the costs, feasibility, etc. of such controls can be properly reflected in the business case.

ALARP judgements should be based on a structured qualitative evaluation of the safety issues based on operational and engineering experience, supported and informed by quantitative analysis where possible. The corporate standard for assessing the monetary valuation of reductions in risk is given in 'Safety Justification and ALARP'. Guidance on the quantification of safety benefits, consistent with the aforementioned standard, can also be found in Appendix F of this manual.

Further advice, for instance on Bus or corporate projects, may be obtained from Safety and Environmental Development on the quantification of risks, and from TfL Business Case Development on appraisal methodology.

Contact Jill Collis [redacted] for advice on safety and environmental risk.

Contact David Hancock [redacted] for risk in appraisal methodology.

3.6.3 Staff accommodation projects

Accommodation projects have two main effects:

- More efficient use of office space

The use of good design and modern system furniture (and IT systems through reduced space requirements for filing etc.) can significantly reduce the amount of space required for staff, whilst at the same time providing an acceptable working environment. Small projects may not enable sites to be released or sold, but nevertheless cumulatively they contribute to savings. For this reason the space saved can be valued in an appraisal, provided it is usable. Current values for space costs can be obtained from the Human Resources Directorate.

- Improvement in staff morale

Improved accommodation can lead to reduced staff absenteeism and turnover, improved productivity, and, seen as part of the employment package, to reduced staff costs. However, researching the relative valuations that staff themselves would put on accommodation improvements, as opposed to improvements in other working conditions, could raise sensitive industrial relations issues. In the absence of such valuations, the appraisal should indicate whether the increased accommodation expenditure remains proportionate (especially by comparing the percentage of total salary cost with that for comparable groups of staff), and quantify any known problems of absenteeism and turnover which may in part be caused by poor accommodation. Decision makers will then need to judge whether the cost of improving the staff environment is likely to be justified by improvements in morale leading to reduced staff costs (absenteeism and turnover), and performance (increased productivity and customer satisfaction).

Similarly, where equipment is provided to help staff carry out their duties, it must be fit for purpose. If not, there will be a loss of morale which may outweigh any savings through not improving the equipment.

3.6.4 Projects in support services (e.g. IT projects)

In principle, these projects generate the same types of benefits as other projects, but where necessary TfL Business Case Development should be consulted about quantification of the benefits. A number of such projects are discussed below and a worked example is shown in Appendix A8.

TfL Business Case Development Ryan Taylor, [redacted]

- Cost savings

Many IT projects, for example, are direct cost saving projects which result in more efficient staff operation. This can result in direct staff savings, which are readily quantified although users tend to quote "improved productivity" without quantifying what direct effects on costs will result. Ongoing benefits from project investment will be reflected in users' operating budgets and budget holders will be expected to achieve claims of improved productivity. It is therefore important that Clients obtain realistic and achievable quantification of such benefits from the users.

- Improved service

Many projects are intended to improve the output of a unit in terms of improved service. In most cases, it is possible to put a value on the improved performance (e.g. reduced train cancellations or better bus regularity) using the principles in this manual.

- Corporate IT Projects

The benefits expected from corporate IT projects are less well defined. For example, the project management system PROCON is generally recognised as being important in improving the management of projects but it is difficult to assess the value of that benefit.

- Management Information Systems

Similar problems arise with management information systems which are intended to improve the effectiveness of managers by providing better information on which they can base their decisions. Since it is difficult to value the output of managers, it follows that it is difficult to value changes in that output.

In some cases it may be informative to authorising bodies to state what improvement in the "output" of the manager is required to justify the project e.g. number of trains in service.

- Marketing campaigns

This type of project would include advertising campaigns, public relations campaigns, etc. Whether funded by operating or capital expenditure, the project should have a properly presented business case, with objectives and deliverables, costs and benefits. An advertising campaign, for example, would usually be associated with a service improvement initiative, and the business case would need to be demonstrated in terms of the wider business objectives.

- Training initiatives

Training initiatives have an effect similar to Management Information Systems (above) in that they are aimed at improving the performance of staff. The benefits obtained will depend on the functions of the staff. For example, training of depot staff might result in lower costs and/or fewer train cancellations, whereas training of station staff could result in improved MSS scores for knowledge and helpfulness of staff.

3.6.5 The appraisal of leases

The appraisal of projects which have a leasing option should be carried out as for "capital" projects with leasing as an alternative option. The comparison of purchase and leasing options will involve different annual cash flow profiles and the discount rate will have a considerable effect on the Present Values for the options.

Therefore, when evaluating lease proposals, as a sensitivity test, in addition to the standard 3.5% discount rate, evaluation at a range of discount rates for all cash and benefit flows in the appraisal should be carried out for both lease and purchase options.

Regarding finance leases, there is a general presumption against nationalised industries entering into this form of borrowing arrangement, since it is generally more expensive than paying for the assets concerned via Government borrowing.

3.6.6 Property

Many appraisals will simply entail comparing financial benefits against costs, to see whether the net financial effect is positive. However some projects, including station developments, will have social benefits, as well as an accompanying revenue effect. The appraisal of these benefits should be carried out as described in sections 3.3 and 3.4 using values for Bus and/or Underground passengers depending on the modes affected. In the case of interchange schemes TfL Business Case Development should be consulted on appropriate values.

Contact Ryan Taylor, [redacted]

Examples of the types of appraisal issues that can arise in other TfL subsidiaries are given in the following two sections.

3.6.7 Museum

Business cases should normally demonstrate that projects have a positive net financial effect. However, the Museum is governed by legislation which specifies a "duty ... to provide and maintain suitable accommodation for ... relics". Therefore projects associated with keeping the museum accommodation in good repair may be justified on statutory grounds alone.

When projects are not based on this statutory requirement, and the business case shows a negative net financial effect, the appraisal should estimate what levels of various possible benefits would be required to make the net financial effect positive. These benefits might include:

- revenue from increased attendance levels;
- revenue from increased use of the museum shop;
- revenue from increased TfL travel to and from the museum;
- revenue from improved "corporate image", or from increased knowledge of TfL services, leading to an ongoing increase in TfL travel;
- revenue from increased entry prices.

As with other London attractions, the long term trend is towards lower attendances because of steadily increasing competition. Therefore any estimated attendance level resulting from a project may be compared with whatever decreased attendance level the long term trend would predict.

An improvement will often be expected to lead to increased attendance, but to help pay for it, entry prices may also be raised. Here it is necessary to estimate the net effect on revenue, which will require an estimate of elasticity -the relationship between a percentage rise in price and the corresponding percentage change in demand. For this, TfL Business Case Development should be consulted

Ryan Taylor,[redacted]

3.6.8 Ticketing Facilities

Projects to improve existing systems can bring benefits through reduced queuing time. Although this queuing is not part of the "entry to exit" journey time, any time saving has an equivalent benefit and should be calculated using the usual value of time / weighting.

3.6.9 Returns from Advertising

Studies into the impact on revenues of various forms of advertising have shown widely varying results. Past analysis carried out by LUL Marketing shows that some advertising campaigns, in retrospect, had relatively weak business cases, whilst others showed a revenue:cost ratio of up to 6:1. One of the key effects can be to accelerate the increase in demand for an improved service, which would otherwise take much longer to build up.

3.7 PRIVATE FINANCE INITIATIVE PROJECTS

3.7.1 Categories of project for which the PFI should be considered

Corporate Finance should be consulted about projects that could potentially be financed under the PFI (or via other non-capital financing arrangements, e.g. Prudential Borrowing).

For Advice on PFIs contact Corporate Finance (Julian Ware, [redacted]

3.7.2 Appraisal issues

Where opportunities for pursuing the project under the Private Finance Initiative (PFI) are being progressed, the benefits and disbenefits of PFI funding need to be considered.

However, with any investment proposal, it must first be established that, irrespective of funding arrangements, there is a good business case for doing the project. Thus the business case should be such that the project would be worth doing within current investment priorities.

The next step will be to look at benefits and costs involved in PFI funding. This is a specialist area where experience is still being gained, but here is a list of possible benefits to be estimated when appraising a PFI option:

- benefits brought forward from the date when they could be delivered by the project if conventionally funded
- more project risk transferred than possible with conventional 'design, supply and maintain' contracts with payment by performance
- increased passenger benefits and revenues, if target performance levels achieved
- penalty payments, if target performance levels not achieved
- asset provider being responsible for maintenance as well -as a result the supplier has more interest in designing the asset to perform well
- worthwhile project enhancements beyond original scope

Tax savings offered by the supplier are regarded as costs to the exchequer, and hence to the taxpayer. They should therefore be ignored as potential benefits.

PFI funding also has the following potential disbenefits:

- delays through the tendering process, especially if abortive
- extra interest paid on the contractor's loan, via continuing lease payments, compared with the lower cost of government borrowing if the project is conventionally funded
- premium for transfer of risk
- decreased passenger disbenefits and revenues, if performance levels likely from a conventionally funded project are not achieved
- termination of contract costs (e.g. termination would usually occur if performance is unacceptable for specified period of time)

- TfL's sourcing strategy in each area aims to ensure that more than one supplier stays in the market, to maintain the benefits of competitive pricing. The choice of PFI funding arrangements may adversely affect this strategy.

(These are not exhaustive lists.) Estimates of all potential benefits and costs should be provided, with estimated probabilities where outcomes are uncertain.

If enhancements to the original project are offered, these should be appraised incrementally -again, to see whether the enhancements would be worth incorporating within current investment priorities.

The appraisal approach in general (and in particular, discounting rates for future payments and benefits) will need to be discussed with TfL Business Case Development and with the DfT.

Ryan Taylor, [redacted]

3.8 THIRD PARTY CONTRIBUTIONS

The impact of any third party contributions on the business case for a scheme should be taken into account by assessing both the economic case (in general terms) and its financial attractiveness to TfL. First the benefit:cost ratio should be calculated using the full cost of the scheme, without subtracting the third party contribution. If the project has a benefit:cost ratio greater than 1.5:1 it is economically worthwhile in the same way as other projects are that have to achieve this passmark. If so, the benefit:cost ratio should then be re-calculated, using the expected cost of the scheme to TfL after allowing for the third party contribution. This second ratio will enable TfL to compare the scheme against others when deciding on priorities.

Any potential contributor should be made aware if there is a more efficient transport option than the one proposed. For example, a new Underground station, for which an external contribution may have been offered, may have a higher profile than other improvements to the transport infrastructure in the surrounding area, but it may not be the solution which minimises journey times or maximises modal shift to public transport. In such a case, the external contribution would distort the comparison.

As with other third party contributions, grants should not be offset against the cost of a project in the main appraisal. Where additional public money is involved, it is particularly important to assess the true economic worth of the project, and to highlight the option with the greatest transport benefits.

3.9 TREATMENT OF SUNK COSTS IN APPRAISALS

When a change occurs to project costs, timescales or deliverables beyond original tolerances, it is necessary to review whether to continue. In these circumstances, it is important not to lose sight of the overall business case for the project. Thus the main analysis should always be based on the full project cost, i.e. what has been spent to date plus all future expenditure proposed. However, in deciding where best to allocate the scarce resources available to TfL it is also important to understand the implications of halting a project prematurely and what return TfL would achieve from the future expenditure alone, especially when a large fraction of the total expenditure has already been incurred (i.e. “sunk costs”).

Where the full cost appraisal no longer justifies a project, the business case should identify clearly the implications of not continuing with a project, taking into account the remaining spend, including the costs associated with bringing a project to a suitable conclusion. The “future” benefit/cost ratio then becomes: future benefits that could be achieved (as opposed to any already achieved), divided by future net costs (i.e. offset by costs of premature closure). This should be quoted as an additional item of business case information and will be the key factor in deciding whether to continue with the project.

In each analysis, i.e. overall business case and “future” business case, all costs, benefits and present value calculations should be based on current year prices. If the original analysis was carried out using parameters or appraisal methodology which has since been superseded, and a decision is required concerning a significant amount of remaining expenditure, it may also be necessary to convert to current BCDM parameters or use the updated methodology.

Contact TfL Business Case Development for further advice on superseded methodologies - Ryan Taylor, [redacted]

3.10 NEW DEMAND ARISING FROM EXTERNAL CHANGES

Increases in demand can arise from service improvements, or sometimes from external changes without any alteration to TfL’s services. In the case of external changes (e.g. new office blocks, a new shopping centre, etc.) the increased demand is usually predicted by estimating the number of new commuting, shopping or leisure trips that will be generated, and multiplying this by the proportion of trips likely to be made using TfL’s services (modal share).

However, it cannot be assumed that this will be the net increase in TfL trips. For example, many trips to a new shopping centre may simply replace TfL trips to other shopping centres. In the worst case, a new development with good parking facilities in outer London could conceivably result in a reduction in TfL trips, if companies relocate from inner London, where there are few parking facilities for commuters. But since it is reasonable to expect some net increase following most new developments, the working assumption shall be that half the predicted number of new trips are a net gain to TfL, unless there is evidence for an alternative assumption.

3.11 CONSUMER SURPLUS WHERE ENTIRELY NEW DEMAND IS CREATED

‘Consumer Surplus’ is the difference between what customers would be willing to pay, and what they actually pay. When a service is improved, the fare does not generally change, and the Consumer Surplus (‘passenger benefit’) is increased. In TfL appraisals, elasticity is used to represent the relationship between this increase in Consumer Surplus and the extra revenue arising from the increase in demand that is attracted as a result of the improved service.

When an entirely new demand is created, e.g. a large new development is constructed near an Underground line, the above relationship between the increase in Consumer Surplus for existing passengers and the extra revenue from new passengers does not hold. Therefore it is wrong to calculate the Consumer Surplus change in these cases as the revenue increase divided by the elasticity.

In the absence of any contrary evidence, an assumption shall be made that the passengers new to public transport would have been prepared to pay an amount ranging from:

the current fare to *the current fare x 1.5*

and the consumer surplus gain shall therefore be estimated as half the fare change multiplied by the new demand, i.e.

0.25 *x* *the revenue arising from the new demand.*

(Under this assumption, the number of passengers prepared to pay increasing amounts tapers off up to the maximum, so on average, passengers would only be prepared to pay about 17% more than the existing fare.)

Note that some specific sectors of the market, including people with impaired mobility, may have been prepared to pay a much higher multiple of the existing fare.

3.12 ACCESSIBILITY FOR PEOPLE WITH IMPAIRED MOBILITY

A business case for the proposed network of 68 key Underground stations with full step-free access has been made, under the assumptions that a number of existing customers with impaired mobility will gain time and comfort improvements, while there will be increases in both revenue and social benefits due to a new set of customers who will be enabled to travel. This set of stations will provide a coherent network, but where there is potential synergy or enhanced value for money, for example during refurbishments, the opportunity to extend accessibility to other stations beyond the network should be carefully examined.

The key stations were chosen on the basis of providing:

- a good geographical spread across London, with all local authorities, lines and most branches served
- above average station usage
- significant interchange traffic between lines or with other modes
- access to particular local facilities, e.g. a main shopping centre, a leisure centre, a hospital, etc.

In view of the case for providing step-free access across the network of key stations, business cases for individual stations in this network can be based on the overall business case, provided that the likely costs and benefits are broadly in line with the assumptions in the overall business case.

A summary of the factors to be investigated is as follows:

- any substantial divergence from the estimated cost assumed in the overall business case

- any substantial decrease in the estimated benefits assumed in the overall business case (for example, arising from an excessively lengthy route from street level to platform)
- any disproportionately high disbenefits during project implementation (especially where they outweigh the benefits following completion)
- the implications of removing a station from the proposed network, i.e. if there are no nearby stations in the network and if possible substitute stations lack the attributes (see above) intended for key stations, the disadvantage of removing this station as a potential origin and destination may be understated
- any unusually high level of synergy which can be secured by carrying out accessibility works at the same time as a general station refurbishment - this will also be relevant to stations which are not included in the key network.

Further information on benefits and business drivers for schemes that aid the mobility impaired can be obtained from Group Planning – Equality and Corporate Sustainability. Contact Stephen Golden on [redacted]

3.13 SERVICE DELIVERY STANDARDS

Service Delivery Standards describe the level and quality of service that LUL is committed to deliver to its customers. The Standards indicate where shortfalls in service quality should be rectified.

It is intended that generic business cases can be demonstrated for most of the Standards, and provided that each proposed project has costs and benefits broadly in line with those assumed in the generic case, no detailed business case will need to be provided.

A user guide is available showing the assumed costs and benefits for each improvement at each location, with guideline values showing at what point increased costs would make each improvement unviable. For any projects falling outside these guidelines, conventional business cases will be required (as they will be for any Standard which does not turn out to have a generic business case).

Further information on Service Delivery Standards can be obtained from Customer Service Strategy. Contact Xavier Brice on, 44336 in the first instance.

3.14 APPORTIONING BENEFITS BETWEEN TWO OR MORE PROJECTS

When two or more projects contribute jointly the achievement of certain benefits, apportioning may or may not be appropriate. In the first example,

suppose project A provides about twice the extra space that a later project B will contribute towards the relief of congestion in a station. Project A might have an excellent benefit:cost ratio, whilst an incremental appraisal of the project B might show a much poorer ratio (though still above the passmark). However, it is possible to envisage that, if the projects were appraised in the reverse order, project B's benefit:cost ratio would be much improved (since the relief of the heaviest congestion brings the greatest benefits). Under these circumstances, it would be appropriate to use a method which is robust to the order in which the projects are carried out, by apportioning the overall benefits in the ratio 2:1.

In the second example, suppose the attainment of a new peak frequency on an Underground line is completely dependent on two different infrastructure projects: a power supply upgrade, and a new signalling system. Should the total benefits be apportioned? (How would it be done? On the basis of cost of each project? How would the other benefits of the projects be taken into account?) Apportioning the benefits would be quite arbitrary, and in this case there is no alternative to a joint appraisal of the two projects.

3.15 OPTIMISM BIAS

The Treasury's Green Book (2003) recommends that optimism bias, in both costs and benefits, should be addressed in appraisals. Optimism bias is the demonstrated systematic tendency for appraisers to be overly optimistic about key parameters.

3.15.1 Costs

The DfT's recommended uplifts refer to cost overruns calculated in constant prices and should be applied to investment costs including the allowance for the expected value of risk. They are derived from the evidence provided by Procedures for Dealing with Optimism Bias in Transport Planning (Bent Flyvbjerg, 2004) and Review of Large Procurement in the UK (Mott MacDonald, 2002).

Table 3-1: DfT recommended optimism bias uplifts

Category	Types of Projects	Pre-QRA + No Single Option	Post QRA + Single Option	Post Detail Design Costs
Roads	Motorway Trunk roads Local roads Bicycle facilities Pedestrian facilities Park and ride Bus lane schemes Guided buses on wheels	44%	15%	3%
Rail	Metro Light rail Guided buses on tracks Conventional rail High speed rail	66%	40%	6%
Fixed Links	Bridges and Tunnels	66%	23%	6%
Building Projects	Stations and Terminal buildings	51%	-	4%

3.15.2 Relationship to risk

In line with Green Book and DfT guidance, optimism bias should be additional to any risk allowance. This applies even where risk analysis has been carried out. However, good risk management can reduce the allowance required for optimism bias. The size of the optimism bias adjustment required will reduce as project definition improves and/or as risks are identified and actions are taken to reduce risk exposure.

Optimism bias should be included in appraisals but not in budgeting or the expected final cost for a project. The equivalent of optimism bias for budgeting is contingency and this is held centrally within each operating business.

For further information on risk and contingency see the TfL Risk and Contingency Standard in Appendix N.

3.15.3 Optimism bias in operating costs, and in benefits

No specific optimism bias levels are specified for excess operating expenditure or benefits shortfall. Nevertheless, the possibility of optimism bias should be assumed. For operating costs this might cover such factors as: output specifications not being defined clearly enough, stakeholder and operator needs not fully understood, etc. For benefits, it would in particular cover the effects of design or scope being unable to be fully realised; offsetting disbenefits being underestimated; projected demand growth rates not being achieved; or other projects effectively superseding the scheme. Where any of these outcomes are feasible, they should be the subject of sensitivity tests.

Note. Full discussions of Optimism bias can be found on the Treasury's and DfT's websites at:

http://www.hm-treasury.gov.uk/green_book_guidance_optimism_bias.htm

http://www.dft.gov.uk/webtag/documents/expert/unit3.5.php

For further information on management contingency in appraisals, contact Ryan Taylor, [redacted]

3.16 HEALTH BENEFITS FROM WALKING AND CYCLING

The appraisal of health benefits arising from taking up cycling on a regular basis is largely derived from a report by The Copenhagen Centre for Prospective Population Studies, which found that individuals who cycle for three hours per week reduce their relative risk of all-cause mortality to 72% compared to those who do not commute by cycle (Andersen et al, 2000). An illustrative example is provided in Appendix A9.

The World Health Organisation has developed the Health Economic Assessment Tool (HEAT) that can be used to monetise health benefits for walking and cycling:

http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/Transport-and-health/activities/promotion-of-safe-walking-and-cycling-in-urban-areas/quantifying-the-positive-health-effects-of-cycling-and-walking/health-economic-assessment-tool-heat-for-cycling-and-walking

With the tool being found on this specific site:

http://www.heatwalkingcycling.org/

This tool is still likely to underestimate health benefits as it only evaluates the benefits as a result of decreased mortality and ignores the benefits due to reduced morbidity or sickness.

Benefits from reduced sickness can however be covered in part through the benefits of reduced absenteeism. It should be noted that these are business rather than consumer benefits.

In the USA, physical activity programmes involving 30 minutes of exercise a day have been shown to reduce short-term sick leave by between 6% and 32% (WHO, 2003). In the UK the average absence of employees is 6.8 days, of which 95% is accounted for by short-term sick leave (CBI, 2003). Therefore, for each employee who takes up physical exercise for 30 minutes a day for 5 days a week as a result of a walking or cycling intervention, the annual benefit to employers is likely to be (on average) at least 0.4 days gross salary costs (6% of 95% of 6.8 days).

In order to calculate the benefits, this figure needs to be combined with the average gross salary costs and the number of affected working people.

The number of working people affected may be calculated from the number of new walking and cycling commuters who are expected to use the facility. These benefits should not be subject to the ‘rule of a half’ which is consistent with the treatment of other benefits from improved levels of health and accident costs.

4 COST BENEFIT APPRAISALS

4.1 Financial Effects

For each option the net financial return can be calculated by combining the present value of all cash flows calculated in Section 3.2, with those arising from changes to passenger revenue calculated in 3.4.

If the project options have no direct effect on passenger benefits and demand then this is the end of the appraisal. If the project makes a net contribution to TfL's finances then its call on scarce resources will be based on its financial effect alone.

For many TfL projects however, the financial effect may be negative and the case will rest on the effects that the project has in improving the services offered by TfL to the public. These benefits and the generated revenue shall be included in a cost benefit appraisal. They shall then be compared to the net cost of the project.

4.2 The Measurement of Total Benefits

Section 3.3 has shown the way that benefits to existing users can be calculated. In principle the following further benefits could be added:

- disbenefit to existing users from increased congestion
- the benefits to new users
- the benefits to non-users (e.g. in reduced road congestion)

The passmark assumes inclusion of benefits to existing users only. For most projects, the benefits to new users are small compared with user benefits (but generated revenue must be included in appraisals).

Projects which generate new users will give external benefits to non users as stated above but will also increase congestion on the Underground. Analysis has shown that these two effects are approximately equal and, for most appraisals, can be ignored. However, for major projects (such as line extensions and congestion relief projects) these effects may be significant and TfL Business Case Development must be consulted.

If there are particular reasons why the benefits to new users or to non-users are likely to be high or low for a particular project then the advice of TfL Business Case Development shall be sought.

For advice concerning treatment of new users and non-users in cost benefit calculations contact Ryan Taylor, [redacted]

When total benefits have been computed for all the project options the benefit to cost ratios of the project options can be calculated.

4.3 Benefit to Cost Ratios

4.3.1 TfL formula

In order to choose between competing projects decision makers need to know the benefit:cost ratio of each project. This shall be calculated as follows:

Benefit to Cost ratio = $\dfrac{\textit{Present Value of Social Benefit}}{\textit{PV of Costs - PV of revenues}}$

Note that it is important that all revenue effects are included as negative costs in the denominator of the expression and not as benefits in the numerator.

4.3.2 Volatility of Benefit to Cost Ratio

TfL's ratio is sometimes 'volatile', i.e. under certain circumstances it can react disproportionately to changes in benefits or costs. When the Net Financial Effect is negative and small (i.e. near the break-even point) the benefit:cost ratio is likely to be very high.

Consider this example:

	£000s NPV
Costs Revenue derived from elasticity (0.28 times increase in Passenger Benefits)	-570 560
Net Financial Effect Increase in Passenger Benefits	-10 2000
Benefit:Cost Ratio	200:1

It is possible that only half the anticipated benefits will occur. (This is quite plausible if the project is breaking new ground, where there is no previous data to inform the estimate.) The business case then becomes:

	£000s NPV
Costs Revenue derived from elasticity (0.28 times increase in Passenger Benefits	-570 280
Net Financial Effect Increase in Passenger Benefits	-290 1000
Benefit:Cost Ratio	3:1

and the benefit:cost ratio has plummeted from 200:1 to 3:1.

Fortunately, the benefit:cost ratio is not liable to such disproportionate effects when the ratio is near the current passmark of 1.5:1. However, when larger ratios are involved, e.g. in the prioritisation of projects, it should be remembered that relatively small percentage changes can make a big difference. If a project with a 25:1 ratio has its benefits reduced by 20%, for example, then typically the ratio will reduce to about 9:1.

This does not reduce the validity of prioritisation, but it does emphasise that differences may be more marginal than they appear.

4.4 Sensitivity Tests

Any factors which put the achievement of the project's value at risk must be listed and included as sensitivity tests as part of the appraisal documentation.

The required components are:

- identify the key uncertainties (e.g. costs, demand, benefits, timescales for implementation), where possible estimating the probability and impact
- identify the worst cases to give the maximum and minimum values they may take based on a realistic analysis of the possible risks, taking account of possible combinations of risks, where they are likely to occur together
- input the results into sensitivity tests (see below) and re-calculate the benefit:cost ratio
- identify any notable point at which the recommendation would change, e.g. “benefit:cost ratio remains below passmark until costs are reduced by 26%”. This kind of test is very effective if the chances of the scenario are known or very obviously low, but if not, it is of limited value unless the risk of it happening can be quantified.

Clearly these tasks are much easier if VIM-BC or a spreadsheet has been used to calculate the benefit:cost ratio for a number of options.

The choice of sensitivity test should accordingly be specific to each proposal and not based on pre-determined +/- X % variations.

For evaluating options which have widely different expenditure and benefit timings, sensitivities at discount rates lower than 3.5% should be carried out.

4.5 Project Risks

4.5.1 Approach in appraisals

In general, there is a tendency for appraisals to have “optimism bias”, i.e. where costs are understated and/or benefits are overstated. In extreme cases the consequences can be unjustified implementations, cost overruns, de-scoping, etc. However, at the other extreme, the overestimation of costs is also unhelpful. While risk release programmes can help redistribute unused monies, investment planning estimates become blurred, and a worse problem is that the downward pressure on costs may be lifted. Thus a key principle for appraisers is that risks should be evaluated as accurately as possible, and evidence from past projects of a similar nature should be sought.

4.5.2 Risk of overspend

Worst case costs should be used only for a sensitivity test, not for the main appraisal. The latter should always be based on the most likely level of costs, where appropriate including specific overspend outcomes multiplied by their estimated probabilities.

4.5.3 Other project risks

As with the risk of overspend, any risk of under-achievement of benefits should be quantified if possible. Again, the appraisal should ideally be based on outcomes and probabilities, rather than the worst case. A “middle case”, half way between worst and best cases, should be used only if it is reasonable to assume that the probabilities of higher and lower outcomes are roughly equal.

4.5.4 Management of risk

At an early stage in a project it is important to compile a register of risks, which could include some or all of the following:

- designs cannot be produced to meet required performance or quality standards
- critical staff resources cannot be procured when needed
- contractors become insolvent
- old technology becomes obsolescent and/or new technology does not become available in time
- legislative, economic or political changes result in unexpected changes to project scope
- unforeseen adverse environmental impact results in delays and/or changes to project scope
- adverse public reaction is not anticipated
- land acquisition process takes longer than expected
- new systems do not interact satisfactorily with existing systems
- agreed ongoing service levels cannot be maintained during implementation
- phases of construction are not completed within budget or on time
- ‘force majeure’, e.g. natural disaster, disrupts project
- claims arise from contractors or third parties
- forecasting of demand for and/or revenue from a new or improved service is incorrect.
- There are broadly four possible responses to each risk:
- transfer it to the party best placed to manage it
- remove it (e.g. by circumventing it or insuring against it)
- contain it by minimising either its probability or its impact.
- tolerate it (e.g. rare, severe weather risks which cannot easily be predicted or mitigated).

Where risks are to be managed, the register should say how and by whom, and when each risk can be expected to materialise. In this way all ‘contingency’ monies can be transferred to specific risks. The risk register will then be monitored, and at the designated times, risk monies will either be moved to 'prime cost' (if they materialise) or be subtracted both from 'risk' and from 'estimated final cost' (if they do not).

4.6 Step-by-Step Guide to Carrying Out an Appraisal

The procedure for carrying out business case appraisals is outlined below.

	Action	**Refer to section**
1	Identify opportunity of gaining revenue and/or social benefit, or risk of revenue loss and/or social disbenefit	
2	Define unit of appraisal e.g. a station, a group of similar stations with similar work to be done, an area bus scheme, the first phase of that scheme, etc.	
3	Define base case	2.2
4	Define option(s), where possible considering an incremental approach to achieving the overall scope, and any practicable alternatives for phasing	2.3 3.6
5	If safety is a significant aspect, do an ALARP appraisal If environmental impact is significant, assess accordingly	App. F6 App.L
6	Define project life	2.6.1
7	Define costs and benefits of base case and option(s) *Costs (negative, or positive if cost savings)* - one-off - maintenance - operating *Incomes (positive, or negative if income reductions)* - sale of land or property - revenue opportunities, eg. rents *Demand-related revenue (positive, or negative if reductions)* - revenue generated from new services - revenue generated from improved existing services (including improved reliability) - avoidance of revenue loss due to safety incidents *Non-Financial Benefits (positive, or negative if disbenefits)* - passenger benefits - safety benefits (NB there is a separate procedure for safety-only appraisals) - road congestion benefits	 2.4.1 2.4.2 2.4.3
8	Calculate costs - use convention that costs are negative, and cost savings are positive - use best estimate in main appraisal, taking account of risks and their probabilities - add appropriate optimism bias - reserve 'worst case' for sensitivity test	3.2 3.14 4.5.1

	Action	Refer to section
9	Calculate passenger benefit - use VIM-BC wherever possible for calculation of LUL 'improvement' benefits [even if there are no customer priority-related benefits, VIM-BC could still be useful for calculating cost and benefit streams] - for LB projects, identify 'willingness-to-pay' values, identify any overlaps between attributes, relate to perfect service and cap value if necessary - for time savings, where there are complex interactions, e.g. between service level, reliability, congestion, etc, use computer models to calculate	3.3 App. E4.7 3.1.2
10	Calculate revenue derived from extra demand - use relevant elasticity applied to passenger benefit (For LUL ambience benefits, VIM-BC does this automatically, with all-day elasticity as default value) - for LB appraisals apply profile of revenue realisation (including fraud level changes) to reflect NCC / GCC split	3.4
11	Ensure that all costs and benefits are related to the same base year	2.6.2
12	'Discount' all costs and benefit streams relative to the base year (usually the first year in which capital will be spent) -in each case the total across all years is the net present value (NPV)	2.6.3
13	For base case and each option, calculate the net financial effect by subtracting incomes and revenues from costs	2.6.5
14	For base case and each option, calculate total social ('non-financial') benefit, adding in any discounted environmental benefits that can be monetised, e.g. from noise reduction	4.2 App L
15	If base case effect is not zero, calculate incremental effect of option(s) by subtracting base case net financial effect and total social benefit from their counterparts in each option; if several options, use 'Multi-Option' approach	App.A4 3.
16	If incremental net financial effect of an option is negative (i.e. there is a net cost), calculate the benefit:cost ratio (total social benefit / net financial effect) and compare with passmark	5.2.2
17	Otherwise state "Positive Financial Effect" and state point at which project will become financially positive	5.2.1
18	Present costs, benefits and ratio in standard table format with list of assumptions appended. (Keep a list of assumptions made throughout the appraisal, and ensure that they are clearly presented in the appraisal. This makes it easier to change assumptions as necessary, and to do sensitivity tests)	5.1
19	Carry out realistic sensitivity tests to show likely margins of error, and critical points at which decisions would alter	4.4
20	Identify, and if possible quantify, environmental benefits which cannot be monetised -use as 'supplementary information'. (If benefits can be monetised, e.g. noise reduction, add into main appraisal -see step 14 above)	App. L
21	State measures of success which would verify the predicted outcomes of the project	2.7
22	Make recommendation about acceptance / rejection of option in the light of passmark criteria and any important qualitative issues (or effects that have been impossible to quantify) which have a bearing on the business case.	

5 PRESENTING A BUSINESS CASE

5.1 Required Presentation Format

Usually all appraisals should be laid out as described in Appendix H. A spreadsheet known as the Business Case Assistant automatically produces a business case summary in the required format.

A summary of contributions to MTS challenges and outcomes is provided by the Strategic Assessment Framework (see 2.8 above).

Measures of success, and impacts (where known) on performance indicators, should also be stated in support of proposals, but not as a replacement for an appraisal.

5.2 Assessing Cost Benefit Results

5.2.1 Net financial return positive - No effect on passenger benefits

If a project improves the financial results of TfL without altering the service to the public then it clearly has a good case for attracting funding - the extra finances it makes available can be used to pay for other benefit creating projects. Problems may, however, still arise if there are restrictions on capital expenditure, as the financial benefits may well be phased over a long period. This is why it is important to indicate the number of years after which the project becomes financially positive.

5.2.2 Net financial return negative - Passenger Benefits

The benefit:cost ratio must be greater than one and should normally achieve the recommended target of 1.5:1. Since cash is limited, a higher target may be set to reflect current circumstances.

However, a project failing to achieve the target (but achieving the DfT "pass mark" of 1:1) may, in exceptional circumstances, be submitted for consideration if it is supported by sufficiently clear unquantified or external benefits, which are additional to those that have been appraised. An example might be a project which strongly supports goals whose benefits are unquantified. The implication would be that the project does achieve a worthwhile benefit to cost ratio, though the benefits cannot, at present, be quantified.

Another exception, discussed in the DfT's guidance on investment appraisal, concerns "renewals, where continuation of the service or facility is essential to meet an established public transport need, if the investment is the most cost effective means of safely continuing the service or facility. However, where the benefit:cost ratio is below 1:1, TfL or its relevant subsidiary should consider with particular care whether the public transport need justifies the investment."

5.2.3 Net financial return positive - Passenger Disbenefits

Some financially viable projects also generate passenger disbenefits e.g. ticket office closure. Such a project may be worthwhile if the finance it releases can be used to undertake another project with a higher benefit to cost ratio. However, there may be wider social disbenefits that should also be assessed. For example, there may be instances where a location specific proposal, such as a station closure, would have a significant effect on road congestion (although such external benefits would not normally be included in the appraisal). In these cases TfL Business Case Development must be consulted to agree how such wider effects can be accommodated in the appraisal.

For TfL Business Case Development contact Ryan Taylor on [redacted]

The Disbenefit:Cost Saving ratio for a project with a net financial return must normally be less than one. However, if financial resources are very scarce and there are plenty of service improving projects which have benefit:cost ratios higher than 1.5:1 (say), then projects with disbenefit:cost ratios higher than 1:1 could be accepted in certain circumstances.

APPENDIX A Examples

A.1 REDUCTION IN LUL JOURNEY TIME

REDUCTION OF AVR. JOURNEY TIME ON BAKERLOO LINE BY 1 MIN.

A.1.1 Basic calculation

Let us assume that an initiative (see 2a and 2b below) reduces average journey time on the Bakerloo Line by 1 minute.

Number of passenger trips on Bakerloo Line is 77m (see Table B2.1 for current value).

Number of minutes saved is 77m minutes which at 8.9p per minute (see Table E1 for current value) results in a passenger time saving valued at £6.853m per annum.

A.1.2 Application

a) Operating Procedure Changes

The initiative could be an operating cost item such as additional platform staff to reduce the duration of station stop times.

Assume an increase in operating cost of £3m p.a.

The benefit/cost ratio would be given by:

Revenue generation = £6.853m x 0.26 = £1.782m per annum

(see Table E2a for current all day elasticity)

	Year 1	Year 2	Year 3	Year 4
Operating Cost	3000	3000	3000	3000
Revenue (1)	624	1336	1604	1782
Net Cost	2376	1664	1396	1218
Passenger Benefit	6853	6853	6853	6853
Benefit/Cost Ratio	2.9	4.1	4.9	5.6

(1) See Section 3.4 for build up of revenues.

b) Project Expenditure

If the benefits resulted from an initial investment (say improved OPO equipment which reduced stop times), then the calculation would need to take into account the life of the project and would be as for the examples A2 & A3 where the NPV of the passenger benefits is divided by the NPV of all cash flows (including revenues).

c) Refinements

The LUL value of time of £8.82 per hour assumes that all customers are seated in uncongested conditions. Clearly this is not always the case and the VoT could be adjusted for average train loadings. Averaged over the whole of traffic hours, this correction is almost negligible but could be significant over some sections in peak conditions.

For investment cases, future values of time should be inflated to take account of real changes in earnings (see Examples A2 and A3). Similarly, demand (trips) should be adjusted to take into account the forecasts in Table C3.

A.2 PROJECT APPRAISAL EXAMPLE - TRAINS

HALF-LIFE REFURBISHMENT

A.2.1 Introduction

There is a proposal to undertake a half life refurbishment on a fleet of Underground trains. Engineering assessment and appraisal has concluded that work is needed to the bogies to ensure safe and satisfactory operation until life expiry of the fleet. Overhaul is the base scenario representing the minimum expenditure. The option for consideration is replacement with new bogies which will result in a noticeable improvement in the quality of ride. This appraisal reviews the best option to undertake.

A.2.2 Definition of Base Case and Options for Evaluation

The Base Case is "Bogie refurbishment". The Option to be tested is "Bogie Replacement". Both options provide safe operation until full fleet replacement.

	Capital Cost	Impact to Passenger
Base: Bogie Refurbishment	£5m	None
Option : New Bogies	£10m	Passenger Benefits (see below)

A.2.3 Passenger Benefits of Option Tested

Using Stated Preference Values for passenger benefits on trains (Table E4.4 of Appendix E) the table below identifies the extent of improvement in ride quality which is expected following bogie replacement. The disbenefit values are pence per trip compared to a perfect service.

Passenger Effects - Impact on Quality of Ride		
	Bogie Refurb.	New Bogies
Quality of Ride (MSS Score)	20%	80%
Disbenefits compared to Perfect Service (pence per trip for "standard 16.2 min trip")	2.78	0.51

A.2.4 Total Passenger Benefit of New Bogies

	Increase in quality of journey (p/std trip)(3)	Average Journey Time (mins)(1)	Annual Passenger Figures (M)(2)	Total Value p.a. (£000s)
Net Passenger Benefit	2.78 to 0.51	14	50	**+1059(4)**

(1) Benefits based on 15 min. trip -for this Line the adjustment factor is 14/15.

(2) Total number of trips.

(3) Could be expressed as decrease in the disbenefit of poor ride quality. The current values are shown in Table 5.7

(4) (2.78 - 0.51) x 14/15 x 50000/100.

A.2.5 Revenue Effects

The revenue implication of the improved ride quality is:

Total Value p.a. (£000s) (non cash)	Fares Elasticity of Demand (i)	Revenue Effect (£000s) (ii) (cash)
+1059	0.26	**+275**

(i) This is the value for All Day, Conditional elasticity value i.e. "New to Public Transport" (see Section E2 for current all day elasticity).

(ii) Note that generated revenue will build up over four years (see Section 3.4).

A.2.6 Comparison of Costs and Benefits of fitting New Bogies against Refurbishing the Existing Bogies

	New Bogies	
	Net additional costs & benefits	**Net Present Value (£000s)**
Financial Cost	- 5,000	-4,887
Revenue Effect	+275 p.a.	3,380
Net Financial Effect		-1,507
Social Benefits	+ 1059 p.a.	13,983
Benefit/Cost Ratio		9.3:1

For annual flow of costs and benefits see Table A2 on the next page. Note that: Passenger benefits are inflated in line with real growth in VoT (here assumed to be 2% p.a., but currently 1% p.a.) and revenue builds up over four years.

The NPV's are calculated using the NPV function in the EXCEL spreadsheet package. Note that this function discounts cash flows into the year preceding the first annual cash flow and a correction (x 1.06) should be made for this. (See Table A3 for an alternative method of calculating NPV)

A.2.7 Conclusion

The revenue expected through an increase in public transport ridership due to an improved quality of ride on the Underground fleet does not fully cover the additional financial cost of fitting new bogies. A high benefit/cost ratio, however, does indicate a strong case for fitting new bogies on the basis of passenger benefits.

A.2.8 Other Considerations

Other factors which could have been taken into account are the effect on passenger journey times and crowding due to trains out of service during the refurbishment, and future maintenance costs.

Table A2: Project Example - Trains

- Appraisal of Bogie Replacement vs Refurbishment
- Assumed Life (years) = 20
- Real Annual Growth in VoT =2.0%
- Year 0 = 1997/98
- Discount Rate = 6%

Period	**Year**	**Real Growth in VoT**	**Capital Costs**	**Revenue Effects**		**Social Benefits**	
			Base	Base	Inc. Real Growth	Base	Inc. Real Growth
0	1997	1.000	-3000.00				
1	1998	1.020	-2000.00	48.18	49.15	529.50	540.09
2	1999	1.040		151.44	157.56	1059.00	1101.78
3	2000	1.061		227.16	241.06	1059.00	1123.82
4	2001	1.082		261.57	283.14	1059.00	1146.30
5	2002	1.104		275.34	304.00	1059.00	1169.22
6	2003	1.126		275.34	310.08	1059.00	1192.61
7	2004	1.149		275.34	316.28	1059.00	1216.46
8	2005	1.172		275.34	322.60	1059.00	1240.79
9	2006	1.195		275.34	329.06	1059.00	1265.60
10	2007	1.219		275.34	335.64	1059.00	1290.92
11	2008	1.243		275.34	342.35	1059.00	1316.73
12	2009	1.268		275.34	349.20	1059.00	1343.07
13	2010	1.294		275.34	356.18	1059.00	1369.93
14	2011	1.319		275.34	363.31	1059.00	1397.33
15	2012	1.346		275.34	370.57	1059.00	1425.27
16	2013	1.373		275.34	377.98	1059.00	1453.78
17	2014	1.400		275.34	385.54	1059.00	1482.86
18	2015	1.428		275.34	393.25	1059.00	1512.51
19	2016	1.457		275.34	401.12	1059.00	1542.76
20	2017	1.486		275.34	409.14	1059.00	1573.62
		NPV Total	-4,886.79	NPV Total	3,380.05	NPV Total	13,983.11

All costs in £000's

B/C Ratio = 9.28

Notes:

1. *Half new bogies in operation in first year.*
2. *Revenue generation lagged as described in 3.4.*
3. *Discount Rate and Growth in Value of Time were values current at the time.*

A.3 PROJECT APPRAISAL EXAMPLE - STATIONS

PLATFORM REFURBISHMENT

A.3.1 Outline of Situation

A station has recently had refurbishment work carried out in the ticket hall and through access areas. Due to financial constraints, however, the project was closed down without any work being done on the platforms which are now in a very poor state. This appraisal reviews the case for undertaking work on the platforms assuming that there is now more money available.

A.3.2 Definition of Base Case and Options for Evaluation

The Base Case is to "Do Nothing". The Option to be tested is "Full Platform Refurbishment" involving tiling, redecoration, re-signing and lighting works.

	Capital Cost	**Impact**
Base Case : "Do Nothing"	Zero	None
Option : Full Platform Refurbishment	£1m	Passenger Benefits (see below)

A.3.3 Passenger Benefits of Option Tested

Using the stated preference values for passenger benefits at station platforms (current values are shown in Table E4.3) the following table identifies the extent of improvement, of the various attributes, which is expected following platform refurbishment. The values are in pence per trip for a standard platform wait time of 3.85 minutes and they must be adjusted by the factor given in Table E4.6 to make them station specific. In this particular station, the average wait time is 4.2 minutes.

The base values are the current MSS scores for that station and the expected values after refurbishment are based on the judgement of the client/user. These assumptions need to be set out in the submission for authority so that the authorising body can judge the "reasonableness" of the assumptions.

	Disbenefit values for condition of Platform (pence/passenger trip)						
MSS Scores	**0%**	**10%**	**20%**	**80%**	**90%**	**100%**	**Benefits compared with Do Nothing**
Cleanliness (Appearance)	0.43					0.0	0.43
Cleanliness			1.23	0.19			1.04
State of repair		0.79			0.04		0.75
Signing			0.36	0.09			0.27
Lighting		1.04		0.15			0.89
							3.38

Note: The two values in the rows show the before and after disbenefit, i.e. state of repair improves from 0.79 to 0.04p/trip.

A.3.4 Total value for Improvement

a) Passenger Benefits (or reduction in social disbenefit)

The total passenger benefits of carrying out the improvement are:

	Benefit/standard trip (pence/passenger)	Ann. Passenger Figures (M)(i)	Total Value p.a. (£000s)
Platform Refurb.	3.38	3.0	103(ii)

(i) This is the number of passenger boardings at this platform

(ii) $\frac{3.38}{100}$ x 1.02 x 3.0 x 1000 [value x adjustment factor (from Table E4.6) x passenger demand x M passengers / £000

b) Revenue Effects

The change in passenger benefit is equivalent to a change in generalised cost. Therefore the effect on revenue of the improved environment is calculated by multiplying the annual social benefit by the *Fares Elasticity of Demand*, in this case *0.26*.

	Passenger benefit p.a. (£'000) (non cash)	Fares Elasticity of Demand (iii)	Revenue Effect £000s (cash)
Platform Refurb.	103	0.26	27

(iii) Value for All Day, Conditional elasticity value i.e. "New to Public Transport" (see Table E2a for current all day elasticity).

A.3.5 Appraisal

The appraisal identifies whether the benefits derived from the option to improve the platforms are worthwhile in respect of the net cost.

The various cash and passenger "social cost" flows over the life of the asset are discounted at 6% (the current discount rate at the time) and the discounted cash flows for each year are totalled to give the present value (NPV) of each stream. (The present value of £1 receivable in 1 year's time is £0.943 [1/1.06], of £1 receivable in two years time is £0.890 [0.943/1.06] etc.).

The spreadsheet table A3 calculates present value figures for the cash and "social benefit" flows. The period over which a project is appraised is the life expectancy of the improvements. In this case it is assumed that the improvements have a life of 20 years.

Whilst annual benefits in terms of time savings are assumed to be constant, the value of time is expected to increase partially in line with real earnings. The planning assumption for the real increase in future value of time is now 1% p.a. rather than the 2% p.a. assumed here.

A.3.6 Results

	Current costs & benefits	**Present* Value (£000s)**
Financial Cost	-1000	-989
Revenue Effect	27 p.a.	328
Net Financial Effect		**-661**
Social benefits	103 p.a	1356
Benefit/Cost Ratio		**2.05:1**

* *Over 20 years*

A.3.7 Conclusion

The expected traffic generation with consequent revenue increase £328k NPV is not sufficient to outweigh the capital costs NPV of £989k and the net financial effect of refurbishing versus doing nothing is -£661k. With the passenger benefits included the project is worthwhile on the basis of the benefit/cost ratio of 2.05:1.

Usage of the station has been assumed to be constant over the appraisal period. A more accurate assessment would use forecast demand levels.

Although not covered in this example, we should also consider whether or not the benefits would change over time. For instance, the refurbish option could deteriorate to "poor" (and eventually to "very poor"), whilst the Do Nothing option will decline to "very poor" more quickly. Signing, lighting and the state of repair may decline only gradually, but cleanliness may deteriorate relatively quickly.

Contact TfL Business Case Development (Ryan Taylor, [redacted]o [redacted] for further advice on degradation of ambience benefits over time.

Table A3: PROJECT EXAMPLE - STATIONS

Appraisal of Platform Improvements vs Base Case of Do Nothing

- Assumed Life (years) =20
- Year 0 =1997/8
- Real Annual Growth in VoT=2%
- Discount Rate =6%

Period	Year	Disc. Factor	Real Growth in VoT	Capital (£k)		Revenue Gain (£k)			Passenger Benefits (£k)		
				Base	DCF	Base	Inc. Growth	DCF	Base	Inc. Growth	DCF
A	B	C	D	E	F=ExC	G	H=GxD	HxC	J	K=JxD	KxC
0	1997	1.00	1.00	-800.00	-800.00	0.00	0.00	0.00	0.0	0.00	0.00
1	1998	0.94	1.02	-200.00	-188.68	0.00	0.00	0.00	0.0	0.00	0.00
2	1999	0.89	1.04			9.01	9.38	8.35	103.0	107.16	95.37
3	2000	0.84	1.06			20.09	21.31	17.89	103.0	109.30	91.77
4	2001	0.79	1.08			24.10	26.09	20.67	103.0	111.49	88.31
5	2002	0.75	1.10			26.78	29.57	22.10	103.0	113.72	84.98
6	2003	0.70	1.13			26.78	30.16	21.26	103.0	115.99	81.77
7	2004	0.67	1.15			26.78	30.76	20.46	103.0	118.31	78.68
8	2005	0.63	1.17			26.78	31.38	19.69	103.0	120.68	75.72
9	2006	0.59	1.20			26.78	32.00	18.94	103.0	123.09	72.86
10	2007	0.56	1.22			26.78	32.64	18.23	103.0	125.56	70.11
11	2008	0.53	1.24			26.78	33.30	17.54	103.0	128.07	67.47
12	2009	0.50	1.27			26.78	33.96	16.88	103.0	130.63	64.92
13	2010	0.47	1.29			26.78	34.64	16.24	103.0	133.24	62.47
14	2011	0.44	1.32			26.78	35.34	15.63	103.0	135.91	60.11
15	2012	0.42	1.35			26.78	36.04	15.04	103.0	138.62	57.84
16	2013	0.39	1.37			26.78	36.76	14.47	103.0	141.40	55.66
17	2014	0.37	1.40			26.78	37.50	13.93	103.0	144.22	53.56
18	2015	0.35	1.43			26.78	38.25	13.40	103.0	147.11	51.54
19	2016	0.33	1.46			26.78	39.01	12.89	103.0	150.05	49.59
20	2017	0.31	1.49			26.78	39.79	12.41	103.0	153.05	47.72
21	2018	0.29	1.52			26.78	40.59	11.94	103.0	156.11	45.92
			NPV's:	-988.68	-988.68		327.94	327.96		1356.37	1356.37
					B/C Ratio =		**2.05:1**				

NPV's have been calculated by two methods - totalling the DCF columns and using the EXCEL function NPV at the foot of columns E, H and K.
Revenue build up over 4 years - see Section 3.4.
Discount Rate and Growth in Value of Time were values current at the time.

A.3.8 Evaluating Temporary Station Closure

It has been assumed in the example above that platform refurbishment can be undertaken with no disbenefit to passengers who use the station with the benefits of the improvement work coming on-line in year 2.

For passengers to be unaffected during improvements site working would have to be contained within non-traffic hours. This will have the effect of extending total site occupation time and increasing contract costs above the normal rates. An alternative for consideration is to temporarily close the station for the duration of the work (say 4 months). Station closure will force passengers to use other stations and alternative modes of transport to undertake their journey. E.g. assume the displacement is as follows:

Station Users (6m p.a.)	Diversion (a)	Mean Added Absolute	Journey Time Weighted(b)
Diversion from Public Transport	5%	+3 mins	+4 mins
Diversion to Bus	20%	+2 mins	+ 4 mins
Retained by LUL	75%	+3 mins	+5 mins
Through Passengers (80 mill p.a.)(c)		-0.1 mins	-0.1 mins

(a) Estimated by examining local alternative travel modes.
(b) Refer to Appendix E for an explanation of weighting the components of a journey according to perceived values of time.
(c) Through passengers benefit from a shorter journey time of 6 seconds.

A.3.9 Disbenefits of temporary station closure

Total additional journey time:

4/12 x 6M x 0.05 x 4 mins	=	-400,000 mins
4/12 x 6M x 0.20 x 4 mins	=	-1,600,000 mins
4/12 x 6M x 0.75 x 5 mins	=	-7,500,000 mins
4/12 x 80M x 1.00 x 0.1 mins	=	+2,667,000 mins
		-6,833,000 mins
Value of additional travel time = -6,833,000 mins x 8.9p*/min	=	-£608k
Revenue Loss (Public Transport) = 4/12 x 6M x 0.05 x -£0.75 (av rev/trip)	=	-£75k

** should be adjusted for real growth in value of time*

A.3.10 Appraisal of Temporary Station Closure

Comparison of Costs and Benefits in Year 0	**Station Closed**	**Station Open**	**Difference**
Duration of Project	4 months	12 months	-8 months
Project Cost	-£800k	-£1M	£200k
Revenue Effect - temp. closure	-£75k	Zero	- £75k
Revenue Effect - condition of platforms(a)	-£39k	-£82k	£44k
Net Financial Effect	**-£914k**	**-£1.082M**	**£168k**
Passenger Effect - temp. closure	-£608k	Zero	-£608k
Passenger Effect - condition of platforms(a)	-£158k	-£330k	£172k
Net Passenger Effect	**-£766k**	**-£330k**	**-£436k**
Disbenefit/Financial Benefit Ratio			**2.6:1**

Note(a): Since under temporary closure the platforms are upgraded in 4 months there is 8 months net benefit to the passenger from an improved standard.

A.3.11 Interpretation of Results

The results indicate that the passenger disbenefits through having to re-route for 4 months are more than double the financial incentive to temporarily close the station. The favoured option is likely to be to keep the station open during the works.

A.4 PROJECT APPRAISAL EXAMPLE - INCREMENTAL APPRAISAL

INSTALLATION OF ONE ESCALATOR, OR TWO ESCALATORS

A.4.1 Original Appraisal

Wherever possible, the elements of a project should be separately identified and costs and benefits assigned to each element. The effect of the elements can then be assessed as increments on the base project.

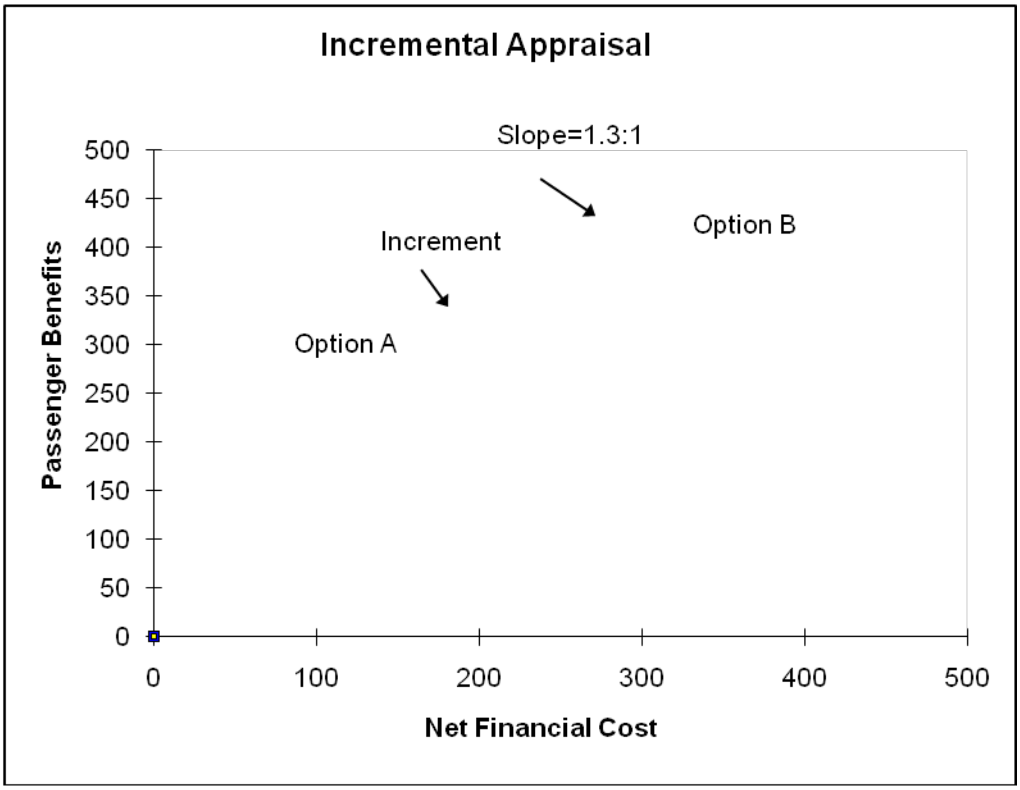
For example, when purchasing a fleet of trains for a line, a certain number of trains will be required to operate a specified base service. Additional trains will enable higher service frequencies resulting in reduced crowding etc. but the incremental benefit of each train compared with the additional cost to purchase and operate will reduce until eventually costs will exceed benefits (the benefit/cost ratio will be less than 1).

Another typical example is the number of escalators to be installed at a station. There will be a point at which the cost of an additional escalator will exceed the weighted passenger time benefits. This is illustrated below. If Option A is the addition of one escalator and option B is the addition of two escalators, by subtracting the two sets of data, the effect of the second escalator can be assessed. It is clear that although assessed as an overall project, Option B appears worthwhile, the additional escalator only generates 160 of benefits at a net cost of 170 (the NPV's in the table are purely illustrative).

	Option A	**Option B**	**Increment**
Capital	-150	-300	-150
Operating Costs	-60	-120	-60
Revenue gain	73	114	42
Net financial effect	-137	-306	-168
Passenger benefits	280	440	160
Benefit/Cost Ratio	2.04	1.44	0.95

The data is illustrated graphically on the next page.

Figure A1: Illustration of Escalator Installation Options



The slope of the Option A line is clearly greater than the 1.3:1 dotted line which is included for comparison. In fact the slope is 2.04:1 (see table on previous page). The Option B line is only slightly greater than 1.3:1 (1.44:1). The incremental investment in going from Option A to Option B has a slope clearly less than 1.3:1 (0.95:1).

This type of diagram is useful to clarify the relationship between a number of alternative options.

Note. This example uses a previous passmark, 1.3:1, rather than the current passmark, which is given in section 2.6.7.

A.4.2 Incremental Cost of Completion

Occasionally, a project which was intended as a complete refurbishment cannot be completed because of lack of resources. In these cases, the contrast between refurbished and unrefurbished parts of the station ("tide-mark" effects) may mean that implementing the final part of the project has a disproportionately high value. However, the other side of the coin is that the incomplete refurbishment would have a disproportionately low value. This emphasises that partial refurbishments should be avoided wherever possible.

A.4.3 Multi - Option Example

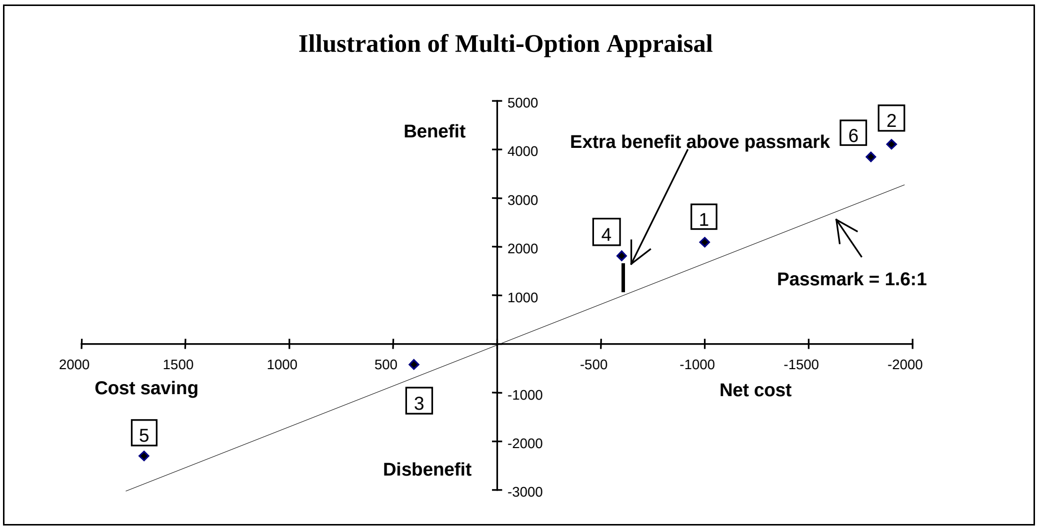
Some projects may generate a considerable number of options (including ones which may be financially positive but have passenger disbenefits). To use the incremental method for more than two projects, an iterative process has to be carried out with pairs of projects compared until the best project is identified. This is laborious and can be confusing and difficult to comprehend. A more comprehensible, "once-through" method is described below.

For example, the following proposals have varying benefit:cost (and disbenefit:cost saving) ratios. Which is the best option?

Option	Net Cost	Benefit	Benefit/Cost	Extra benefit above passmark**
1	-1000	2090	2.09	490
2	-1900	4100	2.16	1060
3	400	-420	1.05 *	220
4	-600	1810	3.02	850
5	1700	-2300	1.35 *	420
6	-1800	3850	2.14	970

** Passenger disbenefit / Cost savings*
*** Extra benefit above passmark is discussed below*

Figure A2: Illustration of Multi option Appraisal



All options are above the 1.6:1 line and therefore pass the appraisal test, but the best option is the one which is **furthest above** the 1.6:1 line.

For any option with social benefits B and cost C, the "extra benefit above passmark" is given by:

Social benefit + (1.6 x Net cost)

Net cost is assumed here to be negative. However, the formula also applies to disbenefits (negative) and cost savings (positive), where it would represent the latitude for further disbenefit before the option becomes non-viable.

For the options above, Option 2 has the highest extra benefit, £1060m, followed by Option 6 with a value of £970m. A check by the incremental method comparing Option 2 with Option 6 shows:

Additional expenditure	=	1900 - 1800	=	100
Additional benefits	=	4100 - 3850	=	250
Benefit/cost ratio	=	2.5:1		

Note that Option 4 has a higher B/C Ratio than Option 2. However, if the incremental method again is used as a test, the additional £1300m expenditure of Option 2 over Option 4 produces a B/C Ratio of 1.76:1.

This method establishes which option is theoretically optimal, but funding availability and the value of other projects in the investment programme would have to be taken into account in choosing the preferred option.

Note. This example uses a previous passmark, 1.6:1, rather than the current passmark, which is given in section 2.6.7.

A.4.4 Further discussion of incremental approach

The above multi-option example demonstrates how a comparison of a large range of options can be carried out. The appraisal of a shortlist of options further illustrates the value of an incremental approach, and gives more information about the relationship between options. For example, separate appraisals of three project options might give the following results:

Option 1 gives a benefit:cost ratio of 10:1

Option 2 gives a benefit cost ratio of 12:1

Option 3 gives a benefit cost ratio of 5:1

Whereas the incremental approach might reveal:

	Benefits £k	Costs £k
Option 1 gives a benefit:cost ratio of 10:1	500	-50
Option 2 gives a benefit cost ratio of 12:1	840	-70
...spending the extra £20k on Option 2 gives a benefit:cost ratio of 17:1	340	-20
Now compare Option 2	840	-70
with Option 3	4000	-800
...spending the extra £730k on Option 3 gives a benefit:cost ratio of 4:1	3160	-730

There might be a temptation simply to choose the option with the highest benefit-cost ratio, but in doing this the opportunity to secure an extra £3m of benefits (with a very respectable benefit:cost ratio) would be missed. Whilst it is true that, in a period of financial stringency, Option 2 might be preferred, it is important that the potential to achieve substantial extra benefits is made transparent, given the company's objective to maximise social benefit net of cost.

A.5 PROJECT APPRAISAL EXAMPLE - CAPITAL PROJECT (BUSES)

BUS SHELTER REPLACEMENT

The proposal is to implement an improved standard of bus shelter throughout the network with the facilities below. In some cases they will be new shelters; in others to replace bus shelters which would have some of the facilities listed below.

- seats
- information panels for the display of bus maps and similar publicity
- passenger lighting (whether or not illuminated advertising is provided)
- mid-height safety rails
- end-panels for additional weather protection

The example appraisal is for replacement by shelters having end panels, perch seats and improved lighting but no advertising panels. Passenger preference data (see Appendix E8) gives the following social benefits for these attributes:

	p/trip
New basic shelter	4.5
End panels	1.1
Bench seat	0.9
Lighting	0.5*

**This is much lower than the passenger preference figure in E4.7, since the percentage of trips when lighting is advantageous is relatively low.*

The sites comprise:

- 50 new sites where no shelter currently exists
- 185 replacements which gain seats and end panels
- 345 replacements which gain only end panels (already have seats)
- All gain improved lighting

It is estimated that new shelters will cost more to maintain (£25 per shelter p.a.) and the improved lighting will incur additional electricity costs (£95 per shelter p.a.) - a total additional operating cost of £120 per shelter p.a..

Assume a usage per shelter of 65,000 trips p.a.

For a shelter which gains seats, end panels (and lighting) the appraisal will be:

	Once-off Cost (£)	Cost p.a. (£p.a.)	NPV 10 yrs at 8% (£)
Capital cost Incremental operating cost	3520	 120	-3520 - 805
Total cost Revenue generated (elast.= 0.35)			-4325 +3816
Net financial effect Passenger benefit (65,000 x 2.5p)		 1625	- 509 10904
Benefit/cost ratio			21:1

The appraisal indicates that for a bus stop with this usage and with the benefit assumptions above, this replacement is justified.

However, results from this recently conducted stated preference research should be regarded as provisional (see page 97). The effect of lower valuations, at the level of 50%, should be tested. Sensitivity to a lower demand level, e.g. 70% of average, could also be tested. The benefit/cost ratios for different assumptions are given below.

Usage (trips/annum)	65000	65000	45500	45500
Benefits factor*	1	0.5	1	0.5
New Sites	Fin. pos.	Fin. pos.	Fin. pos.	18.3
Replacements (+ seats/panels)	21.4	2.26	4.62	1.28
Replacements (+ panels)	3.71	1.12	1.87	0.70

** 1 = benefits as obtained from the research*

The above results indicate the case for replacement of existing bus shelters can be marginal. Other factors might be considered to refine the appraisal calculations, e.g. whether there are likely to be extended wait times on infrequent routes, and whether there are likely to be alternative places to wait near particular bus stops.

Additional calculations would be carried out to evaluate the cases for converting 4-panel advertising shelters to 6-panel, and non-advertising shelters to advertising ones (which would generate advertising income and provide passenger information).

Note. This example uses the previous discount rate, 8%, rather than the current 3.5%.

A.6 PROJECT APPRAISAL EXAMPLE - SERVICE PLANNING (BUSES)

EVALUATION OF CHANGES TO BUS SERVICES

A.6.1 Steps in process :

i) Build demand matrix for route and all parallel routes.

ii) For each origin-destination pair calculate the change in generalised time, and convert to money using value of time .

iii) Feed change in cost into the demand function, to calculate new demand.

iv) From new demand levels calculate change in revenue and consumer surplus[1].

v) Obtain cost of new service levels from operator, and calculate net cost of change.

vi) Calculate change in consumer surplus per £ of net cost.

vii) Compare to benefit cost passmark.

A.6.2 Simplified Example

An increase in frequency provides a waiting time saving of 1 minute for 2 million passengers per year. (Waiting time weighted at 2 x in-bus time).

Demand function : D = A exp ((λ x (vot x time)/length of ride))

[where λ= fares elasticity / average fare per mile]

New demand =Base demand x exp (- λ x vot x change in time/length of ride)

=2m x exp (-0.35 / 0.198 x 0.03 x (-2) / 2.1)

[1] Consumer surplus in general is the difference between what customers would be willing to pay, and what they actually pay. In this instance, the change in consumer surplus is the increase in passenger benefits to existing users, plus half the increase in benefit to new passengers who are persuaded to use the bus by the service improvement. (This is an average of the full amount, for those who are persuaded by only a very slight improvement, and zero, for those who are only just persuaded by the whole improvement.)

Change in demand	=	103,604		
Change in revenue	=	change in demand x average fare		
	=	103,604 x 0.198 x 2.1		
	=	£ 43,079		
Change in Consumer surplus	=	change in cost	x	base demand + new demand)
				2
	=	0.062	x	4,103,604 2
	=	£ 127,212		
Change in cost **Benefit cost ratio**	=	£ 116,000	(supplied by operator, or estimated)	
	=	Change in consumer surplus Change in cost - Change in revenue		
	=	127,212 (116,000-43,079)	=	1.74

This is greater than the 1.5 passmark.

A.7 SAFETY APPRAISAL

INSTALLATION OF CCTV

A.7.1 Outline of situation

One group of stations on the Line is without Closed Circuit TeleVision and also suffers higher than average assaults on staff. Apart from the safety aspect, there is a cost incurred when the victims have to take time off to recover following incidents.

A.7.2 Safety (ALARP) appraisal

The headline findings of an analysis of incidents over the past year is shown below:

Hazard	Frequency of incident (p.a.)	Average consequence (equivalent fatalities per incident)	Expected equivalent fatalities (p.a.)
Assault on staff	19	0.01	0.19

Here, the "equivalent fatalities" of 0.01 indicates a minor injury -see Appendix F6. (Usage of the term "minor" varies, but in this case a brief inspection of the records confirms that the injuries were generally not trivial, in fact some were verging on major injuries.)

It is proposed that CCTV is introduced to these stations, with the expectation of reducing the level of assaults to the average on the Line (5 p.a.). There would be a reduction of 0.14 equivalent fatalities p.a. which is valued at £154,000 -the assumed value of preventing a fatality being £1.1m (currently £1.4m).

The extra cost of covering (at overtime rate) for those taking time off following incidents would be reduced by £34,000 p.a. This assumes that only half the lost shifts are actually covered in practice. In principle, the "lost value" for those shifts not covered could be included, though this would be difficult to quantify.

Using VIM-BC the value (from Customer Priority research) of introducing CCTV is estimated as £6.908m NPV over the 20 year life of the asset. This social benefit is not used in the safety appraisal, but the revenue generated from extra demand (elasticity 0.26 x £6.908m = £1.796m) is relevant because it impinges directly on the net cost of mitigating the safety risk. (See Table E2a for current all day elasticity.)

With installation costs of £609,000 and associated maintenance costs of £341,000 NPV, the safety appraisal is as follows:

	Undiscounted Value		Present Value
	One-off £000s	p.a. £000	(over 20 yrs) £000s
Capital costs	-609		-609
Maintenance costs (including half-life refurb)		-20	-341
Total costs			-950
Lost time (overtime) savings		34	390
Revenue generated from CCTV passenger benefits		170	1796
Total revenue			2186
Net financial effect of project			1236
Safety benefits (minor injuries avoided)		154	1766
Benefit:cost ratio			(Fin. pos.)

When the quantitative appraisal is financially positive (or the benefit:cost ratio is greater than 1:1) this indicates that the safety risk has not been reduced to As Low As Reasonably Practicable. A complete business case would also require qualitative arguments to support the quantitative conclusion.

[If the benefit:cost ratio is lower than 1:1 even with a £4.2m Value of Preventing a Fatality, then there is no quantitative business case for doing the project.

In between, when the b:c ratio is less than 1:1 using £1.4m and greater using £4.2m, the maximum risk to an individual would be investigated - see Appendix F6.]

Finally, the full business case including passenger benefits, should be recorded so that full benefits are claimed in any overview of the investment programme.

A.8 PROJECT APPRAISAL EXAMPLE - SUPPORT SERVICES

BUSINESS CASE FOR AN I.T. PROJECT

(NB. The facts and figures in this example are entirely fictitious.)

A.8.1 Introduction

It is the aim of the project team to compile a comprehensive database of relevant asset cost information for use in future cost estimation and procurement. due to the fast expanding manual record system, searching for historical cost information is likely to prove increasingly difficult as time goes by. it is estimated that there are currently 20,000 relevant documents, making a total of 50,000 pages, in the filing systems. a number of different approaches to the document management problem have been reviewed.

A.8.2 Option 1

In the existing manual process, there are daily searches for asset cost data which is held in three different filing systems. This process is highly inflexible and time consuming, and with the frequent removal and replacement of documents, there is a risk that these may become damaged, misfiled or lost.

A.8.3 Option2

In this option, the data would be photocopied and put into a separate asset cost filing system, while a computer database would hold a catalogue of the copy documents. Whilst this would give increased flexibility to searching, some of the problems of removal and replacement of documents remain. Also, the amount of information to be stored would place a strain upon the existing computer network.

A.8.4 Option 3

Finally, the use of computer software on separate PCs to retrieve scanned images was reviewed. Such systems offer increased and more flexible search facilities, immediate access to documents, and the advantages of Optical Character Recognition.

A cost-benefit analysis showed that a) using a computer database to catalogue the copy documents was more cost effective than a purely manual system, and b) using computer software to retrieve scanned images was more cost effective than the computer cataloguing system. A summary analysis of the options is shown on the following page.

A.8.5 Assumptions

a) Copying of documents into new filing system, and producing computerised reference list

This process would, at a rate of 200 documents per day, take an estimated 5 months to complete, which at current salaries would cost £23,800.

b) Scanning in / coding of documents into new database

The preferred agency quote for scanning in the 50,000 pages and coding the appropriate database references is £27,000.

c) Searching for documents

From diaries kept over a recent period of three weeks, the time spent searching for documents is approximately 10% of total staff time. It is assumed that this could be reduced by a half if a computerised list were available, but with the more sophisticated database software on PCs it is assumed that the search time could be reduced by three-quarters.

d) Handling of hard copies of documents

Currently, the relevant member of staff spends about 20% of his time photocopying and re-filing documents. As with c) above, it is assumed that this time could be reduced by half if a purpose-built filing system for asset cost data is available. With electronic copies on a database, there would be further improvements, although the need for hard copies would not be completely eliminated. Again, it is assumed that with the database the handling time would be reduced by three-quarters.

e) Treatment of reduced staff time in the appraisal

It is assumed that the staff time freed up can be usefully deployed elsewhere on cost estimation work, for example in improving turnaround times, increased work on cost versus reliability, etc. It is not envisaged at this stage that the staff numbers would be reduced.

A.8.6 Business Case Summary

(Operating costs are discounted over the life of the system - 5 years. As usual, capital costs are assumed to occur in year 0, while resulting changes in operating costs occur in years 1-5.)

Capital costs	**Option 1 Existing Manual System** £ PV	**Option 2 Computerised Catalogue of Manual Documents** £ PV	**Option 3 Database of Scanned-in Documents** £ PV	**Increment of Option 3 over Option 1** £ PV
Copying documents / storing in new files / producing reference lists		-23,800		
Scanning in documents			-27,000	
Database software, including Optical Character Recognition			-2,100	
Hardware: 2 PCs			-4,800	
Total	0	-23,800	-33,900	- 33,900
Operating cost savings				
Time spent finding relevant documentation -estimated currently as10% of total working time for 6 staff in section (Total = £15,000 p.a.)	-63,200	-31,600	-15,800	
Time spent handling hard copies of documents -currently estimated as 20% of total working time of 1 admin person in section (Total = £3,800 p.a.)	-16,000	-8,000	-4,000	
Total	-79,200	-39,600	-19,800	59,400
Overall advantage of Option 3 over Option 1				25,500

The table shows that Option 3 is preferable to Option 1 by £25,500 (PV), and as stated earlier, Option 3 also has an incremental advantage over Option 2. The use of a computer database to retrieve scanned images was therefore found to be the most effective and efficient option.

As a sensitivity test, if the time spent finding relevant documentation is only 5%, instead of 10%, of staff working time, Option 3 is still the most favourable, though the advantage over Option 1 is reduced to less than £2,000 (PV).

This example illustrates the following aspects of such financial appraisals:

- where possible, more than one alternative option should be generated,so that decision makers are not left thinking “What if...?”

- the increment of each option over other options should be shown (in this example, only the increment of Option 3 over Option 1 is shown, although it is made clear that Option 3 is also advantageous when compared with Option 2)
- capital costs and operating costs should be shown separately
- it is important to state the predicted life of any assets to be procured, and discount the operating cost effects over that period of years
- the sources of estimates should be stated
- it should be made clear whether any staff time saved is intended to result in a reduction in the number of staff budgeted, and if not, it is helpful to indicate how the freed up time might be deployed
- in the summary table, costs and benefits should be itemised where space permits
- appropriate sensitivity tests, particularly exploring areas where there is most uncertainty, should be applied
- although it is not demonstrated in this particular example, where it is not possible to quantify an impact via a saving in staff time, the impact should be described in terms of the number of people affected, the frequency of impact, and the typical extent of the impact on each occasion.

A.9 BENEFIT APPRAISAL EXAMPLE - HEALTH BENEFITS

CALCULATION OF HEALTH BENEFITS FROM CYCLING

The appraisal of health benefits arising from taking up cycling on a regular basis is largely derived from a report by The Copenhagen Centre for Prospective Population Studies, which found that individuals who cycle for three hours per week reduce their relative risk of all-cause mortality to 72% compared to those who do not commute by cycle. This key finding is used in the illustrative example below.

From the average journey time, a reduction in all-cause mortality risk specific to the average individual using the scheme may be calculated. This may be done by a linear interpolation between 0 and 28% for an average cycling time per 5 weekdays varying from 0 minutes to 180 minutes, taking into consideration the proportion of users that make return trips along the route.

In the absence of data on the likely journey times for users of the proposed scheme, the average journey distance could be estimated using data from the latest Travel in London report. For example, Fig 13.4 from 'Travel in London No. 2' (2009) the average journey distance could be estimated as 2.9km:

Band	Mid-point	Proportion in each band	Mid-point x proportion
0-2 km	1.0	48%	0.48
2-5 km	2.5	29%	0.73
5-8 km	6.5	13%	0.84
8-10 km	9.0	4%	0.36
10+ km	12.0	4%	0.48
Estimated average distance per trip			2.9 km

In the absence of data on average speeds in London, a conservative estimate of the average cyclist's speed, taking into account stops at junctions etc, might be 14 kph. Therefore the average cycle trip time would be: 2.9 / 14 x 60 = 12.4 minutes.

An estimate (typically from a survey of prospective scheme users) is then required for the number of new cycle trips (as opposed to those diverted from other cycle trips) using the scheme. Suppose this is 5,000,000 per annum or approximately 100,000 each week. To calculate the impact for regular cyclists, estimate (again, typically from a survey of prospective scheme users) the proportions who are usually likely to do one trip per week, two trips, three trips, etc. It is also necessary to estimate the overall proportion of trips using this scheme which are likely to be return trips.

The usage pattern may then be estimated as follows:

No. of days cycled per week	Proportion of total trips	Proportion of trips that are return trips	Estimated no. of people making a total of 100k trips per week	No. of trips each	Avr. no. of minutes each person cycles per week	Total no. of trips
a	**b**	**c**	**d = (100,000 x b) / a x (1+c)**	**e = a x (1+c)**	**f = 12.4 x e**	**d x e**
1	20%	90%	10,526	1.9	23.6	20,000
2	10%	90%	2,632	3.8	47.1	10,000
3	10%	90%	1,754	5.7	70.7	10,000
4	10%	90%	1,316	7.6	94.2	10,000
5 or more	50%	90%	5,263	9.5	117.8	50,000
						100,000

The estimated reduction in all-cause mortality is now linearly interpolated between 0% (0 minutes of cycling per 5 weekdays) and 28% (180 minutes of cycling per 5 weekdays).

This proportional reduction is then applied to the all-cause fatality rate p.a. in London for the relevant age group. For example, from the Office for National Statistics 'Registered deaths in 2008' Table ll, the all-cause mortality rate for London population group aged 15-64 can be estimated to be 0.00185. Applying the proportional reductions for each frequency of use per week, and the TfL 2009 Value of Preventing a Fatality, a total valuation can be estimated for the expected annual reduction in fatalities.

No. of days cycled per week	Estimated no. of people making total of 100k trips per week	Avr. no. of minutes each person cycles per week	Reduction in risk p.a. of all-cause mortality	Estimated annual reduction in fatalities	Value of reduction in fatalities p.a.
a	**d**	**f**	**g = f / 180 x 28%**	**h = 0.00185 x d x g**	**h x £1.7m**
1	10,526	23.6	3.66%	0.71	1.21
2	2,632	47.1	7.33%	0.36	0.61
3	1,754	70.7	10.99%	0.36	0.61
4	1,316	94.2	14.66%	0.36	0.61
5 or more	5,263	117.8	18.32%	1.78	3.03
	21,491			3.57	**£6.1m**

Note that the analysis is fairly sensitive to the number of days per week cycled – if at least 2 days per week are considered necessary to achieve a health improvement, the annual benefit becomes £4.9m instead of £6.1m – and particularly sensitive to the age profile of the new cyclists attracted by the scheme; for example, if the age group predominantly attracted by the scheme is 15-34 instead of 15-64, the annual benefit becomes £1.4m instead of £6.1m.

For the period of the appraisal, the health benefits must be calculated each year and then discounted in the usual way.

A.10 PROJECT APPRAISAL EXAMPLE – WHOLE LIFE COSTS

CYCLIC RENEWAL OF LIGHT BULBS ON STATIONS

To evaluate the optimal replace option of replacing Standard light bulbs with Long Life bulbs for critical locations on stations.

- Option 1 – Standard light bulbs at critical locations on Underground stations
- Option 2 – Long Life light bulbs at these locations

A.10.1 Costs

a) Planned replacement

£20 per unit (Standard bulbs), £60 per unit (Long Life bulbs) when replaced via routine relamping programme i.e. all bulbs changed in batches so access costs are shared across multiple units.

b) Failures

£200 per unit (Standard bulbs), £250 per unit (Long Life bulbs) including access costs.

The following table shows forecast patterns of failure for each type of bulb

	Infant mortality	Random failures	Age-related failures
Standard	2%	.005/month	6-60 months
Long Life	0.5%	.001/month	24-96 months

A.10.2 Method

Using a risk software package, specify the above failure patterns. For example, the '@Risk' package (provided as an add-on to Excel) allows the following representations for month of failure in a spreadsheet:

a) Standard bulb

Infant mortality, month 1 =RiskDiscrete({0,1},{0.98,0.02})

Random failure, months 2-5 =
RiskCompound(RiskDiscrete({0,1},{0.98,0.02}),RiskIntUniform(2,5))

Normal distribution, months 6-60 = RiskNormal(35.5,12.5)

These formulas represent a 2% chance of failure in month 1, a 2% chance spread evenly across months 2-5, and a Normally distributed age-related failure with a mean of 35.5 months and a standard deviation of 12.5 months, based on evidence of past failure patterns. Suppose these formulas are held in cells D4, E4, F4. The output cell bringing together the result of these possible outcomes would include an Excel expression which first looks for a failure in month 1, then in months 2-5, and if neither is present, uses the Normally distributed figure:

=RiskOutput("Expiry month for Standard")+IF(D4 = 1,1,IF(E4>0,E4,F4))

b) Long Life bulb

Similarly the representations for Long Life bulbs could be:

Infant mortality (month 1)= RiskDiscrete({0,1},{0.995,0.005})

Random failure months 2-23 = RiskCompound(RiskDiscrete({0,1},{0.978,0.022}),RiskIntUniform(2,23))

Normal distribution. months 24-96 =RiskNormal(67,15)

(Note. An average of 0.001 failures per month over 22 months is equivalent to an overall probability of approximately 2.2%.)

A.10.3 Whole Life Cost (WLC) for a bulb – graphical output

Outputs from the above show the distribution of failure times for each type of bulb. Suppose the output cell for the Standard bulb is G4, then the probability percentiles for failure time after, say, 10000 iterations could be captured by:

=RiskTarget($G$4,C10)

=RiskTarget($G$4,C11)

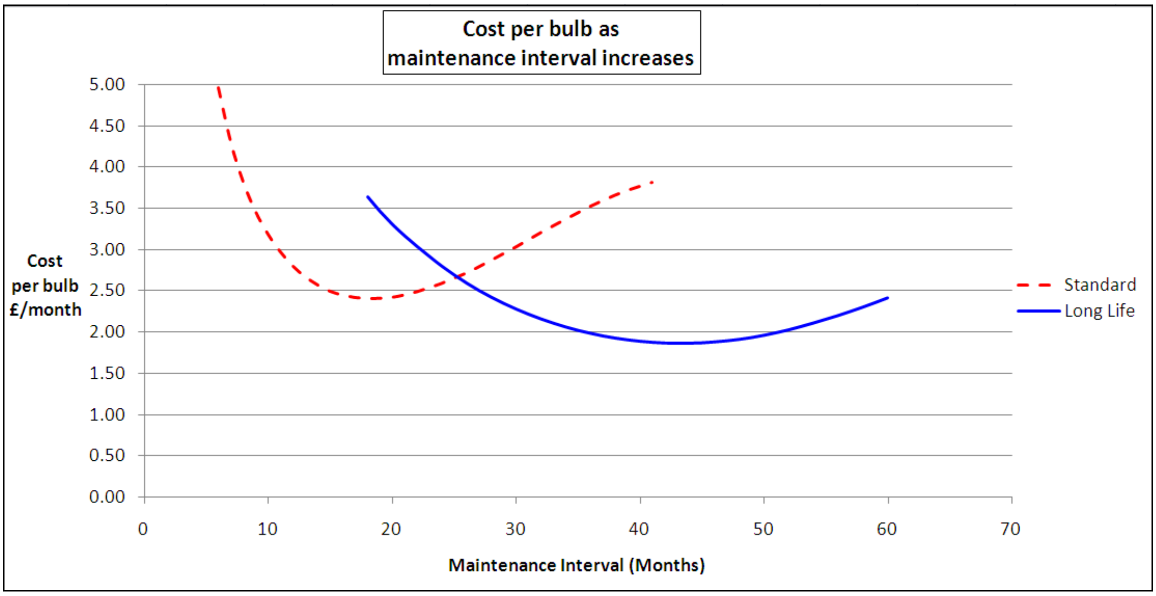
etc

where C10, C11, etc contain 1, 2, etc and the 'RiskTarget' function produces the probability of failure in up to 1 month, up to 2 months, etc. And for any particular period, for example 11 months, Whole Life Cost per month based on a planned maintenance interval of that period is calculated by:

*=(20+D14*200)/C14*

where £20 is the replacement cost per unit of Standard bulbs in a planned relamping programme, D14 contains the 'RiskTarget' probability of failure within 11 months as explained above, £200 is the replacement cost when failure occurs between planned replacements, and C14 contains the planned interval 11 months.

Thus the following graphs for Standard and Long Life bulbs are produced:



A.10.4 Conclusions

The first conclusion is that it is significantly cheaper to replace light bulbs in critical locations via the routine re-lamping programme as a planned activity rather than to wait for failure. For the Standard design the WLC reduces from about £5.40/month/unit (currently being experienced with no planned replacement programme) to about £2.40/month/unit if replaced in planned batches with an 18-month interval, a reduction of about 56% in WLC.

The second conclusion is that it is economic to replace Standard light bulbs with Long Life units, with the replacement interval moved out to about 42 months (i.e. the longer life is optimally exploited). This option is estimated to reduce WLC further to about £1.90/month/unit, representing an overall saving of about 65% in WLC.

A.10.5 Sensitivity tests

This analysis assumes only <u>one</u> failure could occur between programmed replacements. However the probability of more than one failure, although small when the planned interval is relatively short, may have some impact on the conclusions. A sensitivity test could illustrate this; other tests could show how the conclusions are affected when differences between the bulb types in terms of cost, and in terms of reliability, are changed. (Any monetised reduction in CO_2 emissions would also feature in a standard appraisal, and would further support the cost-based advantage of Long Life bulbs.)

APPENDIX B Passenger Demand

There are two main sources of passenger demand data:

- counts and surveys
- revenue information.

Only the former provides the level of detail required for project appraisal.

The main difference between the two data sources is that station entry and exit counts include all passholders (OAPs, staff, police, etc) and passengers without tickets. In addition, all journeys, including those originating on Network Rail (and dealt with through the clearance procedures) and all journeys made on period and return tickets are allocated to the stations and sections of line on which each actual journey takes place.

LUL carries out annual programmes of passenger counts and large scale surveys of travel patterns, such as the Origin and Destination Survey.

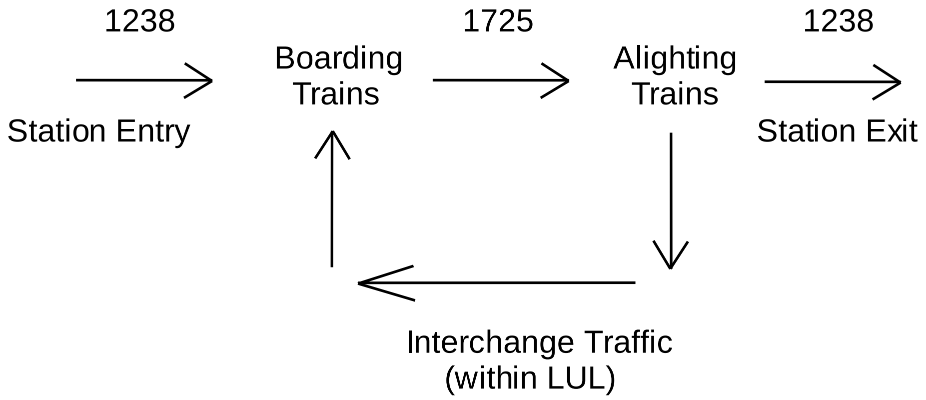
The information set out below is designed to provide a broad picture of the available data and sets out some of the most commonly used facts and figures.

Further information on LU demand can be obtained from LU Transport Planning. Contact Howard Wong, [redacted] in the first instance.

B.1 UNDERGROUND ANNUAL NETWORK DEMAND

In assessing the demand for facilities, it is useful to have in mind the flow of passengers through the Underground system. The figures presented below show 2008/09 traffic levels:

Figure B.1-1: LUL Network Demand 2008/09 (millions)



Source: Station Entry Counts / Origin & Destination Survey updates

Station entry or exit functions, such as ticket checking, are concerned with 927 million journeys per annum, while train service provision is concerned with all 1289 million journey legs. [A journey with one interchange has two "journey legs", two interchanges - three journey legs and so on. E.g. Blackhorse Rd to

St James's Park consists of Blackhorse Rd to Victoria (leg 1), and Victoria to St James's Park (leg 2)].

Table B.1-1: LUL Network Demand 1987-2003 (millions)

Year	Passenger Journeys	Passenger Km	Train Km
1986/87	769	6216	50
1987/88	798	6257	51
1988/89	815	6293	51
1989/90	765	6016	51
1990/91	775	6164	52
1991/92	751	5895	53
1992/93	728	5758	53
1993/94	735	5814	53
1994/95	764	6051	55
1995/96	784	6337	57
1996/97	772	6153	59
1997/98	832	6479	62
1998/99	866	6716	61
1999/00	927	7171	63
2000/01	970	7470	64
2001/02	953	7451	65
2002/03	942	7367	65
2003/04	948	7340	68
2004/05	976	7606	69
2005/06	971	7586	69
2006/07	1014	7665	70
2007/08	1072	8155	71
2008/09	1090	8641	71

Source: Station Entry Counts & Origin & Destination Survey updates
Based on daily counts grossed up to annual totals.

The average journey length on LUL services is 7.9 km and the average length of a journey leg is 5.7 km.

Networkwide demand can also be split by time period:

Table B.1-2: Annual Entry By Time Of Day 2008 (To Nearest Million)

Period		**Weekdays**	**Saturday**	**Sunday**
Early	(Start - 0700)	32	3	1
AM Peak	(0700-1000)	256	14	9
Interpeak	(1000-1600)	257	58	48
PM Peak	(1600-2200)	279	34	28
Evening	(1900-2200)	115	21	15
Late	(2200-Close)	52	12	5
Total	(Traffic Day)	991	142	105

Source: Station Entry Counts (Weekdays 0700-2200), plus a mix of ad-hoc counts

B.2 UNDERGROUND LINE DEMAND

Line demand can be defined in different ways, by:

Line Management — Station entry traffic is allocated as per Line Management. NR managed stations are shown separately.

Line — Station entry traffic is allocated to the line (as shown on the Journey Planner) on which the first journey leg is made. Journeys which involve passing through the LUL barrier but which are made on NR services e.g. Moorgate are shown separately.

Line with Interchange — Passengers are allocated to each line they use on their trip.

Table B.2-1: Annual Demand At 2008 Traffic Levels (millions)

	Line Management	**First leg of journey**	**Any leg of journey**
Bakerloo	104	69	110
Central	177	195	267
Circle	-	53	75
District	142	171	228
East London	0	0	0
H & C	171	43	59
Jubilee	181	156	210
Metropolitan	48	50	73
Northern	158	191	261
Piccadilly	131	157	223
Victoria	100	136	206
Waterloo & City		11	13
Railtrack Station	26	-	-
TOC Service	-	14	0
Total	1238	1246	1725

Sources: Line Management data based on Station Entry Counts
First Leg and Any Leg figures based on Origin & Destination Survey

B.2.1 Line Usage by Section of Line

Available for all Lines, for Monday to Friday traffic, by:

Travel Period	a.m. peak	07:00 - 10:00 hours
	midday	10:00 - 16:00 hours
	p.m. peak	16:00 - 19:00 hours
	evening	19:00 - 22:00 hours
	Total	07:00 - 22:00 hour s
Peak Hour	Time and volume of traffic in a.m. and p.m. peak hours. The time of the a.m. and p.m. peak hours has been calculated to the nearest 15 minutes.	

Table B.2-2: Example - Victoria Line Usage

TRAVEL PERIOD LOADS										
SOUTHBOUND						NORTHBOUND				
a.m. peak	midday	p.m. peak	even -ing	all day		a.m. peak	midday	p.m. peak	even -ing	all day
7850	3098	1555	681	14249	Walthamstow Central : Blackhorse Rd	1042	2572	5461	2674	13026
12133	4662	2573	1123	22304	Blackhorse Rd : Tottenham Hale	1536	3532	8507	4209	19818
16489	6750	3789	1613	30815	Tottenham Hale : Seven Sisters	2299	4824	12174	5295	26998
25732	11743	6932	2902	51601	Seven Sisters : Finsbury Park	4279	8055	19938	8454	44793
38474	18624	10730	4910	78911	Finsbury Park : Highbury & Islington	7151	15869	33064	15461	78695

PEAK HOUR LOADS								
SOUTHBOUND					NORTHBOUND			
a.m. peak		p.m. peak			a.m. peak		p.m. peak	
0745 - 0845	3823	1715-1815	556	Walthamstow Central : Blackhorse Rd	0800-0900	471	1715-1815	2523
0800-0900	5695	1645-1745	944	Blackhorse Rd : Tottenham Hale	0800-0900	696	1730-1830	3824
0745-0845	7749	1630-1730	1451	Tottenham Hale : Seven Sisters	0745-0845	1038	1715-1815	5367
0800-0900	12149	1700-1800	2653	Seven Sisters : Finsbury Park	0800-0900	1911	1715-1815	8618
0800-0900	17992	1700-1800	4130	Finsbury Park : Highbury & Islington	0800-0900	3052	1715-1815	13987

Source:- Rolling Origin and Destination Survey 2002

B.2.2 Distance Travelled by Line

The following are available for all Lines for the standard travel periods and peak hours (defined in B2.2).

- total passenger-kilometres
- average distance travelled

Table B.2-3: Example: Piccadilly Line

	AM PEAK	MIDDAY	PM PEAK	EVENING	TOTAL
Journeys	134,096	170,338	156,217	70,883	531,534
Total Kilometres	1,050,426	1,125,814	1,080,044	516,541	3,772,825
Average Distance (kms)	7.8	6.6	6.9	7.3	7.1

This information includes passengers interchanging to the Line as well as those passengers originating at Central Line stations.

B.2.3 Boarding and Alighting

Available for all Lines for the standard travel periods and peak hours (defined in B2.2). While this information is 'Line based', it also gives an indication of some aspects of station usage.

Table B.2-4: Example: Victoria Line: Southbound, Am Peak (0700-1000)

STATION	ON	OFF
Walthamstow Central	7856	0
Blackhorse Road	4419	46
Tottenham Hale	4650	258
Seven Sisters	9767	246
Finsbury Park	15146	4069
Highbury & Islington	7798	3027
Kings Cross	8753	8216
Euston	8681	3613
Warren Street	898	4034
Oxford Circus	6632	17140
Green Park	3597	8699
Victoria	2151	18445
Pimlico	109	4000
Vauxhall	643	4793
Stockwell	1028	2732
Brixton	0	2810
Total	**82128**	**82128**

Source: Origin and Destination Survey (2002)

B.3 UNDERGROUND STATION DEMAND

B.3.1 Entry and exit Counts

Autumn 1999 entry counts are available for all time periods for all stations; exit counts are available for stations that are gated. Early and late count data from 1995 has been factored up to 1999 traffic levels based on the growth in demand during the period 0700-0800 between 1995 and 1999 (early) and during the period 2100-2200 between 1995 and 1999 (late). The data are available in tabular form for the following time periods:

- Early morning — Start to 07.00
- AM Peak: — 07.00-10.00, Busiest 60 mins, 15 mins
- Interpeak: — 10.00-16.00
- PM Peak: — 16.00-19.00, Busiest 60 mins, 15 mins
- Evening: — 19.00-22.00
- Late night — 22.00 to close

Data can be produced by 15 minutes or any aggregation in 15 minute periods.

Grossing factors can be applied to provide estimates for other periods based on the survey results. Table B3 gives station based factors (applicable to Tottenham Court Road only) for:

- Two-way estimates of all day Saturday passenger flows
- Two-way estimates of all day Sunday passenger flows
- Weekly estimates of two-way passenger flows
- Annual estimates of two-way passenger flows

Where a station is served by more than one line, factors can be provided to split originating traffic between lines. This set of factors is based on 1998 survey data. Table B3 provides an example set of factors for Tottenham Court Road.

Table B.3-1: Example Of Station Demand:Tottenham Court Road Station

			Entering		Exiting
2002 weekday	0530-0700		126		586
	0700-1000		1455		14263
	1000-1600		13872		20661
	1600-1900		17541		11386
	1900-2200		9859		5005
	2200-0100		6595		2502
	Total (0530-0100)		49448		54403
	Total (0700-2200)		42727		51315
	am peak hour	0900-1000	625	0845-0945	8414
	am peak 15 mins	0945-1000	176	0915-0930	2283
	pm peak hour	1730-1830	7088	1730-1830	4682
	pm peak 15 mins	1745-1800	1851	1745-1800	1208
2002 weekend Saturday	before 0700		243		282
	0700-1200		3405		10439
	1200-1700		18590		23827
	1700-2200		16915		14051
	after 2200		7304		2678
	Total		46457		51277
	Busiest 60 minutes	1715-1815	5563	1315-1415	5540
	Busiest 15 minutes	1745-1800	1458	1345-1400	1406
2002 weekend Sunday	before 0700		127		26
	0700-1200		2152		4637
	1200-1700		10063		12061
	1700-2200		8492		5385
	after 2200		2730		709
	Total		23564		22818
	Busiest 60 minutes	1700-1800	2263	1330-1430	2725
	Busiest 15 minutes	1730-1845	802	1345-1400	688
Annual Two-way Flow estimate (m)			34.06		
Factors to Convert 0530-0100 hrs Entry Traffic to:	Two way Saturday		1.98		
	Two way Sunday		0.94		
	Two way weekly		13.42		
	Two way annual		689		
Split entries by line	Central		60%		
	Northern		40%		

Source: 1998 Station Entry Count plus mix of ad-hoc counts

B.3.2 Additional Count and Survey Information

The following information is available for all stations for the standard travel periods and peak hours (defined in B2.2).

- Interchange flows - between Underground Lines and between LUL and NR
- Line of first journey leg - used to split entry count figures at stations served by two or more Lines
- Destination of passengers from each origin station
- Origin of passengers at each destination station

- Trip length statistics by line and station
- Route choice analysis - used when two or more routes are available between origin and destination stations
- Journey Purpose - for both origin and destination addresses
- Feeder Mode - how passengers travel to the Underground (eg Car, Bus, NR)

Catchment area maps are available for all stations. Based on detailed postcode information, each map shows the areas from where 50%, 70% and 90% of the passengers using a given station originate. The maps also differentiate between those passengers arriving at the station by foot, bus and car.

A more detailed listing of information available regarding Underground travel patterns is contained in the Origin and Destination Survey Handbook. It is also possible to interrogate the database to provide information not available from the standard analyses.

B.4 LONDON BUSES DEMAND DATA

Further information Bus demand can be obtained from the Pricing and Forecasting Manager, Revenue Policy, Customer Experience Directorate. Contact Tony Richardson, [redacted]

B.4.1 Bus Annual Network Demand

Table B.4-1: LB Annual Demand And Operated Km 1986-2008 (millions)

Year	Passenger Journeys	Passenger Km	Average Journey (km)	Bus Km
1986/87	1158	4342	3.75	259
1987/88	1211	4258	3.52	262
1988/89	1206	4231	3.51	274
1989/90	1183	4165	3.52	280
1990/91	1180	4141	3.51	285
1991/92	1149	3996	3.48	301
1992/93	1127	3922	3.48	307
1993/94	1112	3819	3.43	311
1994/95	1159	3912	3.38	322
1995/96	1198	4018	3.35	329
1996/97	1234	4159	3.37	332
1997/98	1277	4350	3.41	342
1998/99	1267	4315	3.41	339
1999/00	1296	4429	3.42	348
2000/01	1354	4709	3.48	365
2001/02	1430	5128	3.59	381
2002/03	1534	5734	3.74	397
2003/04	1702	6431	3.78	437
2004/05	1793	6754	3.77	450
2005/06	1816	6653	3.66	454
2006/07	1880	7014	3.73	458
2007/08	2176*	7714	3.55*	468
2008/09	2234*	7941	3.55*	479

Source (for recent years up to 2007/08): 'Travel in London Report 1':
Passenger Journeys p32 (Table 2.7)
Passenger Kilometres p31 (Table 2.6)
Bus Kilometres p91 (Table 4.9)
2008/09 figures from 'Business Plan 2009/10-2017/18' p109 (Appendix B)

**From 2007/08 bus journey calculations use a new methodology, to correct for increasing distortions in the survey and ticket sales based methodology over the previous few years. The new figures incorporate previously excluded journeys by the under 5s and free travel by staff and police. Adjusted data using the new methodology for 2000-2006 are shown in the following table.*

Table B.4-2: LB Annual Demand 2000-2006 (millions)

(Adjusted for new methodology introduced in 2007)

Year	Adjusted Passenger Journeys	Passenger Km	Adjusted Average Journey (km)
2000/01	1368	4709	3.44
2001/02	1459	5128	3.51
2002/03	1586	5734	3.62
2003/04	1779	6431	3.61
2004/05	1885	6754	3.58
2005/06	1979	6653	3.36
2006/07	1995	7014	3.52

Table B.4-3: LB Forecast Annual Demand And Operated KM 2009-2017 (millions)

Forecast Year	Passenger Journeys	Bus Km
2009/10	2255	488
2010/11	2271	488
2011/12	2300	488
2012/13	2322	490
2013/14	2335	491
2014/15	2354	494
2015/16	2374	497
2016/17	2396	501
2017/18	2415	504

Source: 'Business Plan 2009/10-2017/18' p109 (Appendix B)

(Projected passenger kilometres, and thus average journey distances, for the years 2009/10-2017/18 are not available)

Table B.4-4: London Buses Annual Weekday Journeys By Ticket Type / Time Of Day

Ticket Type	Passenger Journeys (000s)						
	4.00 – 7.00	**7.00 – 10.00**	**10.00 – 16.00**	**16.00 – 19.00**	**19.00 – 22.00**	**22.00 – 4.00**	**TOTAL**
Cash	1,295	5,596	10,618	5,952	3,227	2,420	29,108
Bus Pass	24,950	75,060	130,178	90,546	53,724	28,270	402,729
Travelcard	20,875	89,239	105,270	105,021	66,054	31,916	418,375
Oyster PAYG	10,125	65,248	115,855	76,708	39,237	18,973	326,147
Elderly	750	20,125	129,354	34,760	11,694	3,612	200,295
Blind/disabled	552	4,890	21,368	7,848	3,422	1,437	39,517
Child Free	982	73,930	130,736	84,426	25,657	7,268	322,998
Other	2,869	10,930	22,534	13,328	7,521	4,580	61,762
TOTAL	62,398	345,018	665,914	418,589	210,535	98,476	1,800,931

Source: GLBPS 2008/09

Table B.4-5: London Buses Annual Journeys By Ticket Type And Mon-Fri / Saturday / Sunday

Ticket Type	Passenger Journeys (000s)			
	Mon-Fri	**Saturday**	**Sunday**	**TOTAL**
Cash	29,108	5,788	4,911	39,806
Bus Pass	402,729	64,524	53,065	520,318
Travelcard	418,375	73,638	57,057	549,070
Oyster PAYG	326,147	51,942	40,264	418,352
Elderly	200,295	33,957	18,447	252,700
Blind/disabled	39,517	6,033	4,278	49,828
Child Free	322,998	51,906	32,545	407,449
Other	61,762	10,388	7,438	79,588
TOTAL	1,800,931	298,176	218,004	2,317,111

Source: GLBPS 2008/09

Table B.4-6: Annual Bus Station Passenger Usage (Boarders + Alighters)

Location	**Last Counted**	**Yearly Total (station)**	**Yearly total (station & surrounding on-highway stops)**
Brent Cross	2007/08	7,311,183	7,329,067
Canada Water	2007/08	4,937,929	–
Canning Town	2006/07	5,328,263	–
Crystal Palace	2006/07	1,598,680	5,328,263
Ealing Broadway	2007/08	–	9,147,971
East Croydon	2007/08	2,718,266	6,570,615
Edgware	2007/08	2,490,658	8,359,578
Edmonton Green	2007/08	10,189,422	–
Euston	2007/08	5,689,777	8,159,538
Finsbury Park, Station Place	2007/08	3,612,297	16,977,153
Finsbury Park, Wells Terrace	2007/08	7,024,585	
Golders Green	2004/05	2,422,350	12,358,715
Hammersmith	2005/06	20,252,406	21,846,171
Harrow on the Hill	2006/07	9,713,784	–
Hounslow	2005/06	3,603,793	7,601,111
Kingston, Cromwell Road	2006/07	3,751,232	–
Kingston, Fairfield North	2006/07	3,143,248	–
Lewisham	2007/08	7,227,276	16,983,490
Liverpool Street	2007/08	4,089,352	15,450,352
London Bridge	2006/07	6,666,706	–
Morden	2006/07	2,019,185	4,935,247
North Greenwich	2007/08	10,063,064	–
Peckham	2007/08	1,277,142	10,366,716
Putney Bridge	2007/08	1,835,155	3,876,514
Stratford	2005/06	10,831,577	15,825,865
Tottenham Hale	2004/05	1,847,440	2,623,489
Turnpike Lane	2005/06	2,967,409	14,874,932
Uxbridge	2006/07	5,268,753	–
Vauxhall	2006/07	14,280,609	–
Victoria	2005/06	17,375,738	31,759,251
Waltham Cross	2006/07	2,739,247	–
Walthamstow	2005/06	11,379,575	15,731,189
Waterloo	2007/08	–	17,543,297
West Croydon	2005/06	6,008,462	8,000,535

B.4.2 Additional Bus Information

Other information is available, including:

- Passenger profiles by:
  - Ticket type
  - Journey purpose
  - Frequency of use
  - Age / Sex / SEG / Working status

- Service data, e.g. Kilometres operated as % of scheduled
  - Average waiting time (QSIs)
  - Average passenger load per bus
  - Average fare per km

APPENDIX C Assumptions and Forecasts

This appendix provides a list of assumptions and forecasts to be used in appraisals. In some cases the parameters are more fully discussed elsewhere in the manual, as indicated by references.

It is important that these assumptions are adhered to, in between revisions of the manual. Whilst new research and new methodology may indicate the need for future updating of parameter values, and sometimes there are conflicting views about existing values, the 'level playing field' principle requires that, at any one time, TfL appraisals should draw on a single set of assumptions, as laid out in this manual.

(Where authoritative alternative estimates could be cited, the impact of using these different values may be demonstrated using sensitivity tests.)

C.1 APPRAISAL PERIOD AND DISCOUNTING

C.1.1 Appraisal Period

The appraisal period will normally be the time until implementation, plus the life of the project or main asset created. The period following implementation ('project life') will normally be a maximum of 30 years, with assets with a longer life than this being assigned a residual value. (But where an asset is expected to last a standard number of years that is longer than 30 years, e.g. 40 years for underground trains, it is usual to adopt this as the project life.)

Where necessary, a sensitivity test may be used to show the effect of a project life longer than 30 years, although the further forward the appraisal is projected, the more uncertainty will be attached to potential benefits, and the greater the likelihood of increased maintenance costs for ageing assets. (The rate of increase of such costs can be difficult to predict accurately.)

C.1.2 Discount Rate

According to the Treasury's Green Book (2003) the discount rate is 3.5% p.a. (For application, see tables in Appendix G.)

Beyond 30 years a rate of 3.0% p.a. can be used up to 75 years, and beyond that a rate of 2.5% p.a. up to 125 years.

C.2 COSTS

C.2.1 Current prices

Converting cost estimates from previous years to current prices – use the GDP Deflator series (see Table C5.1 below)

C.3 OPTIMISM BIAS

Percentage increases to be applied to cost estimates, where these estimates include risks.

Table C.3-1: DfT recommended optimism bias uplifts

Category	Types of Projects	Stage 1	Stage 2	Stage 3
Roads	Motorway Trunk roads Local roads Bicycle facilities Pedestrian facilities Park and ride Bus lane schemes Guided buses on wheels	44%	15%	3%
Rail	Metro Light rail Guided buses on tracks Conventional rail High speed rail	66%	40%	6%
Fixed Links	Bridges and Tunnels	66%	23%	6%
Building Projects	Stations and Terminal buildings	51%	-	4%

(The three 'stages' broadly correspond to the initial feasibility stage, selection of preferred option, and approach to implementation.)

See section 3.14 of the manual for guidance on optimism bias.

C.4 BENEFIT AND REVENUE PARAMETERS

C.4.1 Values of time (2012)

Table C.4-1: Values of Time for Main modes are as follows

	Resource cost		Market price	
	£ per hr	Pence per min	£ per hr	Pence per min
LUL passenger	8.82	14.71	10.68	17.81
LB passenger	7.70	12.84	9.33	15.55
Car occupant	8.37	13.95	10.13	16.89
Goods vehicle driver	18.31	30.51	22.13	36.89
Nat. Rail passenger	9.46	15.77	11.45	19.09
Taxi driver	17.57	29.28	21.24	35.41
Taxi passenger	31.97	53.28	38.65	64.42
Cyclist	15.02	25.03	18.19	30.31
Pedestrian	15.02	25.04	18.19	30.32
Motorcyclist	9.06	15.09	10.96	18.27

TfL appraisals will normally use resource cost values. The use of market price for benefits implies that market price would also be applied to costs. This means that, although TfL does not pay VAT, an excess of around 21% would have to be added to the costs. (Note that both costs and benefits are treated in the market price unit of account in DfT's multi-modal appraisal tool TUBA, which produces a cost benefit analysis from modelling outputs.)

The starting point is the DfT's WebTAG Unit 3.5.6 (2009), and derivations of the above values, together with a more detailed breakdown, can be found in 'Calculating modal values of time' -see TfL Source: Our Organisation > Strategies & Planning > Business Planning > Business case development documents. For further information on values of time see sections E1 and E3 of Appendix E.

Note. For DLR and other light rail schemes, use LUL values. (The above values of time are based on random sampling of people and their travel behaviour, rather than on users of each mode, and the DfT does not publish values based on the small number of light rail users included in the resulting sample.)

C.4.2 Growth in value of time

Growth rates for Value of Time (VoT) are shown in the following table. These are taken from WebTAG 3.5.6 (Draft revision, June 2012, Table 3b) Value of Time (VoT) which provides different growth rates for travel during working and non-working time. Working time values grow in line with GDP per capita, whereas non-working time values grow at only 0.8 times the GDP per capita growth rates. (In line with Treasury Green Book guidance, after 30 years the rates shown include a factor of 3.0/3.5 = 0.857 to allow for a reduction in the discount rate from 3.5% to 3.0%.)

Where a work/non-work split is not available, an aggregated values can be used – derived using the average split of work / non-work trips across the network.

It should be noted that as a result of the revised DfT Values of Time that were added to WebTAG in August 2012, TfL values are being held constant for two years until they have converged. No price inflation or Value of Time growth should be applied over the period to April 2014. This is reflected in the table below.

Table C.4-2: Value of Time Growth Rates

	Year	Work	NON Work	Weighted average for TfL
*	2013	0.0	0.0	0.0
	2014	1.98	1.58	1.59
	2015	2.3	1.84	1.86
	2016	2.33	1.86	1.88
	2017	2.13	1.7	1.71
	2018	1.63	1.3	1.31
	2019	1.64	1.31	1.32
	2020	1.64	1.31	1.32
	2021	1.85	1.48	1.49
	2022	1.76	1.41	1.42
	2023	1.77	1.42	1.43
	2024	1.89	1.51	1.52
	2025	1.8	1.44	1.45
	2026	1.82	1.45	1.46
	2027	1.83	1.46	1.47
	2028	1.85	1.48	1.49
	2029	1.87	1.49	1.50
	2030	1.88	1.5	1.51
	2031	1.9	1.52	1.53
	2032	1.91	1.53	1.54
	2033	2.03	1.62	1.63
	2034	2.15	1.72	1.73
	2035	2.15	1.72	1.73
	2036	2.15	1.72	1.73
	2037	2.08	1.66	1.67
	2038	2.08	1.66	1.67
	2039	2.08	1.66	1.67
	2040	2.18	1.74	1.75
	2041	2.18	1.74	1.75
	2042	2.21	1.76	1.77
**	2043	1.98	1.58	1.60
**	2044	1.98	1.58	1.60
**	2045	1.89	1.52	1.53
**	2046	1.89	1.52	1.53
**	2047	1.83	1.47	1.48
**	2048	1.83	1.47	1.48
**	2049	1.83	1.47	1.48
**	2050	1.83	1.47	1.48
**	2051	1.75	1.40	1.41
**	2052	1.77	1.42	1.43
**	2053	1.77	1.42	1.43
**	2054	1.77	1.42	1.43
**	2055	1.77	1.42	1.43
**	2056	1.77	1.42	1.43
**	2057	1.78	1.43	1.44
**	2058	1.78	1.43	1.44
**	2059	1.79	1.43	1.44
**	2060	1.79	1.43	1.44
**	2061 onward	1.86	1.49	1.50

** zero growth until the end of 2013/14*

*** change in discount rate applied*

C.4.3 Elasticities

The following values are "long term" conditional elasticities. See Appendix E2 and Appendix J for further information on the use of elasticities.

Table C.4-3: London Underground Elasticities

Time of Day	Elasticity
AM Peak	-0.24
Inter-Peak	-0.29
PM Peak	-0.27
Evening	-0.29
Saturday	-0.34
Sunday	-0.34
Average Overall	-0.28

Table C.4-4: Bus Elasticities

Time of Day	Elasticity
AM Peak	-0.25
Inter-Peak	-0.30
PM Peak	-0.26
Evening	-0.28
Saturday	-0.31
Sunday	-0.30
Average Overall	-0.28

C.4.4 Build up of revenue following a service improvement in Year 0

The assumption for LUL is:

- Year 1, 35%
- Year 2, 75%
- Year 3, 90%
- Year 4, 100%

The assumption for LB is:

- Year 1, 0%
- Year 2, 100%

C.4.5 Value of preventing a fatality

For all modes: £1.7m per fatality prevented

For road-based modes there is also a Killed or Seriously Injured (KSI) valuation: £279k per KSI prevented

The starting point is the DfT's WebTAG Unit 3.4.1 (2007), and derivations of the above values (which are at 2009 prices) can be found in 'Value of preventing a fatality – calculations' -see TfL Source: Our Organisation > Strategies & Planning > Business Planning > Business case development documents. For further information on safety appraisals see section F4 onwards in Appendix F.

C.5 MULTIPLIERS

C.5.1 Vehicle occupancy

Figures for cars are drawn from Table 4 (2000) of DfT's WebTAG Unit 3.5.6. The 'per vehicle kilometre' figures should be used for modelling, where trip distances are calculated automatically, and the 'per trip' figures where trip distances are unknown.

Journey purpose	Weekday					Week-end average	All week average
	7am-10am	10am-4pm	4pm-7pm	7pm-7am	average		
	Occupancy per vehicle kilometre travelled						
Work	1.23	1.19	1.17	1.18	1.20	1.28	1.20
Commuting	1.16	1.15	1.13	1.13	1.14	1.14	1.14
Other	1.71	1.78	1.82	1.77	1.78	1.97	1.85
Average	1.37	1.59	1.45	1.47	1.48	1.88	1.58
	Occupancy per trip						
Work Car	1.26	1.19	1.20	1.21	1.21	1.30	1.22
Commuting	1.16	1.14	1.14	1.13	1.15	1.13	1.14
Other	1.72	1.70	1.76	1.71	1.72	1.96	1.79
Average	1.46	1.59	1.53	1.54	1.54	1.88	1.63

C.5.2 Annualisation factors

Annualisation factors available to convert results for an a.m. three-hour peak to a full year are:

LUL	**1076**	Source: 2008 entry counts, giving numbers of trips at each time during the week; then standard numbers of working days, etc during the year provides annual total; annual divided by a.m. peak is then factored down to TfL Annual Report total annual journeys 2008/09 –based on ticket sales
LB	**1699**	Source: GLBPS 2008/09, giving numbers of trips at each time during the week; then a.m. peak figure is inferred using standard numbers of working days during the year
Highway		There is no standard value for converting results for an a.m. three-hour peak to a full year. The demand profile is likely to be flatter than for other modes. For example, across a group of 14 sites in East London near the proposed Thames Gateway Bridge, the annualisation factor was 1905 for flows. This is suggested as a default factor in outline business cases. However, for detailed modelling, it would be preferable to annualise from a.m. peak to annual total for both peaks, and from inter-peak to annual total for off-peak (using survey data that relates weekday inter-peak demand to weekend demand).

Annualisation factors for benefits are likely to be different to those for counts or flows. The more congestion there is in the base, the greater the benefits from an intervention are. So benefit annualisation factors from a relatively congested period during the day to a less congested aggregate set of periods are likely to be lower than flow annualisation factors. A third type of annualisation factor – for extra fare revenues from an intervention – will be determined by the mix of ticket types anticipated.

C.6 TRENDS AND FORECASTS FOR INFLATION

Year	**GDP Deflator (2011 = 100)**	**% change on previous year**
2000	77.199	0.67
2001	78.461	1.64
2002	80.260	2.29
2003	82.230	2.46
2004	84.356	2.59
2005	86.376	2.40
2006	88.884	2.90
2007	90.848	2.21
2008	93.608	3.04
2009	94.839	1.32
2010	97.463	2.77
2011	100.000	2.60
2012		*2.5*
2013		*2.5*
2014		*2.5*
2015		*2.5*
2016		*2.5*
Beyond		*2.5*

Sources: GDP Deflator http://www.hm-treasury.gov.uk/data_gdp_fig.htm

'Beyond' is an extrapolation of the GDP Deflator series

C.7 HISTORICAL TREND & FORECASTS FOR AVERAGE EARNINGS, 2000 - 2011

Year	Average Weekly Earnings (AWE) – Total Pay (EARN01)	GDP Deflator Growth %	AWE Growth %	Growth in Real Earnings %
2000	317	0.67		
2001	334	1.64	5.22	3.59
2002	345	2.29	3.17	0.88
2003	356	2.46	3.19	0.74
2004	371	2.59	4.38	1.80
2005	388	2.40	4.63	2.23
2006	407	2.90	4.74	1.84
2007	427	2.21	4.86	2.65
2008	442	3.04	3.58	0.54
2009	442	1.32	-0.06	-1.37
2010	452	2.77	2.30	-0.46
2011	463	2.60	2.45	-0.15
Forecast		*2.5*	*3.5**	*1.0*

Sources: Earnings from ONS Labour Market Statistics (September 2012)

http://www.ons.gov.uk/ons/rel/lms/labour-market-statistics/september-2012/index-of-data-tables.html#tab-Earnings-tables

AWE has superseded the Average Earnings Index (AEI) as the lead measure of short term earnings growth. AEI was discontinued after August 2010.

** Earnings forecasts is average AWE growth over the years in the table above.*

GDP Deflator http://www.hm-treasury.gov.uk/data_gdp_fig.htm

Forecasts -Extrapolation of the GDP Deflator Series as in table C5

For further information on earnings indices contact: Ryan Taylor on [redacted]

C.8 FORECAST GROWTH IN LUL PASSENGER KM (INDEX FOR 1999/2000 = 100)

Year	**LUL peak pass. km**	**LUL off-peak pass. km**	**LUL total pass. km**
1999/00	100.0	100.0	100.0
2000/01	104.8	103.6	104.2
2001/02	103.4	104.3	103.9
2002/03	102.2	103.2	102.7
2003/04	102.8	101.9	102.4
2004/05	104.3	107.7	106.1
2005/06	105.8	105.8	105.8
2006/07	107.4	106.4	106.9
2007/08	114.3	113.2	113.7
2008/09	120.8	120.2	120.5
2009/10	*115.7*	*115.7*	*115.7*
2010/11	*114.0*	*114.5*	*114.2*
2011/12	*116.1*	*117.0*	*116.5*
2012/13	*120.6*	*121.8*	*121.3*
2013/14	*123.8*	*125.5*	*124.7*
2014/15	*128.8*	*131.1*	*130.0*
2015/16	*133.0*	*135.6*	*134.4*
2016/17	*134.7*	*137.9*	*136.3*
2017/18	*133.6*	*137.5*	*135.6*
2021/22	*142.7*	*147.8*	*145.3*
2024/25	*153.2*	*160.6*	*157.0*
2028/29	*164.7*	*174.8*	*169.9*

Note that these forecasts are likely to change as expenditure programmes are finalised.

Disaggregated LUL station and line forecasts are available -these are too voluminous to reproduce in this manual.

Further information on future LU demand can be obtained from LU Strategic Planning. Please contact Sarah Scott on [redacted] *in the first instance.*

C.9 FORECAST GROWTH IN LONDON BUS PASSENGER JOURNEYS

Year	Passenger journeys	Passenger km	Indices (1999/2000 = 100)	
			Pass. journeys	Pass. km
2008/09	2234	7941	171.5	179.3
2009/10	2255	8005	173.1	180.7
2010/11	2271	8062	174.3	182.0
2011/12	2300	8165	176.5	184.4
2012/13	2322	8243	178.2	186.1
2013/14	2335	8289	179.2	187.2
2014/15	2354	8357	180.7	188.7
2015/16	2374	8428	182.2	190.3
2016/17	2396	8506	183.9	192.0
2017/18	2415	8573	185.3	193.6

Note that a standard average trip length is used in calculating passenger kilometres for these demand forecasts.

(From 2007/08 bus journey calculations use a new methodology, to correct for increasing distortions in the survey and ticket sales based methodology over the previous few years. The new figures incorporate previously excluded journeys by the under 5s and free travel by staff and police. Data for earlier years have been adjusted accordingly, but this makes only a minor difference in the above table.)

Further information Bus demand can be obtained from the Pricing and Forecasting Manager, Revenue Policy, Customer Experience Directorate. Contact Tony Richardson, [redacted].

C.9.1 GLA Forecast Of Population Growth

Table C.9-1: GLA Forecast Of Population Growth 2001 - 2031

(All figures in 000s)

Borough	2001	2009	2016	2021	2026	2031
Camden	203	205	215	223	231	236
Kensington & Chelsea	161	168	178	179	181	184
Westminster, City of	203	213	220	224	226	232
City of London	7	9	10	11	12	12
Central boroughs	**574**	**595**	**624**	**637**	**650**	**665**
Hackney	208	223	236	244	252	263
Hammersmith & Fulham	169	177	187	194	198	204
Haringey	223	233	254	262	271	282
Islington	180	195	209	216	221	229
Lambeth	275	289	301	309	317	330
Lewisham	255	266	290	303	311	317
Newham	251	268	332	347	359	376
Southwark	258	274	305	321	341	361
Tower Hamlets	202	235	270	286	301	321
Wandsworth	272	286	298	306	311	319
Rest of Inner boroughs	**2,293**	**2,448**	**2,683**	**2,788**	**2,883**	**3,000**
Total Inner boroughs	**2,867**	**3,043**	**3,306**	**3,425**	**3,533**	**3,665**
Barking & Dagenham	165	171	204	217	233	254
Barnet	320	327	367	380	385	394
Bexley	219	216	218	220	223	227
Brent	271	277	296	303	307	315
Bromley	296	299	302	305	308	314
Croydon	335	338	371	384	384	389
Ealing	308	316	327	331	336	344
Enfield	278	288	291	292	294	297
Greenwich	217	238	272	280	286	295
Harrow	211	217	230	229	229	232
Havering	225	228	238	244	247	254
Hillingdon	246	250	262	270	272	276
Hounslow	217	229	242	246	250	256
Kingston upon Thames	149	153	159	161	162	164
Merton	191	197	198	197	197	199
Redbridge	242	251	265	267	269	274
Richmond upon Thames	174	184	189	191	194	198
Sutton	181	183	187	191	193	196
Waltham Forest	223	225	232	236	239	246
Outer boroughs	**4,470**	**4,586**	**4,851**	**4,948**	**5,007**	**5,123**
Greater London	**7,337**	**7,628**	**8,157**	**8,373**	**8,540**	**8,789**

Source: GLA population forecast 2008
All figures from 2009 onwards are forecasts

For further info about population forecasts contact Group Planning – Chris Hyde [redacted]

C.9.2 London Plan forecast of employment growth 2001- 2031

(All figures in 000s)

Year / Sector	2001	2009	2016	2021	2026	2031
Primary and utilities	25	27	21	18	15	12
Manufacturing	303	207	158	130	107	89
Construction	212	236	216	203	191	179
Wholesale	257	213	206	201	196	191
Retail	410	404	415	422	429	437
Hotels & restaurants	289	320	378	426	480	540
Transport & comms	372	339	327	318	310	302
Financial services	360	334	336	336	337	338
Business services	1,132	1,274	1,431	1,522	1,594	1,646
Public administration	213	224	206	194	183	173
Health & Education	639	735	751	762	773	785
Other services	372	422	509	582	665	760
Total	4,586	4,736	4,953	5,114	5,280	5,452

Source: GLA Economics Working Paper 20, 2009 update
For further information about employment forecasts, plus other economic aspects of the London Plan, contact GLA Economics Unit:

Jonathan Hoffman [redacted] (employment)

C.9.3 Network Assumptions

Assumptions about future schemes can change rapidly, but until the next BCDM update, the following key schemes should be assumed. This table is derived from the MTS2 2031 Reference Case assumptions about future public transport and major highway schemes (version 11.2), but is not in any way the "official" list, which can sometimes change rapidly. It is provided simply for the purpose of comparing schemes using a set of standard assumptions about the remainder of the network. (Alternative scenarios can be investigated with sensitivity tests.)

SCHEME	COMMENTS
NATIONAL RAIL	
Integrated Kent Franchise (London Rail version) service pattern	
CTRL Domestic (in conjunction with Integrated Kent Franchise)	
North London Railway Service Level Commitment Phases 1 - 2 (East London Line / North London line / West London Line)	Includes WLL stops at Shepherds Bush and Imperial Wharf

SCHEME	COMMENTS
East London Line Extension Phase 3 to Clapham Junction	
HLOS Commitments South West London (inner)	
South West London (lengthened to 10 cars)	
Southern (inners + ELL knock-on effect)	
Southern (outers and Thameslink knock-on effect)	
West Anglia Phase 1 (increased 12 car services)	
West Anglia (Phase 2/2a)	
South Eastern (additional 12 car trains)	
Great Eastern Inner Upgrades	
Great Eastern Outer Upgrades	
c2c (including Tilbury loop platforms extended to 12 cars)	
London Midland increased to 12 car trains	
Thameslink programme + GN adjustments (Phase 1)	
Thameslink (Phase 2 - London Rail Alternative 24 tph)	
Crossrail 1 (Abbey Wood Scheme) 24 tph in peak with 10 cars (Heathrow Connect removed) + additional stop at Woolwich	Revised Spec (2009) Operational from 2017
UNDERGROUND	
Full PPP Line Upgrades:	
Jubilee	2009
Victoria	2012
Northern	2012
Piccadilly	2014
Sub Surface (District & Circle, Met, including Extended Circle)	2018
Bakerloo	2020
DLR	
Bank-Lewisham 3-car Upgrade	No 3 car trains on Stratford - Lewisham or Tower Gateway-Beckton or Woolwich services

SCHEME	COMMENTS
Poplar to Stratford 3-car upgrade	
Stratford Int. - Canning Town / NLL to Stratford Lea Valley	
BUS	
Bus frequencies in general continue at 2008 levels	
Development Area – some increases in Thames Gateway	
TRANSITS	
East London Transit Phase 1a	
East London Transit Phase 1b (Barking Riverside Loop)	
HIGHWAY	
£8 (at 2007 prices) Congestion Charge	
Highway capacity remains at 2006 levels	
FARES	
Rail fares increase by RPI+1 (approx. 3.7% pa) 2009-2016	
Rail fares increase by RPI 2017 onwards	
LUL & DLR fares are 12% higher than 2001 in real terms by 2016	
LUL & DLR fares increase by RPI 2017 onwards	
Bus fares are 2% lower than 2001 in real terms by 2016	
Bus fares increase by RPI 2017 onwards	
RELIABILITY	
Bus Excess Waiting Time increases to 1.4 min. by 2017/18	
LUL Excess Journey Time decreases to 6.85 min. by 2017/18	

Further information on future network assumptions can be obtained from the Strategic Modelling and Analysis Team, Group Planning. Contact Chris Hyde, [redacted] *in the first instance.*

APPENDIX D Some Journey Parameters

D.1 AVERAGE LUL TRAVEL SPEEDS (2003)

D.1.1 Train Speeds

Table D.1-1:Train speeds (from time-tables, i.e. includes stops)

Line	kph including layovers	kph without layovers	mph without layovers
Bakerloo	25.6	27.6	17.2
Central	35.4	39.3	24.4
Circle	21.1	21.8	13.6
District	26.0	29.4	18.3
East London (out of commission)	-	-	-
Hammersmith & City	21.0	25.2	15.7
Jubilee	30.0	34.1	21.2
Metropolitan	28.9	33.6	20.9
Northern	23.7	26.4	16.4
Piccadilly	27.6	30.5	19.0
Victoria	32.3	34.5	21.4
Waterloo & City	25.4	31.3	19.5
Network weighted average	28.0	31.3	19.4

D.1.2 Escalator speed (measured diagonally)

Range	0.32-0.91 metres/sec	60-180 ft/min
Average	0.72 metres/sec	145 ft/min

D.1.3 Lift speed

Range	0.92-4.06 metres/sec	180-800 ft/min
Usual	1.4 metres/sec	275 ft/min

Stop time/floor 40 secs

D.1.4 Walking speeds

Horizontal	1.34 metres/sec
Up stairs	0.60 (vertical component = 0.30) metres/sec
Down stairs	0.68 (vertical component = 0.34) metres/sec
Congested stairs	0.42 (vertical component = 0.21) metres/sec

D.2 LUL TRIP LENGTH AND REVENUE (2008/09)

Ticket type	Average revenue per trip	Average per		Average Journey Length	
		pass. mile	pass. km	miles	km
Ordinary	£2.67	53.4p	33.2p	5.0	8.1
Period Travelcard	£1.31	28.5p	17.7p	4.6	7.4
One Day Travelcard	£1.60	31.0p	19.2p	5.2	8.3
Oyster Pay-As-You-Go	£1.71	29.2p	18.2p	5.9	9.4
Total Fare-Paying	£1.51	30.6p	19.0p	4.9	7.9
Concessionary	£0.92	17.8p	11.1p	5.2	8.4
Overall Total	£1.48	30.1p	18.7p	4.9	7.9

For further information on LU revenue per trip contact LU Strategic Planning - Sarah Scott, [redacted]

D.3 AVERAGE JOURNEY TIME BY LINE 2009/10

Line	Mins. per Boarding
Bakerloo	9.0
Central	12.7
District	14.5
East London (out of commission)	-
Jubilee	12.2
MCL	14.6
Northern	12.6
Piccadilly	14.7
Victoria	10.0
Waterloo & City	3.8
System Average	12.7

Source: Averages from 2009/10,periods 1 to 5

For further information on LU Journey times, please contact Sandra Weddell on [redacted]

It should be noted that the above on-train times exclude the effects of any line closures. Future modifications to the network (and also major service changes) may change values; line extensions are, of course, likely to increase average journey lengths.

Taking into account an average of 1.38 journey legs, but excluding any extra for interchange, the average on-train journey time for the system equals 17.5 minutes.

D.4 LONDON BUS TRIP LENGTH AND REVENUE (2009)

Ticket type	Average revenue £ per trip	Average £ per pass. km	Average trip length (km)	% of total trips
Single	2.000	0.478	4.22	1.6%
Pre Pay	0.858	0.220	3.91	19.2%
One Day Bus Pass	0.660	0.174	3.79	1.2%
Bus Pass Season	0.441	0.117	3.77	21.9%
One Day Travelcard	0.593	0.200	2.96	1.8%
Travelcard Season	0.472	0.157	3.01	20.4%
Total fare paying	0.618	0.173	3.57	66.2%
Concessions	0.562	0.186	3.02	14.3%
Free under 18	-	-	4.00	18.0%
Staff etc	-	-	2.06	1.5%
Overall total	0.489	0.138	3.54	100.0%

Source: based on Revenue Monitoring P11, 2008/09 to P5, 2009/10

Further information can be obtained from the Pricing and Forecasting Manager, Revenue Policy, Customer Experience Directorate. Contact Tony Richardson, Auto [redacted]

D.5 AVERAGE BUS SPEEDS (2002-2008)

Since the introduction of the Congestion Charging Zone (*CCZ*), detailed information on bus speeds has been made available.

	Average bus speeds (kph)						
	02/03	03/04	04/05	05/06	06/07	07/08	08/09
Congestion Charging Zone (CCZ)	10.9	11.6	11.2	10.8	10.3	10.0	10.1
Inner Ring Road	13.3	13.3	12.8	12.2	11.9	12.0	12.2
Radials close to CCZ	14.0	14.5	13.9	13.5	13.3	13.3	13.1
Orbitals close to CCZ	11.6	11.9	11.8	11.9	11.6	11.5	12.1
Stretches of road further away from CCZ	14.0	14.3	14.3	14.1	14.0	14.2	14.0
Stretches of road beyond North/South Circular	15.7	15.2	14.9	15.0	14.9	14.8	15.2

Source: Congestion Charging Impacts monitoring Sixth Annual Report, 2008

Notes:

*This data refers to **Monday-Friday AM peak only**. Surveys were conducted over 48 weeks (late February/early March to late January/early February).*

APPENDIX E Parameters to be used in Benefit Calculations

TABLES IN THIS APPENDIX

E.1 VALUES OF TIME FOR MAIN MODES

Table E-1: Values of time (2013) for main modes

	Resource cost		Market price	
	£ per hr	Pence per min	£ per hr	Pence per min
LUL passenger	8.82	14.71	10.68	17.81
LB passenger	7.70	12.84	9.33	15.55
Car driver	8.60	14.33	10.41	17.35
Car passenger	8.15	13.59	9.87	16.45
Goods vehicle driver	18.31	30.51	22.13	36.89
Nat. Rail passenger	9.46	15.77	11.45	19.09
Taxi driver	17.57	29.28	21.24	35.41
Taxi passenger	31.97	53.28	38.65	64.42
Cyclist	15.02	25.03	18.19	30.31
Pedestrian	15.02	25.03	18.19	30.32
Motorcyclist	9.06	15.09	10.96	18.27

TfL appraisals will normally use resource cost values. The use of market price for benefits implies that market price would also be applied to costs. This means that, although TfL does not pay VAT, an excess of around 21% would have to be added to the costs. (Note that both costs and benefits are treated in the market price unit of account in DfT's multi-modal appraisal tool TUBA, which produces a cost benefit analysis from modelling outputs.)

The starting point is the DfT's WebTAG Unit 3.5.6 (2009). Derivations of the above values, together with a more detailed breakdown, can be found in 'Calculating modal values of time' – see TfL Intranet: Our Organisation, Strategies & Planning, Business Planning, Business Case Development Documents.

For multi-modal journeys, use the value for the leg of the journey that takes the longest time. WebTAG Unit 3.5.6, states that the non-work values for cyclists and pedestrians should be double weighted.

For DLR and other light rail schemes, use LUL values. (The above values of time are based on random sampling of people and their travel behaviour, rather than on users of each mode, and the DfT does not publish values based on the small number of light rail users included in the resulting sample.)

Values of time can also be applied separately by purpose, contact Ryan Taylor for more information.

E.1.1 Growth of value of time

Growth rates for Value of Time (VoT) are shown in the following table. These are taken from WebTAG 3.5.6 (Draft revision, June 2012, Table 3b) Value of Time (VoT) which provides different growth rates for travel during working and non-working time. Working time values grow in line with GDP per capita, whereas non-working time values grow at only 0.8 times the GDP per capita growth rates. (In line with Treasury Green Book guidance, after 30 years the rates shown include a factor of

3.0/3.5 = 0.857 to allow for a reduction in the discount rate from 3.5% to 3.0%.)

Where a work/non-work split is not available, an aggregated value can be used – derived using the average split of work / non-work trips across the network.

Following the revision to DfT Values of Time incorporated into WebTAG in August 2012, the figures reduced as a result of revised GDP per head growth rates. TfL values are therefore being held constant until the end of the 2013/14 financial year to allow a smooth convergence. This should not have a material effect on most business cases with benefit streams after that date. This has been reflected in the Value of Time growth rates in the table below.

Table E-2: Value of Time Growth Rates

	Year	Work	NON Work	Weighted average for TfL
*	2013	0.0	0.0	0.0
	2014	1.98	1.58	1.59
	2015	2.3	1.84	1.86
	2016	2.33	1.86	1.88
	2017	2.13	1.7	1.71
	2018	1.63	1.3	1.31
	2019	1.64	1.31	1.32
	2020	1.64	1.31	1.32
	2021	1.85	1.48	1.49
	2022	1.76	1.41	1.42
	2023	1.77	1.42	1.43
	2024	1.89	1.51	1.52
	2025	1.8	1.44	1.45
	2026	1.82	1.45	1.46
	2027	1.83	1.46	1.47
	2028	1.85	1.48	1.49
	2029	1.87	1.49	1.50
	2030	1.88	1.5	1.51
	2031	1.9	1.52	1.53
	2032	1.91	1.53	1.54
	2033	2.03	1.62	1.63
	2034	2.15	1.72	1.73
	2035	2.15	1.72	1.73
	2036	2.15	1.72	1.73
	2037	2.08	1.66	1.67
	2038	2.08	1.66	1.67
	2039	2.08	1.66	1.67
	2040	2.18	1.74	1.75
	2041	2.18	1.74	1.75
	2042	2.21	1.76	1.77
**	2043	1.98	1.58	1.60
**	2044	1.98	1.58	1.60
**	2045	1.89	1.52	1.53
**	2046	1.89	1.52	1.53
**	2047	1.83	1.47	1.48
**	2048	1.83	1.47	1.48
**	2049	1.83	1.47	1.48
**	2050	1.83	1.47	1.48
**	2051	1.75	1.40	1.41
**	2052	1.77	1.42	1.43
**	2053	1.77	1.42	1.43
**	2054	1.77	1.42	1.43
**	2055	1.77	1.42	1.43
**	2056	1.77	1.42	1.43
**	2057	1.78	1.43	1.44
**	2058	1.78	1.43	1.44
**	2059	1.79	1.43	1.44
**	2060	1.79	1.43	1.44
**	2061 onward	1.86	1.49	1.50

** zero growth to be applied until the end of 2013/14*
*** change in discount rate applied*

E.2 ELASTICITIES FOR USE IN APPRAISALS

Elasticities can be used to approximate the "new to public transport" revenues from the accrued social benefits.

These are derived from disaggregate elasticities in London Transport Marketing Research Note M(97)70 (Tables 15 and 18), scaled to overall conditional and own price elasticities (RPI deflated) in "London Underground and Bus Demand Analysis 1970-2000", factored to real adult fare levels.

Note: This research is now somewhat outdated, and forecasts more specific to the instance (derived by considering trip generation arising from land use changes, modal split shifts, and fare yield values) are recommended where feasible.

Further information on LU demand can be obtained from LU Strategic Planning. Please contact Sarah Scott on [redacted] the first instance.

More information on elasticities (and fare yields) can be obtained from the Pricing and Forecasting Manager, Revenue Policy, Customer Experience Directorate. Contact Tony Richardson,Auto [redacted]

E.2.1 LUL

The following "long term" conditional elasticities can be used in appraisals for approximating the increase in revenue from the accrued social benefits.

Table E-3: LUL Elasticities For Use In Appraisals

Time of Day	Elasticity
AM peak	-0.24
Inter-peak	-0.29
PM peak	-0.27
Evening	-0.29
Saturday	-0.34
Sunday	-0.34
Average overall	-0.28

Source: Derived from Elmod99

See Appendix J for elasticities used where it may be necessary to calculate the own price revenue effect for LUL.

E.2.2 Bus

Table E-4: Bus Elasticities For Use In Appraisals

The following "long term" conditional elasticities are used for appraisals.

Time of Day	Elasticity
AM peak	-0.25
Inter-peak	-0.30
PM peak	-0.26
Evening	-0.28
Saturday	-0.31
Sunday	-0.30
Average overall	-0.28

E.3 WEIGHTS FOR ELEMENTS OF JOURNEY TIME

E.3.1 London Underground - General

Table E-5: Weights For Elements Of LUL Journey Time (1)

Journey Characteristic	**Weighting**
Pre-journey • queuing to get to a ticket office window or machine • transaction at a ticket office window or machine • queuing at a PASS agent • transaction at a PASS agent • delay at ticket gates	3.4 2.5 3.0 2.0 4.0
Riding • standing (or sitting) in a crowded train • seated in an uncrowded train • on escalators • in lifts	1.0 + RFa 1.0 1.5 2.0
Waiting • for trains or lifts in acceptable uncongested conditions • for trains on crowded platform	2.5 2.5 + CF[b]
Walking • unimpeded • in a congested environment • up stairs or stationary escalators • down stairs unimpeded	2.0 2.0 + CF[b] / 2 4.0 2.5
Penalties • Interchange (LUL/LUL) (LUL/National Rail)	3.5 mins fixed 5.0 mins fixed

*a RF is the formula 0.09 + (2.11-1.13**Y**)**X** giving an overall weighting for those standing and sitting, where **X** = (train load - train seats)/(crush load - train seats) and **Y**, which relates seating capacity to standing capacity, is as follows:*

Bakerloo	*0.289*	*Metropolitan*	*0.405*
Central	*0.208*	*Northern*	*0.247*
Circle	*0.188*	*Piccadilly*	*0.219*
District	*0.248*	*Victoria*	*0.254*
Jubilee	*0.170*		

*b CF = 0.667(**P** - 0.5)^2, where **P** = passengers per m^2 and **P** is between 0.5 and 2. CF = 1.50 if **P** is greater than or equal to 2, and 0 if **P** is less than 0.5. For example, if **P** = 1.2 then CF = 0.327.*

For further information on weightings for elements of LU journey times can be obtained from LU Transport Planning. Contact Howard Wong [redacted]

E.3.2 London Underground – On Train Delays

Weights for increasing **on-train delays** are shown in the table below. The value of the weight is 1.0 for the first three minutes, then increases linearly to 3.0 by the end of the eighth minute.

Table E-6: Weights For Elements Of LUL Journey Time (2)

Minutes of delay	Weighting at end of each minute	Average weighting during each minute
1st minute of delay	1.0	1.0
2nd minute of delay	1.0	1.0
3rd minute of delay	1.0	1.0
4th minute of delay	1.4	1.2
5th minute of delay	1.8	1.6
6th minute of delay	2.2	2.0
7th minute of delay	2.6	2.4
8th minute of delay	3.0	2.8
9th minute of delay and beyond	3.0	3.0

E.3.3 London Underground – On Train Delays

Weights for increasing delays in lifts are shown in the table below. The value of the weight is 2.0 for the first three minutes, then increases linearly to 7.0 by the end of the eighth minute.

Table E-7: Weights For Elements Of Lul Journey Time (3)

Minutes of delay	Weighting at end of each minute	Average weighting during each minute
1st minute of delay	2.0	2.0
2nd minute of delay	2.0	2.0
3rd minute of delay	2.0	2.0
4th minute of delay	3.0	2.5
5th minute of delay	4.0	3.5
6th minute of delay	5.0	4.5
7th minute of delay	6.0	5.5
8th minute of delay	7.0	6.5
9th minute of delay and beyond	7.0	7.0

Notes:
1.For projects affecting train times and crowding levels the Train Service Model can be used to estimate benefits.
2.For projects affecting station walk times and crowding levels, the PEDROUTE and PEDS models can be used to estimate benefit.

Further information on modelling can be obtained from LU Transport Planning. Contact Sandra Weddell [redacted]

E.3.3 a) EXAMPLE

An option involves accessing an uncongested tube station, a journey on a train with seats available followed by interchange to another line (Central) and a journey on a crowded train (with half the standing space occupied) and finally alighting at a station with a lift. The weighted time is calculated as follows:

Table E-8: Example Calculation of Generalised Time

Element	Time (min)	Weighting	Weighted Time (min)
Origin Station			
Walk time	2.0	2.0	4.0
Down stairs	0.6	2.5	1.5
Wait time	3.0	2.5	7.5
Riding Train I			
Seated	10.0	1.0	10.0
Interchange			
Walking (congested)	3.0	$1.0 + 1.0 + 0.667(1\text{-}0.5)^2 / 2$	6.3
Walking up stairs (congested)	1.0	$1.0 + 1.0 + 0.667(1\text{-}0.5)^2 / 2 +$ 2.0	4.1
Waiting (very congested)	2.0	2.5 + 1.50 [e.g. P might be 2.1]	8.0
Interchange penalty		3.5 min (fixed penalty)	3.5
Riding Train II			
Standing	8.0	1.0 + 0.09 + (2.11-1.13 x 0.208) x 0.5	16.2
Destination Station			
Walk time	2.0	2.0	4.0
Waiting for lift	0.8	2.5	2.0
Riding in lift	0.4	2.0	0.8
Total	**32.8**		**67.9**

Notes
1.The weightings for walking, congestion, and going upstairs are broken down into a base element of 1.0 and additional penalties. Hence walking has a weighting of 1.0 + 1.0, and walking up stairs has a weighting of 1.0 + 1.0 + 2.0 (instead of being shown as 4.0). This is in order to demonstrate that penalties are not multiplicative but additive.
Hence the combined weighting here for walking in mildly congested conditions (P = 1 person per sq. m.) up stairs is
not $(2 + 0.667(1\text{-}0.5)^2 / 2) \times 4 = 8.33$
but $1 + 1 + 0.667(1\text{-}0.5)^2 / 2 + 2 = 4.08$
2.For most practical purposes, evaluations are based on the ***difference*** *between options. For example, an increase in interchange station capacity to reduce congestion would only require the impact on the weighted time of those using the interchange to be considered.*

E.3.4 Weights For Elements of Bus Journey Time

Various possible weightings are under consideration in the light of recent research, but the current values are:

Table E-9: Weights For Elements Of Bus Journey Time

Journey Characteristic	Weighting
Riding	1.0
Waiting	2.5
Walking	2.0

For further information on weightings for elements of bus journey time contact Ryan Taylor [redacted]

E.4 CUSTOMER PRIORITIES MANUAL

E.4.1 Introduction

E.4.1.1 Background

This manual summarises the values which passengers place on a comprehensive list of key service attributes. Underground values are covered first, with values for other modes following in sections E.4.4.

For each mode, the figures quoted are averages of all passengers (i.e. averaged across all the different segments of the market for that mode). When applying the values, sensitivity tests should be used. In some cases where proposals are targeted at particular groups of passengers (e.g. the mobility impaired), the average values may not be appropriate. Analysis of the customer priority results by a number of market segments has been carried out. Where an average is not expected to give an accurate reflection of a proposal's benefits, advice should be sought from TfL Business Case Development.

(Ryan Taylor, [redacted]

Other market research reports are available which could provide useful supporting information for planning purposes. Customer Research can provide assistance.

Contact Alison Henderson, Head of Customer Research and Insight, [redacted] *(Auto* [redacted]

There is also a library of historical market research material held by LUL Strategy & Service Development. This is in the process of being catalogued.

Details available from LU Strategy. Please contact Natasha Gray on [redacted]

E.4.1.2 Layout Of Customer Priority Valuations Of Service Attributes

Tables E10 – E17 contain values for improving the provision of Underground service attributes from any given level to the best possible level. The columns relate to varying levels of provision of each attribute.

The information has been split down into the components of an Underground journey (on having reached the station); i.e. the Station component, comprising Ticket Hall(s), Access areas and Platforms, and the Train leg(s). In each table the attributes have been split into sub-tables according to the method used to establish the condition/level of service as follows:

Attributes Linked to MSS or SIS

The sets of attributes in Table E-10, Table E-12, Table E-14 and Table E-16 are linked to the Mystery Shopper Survey (MSS) or Staff and Information Survey (SIS). MSS scores are obtained from surveys carried out four times per year at each station and on the trains serving each line. It is an objective study which measures the condition of an attribute and rates the level of services offered on a scale between 0 and 100. The study is comprehensive and involves many questions on which the customer priorities research was based, and so, where possible, customer priority attributes have been linked to the MSS. Descriptions of the MSS attributes and the condition/performance levels are given in the MSS Ratings Manual.

(The MSS Ratings Manual is available from Victor Santos, [redacted]*.*

The Staff and Information Survey started in 2009. This survey covers attributes relating to Real Time Information and Customer Service which were previously included in the Mystery Shopping Survey.

For further information on the SIS contact Russell Cross, [redacted]

Attributes not Linked to MSS or SIS

The other tables contain attributes which cannot be linked to MSS or SIS because there is no corresponding measure in these surveys.

- Multi-Level

Some of the customer priority attributes have a 3 point or 4 point scale describing condition. Level one indicates the worst level and levels 3 or 4 the best levels. A description of all the levels for each attribute is given in the **Attribute Improvement Level** (Section E.4.3). Rather than referring to MSS to provide information on current level of service, for these attributes "positioning" will need to be done using other market reports, commissioning market surveys or using judgement and observation.

- Single Level

The remaining customer priority attributes have only one point of improvement - i.e. the value for introducing a service or achieving a defined measured improvement - as described in Section E.4.3.

Within each sub-table attributes have been grouped and ordered into "factors" of journey quality as follows:

Station	**Train**
Cleanliness	Cleanliness
Information	Information
Safety	Safety
Service	Environment
Facilities	

A full listing of each attribute in factor order, and a verbal description of the condition/level of service that each level/score represents is given in the **Attribute Improvement Level** (Section E.4.3).

E.4.1.3 Using Customer Priority Tables

The tables in E.4.2 summarise the values to be used to quantify the improvement (or worsening) in an attribute.

In using the tables, the following sequence of steps must be followed.

Establishing Level of Improvement

a) List what attributes will be affected and in which components of the passenger journey i.e. Ticket Hall, Access areas, Platforms, In-Train.
b) Establish level of improvement of each attribute in turn by:

i) Defining current position - Position using latest MSS results (if appropriate), or by using other survey work in combination with the descriptions of each level in Attribute Improvement Levels (Section E.4.3).

ii) Defining position after implementation - Using market survey information or best judgement (assisted by Attribute Improvement Levels tables), estimate level of provision of attribute after the project/service change has been implemented.

iii) Calculate predicted/desired increase - Subtract values obtained in (i) and (ii) above to give change in provision of attribute.

Making Station/Train Specific

All values in the tables are based on an overall average Underground journey. To translate into values specific to the proposed development apply the following rules:

- Stations
  - **Ticket Hall** - Value of attributes do not vary with time spent in hall. Use given values in all cases.
  - **Access and Interchange -** Values in the table are based on average access and interchange times of 1 minute. Adjust by applying the adjustment factor for the relevant stations (listed in Table E4.3.5).
  - **Platform -** Values in the table are based on average access platform wait time of 3.85 minutes. Adjust by applying the adjustment factor at the relevant stations (listed in Table E4.3.5).
  - Note that while raw access times etc. are included in Table E4.3.5 for information, only the factors should be used when calculating station specific times.

- Trains
  - Values provided are representative for a typical on-train journey time for the system of 15 minutes. Use pro rata values in relation to the line leg times for the relevant rolling stock. Line values are provided in Table D3
  - Exceptions to this rule are the attributes of external train cleanliness, external graffiti and external train livery. Although part of a train the actual impact is on passengers waiting to board the train but is not a function of platform waiting time and is therefore a one-off value to be multiplied by the number of passengers entering from the platform.

Conversion into Annual Benefits -Stations

If price base is different from that specified in the tables, adjust pro-rata with the value of time appropriate to the time base (using the real earnings table, Section C6). Convert to £ per annum by multiplying by annual passenger usage.

The values in the tables are per passenger. To arrive at total passenger per annum apply the following factors:

Ticket Hall - multiply by number of passengers per annum entering station only.

(Refer to latest Station Entry Census - available from Howard Wong [redacted] *use 1/2 of annual two way flow).*

Access - multiply by passengers per annum entering and exiting + all interchange passengers (refer to latest Station Entry Census for annual 2-way entry/exits flow figure, and seek advice on interchange passengers).

Platform - multiply by numbers of passengers entering station + interchange passengers (see above). In the event that at multi-line stations only a proportion of the platforms are being affected then seek advice to calculate the number of passengers affected.

For further advice contact Howard Wong, [redacted]

Note. In appraising the benefits of an attribute common to more than one area of the station it is necessary to apply the traffic factors as noted above individually and sum the results together. If these "best-fit" planning factors are thought to be inappropriate to a particular case then any proposed changes will need the support of TfL Business Case Development.
(contact Ryan Taylor on [redacted]

Conversion into Annual Benefits -Trains

Convert to £ per annum by multiplying by annual passenger usage (use figures for total number of passengers carried by line - and not the figures for originating passengers by line only which would understate the benefits (see Appendix B)**.**

For further advice on annual demand by LU line contact Howard Wong, [redacted]

Exceptions to this are the attributes of external train cleanliness, external graffiti and external train livery. Although part of a train the actual impact is on passengers waiting to board the train. Therefore, the per passenger benefits are grossed up by the total number of passengers on the platform (i.e. station entry + interchange passengers).

E.4.1.4 Example Of Use

Stations

A station is being re-signed to a better standard. The current MSS score for signing throughout the station is *40*.

Establishing level of improvement:

The ticket hall, access areas and platforms will all be improved by the same degree.

The expected MSS score after re-signing is expected to be about 75. The improvement in Pence/passenger will be:

Ticket Hall 0.298 - [(0.140 + 0.091)/2] = 0.183 pence

Access 0.326 - [(0.153 + 0.100)/2] = 0.200 pence

Platforms 0.410 - [(0.192 + 0.125)/2] = 0.252 pence

Making Station Specific:

Access factor = 1.26 (e.g. Camden Town);

benefits of re-signing in access areas = 0. 200 x 1.17 pence/pax

= 0.234

Interchange adjustment factor = 0.95

benefits of re-signing in interchange area = 0. 234 x 0.95 pence/pax

= 0.222

Platform adjustment factor = 0.99

benefits of re-signing in platform areas = 0. 252 x 0.99 pence/pax

= 0.249

Annual Benefits:

Station entry p.a. say 5m, Annual 2-way = 10m, Interchangers are say 4m.

Ticket Hall = 0.183 pence x 5m

= £ 9,150 per annum

Access = 0.234 pence x 10m

= £23,400 per annum

Interchange = 0.222 pence x 4m

= £8,880 per annum

Platform = 0.249 pence x 4m #

= £ 9,960 per annum

Total benefit = £51,390 per annum.

 # Note that signing on platforms is here assumed to be relevant to interchange passengers rather than to those entering platforms, who usually require no further directions. For many other attributes, platform improvements would apply to entries and interchangers.

Trains

Establishing level of improvement:

Improvements are proposed to PA systems on the train. Research has provided details about the current level of clarity and usefulness of the PA system and a proposal should achieve an improvement corresponding to movement from MSS 40% to 60%.

The benefits generated will be (from the clarity and usefulness attributes):

(2.938+1.521) - (2.503+0.402) = 1.554 pence/pax

Making Specific to Train Leg

Train leg time say 16 mins, therefore benefit = 1.554 x 16/15

= 1.658 pence/pax

Annual Benefits

Passengers journeys p.a. say 100 million p.a., therefore:

total benefit p.a. = £1.658m

E.4.2 Benefit Values For Journey Quality Attributes

E.4.2.1 Station Ticket Hall (MSS/SIS)Attributes Linked To MSS/SIS1

Price Base September 2013

Table E-10: Station Ticket Hall MSS/SIS Attributes - Value Of Going From Each Score To 100% (Pence/Pass)

Group	Attribute	MSS/SIS	0	10	20	30	40	50	60	70	80	90	100
Access	Ease of station identification from outside	MSS	0.729	0.714	0.682	0.634	0.574	0.503	0.421	0.329	0.228	0.118	0.000
Condition	Cleanliness	MSS	2.217	1.549	1.139	0.838	0.615	0.460	0.332	0.217	0.127	0.056	0.000
	Condition/appearance	MSS	2.822	2.776	2.546	2.193	1.774	1.367	1.005	0.693	0.401	0.169	0.000
	Cabling	MSS	0.835	0.743	0.602	0.467	0.355	0.280	0.221	0.164	0.103	0.048	0.000
	LUL posters	MSS	0.167	0.084	0.057	0.041	0.030	0.022	0.015	0.010	0.006	0.003	0.000
	Graffiti	MSS	0.337	0.192	0.131	0.105	0.088	0.073	0.058	0.042	0.027	0.014	0.000
	Litter	MSS	0.538	0.517	0.463	0.388	0.307	0.226	0.145	0.103	0.064	0.038	0.000
	Condition of station exterior	MSS	1.718	1.606	1.395	1.154	0.915	0.693	0.497	0.317	0.170	0.068	0.000
Facilities	Condition of ticket machines	MSS	0.200	0.199	0.191	0.175	0.150	0.130	0.100	0.072	0.050	0.025	0.000
	Condition of public phones	MSS	0.079	0.078	0.075	0.068	0.059	0.049	0.038	0.027	0.017	0.008	0.000
	Customer toilets	MSS	0.545	0.516	0.475	0.445	0.385	0.321	0.260	0.187	0.121	0.058	0.000
	Appearance of retail outlets	MSS	2.142	1.765	1.389	1.065	0.796	0.578	0.402	0.263	0.148	0.063	0.000
	Condition of photobooths	MSS	0.089	0.088	0.083	0.074	0.064	0.052	0.040	0.029	0.018	0.008	0.000
Information	Clarity of the PA announcer's delivery	SIS	0.351	0.340	0.308	0.263	0.213	0.171	0.131	0.094	0.059	0.027	0.000
	Usefulness of the PA messages	SIS	0.325	0.278	0.235	0.196	0.160	0.127	0.096	0.069	0.044	0.021	0.000
	Directional signing	MSS	0.433	0.395	0.363	0.334	0.298	0.244	0.191	0.140	0.091	0.046	0.000
	Clocks	MSS	0.241	0.234	0.215	0.189	0.160	0.130	0.100	0.072	0.045	0.021	0.000
	System disruption information	MSS	3.610	3.551	3.311	2.934	2.465	1.953	1.447	0.962	0.547	0.229	0.000
	Next train information	MSS	3.097	2.734	2.368	2.010	1.665	1.337	0.933	0.605	0.349	0.152	0.000
	LUL information leaflets	MSS	0.380	0.372	0.344	0.305	0.260	0.211	0.163	0.117	0.074	0.035	0.000
Security	Brightness of lighting	MSS	2.358	2.319	2.205	1.977	1.677	1.340	0.999	0.682	0.406	0.168	0.000
	Staff visibility	SIS	4.140	3.516	3.009	2.551	2.126	1.726	1.349	0.989	0.617	0.275	0.000
	Staff knowledge	SIS	2.127	2.123	2.020	1.818	1.547	1.239	0.924	0.630	0.373	0.150	0.000
	Staff willingness to help	SIS	1.279	1.204	1.078	0.918	0.746	0.577	0.420	0.283	0.168	0.068	0.000
	Staff appearance	SIS	0.426	0.401	0.359	0.306	0.249	0.192	0.140	0.094	0.056	0.023	0.000

NOTES

1. *Attributes are linked to either the Mystery Shopper Survey or the Staff and Information Survey.*
2. *Pro-rata values for intermediate scores.*
3. *Convert to annual benefits by multiplying by annual station entry.*
   For a fuller description of application see Section E.4.1.3.

E.4.2.2 Station: Ticket Hall (Non-MSS)

Benefit values for journey quality attributes, price base September 2013

Table E-11: Station Ticket Hall Non MSS/SIS - Value Of Going From Each Level To Best Level (Pence/Pass)

Group	Attribute	Level 1	Level 2	Level 3	Level 4
Access	Step free access in the origin station	0.932	0.299	0.000	0.000
	Step free network	1.887	0.000	0.000	0.000
	Wide Aisle Gates	0.562	0.137	0.000	0.000
	Station entrance	3.388	1.602	0.000	0.000
	Integrated bus connections	0.975	0.611	0.000	0.000
	Taxis at the station	0.664	0.438	0.217	0.000
	Bicycle parking at the station	0.587	0.388	0.193	0.000
Facilities	Ticket machine facilities	1.514	0.771	0.350	0.000
	Ticket office opening	3.519	0.955	0.000	0.000
	Booking tickets via the telephone	0.466	0.100	0.000	0.000
	Availability of public telephones	0.393	0.131	0.000	0.000
	Customer toilets	1.488	0.771	0.152	0.000
	Retail outlets	1.852	0.232	0.000	0.000
	Photobooths	0.447	0.094	0.000	0.000
	Cashpoints	5.628	0.000	0.000	0.000
	Access to wifi	0.807	0.000	0.000	0.000
Information	Audibility of the PA system	0.351	0.035	0.000	0.000
	Ease of seeing signs	0.326	0.160	0.000	0.000
	Information available via the help points	0.461	0.000	0.000	0.000
	Service disruption notices in the ticket hall	5.781	1.823	0.527	0.000
	Info on planned station and line closures	6.193	2.451	0.321	0.000
	Information button in help points – speed of response	0.361	0.000	0.000	0.000
	Station service during special line closures, e.g. for engineering works	11.094	1.135	0.000	0.000
Security	Help points	0.975	0.122	0.007	0.000
	Surveillance cameras	1.764	0.511	0.211	0.000
	Control room at the station	2.578	0.592	0.000	0.000
	Transport Police	5.172	0.620	0.000	0.000
	Emergency help at stations	2.421	1.164	0.000	0.000

NOTES

1. For description of conditions matching levels see Section E.4.3.

2. Pro-rata values for intermediate levels.

3. Convert to annual benefits by multiplying by annual station entry.

For a fuller description of application Section E.4.1.3

Attributes in bold are either new or the level descriptions have changed.

E.4.2.3 Station Access (MSS/SIS)

All values are for access time of 1 minute, price base September 2013

Table E-12: Station Access MSS/SIS - Value Of Going From Each Score To 100% (Pence/Pass)

Group	Attribute	MSS/SIS	0	10	20	30	40	50	60	70	80	90	100
Condition	Cleanliness	MSS	1.586	1.058	0.767	0.564	0.424	0.327	0.243	0.166	0.102	0.047	0.000
	Condition/appearance	MSS	0.804	0.770	0.710	0.577	0.433	0.302	0.210	0.145	0.085	0.037	0.000
	Graffiti	MSS	0.369	0.211	0.143	0.115	0.097	0.080	0.064	0.046	0.029	0.015	0.000
	Cabling in the station	MSS	0.914	0.813	0.659	0.512	0.388	0.306	0.242	0.179	0.113	0.052	0.000
	LUL posters in the station	MSS	0.183	0.091	0.063	0.045	0.033	0.024	0.017	0.011	0.007	0.003	0.000
	Condition of the escalator/lift	MSS	0.657	0.493	0.409	0.343	0.286	0.234	0.185	0.138	0.092	0.042	0.000
	Condition of mirrors	MSS	0.651	0.421	0.304	0.224	0.166	0.121	0.085	0.057	0.035	0.016	0.000
	Litter	MSS	0.589	0.566	0.507	0.425	0.336	0.248	0.158	0.113	0.070	0.042	0.000
Environment	Air quality	MSS	0.555	0.520	0.464	0.401	0.339	0.279	0.224	0.170	0.119	0.062	0.000
	Draughts	MSS	0.637	0.591	0.514	0.428	0.344	0.266	0.198	0.138	0.086	0.041	0.000
	Quietness of escalator/lift	MSS	0.377	0.263	0.204	0.161	0.127	0.098	0.074	0.052	0.032	0.014	0.000
Information	Clarity of the PA announcer's delivery	SIS	0.384	0.372	0.338	0.288	0.233	0.187	0.143	0.102	0.064	0.030	0.000
	Usefulness of the PA messages	SIS	0.356	0.305	0.258	0.214	0.175	0.139	0.105	0.075	0.048	0.023	0.000
	Directional signing	MSS	0.474	0.433	0.398	0.365	0.326	0.268	0.209	0.153	0.100	0.051	0.000
Security	Brightness of lighting	MSS	1.287	1.198	1.035	0.831	0.623	0.440	0.296	0.189	0.111	0.051	0.000
	Staff presence	SIS	1.110	0.947	0.831	0.710	0.584	0.459	0.341	0.234	0.142	0.064	0.000
	Staff knowledge	SIS	0.638	0.634	0.602	0.542	0.463	0.372	0.280	0.193	0.116	0.048	0.000
	Staff willingness to help	SIS	1.400	1.318	1.180	1.005	0.817	0.631	0.460	0.310	0.184	0.075	0.000
	Staff appearance	SIS	0.467	0.439	0.393	0.335	0.272	0.210	0.153	0.103	0.061	0.025	0.000

NOTES

1. *Attributes are linked to either the Mystery Shopper Survey or the Staff and Information Survey.*
2. *Pro-rata values for intermediate scores.*
3. *Multiply improvement value by access time adjustment factor (Table E-18) to make station specific.*
4. *Convert to annual benefits by multiplying by annual 2-way flow + total annual interchange.*

For a fuller description of application see Section E.4.1.3.

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E.4.2.4 Station: Access (Non-MSS)

Benefit values for journey quality attributes, all values are for access time of 1 minute, price base September 2013

Table E-13: Station Access Non MSS - Value Of Going From Each Level To Best Level (Pence/Pass)

Group	Attribute	Level 1	Level 2	Level 3	Level 4
Facilities	Mobile phone use	0.433	0.000	0.000	0.000
	Access to wifi	0.807	0.000	0.000	0.000
Information	Audibility of the PA system	0.384	0.038	0.000	0.000
	Information available via the help points	0.634	0.133	0.008	0.000
	Ease of seeing signs	0.440	0.305	0.000	0.000
	Information button in help points	0.361	0.000	0.000	0.000
Security	Help points	0.764	0.267	0.016	0.000
	Surveillance cameras	1.290	0.408	0.000	0.000
	Provision of corner mirrors	0.712	0.474	0.000	0.000
	Emergency help at stations	2.421	1.164	0.000	0.000

NOTES

1. *For description of conditions matching levels see Section E.4.3.*
2. *Pro-rata values for intermediate levels.*
3. *Multiply improvement value by access time adjustment factor (Table E-18) to make station specific.*
4. *Convert to annual benefits by multiplying by annual 2-way flow + total annual interchange.*

For a fuller description of application see Section E.4.1.3.

Attributes in bold are new.

E.4.2.5 Station: Platform (MSS/SIS)

Benefit values for journey quality attributes, all values are for platform wait time of 3.85 min, price base September 2013

Table E-14: Station Platform MSS/SIS - Value Of Going From Each Score To 100% (Pence/Pass)

Group	Attribute	MSS/SIS	0	10	20	30	40	50	60	70	80	90	100
Condition	Cleanliness	MSS	2.593	1.665	1.207	0.885	0.663	0.491	0.350	0.228	0.134	0.059	0.000
	Condition/appearance	MSS	2.222	2.163	1.973	1.688	1.352	1.011	0.719	0.495	0.297	0.132	0.000
	Cabling	MSS	1.148	1.021	0.827	0.642	0.488	0.385	0.304	0.225	0.142	0.065	0.000
	LUL posters	MSS	0.230	0.115	0.079	0.057	0.041	0.030	0.021	0.014	0.009	0.004	0.000
	Advertising posters	MSS	0.034	0.017	0.012	0.009	0.006	0.005	0.003	0.002	0.001	0.001	0.000
	Graffiti	MSS	0.463	0.264	0.180	0.145	0.121	0.100	0.080	0.058	0.037	0.019	0.000
	Litter	MSS	0.740	0.710	0.636	0.534	0.422	0.311	0.199	0.141	0.088	0.052	0.000
Environment	Air quality	MSS	0.555	0.520	0.464	0.401	0.339	0.279	0.224	0.170	0.119	0.062	0.000
	Draughts	MSS	0.800	0.741	0.645	0.538	0.432	0.335	0.248	0.173	0.108	0.051	0.000
Facilities	Condition of public phones	MSS	0.108	0.108	0.103	0.093	0.081	0.067	0.052	0.038	0.024	0.011	0.000
	Appearance of retail outlets	MSS	0.453	0.448	0.420	0.377	0.324	0.266	0.206	0.147	0.093	0.043	0.000
	Seats	MSS	1.243	0.934	0.697	0.514	0.409	0.331	0.258	0.188	0.122	0.059	0.000
	Waiting rooms	MSS	1.535	0.755	0.315	0.144	0.132	0.117	0.099	0.078	0.055	0.029	0.000
Information	Clarity of the PA announcer's delivery	SIS	0.482	0.467	0.424	0.362	0.292	0.235	0.180	0.129	0.081	0.037	0.000
	Usefulness of the PA messages	SIS	0.446	0.382	0.323	0.269	0.219	0.174	0.132	0.095	0.060	0.029	0.000
	Directional signing	MSS	0.595	0.543	0.499	0.459	0.410	0.336	0.262	0.192	0.125	0.064	0.000
	Clocks	MSS	0.266	0.261	0.242	0.215	0.183	0.150	0.116	0.084	0.053	0.025	0.000
	Next train information	MSS	1.372	1.314	1.238	1.144	1.022	0.880	0.726	0.558	0.377	0.190	0.000
	System disruption information	MSS	2.954	2.545	2.135	1.752	1.405	1.027	0.718	0.474	0.279	0.124	0.000
Security	Brightness of lighting	MSS	1.607	1.479	1.262	0.998	0.733	0.505	0.327	0.200	0.112	0.048	0.000
	Staff presence	SIS	3.040	2.820	2.509	2.148	1.764	1.360	0.952	0.615	0.349	0.147	0.000
	Staff knowledge	SIS	0.801	0.797	0.756	0.680	0.581	0.467	0.352	0.242	0.146	0.060	0.000
	Staff willingness to help	SIS	1.758	1.655	1.481	1.262	1.026	0.793	0.578	0.389	0.231	0.094	0.000
	Staff appearance	SIS	0.586	0.552	0.494	0.421	0.342	0.264	0.193	0.130	0.077	0.031	0.000

NOTES

1. *Attributes are linked to either the Mystery Shopper Survey or the Staff and Information Survey.*
2. *Pro-rata values for intermediate scores.*
3. *Multiply improvement value by adjustment factor (Table E-18) to make station specific.*
4. *Convert to annual benefits by multiplying by annual station entry + total annual interchange.*

For a fuller description of application see Section E.4.1.3.

E.4.2.6 Station: Platform (Non-MSS)

Benefit values for journey quality attributes, all values are for platform wait time of 3.85 min, price Base September 2013

Table E-15: Station Platform Non MSS - Value Of Going From Each Level To Best Level (Pence/Pass)

Group	Attribute	Level 1	Level 2	Level 3	Level 4
Access	Step free access between the platform and train	1.477	0.530	0.000	0.000
Environment	Platform canopy	1.158	0.334	0.000	0.000
	Seating on platform	2.750	0.768	0.000	0.000
	Platform Air Cooling	7.714	1.048	0.000	0.000
Facilities	Availability of public telephones	0.540	0.180	0.000	0.000
	Retail outlets	0.839	0.000	0.000	0.000
	Access to wifi	0.807	0.000	0.000	0.000
Information	Audibility of the PA system	0.446	0.104	0.000	0.000
	Information available via the help points	0.959	0.335	0.020	0.000
	Information on the outside of the train	0.613	0.000	0.000	0.000
	Next train information on platform displays	5.948	0.456	0.000	0.000
	Disruption information on platform displays	0.482	0.000	0.000	0.000
	Ease of seeing signs	0.552	0.382	0.000	0.000
	Information button in help points	0.361	0.000	0.000	0.000
Security	Help points	0.959	0.335	0.020	0.000
	Surveillance cameras	2.302	0.889	0.000	0.000
	Emergency help at stations	2.421	1.164	0.000	0.000

NOTES

1. *For description of conditions matching levels see Section E.4.3.*
2. *Pro-rata values for intermediate levels.*
3. *Multiply improvement value by adjustment factor (Table E-18) to make station specific.*
4. *Convert to annual benefits by multiplying by annual station entry + total annual interchange.*

For a fuller description of application see Section E.4.1.3

Attributes in bold are new.

E.4.2.7 Train (MSS/SIS)

Benefit values for journey quality attributes, values are for typical on–train leg time of 15 mins, price base September 2013

Table E-16: Train MSS/SIS - Value Of Going From Each Score To 100% (Pence/Pass)

Group	Attribute	MSS/SIS	0	10	20	30	40	50	60	70	80	90	100
Environment	Air quality	MSS	10.847	10.814	10.088	8.822	7.264	5.620	4.176	2.898	1.662	0.703	0.000
	Temperature	MSS	32.351	28.859	25.367	21.875	18.383	14.891	11.399	7.907	4.415	0.922	0.000
	Noise from trains (wheels/track etc)	MSS	4.069	3.829	3.433	2.995	2.558	2.070	1.615	1.168	0.730	0.344	0.000
	Ride quality	MSS	13.207	11.926	10.537	9.162	7.844	6.554	5.234	3.880	2.552	1.263	0.000
Condition	Cleanliness of seats	MSS	2.794	2.541	2.197	1.851	1.503	1.190	0.915	0.656	0.397	0.182	0.000
	Litter	MSS	4.578	4.288	3.870	3.357	2.787	2.206	1.626	1.061	0.626	0.284	0.000
	Condition of seats	MSS	5.634	4.657	4.076	3.355	2.724	2.191	1.685	1.187	0.748	0.356	0.000
	Overall cleanliness inside train	MSS	2.956	1.708	1.198	0.946	0.760	0.608	0.463	0.328	0.209	0.100	0.000
	Outside cleanliness of the train #	MSS	2.956	1.708	1.198	0.946	0.760	0.608	0.463	0.328	0.209	0.100	0.000
	State of LUL posters inside the train	MSS	4.637	4.493	4.048	3.430	2.740	2.066	1.518	1.032	0.587	0.249	0.000
	State of adverting posters inside the train	MSS	2.014	1.569	1.261	1.007	0.567	0.463	0.349	0.248	0.157	0.075	0.000
	Surface graffiti on inside of the train	MSS	2.014	1.569	1.261	1.007	0.567	0.463	0.349	0.248	0.157	0.075	0.000
	Graffiti on windows and fixtures	MSS	1.516	1.001	0.769	0.616	0.497	0.391	0.291	0.204	0.125	0.057	0.000
	Graffiti on outside of the train #	MSS	3.969	3.488	2.860	2.239	1.689	1.250	0.886	0.586	0.345	0.145	0.000
	Trackside graffiti	MSS	4.419	3.600	2.898	2.299	1.776	1.332	0.961	0.583	0.314	0.127	0.000
Information	Clarity of driver's delivery over PA	SIS	3.478	3.396	3.274	3.120	2.938	2.731	2.503	2.173	1.491	0.765	0.000
	Usefulness of PA messages on train	SIS	3.261	3.090	2.787	2.367	1.521	0.821	0.402	0.213	0.115	0.051	0.000
	Interchange and next station information over the train PA	SIS	3.261	3.090	2.787	2.367	1.521	0.821	0.402	0.213	0.115	0.051	0.000
	Electronic displays in the carriages	MSS	5.175	5.050	4.809	4.398	3.830	3.168	2.538	1.974	1.376	0.697	0.000
	Time of first PA announcement when a delay occurs	MSS	3.158	2.978	2.740	2.477	2.185	1.761	1.373	1.003	0.656	0.317	0.000
	Frequency of PA announcements when a delay occurs	MSS	2.721	2.449	2.177	1.905	1.633	1.361	1.088	0.816	0.544	0.272	0.000
Security	Brightness of lighting	MSS	5.031	4.510	3.993	3.474	2.952	2.428	1.907	1.396	0.903	0.423	0.000

NOTES

1. *Attributes are linked to either the Mystery Shopper Survey or the Staff and Information Survey.*
2. *Pro-rata values for intermediate scores.*
3. *Multiply improvement value by actual train leg time (min) / 15min to make line specific.*
4. *Convert to annual benefits by multiplying by annual passenger journeys on leg. For a fuller description of application see Section E.4.1.3*

 # These attributes impact on passengers waiting to board train, therefore factoring of benefits as per note 3 does not apply.

E.4.2.8 Train (Non-MSS)

Benefit values for journey quality attributes, values are for typical on–train leg time of 15 mins, price base September 2013

Table E-17: Train Non MSS - Value Of Going From Each Level To Best Level (Pence/Passenger)

Group	Attribute	Level 1	Level 2	Level 3	Level 4
Condition	Ability of staff to stop the train from the platform	5.318	0.000	0.000	0.000
	Newness of the train	1.787	1.313	0.000	0.000
	External décor #	1.176	0.698	0.000	0.000
	Automatic doors	1.492	0.000	0.000	0.000
Environment	Type of train seats	2.093	0.000	0.000	0.000
	Size of windows	2.657	0.000	0.000	0.000
	Carriage seat layout	2.007	0.000	0.000	0.000
	Multi-purpose areas	3.891	0.000	0.000	0.000
	Gangways	0.599	0.599	0.000	0.000
	Comfort of seating	3.472	0.000	0.000	0.000
Facilities	**Wifi on train**	tbc	0.000	0.000	0.000
Information	**Train operator announcements of disruption on connecting lines**	8.561	5.328	1.976	0.000
Security	Staff on the train	5.849	1.598	0.000	0.000
	Customer alarms	9.249	1.654	0.000	0.000
	Surveillance cameras	6.992	1.559	0.000	0.000
	Access between carriages	2.768	0.654	0.000	0.000
	Ability to see between carriages	3.048	0.000	0.000	0.000

NOTES

1. *For description of conditions matching levels see Section E.4.3.*
2. *Pro-rata values for intermediate levels.*
3. *Multiply improvement value by actual train leg time (min) / 15min to make line specific.*

 # This attribute impacts on passengers waiting to board train, therefore factoring as per note 3 does not apply.

4. *Convert to annual benefits by multiplying by annual passenger journeys on leg.*

   For a fuller description of application see Section E.4.1.3.

Attributes in bold are new

E.4.3 Attribute Improvement Levels

Descriptions of the levels for each of those attributes in Tables E10 – E17 which are not measured in the Mystery Shopping Survey are given below.

For those attributes measured in the Mystery Shopping Survey, refer to the Mystery Shopping Survey Ratings Manual (contact Victor Santos, [redacted]

For attributes measured in the Staff and Information Survey contact Russell Cross, [redacted]

E.4.3.1 Ticket Hall Non-MSS Attribute Descriptions

Step free access in the origin station

1 No step free access in station
2 Step free access from station entrance to ticket hall but not between ticket hall and platform or between platforms
3 Step free access throughout station

Step Free Network

1 Small number of step free stations
2 Step free at major stations/interchanges so that you are always within 2 stations of a step free station

Wide Aisle Gates

1 One wide gate which has to be manually opened by staff
2 One wide gate which can be manually opened by customers
3 One wide automatic ticket gate

Station entrance

1 Difficult to recognise the station until you are at the entrance
2 Difficult to recognise the station from more than 100 metres away
3 Easily recognisable as a station from over 100 metres away

Integrated bus connections

1 No bus stop nearby
2 Bus stop nearby, but buses are infrequent and not timed to connect with trains
3 Bus stop nearby with frequent service or guaranteed connection (bus waits for train)

Taxis at the station

1 No taxi rank outside station
2 Taxi rank outside station
3 Taxi rank outside station and free phone facility (if no taxi is there)
4 London Underground licensed taxi company guaranteeing a taxi available outside station

Bicycle parking at the station

1 No bicycle racks outside station
2 Bicycle racks provided, open to the elements
3 Bicycle racks provided, under cover
4 Secure storage shed provided

Ticket machine facilities

1 Only some machines give change, none accept notes or payment cards
2 All machines give change, some accept notes
3 All machines give change, some accept notes and some accept payment cards
4 All machines give change and accept notes and payment cards

Ticket Office Opening

1 No ticket office (but station still staffed while open)
2 Ticket office open 8am-7pm (but station still staffed while open)
3 Ticket office open while the station is open

Booking tickets via the telephone

1 No telephone bookings of ticket sales possible
2 Telephone bookings using credit card payment possible for monthly and annual Travelcards
3 Telephone bookings using credit card payment possible for weekly, monthly and annual Travelcards

Availability of public telephones

1 No pay phones on station
2 Phones in ticket hall only
3 Phones in ticket hall and on the platform

Customer Toilets

1 No customer toilets available on station
2 Basic toilet facilities, unmodernised or poor condition
3 Modern Super Loo cubicle available
4 Modernised or new toilet facilities in good state of repair

Retail outlets

1 No shops in ticket hall
2 General shop with range of goods in the ticket hall
3 Recognised brand shop in the station – Marks and Spencer Food, TESCO Metro etc.

Photobooths in the station

1 No photo booths in the station
2 Photo booth in the ticket hall
3 Photo booths in the ticket hall and on platforms

Cashpoints in the station

1 No cashpoints at the station
2 1 or more cashpoints

Access to wifi

1 No access to wifi for your internet device
2 Access to wifi at stations

Audibility of the PA system

1 Impossible to hear (muffled, echoing, overriding message, etc)
2 Able to hear with some difficulty, some of the message inaudible
3 Whole message can be clearly heard

Ease of seeing signs

1 Many important signs and equipment are obstructed (eg by other signs or fixtures)
2 Some important signs or equipment are obstructed
3 No obstructions - all important signs and equipment can be clearly seen

Information available via the Help points

1 No information available via Help Points
2 Help Points allowing you to speak to a member of staff

<u>Service disruption notices in the Ticket Hall</u>

1 No information in the ticket hall about service disruptions
2 Hand-written notices in the ticket hall showing service disruptions
3 Display board manually updated by staff showing service disruptions in ticket hall
4 Electronic display in the ticket hall showing service disruptions

<u>Info on planned station and line closures</u>

1 Leaflets at station
2 Leaflets at station and public announcements in week preceding
3 Leaflets at station, public announcements and specific information handed out in week preceding
4 Leaflets at station, public announcements and specific information handed out in week preceding + email to Oystercard holders

<u>Information button in help points – speed of response</u>

1 Response to pressing button is not immediate
2 Response to pressing button is immediate and information is given about the train service (no additional benefit if information about the local area is provided)

<u>Station service during special line closures, e.g. for engineering work</u>

1 On occasions when line is closed, station is closed, no staff, no ticketing facilities
2 On occasions when line is closed, station closed, no ticketing facilities but staff outside to give advice
3 On occasions when line closed, ticket hall open with ticket machines and staff in the ticket hall to give advice (but no train service)

<u>Help points in the ticket hall</u>

1 No help points in ticket hall
2 Help points in the ticket hall, but not easily visible
3 Help points in the ticket hall, easily visible

<u>Surveillance cameras in the ticket hall</u>

1 No surveillance cameras
2 Surveillance cameras covering the ticket hall area only
3 Surveillance cameras covering ticket hall area and station exit
4 Surveillance cameras covering ticket hall, station exit, plus dark pathways/car park, access routes, etc.

<u>Control room at the station</u>

1 No control room at the station
2 Control room at the station, but not visible from the ticket hall
3 Control room at the station, visible from the ticket hall

<u>Transport Police</u>

1 Police available on system but not necessarily close to station. Response time more than 15 minutes
2 Police available locally. Response time 5-15 minutes
3 Police available immediately. Response time less than 5 minutes

<u>Emergency help at stations</u>

1 No-one on the station available to give help and advice
2 No London Underground staff on the station, but someone usually present to advise if needed – shop staff, cleaners etc.
3 London Underground station staff visible

E.4.3.2 Access Area Non-MSS Attribute Descriptions

Mobile Phone use

1 Ticket hall only
2 Throughout station

Access to wifi

1 No access to wifi for your internet device
2 Access to wifi at stations

Audibility of the PA system

1 Impossible to hear (muffled, echoing, overriding message, etc)
2 Able to hear with some difficulty, some of the message inaudible
3 Whole message can be clearly heard

Information available via the Help points

1 No information available via Help Points
2 Help Points allowing you to speak to a member of staff

Ease of seeing signs

1 Many important signs and equipment are obstructed (eg by other signs or fixtures)
2 Some important signs or equipment are obstructed
3 No obstructions - all important signs and equipment can be clearly seen

Information button in help points – speed of response

1 Response to pressing button is not immediate
2 Response to pressing button is immediate and information is given about the train service (no additional benefit if information about the local area is provided)

Help points in the walkways

1 No help points
2 Help points with fire alarm only
3 Help points with fire alarm and emergency button
4 Help points with fire alarm and emergency button with facility to talk to staff

Surveillance cameras in the walkways

1 No surveillance cameras
2 Surveillance cameras covering about half the walkway areas
3 Surveillance cameras covering all the walkway areas

Provision of corner mirrors

1 No corner mirrors
2 Some corner mirrors, but not all corners covered
3 Corner mirrors provided at all corners

Emergency help at stations

1 No-one on the station available to give help and advice
2 No London Underground staff on the station, but someone usually present to advise if needed – shop staff, cleaners etc.
3 London Underground station staff visible

E.4.3.3 Platform Non-MSS Attribute Descriptions

Step free access between the platform and train
1 Step and discernible gap between platform and train
2 Step between platform and train but no discernible gap
3 No step or discernible gap between platform and train

Platform canopy
1 No canopy
2 Canopy covering some of the platform
3 Canopy covering all of the platform

Seating on Platform
1 No seats provided
2 Seats provided, but vandalised/in poor state of repair
3 Seats provided, in good condition

Platform Air Cooling
1 No air movement or cooling
2 Flow of air maintained along platform
3 Cooled air fans at points along platform in summer

Availability of public telephones
1 No pay phones on station
2 Phones in ticket hall only
3 Phones in ticket hall and on the platform

Retail outlets
1 No shops on the platform
2 Kiosk on the platform – milk, sweets and newspapers etc.

Access to wifi
1 No access to wifi for your internet device
2 Access to wifi at stations

Audibility of the PA system
1 Impossible to hear (muffled, echoing, overriding message, etc)
2 Able to hear with some difficulty, some of the message inaudible
3 Whole message can be clearly heard

Information available via the Help points
1 No information available via Help Points
2 Help Points allowing you to speak to a member of staff

Information on the outside of the train
1 No information on the front of the train
2 Front of train showed destination and route

Next train information on platform displays
1 No information about next train on the platform
2 Electronic information on the platform about next train destination
3 Electronic information on the platform about next train destination AND arrival time

Disruption information on platform displays

1 No information about system disruptions on platform displays
2 Information about service disruptions on platform displays

Ease of seeing signs

1 Many important signs and equipment are obstructed (eg by other signs or fixtures)
2 Some important signs or equipment are obstructed
3 No obstructions - all important signs and equipment can be clearly seen

Information button in help points – speed of response

1 Response to pressing button is not immediate
2 Response to pressing button is immediate and information is given about the train service (no additional benefit if information about the local area is provided)

Help points on the platform

1 No help points
2 Help points with fire alarm only
3 Help points with fire alarm and emergency button
4 Help points with fire alarm and emergency button with facility to talk to staff

Surveillance cameras on the platform

1 No surveillance cameras
2 Surveillance cameras covering about half the platform areas
3 Surveillance cameras covering all the platform areas

Emergency help at stations

1 No-one on the station available to give help and advice
2 No London Underground staff on the station, but someone usually present to advise if needed – shop staff, cleaners etc.
3 London Underground station staff visible

E.4.3.4 Train Non-MSS Attribute Descriptions

Ability of staff to stop the train from the platform

1 Station staff cannot stop the train at the platform
2 Station staff can stop the train at the platform

Newness of the train

1 Unmodernised train
2 Refurbished train
3 New train

External décor of the train

1 Trains not painted (aluminium exteriors retained)
2 Trains painted but the paint looking old
3 Trains painted recently

Automatic doors

1 Doors do not open and close individually
2 Doors open and close individually (when you press a button)

Type of train seats

1 Hard seats
2 Sprung seats

Size of Windows

1 Reduced height windows
2 Standard height windows

Carriage seat layout

1 All upholstered seats, no tipping seats in the vestibule
2 Mostly upholstered seats with some tipping seats in the vestibule

Multi-purpose areas

1 No multi-purpose areas
2 Multi-purpose area available

Gangways

1 No gangway: carriages divided by doors
2 Connecting area to walk through but not stand in
3 Gangway: room to stand between carriages and to move through the train

Comfort of seating

1 Fairly upright seat with small amount of padding
2 Taller seat leaning back with full amount of padding

Wifi on train

1 No access to wifi for your internet device
2 Access to wifi at stations

Train operator announcements of disruption on connecting lines

1 Makes no announcement
2 Train operator explains disruptions only to the line you are on
3 Makes announcement about disruptions to the tube network
4 Train operator announces disruptions on the tube, DLR and Overground services

Staff on the train

1 Train driver in cab
2 Automatically controlled train with a train captain in a clearly marked carriage
3 Automatically controlled train with a train captain moving up and down inside the train

Customer alarms on the train

1 No – none at all
2 Yes - some in each carriage, widely spaced out
3 Yes - lots in each carriage, within easy reach

Surveillance cameras on the train

1 No surveillance cameras on the train
2 Surveillance cameras in some clearly marked carriages
3 Surveillance cameras in all carriages

Access between carriages

1 No access between train carriages
2 Limited access for emergency use only
3 Easy access between carriages

Ability to see between carriages

1 Yes, able to see clearly between adjacent carriages (through windows at end of carriages)
2 No, unable to see clearly into adjacent carriages

E.4.3.5 Station Access Times & Adjustment Factors

Analysis has shown that customer valuations of attributes on platforms and access are not in direct proportion to time. That is, there is a "standing" element which is independent of time plus a "variable" element proportional to time. For ease of use, factors have been calculated for the individual stations to apply to the values quoted in the passenger priorities Tables E9 to E15.

For further information on access times, wait times and station adjustment factors contact Gillian Yates [redacted]

Table E-18: Station Access/Wait Times (Mins) & Adjustment Factors

Station	Access		Interchange		Platform	
	Time	Factor	Time	Factor	Time	Factor
Acton Town	1.38	1.08	2.54	1.31	3.15	0.97
Aldgate	1.22	1.04	-	0.80	4.90	1.05
Aldgate East	1.53	1.11	1.60	1.12	4.34	1.02
Alperton	0.52	0.90	-	0.80	6.93	1.15
Amersham	0.50	0.90	-	0.80	10.00	1.31
Angel	2.58	1.32	-	0.80	4.27	1.02
Archway	2.03	1.21	-	0.80	5.67	1.09
Arnos Grove	1.01	1.00	-	0.80	2.24	0.92
Arsenal	1.97	1.19	-	0.80	2.38	0.93
Baker Street	1.95	1.19	1.97	1.19	3.64	0.99
Balham	1.28	1.06	-	0.80	3.92	1.00
Bank	2.99	1.40	3.08	1.42	3.29	0.97
Barbican	1.08	1.02	-	0.80	3.78	1.00
Barking	1.46	1.09	-	0.80	4.34	1.02
Barkingside	1.02	1.00	-	0.80	5.67	1.09
Barons Court	1.14	1.03	-	0.80	3.22	0.97
Bayswater	0.60	0.92	-	0.80	6.44	1.13
Becontree	1.00	1.00	-	0.80	4.41	1.03
Belsize Park	1.36	1.07	-	0.80	5.11	1.06

Station	Access		Interchange		Platform	
	Time	Factor	Time	Factor	Time	Factor
Bermondsey	0.92	0.98	-	0.80	4.06	1.01
Bethnal Green.	1.99	1.20	-	0.80	3.85	1.00
Blackfriars	0.70	0.94	-	0.80	3.22	0.97
Blackrhose Road	1.72	1.14	-	0.80	3.57	0.99
Bond Street	2.28	1.26	2.26	1.25	3.85	1.00
Borough	1.10	1.02	-	0.80	4.62	1.04
Boston Manor	1.12	1.02	-	0.80	4.13	1.01
Bounds Green	1.27	1.05	-	0.80	2.45	0.93
Bow Road	0.98	1.00	-	0.80	4.20	1.02
Brent Cross	0.53	0.91	-	0.80	5.04	1.06
Brixton	1.83	1.17	-	0.80	3.08	0.96
Bromley-by-Bow	1.21	1.04	-	0.80	3.99	1.01
Buckhurst Hill	1.23	1.05	-	0.80	7.77	1.20
Burnt Oak	0.53	0.91	-	0.80	4.55	1.04
Caledonian Road	1.40	1.08	-	0.80	2.73	0.94
Camden Town	1.84	1.17	0.76	0.95	3.71	0.99
Canada Water	1.91	1.18	0.89	0.98	4.27	1.02
Canary Wharf	2.00	1.20	-	0.80	4.27	1.02
Canning Town	1.28	1.06	0.50	0.90	3.99	1.01
Cannon Street	0.77	0.95	-	0.80	2.52	0.93
Canons Park	1.01	1.00	-	0.80	5.11	1.06
Chalfont&Latimer	0.82	0.96	1.55	1.11	10.00	1.31
Chalk Farm	1.09	1.02	-	0.80	5.32	1.07
Chancery Lane	1.64	1.13	-	0.80	4.06	1.01
Charing Cross	2.05	1.21	3.20	1.44	3.85	1.00
Chesham	1.00	1.00	-	0.80	10.00	1.31
Chigwell	1.02	1.00	-	0.80	10.00	1.31
Chiswick Park	1.32	1.06	-	0.80	9.17	1.27
Chorleywood	1.00	1.00	-	0.80	10.00	1.31
Clapham Common	1.87	1.17	-	0.80	4.06	1.01
Clapham North	1.72	1.14	-	0.80	4.20	1.02
Clapham South	1.92	1.18	-	0.80	3.85	1.00
Cockfosters	1.20	1.04	-	0.80	3.57	0.99
Colindale	0.53	0.91	-	0.80	4.83	1.05
Colliers Wood	1.11	1.02	-	0.80	3.78	1.00
Covent Garden	1.73	1.15	-	0.80	3.64	0.99
Croxley	1.00	1.00	-	0.80	10.00	1.31
Dagenham East	1.01	1.00	-	0.80	4.27	1.02
Dagenham.Hthwy	1.23	1.05	-	0.80	4.76	1.05
Debden	1.05	1.01	-	0.80	7.63	1.19
Dollis Hill	0.80	0.96	-	0.80	4.41	1.03
Ealing Broadway	1.31	1.06	0.62	0.92	6.86	1.15
Ealing Common	0.87	0.97	1.52	1.10	6.16	1.12
Earl's Court	2.55	1.31	1.74	1.15	3.36	0.98
East Acton	2.03	1.21	-	0.80	4.69	1.04
East Finchley	0.78	0.96	-	0.80	6.23	1.12
East Ham	1.03	1.01	-	0.80	3.78	1.00
East Putney	2.13	1.23	-	0.80	5.53	1.08
Eastcote	1.00	1.00	-	0.80	7.98	1.21
Edgware	0.77	0.95	-	0.80	5.81	1.10
Edgware Rd.(Bak)	1.03	1.01	-	0.80	3.15	0.97
Edgware Rd.(Cir)	0.60	0.92	1.00	1.00	5.32	1.07
Elephant&Castle	2.12	1.22	1.15	1.03	3.78	1.00
Elm Park	1.28	1.06	-	0.80	4.69	1.04
Embankment	1.06	1.01	1.68	1.14	3.43	0.98
Epping	0.65	0.93	-	0.80	8.54	1.23
Euston	2.87	1.37	1.50	1.10	3.36	0.98
Euston Square	0.83	0.97	-	0.80	3.99	1.01
Fairlop	1.02	1.00	-	0.80	4.97	1.06
Farringdon	1.18	1.04	-	0.80	3.22	0.97
Finchley Central	0.86	0.97	0.73	0.95	6.16	1.12
Finchley Road	0.97	0.99	1.53	1.11	3.99	1.01
Finsbury Park	1.58	1.12	0.20	0.84	2.38	0.93
Fulham Broadway	1.04	1.01	-	0.80	5.81	1.10
Gants Hill	2.53	1.31	-	0.80	5.88	1.10
Gloucester Road	1.04	1.01	1.65	1.13	3.92	1.00

Station	Access		Interchange		Platform	
	Time	Factor	Time	Factor	Time	Factor
Golders Green	0.76	0.95	-	0.80	5.32	1.07
Goldhawk Road	1.01	1.00	-	0.80	5.53	1.08
Goodge Street	1.11	1.02	-	0.80	4.27	1.02
Grange Hill	1.02	1.00	-	0.80	10.00	1.31
Green Park	1.97	1.19	3.56	1.51	2.87	0.95
Greenford	2.02	1.20	-	0.80	5.81	1.10
Gt.Portland Street	0.94	0.99	-	0.80	4.55	1.04
Gunnersbury	1.38	1.08	-	0.80	6.93	1.15
Hainault	1.16	1.03	2.32	1.26	6.02	1.11
Hammsmith (Dist)	0.53	0.91	0.70	0.94	3.71	0.99
Hammsmith (H&C)	0.33	0.87	-	0.80	5.53	1.08
Hampstead	0.68	0.94	-	0.80	5.32	1.07
Hanger Lane	1.63	1.13	-	0.80	6.23	1.12
Harlesden	0.77	0.95	-	0.80	5.74	1.09
Harrow Weald	2.04	1.21	-	0.80	8.05	1.21
Harrow-on-the-Hill	1.62	1.12	1.50	1.10	6.44	1.13
Hatton Cross	0.77	0.95	-	0.80	3.85	1.00
Heathrow T 123	0.90	0.98	-	0.80	5.11	1.06
Heathrow T 4	0.75	0.95	-	0.80	7.28	1.17
Hendon Central	0.53	0.91	-	0.80	4.83	1.05
High Barnet	0.52	0.90	-	0.80	7.56	1.19
High Street Ken.	1.32	1.06	1.00	1.00	7.21	1.17
Highbury	2.36	1.27	-	0.80	2.80	0.95
Highgate	3.74	1.55	-	0.80	5.18	1.07
Hillingdon	0.97	0.99	-	0.80	7.84	1.20
Holborn	2.71	1.34	2.54	1.31	3.22	0.97
Holland Park	1.03	1.01	-	0.80	3.50	0.98
Holloway Road	1.07	1.01	-	0.80	3.22	0.97
Hornchurch	1.02	1.00	-	0.80	4.97	1.06
Hounslow Central	1.13	1.03	-	0.80	4.27	1.02
Hounslow East	0.77	0.95	-	0.80	4.34	1.02
Hounslow West	1.53	1.11	-	0.80	3.92	1.00
Hyde Park Corner	1.14	1.03	-	0.80	3.57	0.99
Ickenham	0.75	0.95	-	0.80	8.54	1.23
Kennington	1.42	1.08	1.17	1.03	3.57	0.99
Kensal Green	1.02	1.00	-	0.80	5.88	1.10
Kensington (Olympia)	1.52	1.10	-	0.80	10.00	1.31
Kentish Town	1.50	1.10	3.00	1.40	5.95	1.11
Kenton	0.87	0.97	-	0.80	7.49	1.18
Kew Gardens	0.78	0.96	-	0.80	7.35	1.18
Kilburn	1.03	1.01	-	0.80	3.50	0.98
Kilburn Park	1.03	1.01	-	0.80	2.87	0.95
King's Cross	1.81	1.16	2.24	1.25	3.15	0.97
Kingsbury	1.02	1.00	-	0.80	5.18	1.07
Knightsbridge	1.99	1.20	-	0.80	3.64	0.99
Ladbroke Grove	1.32	1.06	-	0.80	6.02	1.11
Lambeth North	0.83	0.97	-	0.80	3.85	1.00
Lancaster Gate	0.98	1.00	-	0.80	3.22	0.97
Latimer Road	1.02	1.00	-	0.80	5.67	1.09
Leicester Square	1.74	1.15	0.99	1.00	3.85	1.00
Leyton	1.05	1.01	-	0.80	3.71	0.99
Leytonstone	1.62	1.12	2.83	1.37	3.64	0.99
Liverpool Street	1.77	1.15	2.35	1.27	3.64	0.99
London Bridge	2.45	1.29	2.34	1.27	3.36	0.98
Loughton	1.03	1.01	-	0.80	8.19	1.22
Maida Vale	0.83	0.97	-	0.80	2.87	0.95
Manor House	1.48	1.10	-	0.80	2.73	0.94
Mansion House	1.38	1.08	-	0.80	3.92	1.00
Marble Arch	3.22	1.44	-	0.80	3.99	1.01
Marylebone	3.47	1.49	-	0.80	2.87	0.95
Mile End	1.16	1.03	1.40	1.08	3.36	0.98
Mill Hill East	0.80	0.96	-	0.80	10.00	1.31
Monument	0.91	0.98	3.07	1.41	3.92	1.00
Moor Park	0.62	0.92	0.96	0.99	10.00	1.31
Moorgate	2.06	1.21	2.28	1.26	4.20	1.02
Morden	0.87	0.97	-	0.80	4.13	1.01

Station	Access		Interchange		Platform	
	Time	Factor	Time	Factor	Time	Factor
Mornington Cres	1.31	1.06	-	0.80	5.18	1.07
Neasden	1.02	1.00	-	0.80	4.13	1.01
New Cross	0.93	0.99	-	0.80	10.00	1.31
New Cross Gate	1.23	1.05	-	0.80	10.00	1.31
Newbury Park	1.33	1.07	-	0.80	6.09	1.11
North Acton	1.40	1.08	1.07	1.01	4.76	1.05
North Ealing	1.10	1.02	-	0.80	7.28	1.17
North Greenwich	1.02	1.00	-	0.80	4.13	1.01
North Harrow	1.20	1.04	-	0.80	10.00	1.31
North Wembley	0.76	0.95	-	0.80	7.63	1.19
Northfields	1.12	1.02	-	0.80	4.20	1.02
Northolt	1.13	1.03	-	0.80	5.81	1.10
Northwick Park	1.13	1.03	-	0.80	7.21	1.17
Northwood	1.01	1.00	-	0.80	10.00	1.31
Northwood Hills	1.10	1.02	-	0.80	10.00	1.31
Notting Hill Gate	2.38	1.28	3.22	1.44	4.97	1.06
Oakwood	1.22	1.04	-	0.80	3.64	0.99
Old Street	2.07	1.21	-	0.80	4.13	1.01
Osterley	1.10	1.02	-	0.80	4.69	1.04
Oval	2.03	1.21	-	0.80	4.27	1.02
Oxford Circus	2.69	1.34	2.15	1.23	3.29	0.97
Paddington	1.24	1.05	2.64	1.33	4.55	1.04
Park Royal	1.33	1.07	-	0.80	7.91	1.20
Parsons Green	1.22	1.04	-	0.80	5.95	1.11
Perivale	1.13	1.03	-	0.80	5.81	1.10
Piccadilly Circus	3.21	1.44	1.16	1.03	3.43	0.98
Pimlico	1.07	1.01	-	0.80	3.57	0.99
Pinner	1.01	1.00	-	0.80	10.00	1.31
Plaistow	1.12	1.02	-	0.80	4.06	1.01
Preston Road	0.78	0.96	-	0.80	6.51	1.13
Putney Bridge	1.13	1.03	-	0.80	6.16	1.12
Queens Park	1.02	1.00	-	0.80	3.01	0.96
Queensbury	1.01	1.00	-	0.80	4.83	1.05
Queensway	1.14	1.03	-	0.80	3.50	0.98
Ravenscourt Park	1.03	1.01	-	0.80	5.67	1.09
Rayners Lane	0.88	0.98	1.55	1.11	6.93	1.15
Redbridge	1.02	1.00	-	0.80	5.53	1.08
Regents Park	2.01	1.20	-	0.80	3.08	0.96
Richmond	1.50	1.10	-	0.80	7.42	1.18
Rickmansworth	0.52	0.90	-	0.80	10.00	1.31
Roding Valley	0.77	0.95	-	0.80	10.00	1.31
Rotherhithe	1.51	1.10	-	0.80	7.56	1.19
Royal Oak	1.22	1.04	-	0.80	6.02	1.11
Ruislip	1.01	1.00	-	0.80	8.05	1.21
Ruislip Gardens	1.02	1.00	-	0.80	8.61	1.24
Ruislip Manor	1.01	1.00	-	0.80	7.98	1.21
Russell Square	1.81	1.16	-	0.80	3.29	0.97
Seven Sisters	2.46	1.29	-	0.80	3.01	0.96
Shadwell	1.21	1.04	-	0.80	7.00	1.16
Shep's Bush (C)	2.01	1.20	-	0.80	3.22	0.97
Shep's Bush (H&C)	1.05	1.01	-	0.80	5.60	1.09
Shoreditch	0.60	0.92	-	0.80	9.03	1.26
Sloane Square	0.91	0.98	-	0.80	3.78	1.00
Snaresbrook	2.02	1.20	-	0.80	8.12	1.21
South Ealing	1.12	1.02	-	0.80	4.06	1.01
South Harrow	1.01	1.00	-	0.80	6.72	1.14
South Kensington	1.57	1.11	1.91	1.18	3.50	0.98
South Kenton	0.52	0.90	-	0.80	8.12	1.21
South Ruislip	1.12	1.02	-	0.80	8.40	1.23
South Woodford	1.29	1.06	-	0.80	7.91	1.20
Southfields	1.03	1.01	-	0.80	5.25	1.07
Southgate	1.03	1.01	-	0.80	3.57	0.99
Southwark	1.55	1.11	-	0.80	4.06	1.01
SouthWimbledon	1.47	1.09	-	0.80	3.43	0.98
St. James's Park	0.98	1.00	-	0.80	4.06	1.01
St. John's Wood	1.53	1.11	-	0.80	3.99	1.01

Station	Access		Interchange		Platform	
	Time	Factor	Time	Factor	Time	Factor
St. Paul's	3.13	1.43	-	0.80	3.85	1.00
Stamford Brook	1.11	1.02	-	0.80	5.32	1.07
Stanmore	1.02	1.00	-	0.80	4.55	1.04
Stepney Green	1.28	1.06	-	0.80	4.48	1.03
Stockwell	2.02	1.20	0.72	0.94	3.36	0.98
Stonebridge Park	1.03	1.01	-	0.80	5.53	1.08
Stratford	2.63	1.33	2.73	1.35	3.57	0.99
Sudbury Hill	1.13	1.03	-	0.80	6.65	1.14
Sudbury Town	0.99	1.00	-	0.80	6.93	1.15
Surrey Docks	0.79	0.96	-	0.80	8.12	1.21
Swiss Cottage	1.72	1.14	-	0.80	3.50	0.98
Temple	0.96	0.99	-	0.80	3.36	0.98
Theydon Bois	1.02	1.00	-	0.80	8.26	1.22
Tooting Bec	1.52	1.10	-	0.80	3.85	1.00
Tooting Broadway	1.28	1.06	-	0.80	3.64	0.99
Tottenham Ct Rd	3.21	1.44	3.35	1.47	3.99	1.01
Tottenham Hale	1.73	1.15	-	0.80	3.43	0.98
Totteridge	1.12	1.02	-	0.80	6.30	1.12
Tower Hill	0.87	0.97	1.20	1.04	4.20	1.02
Tufnell Park	1.23	1.05	-	0.80	5.74	1.09
Turnham Green	1.17	1.03	2.13	1.23	4.48	1.03
Turnpike Lane	1.52	1.10	-	0.80	2.66	0.94
Upminster	1.89	1.18	-	0.80	4.55	1.04
Upminster Bridge	1.42	1.08	-	0.80	4.27	1.02
Upney	1.27	1.05	-	0.80	4.55	1.04
Upton Park	1.12	1.02	-	0.80	3.92	1.00
Uxbridge	1.22	1.04	-	0.80	9.66	1.29
Vauxhall	1.70	1.14	-	0.80	3.29	0.97
Victoria	1.13	1.03	1.36	1.07	3.29	0.97
Waltham Street C.	1.66	1.13	-	0.80	3.57	0.99
Wanstead	1.52	1.10	-	0.80	6.02	1.11
Wapping	1.37	1.07	-	0.80	8.19	1.22
Warren Street	2.37	1.27	2.36	1.27	3.15	0.97
Warwick Av.	1.02	1.00	-	0.80	2.87	0.95
Waterloo	2.80	1.36	2.99	1.40	3.22	0.97
Watford	1.02	1.00	-	0.80	10.00	1.31
Wembley Central	1.03	1.01	-	0.80	7.77	1.20
Wembley Park	1.00	1.00	1.62	1.12	4.48	1.03
West Acton	1.13	1.03	-	0.80	6.09	1.11
West Brompton	1.02	1.00	-	0.80	6.30	1.12
West Finchley	0.52	0.90	-	0.80	5.95	1.11
West Ham	1.45	1.09	3.28	1.46	3.78	1.00
West Hampstead	1.67	1.13	-	0.80	3.22	0.97
West Harrow	0.50	0.90	-	0.80	8.75	1.25
West Kensington	1.02	1.00	-	0.80	4.83	1.05
West Ruislip	1.12	1.02	-	0.80	8.40	1.23
Westbourne Park	0.88	0.98	-	0.80	6.09	1.11
Westminster	1.43	1.09	2.02	1.20	3.99	1.01
White City	1.25	1.05	-	0.80	4.13	1.01
Whitechapel	1.19	1.04	0.95	0.99	4.76	1.05
Willesden Green	1.02	1.00	-	0.80	3.57	0.99
Willesden Junction	1.53	1.11	2.00	1.20	5.95	1.11
Wimbledon	3.53	1.51	-	0.80	5.81	1.10
Wimbledon Park	0.77	0.95	-	0.80	5.32	1.07
Wood Green	1.48	1.10	-	0.80	2.80	0.95
Woodford	1.52	1.10	1.03	1.01	7.84	1.20
Woodside Park	0.52	0.90	-	0.80	6.09	1.11

The values in section E4 were obtained from a multi-modal Stated Preference survey carried out in 2011 and updated for inflation to 2013.

E.4.4 Improvement and Benefit Values

E.4.4.1 Bus Improvements and Benefit Values (Pence Per Journey, 2013)

Table E-19: Bus Improvements And Benefit Values (Pence Per Journey, 2013)

	Attribute	Value (p) or (p/min*)
BUS STOP/SHELTER		
Condition	In basic working order but parts worn or tatty	0
	Good condition, but some repair needed	0.24
	Excellent condition, looks like new	0.96
Cleanliness of shelter	Shelter very dirty	0
	Shelter very clean	2.74
Timetable illumination	Timetable and bus stop flag not illuminated	0
	Timetable and bus stop flag illuminated	3.36
Litter	Lots of litter	0
	Small amount of litter	0.96
	No litter	1.68
Graffiti	Lots of graffiti and/or offensive graffiti	0
	Small patches of graffiti	3.24
	No graffiti at all	3.84
Type of Shelter	No shelter	0
	Shelter giving protection from the rain and some protection from the wind	1.55
BUS STOP SECURITY		
Surveillance cameras	No CCTV	0
	CCTV recording at some stops	6.72
	CCTV recording at all stops	6.96
Brightness of lighting	No lighting specifically for stop or shelter	0
	Stop or shelter well lit	4.91
BUS STOP INFORMATION		
Countdown signs	No Countdown sign	0
	Countdown displays up to the minute bus arrival times	3.35
	Countdown displays up to the minute bus arrival times, diversions and delays	4.11
Mobile phone real-time information	No information on phone about time of next bus or disruptions	0
	By typing in code shown on bus stop, receive information sent to phone about time of next bus	0.83
	By typing in code shown on bus stop, receive information sent to phone about time of next bus and any service delays	1.39
Spider Map	No diagramatic map of bus routes serving the stop	0
	Stop with diagrammatic map of bus routes serving the stop	4.63

	Attribute	Value (p) or (p/min*)
Local Map	No map of local information / services	0
	Stop with map of local information / services	4.52
BUS STATION INFORMATION		
Public announcements	No public announcements	0
	Public announcemetns that can clearly be heard	1.12
Staff providing bus service information	No staff at the station	0
	Member of staff walking around bus station	0.92
	Member of staff at information desk	1.25
Bus service information displayed on screen	No countdown sign	0
	Countdown displays up to the minute bus departure times	2.88
Finding your way arround the bus station - signage	Unclear of badly located signing, difficult to find your way around the bus station	0
	Good signing, easy to find your way around the bus station	2.62
Finding your way arround the bus station - maps	No display	0
	Displays showing location of the stop for your bus	6.08
BUS STATION ENVIRONMENT		
Surveillance cameras	No CCTV at the bus station	0
	CCTV signs and CCTV recording for the safety of customers and staff	2.28
Condition of station	Repair or refurbishment needed	0
	Bus station in very good condition	1.60
Condition of toilets	No toilets at the station	0
	Toilets which are cleaned at least twice a day	1.54
Type of shelters	Individual bus shelters at each stop giving protection from rain and some protection from the wind for those under the shelter	0
	Glass cubicle at each stop under the bus station canopy giving good all round protection from the wind and rain for everyone waiting at the stop	0.99
Cleanliness of bus station	Bus station very dirty	0
	Bus station very clean	1.42
Litter	A lot of litter throughout the bus station	0
	Very little litter anywhere in the bus station	1.67
Availability of seating	No seats provided	0
	Rest seats, which slope	0
	Flat seats (enough for those wanting to sit)	6.45
	Bench seats (enough for those wanting to sit)	7.69
DRIVER AND QUALITY OF JOURNEY		
Attitude of driver	Businesslike but not very helpful	0
	Polite, helpful and cheerful	3.61
Smoothness of driving	Jerky ride causing those standing to worry about losing their balance	0
	Smooth ride - no jerkiness	5.95

	Attribute	**Value (p) or (p/min*)**	
Noise	Engine produces intrusive noise or vibration throughout journey	0	
	Engine produces intrusive noise or vibration only while bus is at stops	0.36	
	No intrusive noise or vibration from engine throughout journey	3.48	
CLEANLINESS OF BUS			
Cleanliness of exterior	Some very dirty areas	0	
	Reasonably clean everywhere	0.12	
	Very clean everywhere	0.24	
Etching on windows	Some etching on most windows	0	
	No etching at all	2.76	
Cleanliness of interior	Some very dirty areas	0	
	Reasonably clean everywhere	6.96	
	Very clean everywhere	8.43	
Litter	Lots of litter	0	
	Small amount of litter	5.04	
	No litter at all	5.88	
BUS ENVIRONMENT			
Surveillance cameras	Posters indicating that bus is monitored by CCTV	0	
	Screens showing live CCTV views inside the bus, upstairs only (artic back only)	2.28	
	Screens showing live CCTV views inside the bus, upstairs and downstairs (artic front & back)	2.76	
Ventilation	Opening windows giving ventilation to some passengers	0	
	Opening windows giving ventilation throughout the bus	3.12	
	Air conditioning, circulating cool fresh air throughout the bus	3.84	
Seating	Bench style seats with very little cushioning	0	
	Seperate seats with very little cushioning	0.15	*
	Seperate seats with soft cushioning	0.23	*
Wheelchair/buggy space	Dedicated area for wheelchairs and/or buggies or up to six people standing	0	
	Large dedicated area for wheelchairs and/or buggies or up to ten people standing, with fewer seats elsewhere	1.32	
Information provided inside bus	No electronic information inside the bus about the next stop	0	
	Electronic sign and voice announcement of the next stop	2.34	
	Electronic sign and voice announcement of the next stop and also connections that can be made with other transport services, plus nearby attractions that can be reached from that stop	2.54	
Smoothness of road surface	Uncomfortable, bumpy ride	0	
	Smooth ride without bumps	0.03	*

	Attribute	Value (p) or (p/min*)
BUS-UNDERGROUND INTERCHANGE		
Visual information on bus service disruption	No service disruption information in the Underground station for bus services	0
	Hand-written notices in the Underground station about disruptions to bus services	6.55
	Electronic information in the Underground station about disruptions to bus services	8.62
Signage at interchange	No signs to bus and Underground services	0
	Generally good signs between bus and Underground services, but additional signs would make it easier to find the way	3.52
	Excellent signs giving a direct route between bus and Underground services	6.92
Lighting in bus-Underground interchange	Walkway between Underground station and bus stop badly lit throughout	0
	Walkway between Underground station and bus stop well lit throughout	4.00
Weather protection between Underground and bus stop	Walkway between the Underground station and bus stop totally exposed to the elements	0
	Entire walkway covered/sheltered between the Underground station and bus stop	6.84

E.4.4.2 Tram Improvements and Benefit Values (Pence Per Journey, 2013)

Table E-20: Tram Improvements And Benefit Values (Pence Per Journey, 2013)

	Attribute	Value (p)
Ventilation	Opening windows giving ventilation to some passengers	0
	Opening windows giving ventilation throughout the tram	1.69
	Air conditioning, circulating cool fresh air throughout the tram	3.25
Noise	Tram often produces intrusive rail noise during journey	0
	Tram rarely produces intrusive rail noise during journey	3.90
Smoothness of driving	Jerky ride causing those standing to worry about losing their balance	0
	Fairly smooth ride	3.90
	Very smooth ride - no jerkiness	4.29
Separate tram lane	No separate lane (traffic on all sections)	0
	Separate lane all of the time (no traffic sharing lane)	4.29

E.4.4.3 Rail Improvements And Benefit Values (Pence Per Journey, 2013)

Table E-21: Rail Improvements And Benefit Values (Pence Per Journey, 2013)

	Attribute	Value (p)
TICKET HALL		
Cleanliness	Ticket hall very dirty	0
	Ticket hall very clean	9.63
Information about service disruptions	No information in the ticket hall about service disruptions	0
	Hand-written notices in the ticket hall showing service disruptions	14.31
	Electronic display in the ticket hall showing service disruptions	17.31
Ticket office opening hours	No ticket office (but station still staffed while open)	0
	Ticket office open 8am-7pm or longer	8.72
PLATFORM FACILITIES		
Cleanliness of platform	Platform very dirty	0
	Platform very clean	6.38
Next Train information	No information about next train on the platform	0
	Electronic information about next train arrival time, destination and all stations where the train is stopping	14.83
Seating on platform	No seats provided	0
	Seats provided, but in poor state of repair	1.43
	Seats provided, in good condition	5.86

	Attribute	Value (p)
Protection from weather	No waiting rooms or areas protected from the weather on the platform	0
	Wind shelters in some places, providing some protection from wind and rain	5.07
	Waiting room, providing good all-round protection from the wind and rain	5.47
STATION ENVIRONMENT		
Litter	Lots of litter throughout the station	0
	Some litter in the station	4.94
	No litter anywhere in the station	7.42
Condition of station exterior	Outside of station in poor state of repair	0
	Outside of station in good state of repair	5.60
Graffiti	Extensive graffiti sprayed or drawn in the station	0
	A fair amount of graffiti in the station	3.90
	No graffiti sprayed or drawn in the station	7.94
Step free access around station	No step free access in station	0
	Step free access between the station entrance and ticket hall only	6.90
	Step free access throughout station	7.55
STATION SECURITY		
Staff presence	No staff visible in the station or ticket hall	0
	Staff present in the station / ticket hall but difficult to see	16.13
	Staff present in the station / ticket hall and easy to see	19.52
Surveillance cameras	No CCTV in the station	0
	CCTV in the station monitored some of the time and recorded	12.88
	CCTV in the station, monitored all of the time and recorded	13.14
Transport police presence	Police available on system but not necessarily close to the station. Response time more than 15 minutes	0
	Police available locally. Response time 5-15 minutes	7.81
	Police available immediately. Response time less than 5 minutes	10.02
Help points	No help points in the station	0
	Help point with fire alarm only	7.16
	Help point with fire alarm and emergency button with facility to talk to staff	10.15
TRAIN SECURITY AND INFORMATION		
Lighting on train	Carriage dimly lit	0
	Carriage brightly lit	7.81
Electronic display	No electronic display in carriages	0
	Flat screen style display showing next station, final destination information and relevant service disruption information	11.71

	Attribute	Value (p)
Surveillance cameras	No CCTV on the train	0
	CCTV covering majority or entire carriage	17.96
PA announcements	Public announcement impossible to hear, muffled or echoing	0
	Public announcement message able to be heard	11.32
TRAIN ENVIRONMENT		
Cleanliness of train and seating	Inside of train very dirty	0
	Inside of train reasonably clean	9.89
	Inside of train very dirty Inside of train spotlessly clean	12.23
Overall condition of train	Train in poor condition – lots of torn or patched upholstery or significant damage to other fittings (arm rests, handrails etc)	0
	Train in fairly good condition – small areas of torn or patched upholstery or damage to other fittings	6.38
	Train in excellent condition - all items looking new	9.63
Quality of ride	Extremely bumpy and uncomfortable ride - impossible to read or stand comfortably	0
	A lot of train movement - difficult to read while standing or to stand comfortably	8.20
	Very smooth ride	11.58
CROSSRAIL		
Ticket machines	Ticket Machines providing a full range of tickets but no staff available when ticket office is closed	0
	Ticket Machines provide a full range of tickets, plus additional information via a video link to a member of staff who can help you obtain your ticket in the same way as if they were standing there with you	6.73
Station help zones	Station has standard lighting, CCTV and press-button Help Point	0
	Station has standard lighting, CCTV and press-button Help Point, plus a designated area close to the platform entrance providing seating, enhanced lighting Help Point and CCTV	4.21
Station travel information	Standard press-button Help Points where your call is answered by a member of staff within 30 seconds	0
	Enhanced customer Help Points where your call is answered by a member of staff within 30 seconds and a video link ot them is also provided	6.34
Train security	Driver only	0
	Driver and pairs of uniformed staff who go from train to train offering assistance to anyone who needs it and dealing with any anti-social behaviour	12.69
Retail facilities	No ticket office open	0
	Ticket sales within a convenience store at the station and open between 07:00 and 20:00 *Only applicable where there is curently no ticket office at all.	4.48
Cleanliness of platform	Platform very dirty	0
	Platform spotlessly clean	14.33

	Attribute	Value (p)
Staff presence	No staff visible in the station or ticket hall	0
	Staff present in the station / ticket hall but difficult to see	11.90
	Staff present in the station / ticket hall and easy to see	18.74
Provision of waiting rooms	No waiting rooms or areas protected from the weather on the platform	0
	Wind shelters in some places providing some protection from wind and rain	8.89
	Waiting room providing good all-round protection from the wind and rain	0 (No effect)

E.4.4.4 Walking Improvements & Benefit Values (Pence Per Journey)

<u>*Table E-22: Walking Improvements & Benefit Values (Pence Per Journey, 2013)*</u>

	Attribute	Value (p) or (p/min*)	
CROSSINGS			
Proximity of 'green man' crossing	No pedestrian 'green man' crossing nearby	0	
	Pedestrian 'green man' crossing a few minutes walk out of your way	3.02	
	Pedestrian 'green man' crossing at a convenient point nearby	3.78	
Directness of 'green man' crossing	No pedestrian 'green man' crossing	0	
	'Green man' crossing in stages	4.33	
	Direct 'green man' crossing	5.42	
Crossing elsewhere	Normal urban street where it is safer to use specified crossing points	0	
	Dedicated crossing place (without 'green man') at a convenient point nearby	2.70	
	Very light traffic flow and unimpeded views so that it is safe to cross without introducing special crossing points	3.13	
Use of a subway or pedestrian crossing	Crossing using a subway	0	
	Crossing using pedestrian crossing, taking about the same time as crossing by subway	4.79	
Crossing countdown	Pedestrian crossing where 'green man' goes out and the display is blank for 12 seconds	0	
	Pedestrian crossing telling you how many seconds you have left to cross before the traffic starts again	3.83	
Speed limit	30 miles per hour speed limit	0	
	20 miles per hour speed limit	0.35	*
STREET SECURITY			
Lighting quality	Very poor lighting after dark	0	
	Good, bright and even lighting after dark	1.03	*
Litter & Graffiti	Lots of litter, graffiti and fly-posting	0	
	Some litter, graffiti and fly-posting	0.26	*
	No litter, graffiti and fly-posting	0.48	*

	Attribute	Value (p) or (p/min*)	
Chewing gum on pavement	Lots of chewing gum on pavement	0	
	Pavement generally free of chewing gum	0.13	*
CCTV Provision	No CCTV Provision	0	
	Surveillance cameras monitored and recorded some of the time	0.74	*
	Surveillance cameras monitored and recorded all of the time	0.88	*
STREET SIGNS			
Directions	No signs to public transport and major attractions	0	
	Signs to public transport and major attractions	8.60	
	Maps of the local area, information boards and signs to public transport and major attractions	17.38	
Street names	Street names often not provided at road junctions	0	
	Street names always provided at road junctions, but often obscured or weathered	0.45	*
	Street names always provided at road junctions, and clearly visible	0.64	*
PAVEMENTS			
Pavement width	Pavement is too narrow to allow two people to walk side by side	0	
	There are sections of the pavement where it is too narrow to allow two people to walk side by side	0.26	*
	Pavement is wide and two people can always walk side by side	0.50	*
Pavement surface	There are a lot of broken and missing paving slabs resulting in an uneven surface	0	
	There are a number of cracked paving slabs and occasional unevenness	0.44	*
	Pavement has no cracks and is even	0.79	*
Dropped kerbs	Noticeable difference in height between the pavement and the road at all junctions	0	
	Little difference in height between the pavement and the road at some junctions	0.21	*
	Little difference in height between the pavement and the road at all junctions	0.26	*
Pavement clutter	Lots of bins, benches, posts etc across pavement	0	
	Some bins, benches, posts etc across pavement	0.15	*
	All bins, benches, posts etc along edge of pavement	0.31	*
Overhang of trees and plants	Lots of trees and plants hanging over the pavement	0	
	Some trees and plants hanging over the pavement	0.05	*
	No trees and plants hanging over the pavement	0.12	*
Parked vehicles	Vehicles park on the pavement	0	
	Vehicles do not park on the pavement	0.57	*
Schemes with shared walking / cycling	Pavement shared between cyclists and pedestrians	0	
	Pavement for pedestrians only	0.30	*

	Attribute	Value (p) or (p/min*)
FACILITIES AND VISUAL ATTRACTIONS		
Seating	No seating provided	0
	Seating areas at well chosen locations	7.63
Areas alongside pavement, between buildings	Basic tarmac or paved areas where there are no buildings	0
	Well maintained grass, plants and trees where there are no buildings	0.26 *
Public art	No public art provided	0
	Public art at well chosen locations	0.46

E.4.4.5 Cycling Improvements & Benefit Values (Pence Per Journey)

Table E-23: Cycling Improvements & Benefit Values (Pence Per Journey, 2013)

	Attribute	Value (p) or (p/min*)
CYCLE PARKING		
Cycle Parking Provision	No cycle parking provided	0
	Cycle parking provided	19.55
Cycle racks	Cycle racks located in quiet location with few people passing	0
	Cycle racks located in busy location with many people passing	3.88
Cycle parking security	No surveillance cameras or other security	0
	Dedicated surveillance cameras covering the cycle parking	5.83
Lighting in car parking area	Very poor lighting after dark	0
	Good, bright, even lighting after dark	8.82
Condition of cycle parking areas	Cycle parking area in poor condition (poor repair, dirty, litter)	0
	Cycle parking area in reasonable condition (patches of dirt and some litter)	1.19
	Cycle parking area in excellent condition (in good repair, clean and litter free) and near to cycle servicing shop	6.16
Changing facilities	No cycling parking provided	0
	An enclosed, secure cycle park, with showers & changing facilities costing £1 a day to use (£1.50 overnight) and a small staffed kiosk selling basic equipment. No other secure cycle parking would be available.	2.28
CYCLE ROUTE		
Width of cycle lane	Narrow cycle lane with traffic close to cyclists	0
	Narrow cycle lane with traffic further away from cyclists	0.46 *
	Cycle lane with traffic further away from cyclists and wide enough for two cyclists to pass	0.77 *

	Attribute	Value	
Segregation	No long segregated stretches of route for cyclists	0	
	Journey includes a one-mile stretch with bus lane usable by cyclists	5.79	
	Journey includes a one-mile stretch with cycle lane marked on road, wide enough to pass other cyclists	5.92	
Advanced stop boxes	No advanced stop boxes for cyclists at traffic lights	0	
	Advanced stop boxes for cyclists on all roads at all traffic lights with fines for vehicles that enter the box (cameras capture registration numbers)	3.72	
Attractiveness of route	15 minute journey has a quiet but unattractive route (e.g. through an industrial estate)	0	
	15 minute journey has a quiet route through some attractive and unattractive areas (e.g. through a park and then an industrial estate)	0.37	*
	15 minute journey has a quiet and attractive route (e.g. through a large park, pleasant suburb)	0.60	*
CYCLE SURFACE			
Surface quality	Uncomfortable ride due to potholes and ridges	0	
	Fairly uncomfortable ride due to cracks in the surface	5.68	
	Even and smooth cycle surface and ride	6.84	
Debris	Debris across the cycle surface	0	
	Debris collected at kerb edge only	0.51	*
	Cycle surface free completely free from debris	0.82	*
Drainage	Large puddles cover majority of cycle surface when wet	0	
	Isolated puddles collecting near to the kerb edge	5.95	
	No standing water on cycle surface when wet	7.14	
Cycle signage	No specific cycle signs: navigation by existing road signage	0	
	Cycle specific signs at regular intervals	1.03	
Cycle route signage and information	No specific cycle signs: navigation by existing road signage	0	
	Cycle route with name of route, e.g. CS7, painted regularly on highway (every 100m)	12.41	
	Cycle route with name of route, e.g. CS7, painted regularly on highway (every 100m) and maps of nearby streets at convenient locations	4.76	
CYCLE PROVISION			
Routes to avoid roundabouts	Route involves using a roundabout that offers no priority to cyclists	0	
	Route involves using a roundabout where the trafic signals have been adapted to help cyclists	10.04	
Information on cycle parking availability	No information to your phone about cycle parking availability	0	
	You send a text to identify your location and receive a text of any cycle parking available in the area	0 (No effect)	

E.4.4.6 Car Improvements & Benefit Values (Pence Per Journey)

Table E-24: Car Improvements And Benefit Values (Pence Per Journey, 2013)

	Attribute	Value (p)
INFORMATION		
Mobile phone real time information about delays in your area or in your current location	No information about traffic delays	0
	Automatic alert to your phone before you travel advising you of any traffic delays for a pre-registered route	1.99
Travel Information	Up to the minute information about traffic delays available on the internet at home/work before you travel	0
	Up to the minute information about traffic delays available on the internet before you travel and can also be accessed through your phone or satnav on the journey	0.84
Alerts about parking	No information about parking availability	0
	You send a text to identify your location and receive a text of any on-street parking available in the area	1.93
Temporary signs providing advance warning of roadworks	No advance warning of roadworks on your usual route	0
	Temporary road signs warning of roadworks on your route	2.25
Variable Message Signs (VMS) about future delays	No variable message sign	0
	Variable message sign providing early warning of disruption e.g. Demonstration in 2 weeks time	2.65
Variable Message Signs (VMS) about current disruptions	No variable message sign about current disruptions	0
	VMS providing real time disruption details giving information about major traffic delays and advising alternative routes	2.45
	VMS providing real time disruption details giving information about major traffic delays and advising alternative routes, also advising of the length of delay along main route	2.86
CONDITION		
Condition of highway surface quality	Road surface in poor condition causing jolts to your vehicle	0
	Road surface with minor defects causing slight jolts to your vehicle	6.26
	Road surface perfectly smooth causing no jolts to your vehicle	7.48

	Attribute	Value (p)
ENVIRONMENT		
Lighting on highway	No street lighting	0
	Street lighting provided all the way, but dimmed at certain times in the night	9.99
Traffic light phasing	Traffic lights change in a set routine whether or not there is any traffic around	0
	Traffic lights respond automatically to the amount of traffic flow	3.68
Traffic light maintenance	Some traffic lights on main route not working once per fortnight	0
	Some traffic lights on main route not working once per month	1.90
	Traffic lights on main route always working	3.25

E.5 COSTS OF TRAINS OUT OF SERVICE AND DELAYS

The Nominally Accumulated Customer Hours system (known as NACHs or NAX) enables the disbenefits of a wide variety of incidents and restrictions to be quantified, without resort to model runs. It estimates the impact of incidents on LUL's lines in terms of increased passenger journey times, which can then be translated to disbenefit by multiplying by the current value of time. The incidents and restrictions covered are:

- Delays in service
- Trains out of service
- Line closures
- Speed restrictions
- Signal failures
- Late start-ups
- Station closures
- Lifts and escalators out of service

Advice on how to use the NACHs system, and further information on underlying assumptions and the interpretation of outputs can be obtained from LU Transport Planning. Contact Sandra Weddell on [redacted]

APPENDIX F Quantification of Safety Benefits

F.1 INTRODUCTION

Considerable expenditure is undertaken by TfL to minimise the occurrence of incidents which could lead to loss of life or injury or to damage to assets. Because expenditure is expressed in financial terms, in order to compare the magnitude of the safety benefits with the expenditure and arrive at an estimate of whether or not the expenditure is worthwhile, the benefits must also be expressed in financial terms.

In principle, appraisal of such projects is straightforward. If the probable frequency (expressed as number per annum) of an event occurring and the probable outcome if the event occurred (expressed financially) are known, then the product of these two numbers is the probable cost per annum of the risk. If as a result of the expenditure the magnitude of either or both of these two quantities is reduced then the reduction in annual costs can be ascertained and used in appraisal calculations in the same manner as any other benefit.

If an event has a probable occurrence frequency once every 10 years, and the most likely consequent cost is £1m, then the probability per annum is 1/10 and the probable cost per annum is 1/10 times £1m i.e. £100,000. This can be treated as a discounted cash flow and compared with the cost of eliminating the hazard.

Ideally the probabilities will be based on historical data but for many events historical data is sparse. Indeed a major function of safety appraisal is to identify events which have never happened and to estimate the probable frequency and severity.

Requirements of legislation (the Health and Safety at Work Act) stipulate that expenditure to reduce hazards must be incurred up to the point where the remaining risk is "as low as reasonably practicable" (ALARP). The ‘Safety Justification and ALARP’ standard describes the approach to demonstrating ALARP, and the method and parameters to be used when assessing the value of safety benefits.

F.2 QUANTIFIED RISK ASSESSMENT (QRA)

The first step is to quantify the safety risk. This requires the combination of the consequences and likelihood of all the outcomes from the incidents to be considered. Quantification of this risk requires assigning frequencies and probabilities to all the contributing factors leading to an event. For example, for a car to skid off a road, there may need to be a combination of a wet road, bald tyres and excessive speed. If say 10,000 cars per annum use this road, there are 20% wet days, 1% of cars have bald tyres, and 10% are speeding, then the expected frequency of skidding is given by:

10,000 x 20/100 x 1/100 x 10/100 = 2 per year

The safety consequences of a car skidding may depend on the number of people in the car, the likelihood of the car colliding with a solid object such as a tree or another car etc. If say an analysis of the consequences gave the result that a skid on this road would give a 94% chance of no fatality, a 5% chance of a single fatality and a 1% chance of 4 fatalities, then the expected risk of a fatality (in the probabilistic sense) due to skidding is:

2 per year x [(5/100 x 1) + (1/100 x 4)] = 0.18 fatalities per year

A similar evaluation could be carried out to ascertain the expected risk of major injury etc.

Clearly, combining these probabilities becomes increasingly complicated as the number of contributing factors and possible outcomes increases. Here, fault tree and consequence (event) tree techniques are useful to map out the logic of the accident scenarios and to apply the mathematical operations on the assigned probability and outcome data to produce the quantitative estimates of the expected risk.

For LUL railway operations, such fault and consequence tree techniques have been employed to quantify the risk of fatality from those events (known as "top events") with the potential to cause major injury or fatality to LUL passengers (and staff involved in such incidents). These top events, and LUL Quantified Risk Assessment modelling in general, are discussed in Section 4 of the LUL Safety Certification and Authorisation Document. A list of top events can be found in the 'Safety Decision Making' standard, section 5. The top event may be extremely rare but the large number of contributing events can occur relatively frequently and these frequencies can be observed or estimated.

(For further information, contact Jill Collis, [redacted])

The implementation of options may reduce risk by:

- reducing the likelihood of the base events which initiate the accident sequence (i.e., improve "prevention") and/or
- reducing the likelihood of the contributing failure of control measures should these base events occur (i.e., improve "protection"), and/or
- improving the emergency response should the accident occur to reduce the number and severity of casualties (i.e. improve "accident mitigation").

Although as a general principle the priority for safety attention shall be in the order: prevention / protection / accident mitigation, a project option which affects any of the above can be modelled to assess the risk reduction associated with implementation. Usually this can be done using the existing Fault Tree and Consequence Analysis, though where a project has no impact on the "top events", a separate analysis may have to be carried out.

Safety and Environmental Development is responsible for ensuring the maintenance of the models and data relating to the assessment of top event risks. Section 3 of the 'Assessment and Management of Health Safety and Environment Risk' standard describes the respective roles of LUL and suppliers in projects requiring Quantitative Risk Assessments. The aim is to ensure that future QRAs build upon existing analysis and understanding. Section 3 also provides guidance on the application of fault tree and event tree techniques.

F.3 VALUATION OF SAFETY BENEFITS

The output of the QRA (above) will be the probable number of fatalities and/or injuries per annum before and after the implementation of the initiative. The safety benefit is the risk reduction arising from implementation, and a valuation can be assigned to this by applying monetary values to the avoidance of fatalities and/or injuries (see below).

F.4 TREATMENT OF SAFETY BENEFITS IN APPRAISALS

Benefits arise from three types of risk reduction, relating to:

- Injuries or fatalities to passengers
- Injuries or fatalities to staff or other non-passengers (e.g. trespassers)
- Material damage and service disruption.

Originally, these were all covered in one figure applied for each fatality, but in current appraisals each benefit must be quantified separately.

The current approach places a reference value of £1.8m (at 2013 prices) on the avoidance of a fatality, with a possible multiplier of 3 (giving £5.3m) applied, depending on the maximum risk to an individual.

The multiplier of 3, depending on the above factor, addresses the aspect of the ALARP principle which requires safety measures to be implemented unless the cost etc. is disproportionately greater than the safety benefit obtained. The ALARP case should be investigated using the value of £1.8m, and if this fails, £5.3m. If the case fails using £1.8m but succeeds using £5.3m, the individual risk should be examined to see which of these two valuations is more justified (see F6 below). An estimate of the reduction in risk of "major" and "minor" injuries should also be included, either by reference to the Equivalent Fatality Factor for top events, see F6(4), or preferably by assessing the risk separately and applying weightings of (for rail appraisals) 0.1 and 0.005 respectively to the appropriate fatality value. The fatalities and weighted injuries can then be added together to form a single ‘Equivalent Fatality’ value.

The ALARP judgement should consider the safety benefits against the cost of implementation. Avoidance of loss of revenue, e.g. from material damage or service disruption should be set against the implementation cost.

The £1.8m represents the casualty related costs, which includes lost output, human costs and medical and ambulance costs. Material damage and service disruption should be included in addition to this.

F.5 SUMMARY OF (QUANTITATIVE) APPRAISAL PROCEDURE

In outline, the procedure is this. Do a risk assessment appraisal using the ALARP principle. All costs should be included, but only direct safety-related benefits and risk-related revenues. Then (even if the project is warranted by ALARP) do the full appraisal with all costs and benefits, with VPF (Value of Preventing a Fatality) at the lower limit, using the upper limit of VPF as a sensitivity test if the case fails.

The details are as follows:

Risk assessment appraisal (ALARP)

In the preparation of a safety case, both the qualitative and quantitative safety issues need to be considered. This section of the BCDM concentrates on the quantitative side.

- Quantify the risk in question (expected fatalities per annum).
- Use a VPF of £1.8m.
- Obtain the total annual value of avoiding fatalities by multiplying by the change in annual risk of fatalities.
- Injuries
    - If possible, the risks of major and minor injuries should be estimated separately. The values of major and minor injuries are taken as 0.1 and 0.01 respectively times the appropriate value of a fatality. Major injuries are defined as:
        - -any fracture or dislocation other than to fingers, thumbs, or toes
        - -any amputation
        - -loss of sight or permanent damage to an eye
        - -any other injury or illness requiring detention in hospital.
    - But if separate estimation of injuries is not possible...
        - where the risk arises from a "top event", include the total annual value of major and minor injuries using a single figure from the Equivalent Fatality Table F1 and multiplying this by the total annual value of fatalities avoided, as obtained in (4).

Table F.5-1: EQUIVALENT FATALITY FACTORS FOR TOP EVENTS

Top Event	Main Scenarios	Equivalent Fatalities
Arcing	traction earth faults	1.4
Collision Between Trains	collision between trains (end to end/side on)	1.4
	side swipe collision	1.0
Collision Hazard	collision with a floodgate	1.3
	collision with a lineside structure / tunnel wall	1.0
	collision with a terminal	1.1
	collision with a platform	1.1
Derailment	derailment on LU infrastructure	1.2
	derailment on NR infrastructure	1.2
Escalator Fires	fires on metal escalators	1.0
	fires on modified escalators	1.0
Escalator Incidents	step, step chain or top shaft failure	1.0
	falls on escalators	1.0
Explosion	explosions from internal and external sources	1.1
Flooding	direct flooding from River Thames	1.0
	indirect flooding from River Thames	1.2
Lift Fires	lift machine room fire	1.0
	lift car fire	1.0
	lift shaft fire	1.0
Lift Incidents	lift incidents	1.0
On Train Incidents	spurious door opening	1.0
	unauthorised use of Inter-car doors	1.0
Platform Train Interface	passenger falls from the platform	1.0
	passenger struck by train whilst on the platform	1.0
	passenger falls between train and the platform	1.0
	passenger dragged along the platform	1.0
Power Failure	affecting train service	1.4
	affecting stations	1.0
Station Area Accidents	overcrowding	1.0
	falls on stairs	1.0
	assaults	1.0
Station Fires	public area fires	1.2
	non-public area fires	1.2
	interlock room fires	1.0
Structural Failures	tunnels and bridges	1.0
	stations and buildings	1.4
	earth structures and drainage	1.2
Train Fires	under car fires in tunnel	1.4
	under car fires above ground	1.0
	in car fires in tunnel	1.4
	in car fires above ground	1.0
Tunnel Fires	tunnel fires (including track fires)	1.4
Unauthorised Access to Track	person on track (outside platform area)	1.0
Ventilation Hazard	train held in section	1.4
	authorised track detrainment without protection	1.0
	self detrainment	1.0

Appraise the project solely on the safety benefits of preventing fatalities and injuries as described above. Other passenger benefits (including time savings) should not be included at this stage. However any operating cost savings or additions resulting from the project should be taken into account. Revenue derived from safety benefits should be deducted from the costs. Revenue (but to reiterate, not the associated passenger benefits) arising from the avoidance of risk of disruption should also be included, as should the cost of any material damage avoided.

Calculate the B/C Ratio. If this is > 1.0, the quantitative appraisal indicates support for the project, and the quantitative conclusion should be used to inform and support the qualitative arguments.

If the B/C Ratio is < 1.0, the project should be reappraised using a VPF of £5.3m (only for the safety benefits -continue to use £1.8m for the revenue derived from safety benefits). If the ratio is still < 1.0, the quantitative appraisal does not indicate support for the project, and once again the quantitative conclusion should be used to support the qualitative arguments. (If the risk is relatively large but the case is not made for a particular project, alternative ways of reducing the risk should be considered.)

If the B/C Ratio is < 1.0 with VPF £1.8m but >1.0 with VPF £5.3m, the maximum level of risk to an individual needs to be assessed, to see whether the risk falls within the maximum acceptable level specified by the Health and Safety Executive. For example, consider a risk which has been quantified using the total number of passenger journeys per annum to assess the consequences from the hazard in question. In this case, the "most at risk" individual would be assumed to make 500 journeys per annum (provided that the hazard is encountered in both directions, e.g. to and from work). The base case expected number of fatalities per annum (or equivalent fatalities, which includes injuries) is then factored down to give the maximum risk to an individual:

$$\text{maximum risk to an individual p.a.} = \text{expected no. of fatalities p.a.} \times \frac{500}{\text{total passenger journeys affected p.a.}}$$

If the maximum level of risk to an individual is found to be high, i.e. greater than 1 in 100,000 (which can also be written as > 10-5), then the quantitative assessment should be based on a VPF of £5.3m. NB. If the maximum level of risk to an individual is greater than 1 in 10,000 p.a. for passengers, or 1 in 1,000 p.a. for staff, the risk would normally be regarded as intolerable and as such would warrant some urgent action to reduce the risk. (See the LUL standard Safety Justification and ALARP.)

If the maximum risk to an individual is less than or close to 1 in 10,000,000 (a risk of 10-7), then the quantitative assessment should be based on a VPF of £1.8m.

If the maximum risk to an individual from this particular hazard is in the area between 10-5 and 10-7, then the overall risk to that individual needs to be considered. Here, £1.8m (rather than £5.3m) should be used only if it can be claimed with confidence that the overall risk to the individual is less than 10^{-5}.

F.6 FULL APPRAISAL

A full appraisal should also be carried out. Even if the project is justified by ALARP, the full appraisal will establish the total benefits achievable.

Appraise the project using £1.8m as the VPF but include passenger benefits (based on time savings) from avoided disruption, together with those passenger benefits and generated revenues which are not associated with the avoidance of risk. These could be generated by, for example, improved appearance of station, removal of speed restrictions, etc.

Calculate the B/C Ratio based on the total benefits and compare with a passmark of 1.5:1.

If the case fails on this basis (and the ALARP criterion also failed to justify the project), carry out a sensitivity test using £5.3m VPF (but again with revenue calculated on the basis of £1.8m VPF).

F.7 TREATMENT OF THE VALUES IN APPRAISALS

The values of passenger life and injuries to passengers are based on attitude research on willingness to pay, and should therefore be treated as a passenger benefit, with benefits in future years inflated to take account of real growth in the Value of Time.

Incidents involving passengers do have an effect on demand and the normal elasticity should be applied to the safety benefit, based on the reference fatality valuation of £1.8m, to calculate the risk of loss of revenue.

Where the potential incident prevented will reduce staff fatalities and/or injuries, the same approach should be applied - treating the improvement as social benefit but with no impact on revenue. However, for injuries, the effect on operating costs of, for example, sick cover could be included.

F.8 SUMMARISING COMPLEX QRAS

Inevitably major quantified risk assessments can be complex, and there can be a temptation to present results in a purely numeric form, avoiding any description of the risks themselves and their consequences. For example, a study of electrical hazards in an Underground depot could be summarised as:

“The total risk to individuals is 6.37E-4 p.a. and is therefore not ALARP.”

However the maximum risk to individuals is only one factor in the appraisal and the summary should focus instead on:

- the nature of the hazard
- the risk of an incident
- the average consequence of an incident
- the overall probable loss of life.

The headline findings could therefore be:

Hazard	Probability of incident (p.a.)	Average consequence (fatalities per incident)	Expected fatalities (p.a.)
Electrocution during inspections	0.31	0.096	0.030
Electrocution during train movements (mainly as they move off to enter service)	0.090	0.096	0.0087
Electrocution while staff moving around depot (slips/trips, inadvertent contact, or damaged equipment)	0.064	0.096	0.0061
Train enters service with overhead supply lead still inserted	0.29	0.030*	0.0086
Total			0.0534

Overall risk is low, but in worst case fire caused by arcing results in estimated 10 fatalities

This is an unusually complex QRA and many others could be summarised by a table with only one or two lines. With safety, there is always an obligation to examine all possible options, even when risks are comparatively low. It is difficult for authorising bodies to do this unless the business case gives a reasonable summary of the nature of the risks. Hence the need for a standard summarising procedure as outlined above.

For further information on LUL safety appraisals contact Jill Collis, [redacted]

APPENDIX G Discount Rates and Present Value Calculation

For all TfL appraisals the discount rate to be used is taken from the Treasury's Green Book 2003. This is set at 3.5% for the first 30 years, then as follows.

Period of years	0–30	31–75	76–125	126–200	201–300	301+
Discount rate	3.5%	3.0%	2.5%	2.0%	1.5%	1.0%

To calculate present values the procedures are:

- Ensure that all costs, revenues and benefits are at constant prices
- Decide what the base financial year is (usually the first year in which capital will be spent), and call this year zero
- Multiply all costs, revenues and benefits for all future years by the factors in the table below, and sum to give total present values for all years.

G.1 DISCOUNT FACTORS

Table G.1-1: Discount Factors (for discount rate of 3.5%, reducing to 3.0% from year 31)

Year	Factor	Year	Factor	Year	Factor
0	1.0000	17	0.5572	34	0.3165
1	0.9662	18	0.5384	35	0.3073
2	0.9335	19	0.5202	36	0.2984
3	0.9019	20	0.5026	37	0.2897
4	0.8714	21	0.4856	38	0.2812
5	0.8420	22	0.4692	39	0.2731
6	0.8135	23	0.4533	40	0.2651
7	0.7860	24	0.4380	41	0.2574
8	0.7594	25	0.4231	42	0.2499
9	0.7337	26	0.4088	43	0.2426
10	0.7089	27	0.3950	44	0.2355
11	0.6849	28	0.3817	45	0.2287
12	0.6618	29	0.3687	46	0.2220
13	0.6394	30	0.3563	47	0.2156
14	0.6178	31	0.3459	48	0.2093
15	0.5969	32	0.3358	49	0.2032
16	0.5767	33	0.3260	50	0.1973

The discount factors are calculated as follows:-

For Year 1, Factor is 1/1.035 = 0.9662; Year 2, $1/(1.035)^2$ = 0.9335.

These factors can be calculated within spreadsheets (see examples in Appendix A). A table of cumulative factors (PVs of £1 per annum) is shown below including factors which take into account the build up of LUL revenue following a service improvement.

G.2 CUMULATIVE DISCOUNTED CASH FLOWS

Table G.2-1: Table Of Cumulative Discounted Cash Flows

(Present values of £1 per annum - including cumulative DCFs for LUL revenue and for other financial streams)

Years	Discount Factor	Revenue Growth	Revenue Disc. Factor	Cumulative DCF (£)	
				LUL revenue	Other fin. streams
1	0.966	0.35	0.338	0.338	0.966
2	0.934	0.75	0.700	1.038	1.900
3	0.902	0.90	0.812	1.850	2.802
4	0.871	1.00	0.871	2.721	3.673
5	0.842	1.00	0.842	3.563	4.515
6	0.814	1.00	0.814	4.377	5.329
7	0.786	1.00	0.786	5.163	6.115
8	0.759	1.00	0.759	5.922	6.874
9	0.734	1.00	0.734	6.656	7.608
10	0.709	1.00	0.709	7.365	8.317
11	0.685	1.00	0.685	8.050	9.002
12	0.662	1.00	0.662	8.712	9.663
13	0.639	1.00	0.639	9.351	10.303
14	0.618	1.00	0.618	9.969	10.921
15	0.597	1.00	0.597	10.566	11.517
16	0.577	1.00	0.577	11.143	12.094
17	0.557	1.00	0.557	11.700	12.651
18	0.538	1.00	0.538	12.238	13.190
19	0.520	1.00	0.520	12.758	13.710
20	0.503	1.00	0.503	13.261	14.212
21	0.486	1.00	0.486	13.746	14.698
22	0.469	1.00	0.469	14.216	15.167
23	0.453	1.00	0.453	14.669	15.620
24	0.438	1.00	0.438	15.107	16.058
25	0.423	1.00	0.423	15.530	16.482
26	0.409	1.00	0.409	15.939	16.890
27	0.395	1.00	0.395	16.334	17.285
28	0.382	1.00	0.382	16.715	17.667
29	0.369	1.00	0.369	17.084	18.036
30	0.356	1.00	0.356	17.440	18.392
31	0.344	1.00	0.344	17.785	18.736
32	0.333	1.00	0.333	18.117	19.069
33	0.321	1.00	0.321	18.439	19.390
34	0.310	1.00	0.310	18.749	19.701
35	0.300	1.00	0.300	19.049	20.001
36	0.290	1.00	0.290	19.339	20.290
37	0.280	1.00	0.280	19.619	20.571
38	0.271	1.00	0.271	19.889	20.841
39	0.261	1.00	0.261	20.151	21.102
40	0.253	1.00	0.253	20.403	21.355

Notes

1. *As is the convention for these tables, cash flows are discounted back to year 0.*
2. *Discount rate is 3.5% up to year 30, then 3.0%.*

APPENDIX H Required Format for Business Cases

Business cases should be presented in two parts, a Narrative (see H1 below) and a Business Case Summary spreadsheet (see H2). The purpose of the Narrative is to explain various aspects of the business case more easily than could be done in a tabular format. On the other hand, the purpose of the spreadsheet is to present summary information in tabular form, allowing easier numerical comparisons, recalculations, and transfers to the business case database.

It is acceptable to submit a Business Case Summary alone (as generated in a Business Case Assistant workbook) for a proposal seeking inclusion in the TfL Business Plan (although the extra explanation afforded by a Business Case Narrative, for example on benefits that are difficult to categorise, is always helpful). However, for implementation, both Narrative and Summary are required.

The Strategic Assessment Framework (SAF) summary sheet (see H3) assesses impacts on MTS goals, challenges and outcomes.

H.1 BUSINESS CASE NARRATIVE

The latest Business Case Narrative template should be downloaded from either the Business Case Source Page: http://source.tfl/OurCompany/541.aspx

Source Home > Our Organisation > Strategies & Planning > Business Planning > Business case development documents

Source Home > Doing My Job > Project Management > Business Case, Risk, Benefits

Or the Pathway site:
http://onelink.tfl.gov.uk/sites/ptpm/TfL%20Pathway/Pages/TfL%20Pathway%20Home.aspx
(see the Product Matrix)

Source Home > Doing My Job > Project Management > TfL Pathway

H.2 BUSINESS CASE SUMMARY (EXCEL SPREADSHEET)

The latest Business Case Spreadsheet template should be downloaded from the Business Case Source Page: http://source.tfl/OurCompany/541.aspx

Source Home > Our Organisation > Strategies & Planning > Business Planning > Business case development documents

Source Home > Doing My Job > Project Management > Business Case, Risk, Benefits

Either the Business Case Assistant or the Financial Appraisal Model (LU) can be used until the merged product is released (expected later in 2013).

H.3 STRATEGIC ASSESSMENT FRAMEWORK

Can be downloaded from the SAF Source Page.

http://source.tfl/OurCompany/11717.aspx

Source Home > Our Organisation > Strategies & Planning > Strategic Assessment Framework

Within Surface it is acceptable to use the Surface Outcomes to define the strategic drivers of a project (Contact: Tanya Durlen on [redacted]

APPENDIX I Presentation of DfT Appraisals

The DfT maintains a website (WebTAG - Transport Appraisal Guidance on the Web, established in 2003 but with incremental updates on an ongoing basis) which has extensive detail on the conduct of major transport appraisals to meet the Department's requirements. The website can be found at

http://www.webtag.org.uk/index.htm

and the guidance documents 3.1 to 3.9 contain most of the material that would be relevant to such appraisals.

The Five-Case Format

The Treasury's recommended best practice business case format is the Five-Case format. This format should be used if the Department for Transport or the Treasury requests a specific business case in this style. Guidance and templates can be found on the following link.

http://www.hm-treasury.gov.uk/data_greenbook_business.htm

A quick guide to the Five-Case format is also provided on the business case Source page: http://source.tfl/OurCompany/541.aspx

Other DfT Required Formats

The Department for Transport may also require information on business cases such as for a Spending Review.

The formats reproduced below show standard DfT required tables. in I(1) the overall appraisal framework as shown in the Appraisal Summary Table (AST) and supporting analyses, and in I(2) three summaries of financial and monetised impacts:

Transport Economic Efficiency (TEE) table
Public Accounts
Analysis of Monetised Costs and Benefits (AMCB).

I.1 APPRAISAL SUMMARY TABLE

This is a link to the Department for Transport Appraisal Summary Table (AST):

http://www.dft.gov.uk/webtag/documents/project-manager/unit2.7.2.php

In addition to the AST, other supporting analyses are required:

- achievement of local and regional objectives
- amelioration of problems
- distribution and equity analysis
- affordability and financial sustainability analysis
- practicability and public acceptability analysis

plus the analyses shown in I(2) below which provide more detail on the Economy objective.

Appraisal Summary Table

Date produced:		Contact:	
Name of scheme:		Name	
Description of scheme:		Organisation	
		Role	Promoter/Official

Impacts		Summary of key impacts	Assessment: Quantitative	Assessment: Qualitative	Assessment: Monetary £(NPV)	Assessment: Distributional 7-pt scale/ vulnerable grp
Economy	Business users & transport providers		Value of journey time changes(£); Net journey time changes (£): 0 to 2min, 2 to 5min, > 5min			
	Reliability impact on Business users					
	Regeneration					
	Wider Impacts					
Environmental	Noise					
	Air Quality					
	Greenhouse gases		Change in non-traded carbon over 60y; Change in traded carbon over 60y (CO2e)			
	Landscape					
	Townscape					
	Heritage of Historic resources					
	Biodiversity					
	Water Environment					
Social	Commuting and Other users		Value of journey time changes(£); Net journey time changes (£): 0 to 2min, 2 to 5min, > 5min			
	Reliability impact on Commuting and Other					
	Physical activity					
	Journey quality					
	Accidents					
	Security					
	Access to services					
	Affordability					
	Severance					
	Option values					
Public	Cost to Broad Transport Budget					
	Indirect Tax Revenues					

I.2 SUMMARIES OF FINANCIAL AND MONETISED IMPACTS

I.2.1 TEE Table (Transport Economic Efficiency)

The TEE table contains mixed financial and non–financial effects on

- consumers; including journey time savings and motorists' costs, and
- businesses; including journey time savings for those travelling on business, private sector transport operator costs, and developer contributions.

The latest format can be found on this WebTAG link:

http://www.dft.gov.uk/webtag/documents/expert/unit3.5.2.php#012

For cycling and walking projects, these modes should be inserted to show the effect on them.

Non-business: Commuting	ALL MODES		ROAD		BUS and COACH	RAIL		OTHER
User benefits	TOTAL		Private Cars and LGVs		Passengers	Passengers		
Travel time								
Vehicle operating costs								
User charges								
During Construction & Maintenance								
NET NON-BUSINESS BENEFITS: COMMUTING		*(1a)*						
Non-business: Other	ALL MODES		ROAD		BUS and COACH	RAIL		OTHER
User benefits	TOTAL		Private Cars and LGVs		Passengers	Passengers		
Travel time								
Vehicle operating costs								
User charges								
During Construction & Maintenance								
NET NON-BUSINESS BENEFITS: OTHER		*(1b)*						
Business								
User benefits			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers	
Travel time								
Vehicle operating costs								
User charges								
During Construction & Maintenance								
Subtotal		*(2)*						
Private sector provider impacts						Freight	Passengers	
Revenue								
Operating costs								
Investment costs								
Grant/subsidy								
Subtotal		*(3)*						
Other business impacts								
Developer contributions		*(4)*						
NET BUSINESS IMPACT		*(5) = (2) + (3) + (4)*						
TOTAL								
Present Value of Transport Economic Efficiency Benefits (TEE)		*(6) = (1a) + (1b) + (5)*						
	Notes: Benefits appear as positive numbers, while costs appear as negative numbers. All entries are discounted present values, in 2002 prices and values							

I.2.2 Public Accounts table

The 'Public Accounts' table includes all costs and revenues to public bodies, divided into Local Government and Central Government sections. In this table, costs are shown as positive and revenues negative, a departure from normal practice in appraisals.

The latest format can be found on this WebTAG link:

http://www.dft.gov.uk/webtag/documents/expert/unit3.5.1.php

	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
Local Government Funding	TOTAL		INFRASTRUCTURE			
Revenue						
Operating Costs						
Investment Costs						
Developer and Other Contributions						
Grant/Subsidy Payments						
NET IMPACT		*(7)*				
Central Government Funding: Transport						
Revenue						
Operating costs						
Investment Costs						
Developer and Other Contributions						
Grant/Subsidy Payments						
NET IMPACT		*(8)*				
Central Government Funding: Non-Transport						
Indirect Tax Revenues		*(9)*				
TOTALS						
Broad Transport Budget		*(10) = (7) + (8)*				
Wider Public Finances		*(11) = (9)*				

Notes: Costs appear as positive numbers, while revenues and 'Developer and Other Contributions' appear as negative numbers.
All entries are discounted present values in 2002 prices and values.

I.2.3 Analysis of Monetised Costs and Benefits

The 'Analysis of Monetised Costs and Benefits' looks separately at all monetised values.

The footnote emphasises that appraisals should not set aside benefits which cannot be monetised. This reinforces the principle that, while monetising with an accepted methodology has the advantage of a common currency that enables more light to be shed on comparisons, decisions should nevertheless be based on all significant impacts, whether monetised, quantified or described.

The latest format can be found on this WebTAG link:

http://www.dft.gov.uk/webtag/documents/expert/unit3.5.1.php#013

Noise		(12)
Local Air Quality		(13)
Greenhouse Gases		(14)
Journey Ambience		(15)
Accidents		(16)
Economic Efficiency: Consumer Users (Commuting)		(1a)
Economic Efficiency: Consumer Users (Other)		(1b)
Economic Efficiency: Business Users and Providers		(5)
Wider Public Finances (Indirect Taxation Revenues)		- (11) - sign changed from PA table, as PA table represents costs, not benefits
Option Values		(17)
Present Value of Benefits (see notes) (PVB)		(PVB) = (12) + (13) + (14) + (15) + (16) + (1a) + (1b) + (5) + (17) - (11)
Broad Transport Budget		(10)
Present Value of Costs (see notes) (PVC)		(PVC) = (10)
OVERALL IMPACTS		
Net Present Value (NPV)		NPV=PVB-PVC
Benefit to Cost Ratio (BCR)		BCR=PVB/PVC
Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.		

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APPENDIX J Calculation of Revenue Effects

As stated in Section 3.4, the generated revenue is a function of the quantified passenger benefits and is calculated by multiplying the passenger benefit by the elasticity. For appraisal of the type to which this manual applies, only the net revenue to public transport is considered. This net revenue effect is calculated using the **conditional** elasticity. The conditional elasticity also can be used to estimate the actual change in revenue in the long term since it can be assumed that other transport modes will institute a similar degree of improvements.

If a proposed change will have a large impact on revenue in the short term and if the Client has reason to believe that other modes will not change at a comparable rate, they may wish to estimate a revenue impact that assumes transfers from other modes, at least in the short term, to illustrate the effect on gross margin. The maximum potential gain would be calculated using the "**own price**" elasticity which assumes no improvement in other modes.

The own price elasticity should only be used to calculate the effect on LUL or LB income in the short term and not for appraisals. TfL Business Case Development (Ryan Taylor, [redacted] should be consulted on all occasions when calculations using own price elasticity are considered.

The tables below set out own price compared with conditional elasticities.

J.1 CONDITIONAL & OWN PRICE ELASTICITIES (LU)

Table J.1-1: CONDITIONAL & OWN PRICE ELASTICITIES (LUL)

Time of day	Conditional	Own price
AM	-0.24	-0.64
Inter-peak	-0.29	-0.68
PM	-0.27	-0.66
Evening	-0.29	-0.74
Saturday	-0.34	-0.80
Sunday	-0.34	-0.84
Average	-0.28	-0.69

Source: Derived from Elmod99

(Contact LU Strategic Planning for more information on LU demand - Sarah Scott on [redacted]

J.2 CONDITIONAL & OWN PRICE ELASTICITIES (LONDON BUSES)

Table J.2-1: CONDITIONAL & OWN PRICE ELASTICITIES (LB)

Time of day	Conditional	Own price
AM peak	-0.25	-0.41
Inter-peak	-0.30	-0.51
PM peak	-0.26	-0.44
Evening	-0.28	-0.47
Saturday	-0.31	-0.52
Sunday	-0.30	-0.49
Average	-0.28	-0.47

These are 2000 elasticities as per 'London Underground and Bus Demand Analysis 1970-2000', factored up to 2004 using changes in real fare per passenger km.

Further information on conditional and own-price elasticities can be obtained from the Pricing and Forecasting Manager, Revenue Policy, Customer Experience Directorate. Contact Tony Richardson, [redacted]

APPENDIX K Techniques for Appraising Renewals

Four techniques are discussed:

K.1 Overview of Asset Degradation

K.2 Appraising the Effect of Bringing Forward Renewal by One Year

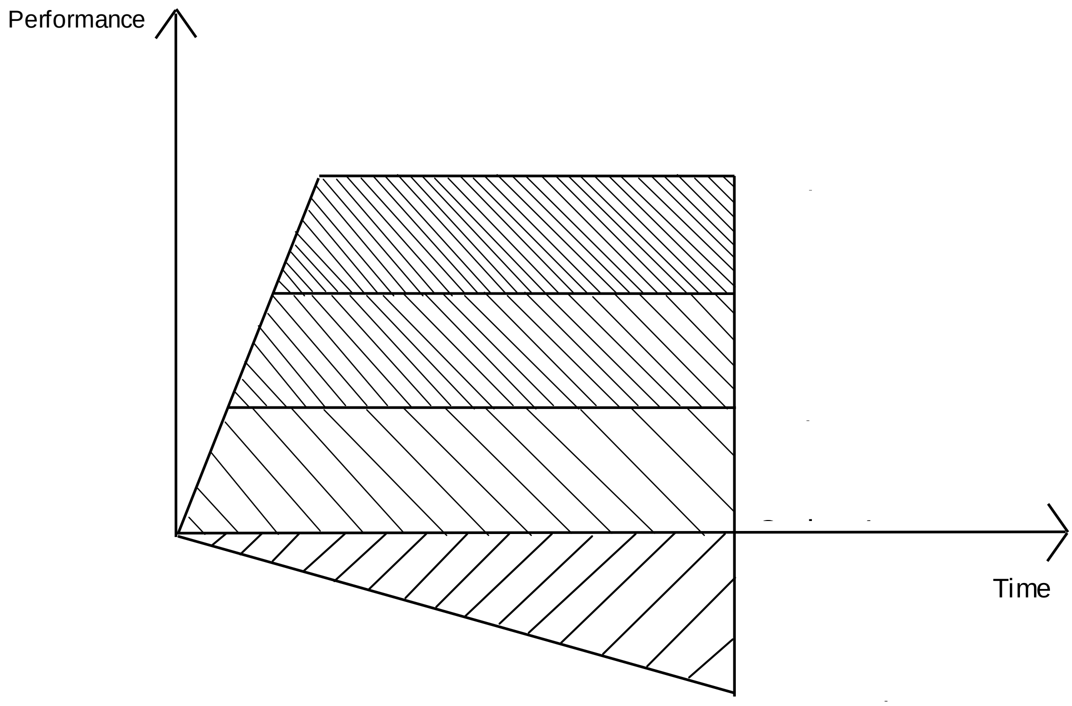
K.3 Equivalent Annual Cost

K.4 Methodology for Scenarios in Which Risk Accelerates in "Do Nothing" Option

K.1 OVERVIEW OF ASSET DEGRADATION

When an asset is approaching life expiry, various options may need to be considered, but a key aspect of the appraisal will be to define, and assess, the base case. A diagram is presented below showing the base case, an option to maintain existing service levels, and various enhancement options.

'Performance' here is intended to embrace both social and (gross) financial benefits. The shaded areas indicate increments in performance of each option over the option below.



This diagram is schematic, with the possible implementations of enhancement options phased in over time (as might be required because of funding constraints, or uncertainty about technological developments). With these options, the actual line of performance would probably dip below the Base Option line at first, since service levels are typically reduced during the implementation stage.

K.1.1 Base option

Broadly speaking, this will be a “Do Minimum” option. One approach could be to look at the effect of continuing with the same levels of capital investment and maintenance. However, the overriding principle is that it must stand up as a reasonable option. If the existing asset is unlikely to survive for any length of time, then the loss of the asset at some point must be recognised. Under this scenario, it is possible that some earlier alternative course of action would be a more realistic base option than continuing with the asset until it fails completely.

If the amount of maintenance would simply have to increase for the asset to kept in service, then these costs should be included. If there is a high safety risk, the base option should not assume fatalities each year on a continuing basis. (The disbenefits of such a base option might then justify practically any alternative.) Instead, the base option should include the estimated costs needed to keep risks As Low As Reasonably Practicable.

Any passenger disbenefits, safety disbenefits, and costs that arise as

- the asset increasingly fails in service
- the frequency and periods of being out of service increase
- service levels have to be reduced (e.g. imposition of speed limits)

should be quantified in the base case.

Components which are critical to the overall operation of the asset, and which lack an ongoing supply of spares, should be identified. Apart from increased maintenance, the cost implications may include:

- design costs for the replacement of components which are no longer in production
- having to take on extra staff, either to monitor safety risks or to carry out manually functions that would normally be automated.

Option 1 would include any costs needed to maintain the existing performance that the asset currently provides, without providing any enhancements.

Options 2, 3, 4, etc. would offer packages of enhancements, typically assembled in such a way that each option entails a step change in costs over the previous one.

K.2 APPRAISING THE EFFECT OF BRINGING FORWARD RENEWAL BY ONE YEAR

K.2.1 Example

Consider an asset which currently, because of its age, incurs additional maintenance costs and causes a reduced service level through poor reliability. If there is a one year delay in investment, then there is also a one year delay before the normal maintenance costs and service level are restored.

Capital cost of renewal	£1,100,000
Additional maintenance if not done	£20,000 pa
Passenger disbenefit if not done	£112,000 pa
Revenue loss following from passenger disbenefit	£29,000 pa

The approach is to consider only the effect over the first two years. The base option is to renew in one year's time, and the appraisal tests the value of bringing forward the investment to the current year. Differences between the options are shown in bold.

Year	**BASE OPTION RENEW IN ONE YEAR**			**OPTION TO RENEW NOW**			**INCREMENT**		
	Capital cost £000	Additional maintenance and revenue loss (pa) £000	Passenger disbenefit (pa) £000	Capital Cost £000	Additional maintenance and revenue loss (pa) £000	Passenger disbenefit (pa) £000	Capital Cost £000	Additional maintenance and revenue loss avoided (pa) £000	Passenger disbenefit avoided (pa) £000
0	**0**	-49	-112	**-1100**	-49	-112	-1100	0	0
1	**-1100**	**-49**	**-112**	**0**	**0**	**0**	1100	49	112
NPV	-1038	-95	-218	-1100	-49	-112	-62	46	106
	Benefit : Cost Ratio						**6.6:1**		

The benefit:cost ratio of 6.6:1 shows that the extra cost of bringing forward the renewal expenditure by one year is justified by avoiding additional maintenance and passenger disbenefit.

This method gives a simple approximation for long-life projects of, say, 15 years or more. There is the possibility of further advantage/disadvantage by virtue of being able to bring forward the renewal by one year again at the end of the life-cycle, but it is very difficult to predict what the costs and benefits might be at that stage.

However, any known future costs, for example half-life refurbishments, should be accounted for. The following table shows the effect of bringing forward costs by one year at the 5 year stage, 10 years, etc.

Stage (years)	5	10	15	20	25	30	35	40
Effect on cost (NPV)	0.0423	0.0316	0.0236	0.0176	0.0132	0.0099	0.0074	0.0055

K.2.2 Example of use of table

Suppose the above renewal will last 30 years, and a half-life refurbishment will cost £0.2m. The NPV of costs would increase by

£200,000 x 0.0236 = £4,720

which would change the benefit cost ratio from 6.6:1 to 5.5:1.

Note: Approximation using the costs and benefits of bringing forward a renewal by one year should not be used where the project life is less than 15 years, or for a major project, where a more detailed appraisal would be required.

For further guidance, contact TfL Business Case Development (Ryan Taylor, [redacted]

K.3 EQUIVALENT ANNUAL COST

Choosing between different renewal cycle options

The aim is to compare different renewal cycles. Typically there is a trade off between the capital cost, how long the infrastructure will last, and how expensive it is to maintain. At the end of the renewal cycle the process repeats. If the cycles have a straightforward Common Multiple, e.g. 10 years and 15 years, they can be appraised using the appropriate project life: 30 years in this example.

To make comparison between options easier (especially where the different life cycles do not have an easy Common Multiple) the 'Equivalent Annual Cost' converts the actual pattern of spend into an equivalent amount to be spent each year.

The Equivalent Annual Cost is the amount you would invest every year of the cycle to give the same overall Net Present Value as the project. It is the NPV of one renewal cycle divided by the Annuity Factor for the cycle length in years.

[The Annuity Factor is the sum of the discount factors of the cycle i.e.

1/1.06 + 1/1.06 2 + 1/1.06 3 + ... + 1/1.06 C

where 6% is the discount rate p.a. used in this example and C is the number of years in the cycle.]

To simplify the analysis, it is assumed that the capital cost is incurred in year 1 rather than the usual convention, year 0. Then the equivalent annual cost spent each year gives the same NPV as a combination of one-off and recurring expenditure:

Year	**Actual expenditure**		**Equivalent Annual Cost** £000s
	Capital cost £000s	**Maintenance costs** £000s	
1	1000	100	324
2		100	324
3		100	324
4		100	324
5		100	324
NPV	943	421	1365

The Equivalent Annual Cost, £324k p.a., is calculated by dividing the total NPV of actual expenditure (£943,000 + £421,000) by the Annuity Factor for the first 5 years (4.212).

K.3.1 Example of use of Equivalent Annual Cost

The following options to be considered have life-cycles of 5, 9 and 13 years:

	Option 1 £000s	Option 1a £000s	Option 2 £000s	Option 3 £000s
Capital cost	1000	2000	1500	2500
Maintenance costs p.a.	100	200	70	40
Useful life (years)	5	10	9	13
NPV	1365	3359	1891	2713
Annuity Factor*	4.212	7.360	6.802	8.853
Equivalent Annual Cost	324	456	278	306

Option 1a is included purely for comparison with Option 1. It illustrates that if all spending is increased proportionately (i.e. doubled in this case) together with the life span, the shorter life option has a lower Equivalent Annual Cost, the decisive factor being the avoidance of large expenditure in early years.

When Options 1, 2 and 3 are compared, Option 2 is shown to have the lowest Equivalent Annual Cost, and would therefore be the preferred option.

Note: Equivalent Annual Cost should only be used for a preliminary prioritisation of options. It should not be used as a substitute for a full appraisal.

* If a table of Annuity Factors is held in an Excel spreadsheet ANNUITY in cells C1:D41, column 2, i.e.

Year	Annuity Factor
1	0.943
2	1.833
...	...
39	14.949
40	15.046

then the following function will locate the Annuity Factor for year 5:

=VLOOKUP(5, [ANNUITY.XLS]Sheet1! $C$1:$D$41, 2)

K.4 METHODOLOGY FOR SCENARIOS IN WHICH RISK ACCELERATES IN "DO NOTHING" OPTION

This technique is included for two reasons. Firstly, it is to discourage appraisals where an investment is given exaggerated benefits by comparison with to the Do Nothing option, by virtue of avoiding relatively large numbers of fatalities, year after year, when in practice the Do Nothing option would no longer be viable in the aftermath of any incident with a significant number of fatalities. Secondly, it is to add a further dimension to the appraisal, namely to answer the question "When would the project have a business case?" in addition to the usual question "Does the project currently have a business case?". This is particularly relevant where safety is concerned. (See Appendix F for fuller discussion of safety appraisals.)

Example: A hazard has been identified which, following a Quantified Risk Analysis, will cause an "expected" 4 fatalities over the first decade, increasing to 8 fatalities over the subsequent decade. To mitigate the risk entirely, a project costing £9.2m is proposed.

A curve showing increasing risk of fatalities has been provided by the QRA:

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Expected fatalities	.31	.32	.33	.34	.36	.38	.41	.44	.47	.51	.56	.60	.65	.72	.78	.85	.94	1.03	1.11	1.20

Then a table of changing scenarios could be developed as follows:

Year	Expected fatalities if project not yet implemented	Cost of project which mitigates risk £000s	Cost of implementing that year, instead of deferring by one year £000s	Loss of revenues avoided £000s	Net Financial Effect £000s	Value of avoiding fatalities £000s	Safety benefit:cost ratio
1	0.24	-9200	-521	126	-395	339	0.86
2	0.25	-9200	-521	129	-392	349	0.89
3	0.26	-9200	-521	131	-390	360	0.92
4	0.27	-9200	-521	134	-387	371	0.96
5	0.28	-9200	-521	139	-382	393	1.03
6	0.30	-9200	-521	144	-377	415	1.10
7	0.32	-9200	-521	152	-369	448	1.21
8	0.34	-9200	-521	159	-362	480	1.33

(The costs and benefits of implementing one year, instead of deferring until the next, are calculated as in Appendix K2.)

There are many assumptions within this table, including a Value of Avoiding a Fatality of £1.4m, and potential loss of revenues increasing with increased risk of fatalities. However, setting these aside, the purpose of the example is to illustrate a scenario where the expenditure is not quite warranted at present for purely safety reasons, but where by year 5 it would be. The knowledge that the project would need to be done in the next few years, coupled with the usual margins of error in quantifications of risk, are factors that may lead to the project being recommended on safety grounds, despite currently being below the 1:1 benefit:cost threshold for safety projects.

Notes

1. There is no discounting in this table, apart from the discount implicit in the cost of renewing in any particular year instead of a year later, since there is no attempt to total across the whole time period. Each year, the calculation uses broadly the same figures as in year 1 in real terms, except for valuations affected by the increased risk of fatalities.

2. Although the rate of change of risk in this case is a curve with smoothly increasing steepness, there is always a possibility that at some stage there will be a step change increase. In forecasting future risks, QRAs should examine the underlying patterns in related historical data, including any which might suggest a sudden worsening of risk at some point.

APPENDIX L Wider Impacts (Including Environmental)

L.1 INTRODUCTION

This appendix begins with an environmental overview and detailed checklist of potential impacts in L2 and L3. There follows a brief discussion of best practice and quantification issues in L4 and L5.

In the sections thereafter, appraisal guidance is largely based on the DfT's WebTAG (Transport Appraisal Guidance on the Web, established in 2003 but with incremental updates on an ongoing basis).

It is intended that future editions of the BCDM will distil WebTAG guidance and/or supplement it with a London perspective where necessary, as for example in L7 Air Quality. (However, in many cases the current entries simply provide relevant WebTAG references.)

Specific environmental impacts are covered in L6 to L12:

L6	Noise
L7	Air quality
L8	Greenhouse gases
L9	Journey ambience
L10	Physical fitness
L11	Townscape
L12	Other environmental impacts: Landscape Heritage of historic resources Biodiversity Water environment

Non-environmental impacts are then covered in L13 to L15:

L13	Regeneration ('Wider economic impacts')
L14	Equality and Inclusion
L15	Other non-environmental impacts: Reliability Option values Severance Access to the transport system Transport Interchange Integration with land-use policy Integration with other government policies

L.2 ENVIRONMENTAL OVERVIEW

Starting at project inception and throughout the project lifecycle, relevant environmental issues should be considered by reviewing the proposed deployment of resources (revenue or capital) against the checklist below (see L3).

[In an environmental review of the investment programme all parts of the programme are examined using the checklist of environmental issues. The conclusions, including possible changes to scope, can then be incorporated into project planning earlier than if environmental impacts were not considered until the project submission stage.]

Environmental policy would not normally require unscheduled replacement of assets (except in extreme circumstances to comply with legislation) nor would it normally require retro-fitting of environmental technology to existing assets. However, it is important to ensure that proposals for new expenditure take into account environmental issues, and that any opportunities for environmental improvement are identified and exploited.

In the presentation of a business case, any significant environmental issues outlined within the checklist should be mentioned, e.g. any specific features that are required to comply with environmental legislation. In particular, where an environmental review of the investment has previously been carried out, the business case should comment on any significant issues which the project was expected to address.

[Note that where planning permission is sought or the Transport and Works Act procedure is being applied, an Environmental Impact Assessment (EIA) may be required, at the discretion of the local authority. An EIA may be required a) if the site is environmentally sensitive, such as a Site of Special Scientific Interest, or b) if the works may have hazardous consequences, e.g. development on contaminated land, or c) for large-scale projects. If the area of the works is less than 1 hectare, or 10000 sqm, an EIA is unlikely to be required.

Further information on EIAs can be obtained from Group Planning. Contact Neil Kedar on [redacted]

L.3 ENVIRONMENTAL CHECKLIST

The checklist below is relevant at each point in the lifecycle of a project, i.e.

- design
- procurement
- construction
- use
- disposal of asset at the end of its lifetime.

L.3.1 Emissions to air

Will the project generate emissions to air?

- Are they of environmental concern? (e.g. greenhouse gases, ozone depleters, particulates (black smoke))
- Is there legislation relating to these emissions?
- Are alternatives available that have lower emissions?
- Will the new asset result in more or less emissions?

L.3.2 Discharges to water / effluent

Will the project change the quality or quantity of discharges to water?

- Are they of environmental concern? (substances contained in discharges)
- Are any additional discharge consents required?
- Are there alternative approaches that will result in reductions in the quantity of the discharges?
- Are there alternatives that will improve the quality of the water discharged?

L.3.3 Contaminated land

Is the site to be used contaminated?

- What measures will be taken to ensure that environmental risk is reduced during the demolition, excavation and construction period?
- What measures will be taken to ensure that environmental risk is reduced during the subsequent use of the site?

L.3.4 Noise and vibration

Will there be a change in levels of noise and vibration as a result of the project?

- Is there an option which would generate less noise?
- Can construction work be carried out at less sensitive times?
- Can measures be implemented which will reduce noise or vibration? (e.g. barriers, screening, etc.)
- What are the operational implications of increased levels of noise or vibration? (e.g. reduced speed and frequency, hours of operation)

L.3.5 Waste

Will a significant amount of waste be generated by the project?

- Will the levels of operational waste subsequently be increased?
- Has provision been made for the segregation of waste during the lifetime of the facility?
- Can parts of the old asset be utilised as an input to this or other projects?
- Can the waste be recycled?
- Has minimising waste been considered as part of a refurbishment / renewal decision?
- Will hazardous waste (e.g. asbestos, clinical waste) be generated? How will this be dealt with?

L.3.6 Dust

Will the project lead to increased levels or circulation of dust?

- Can measures be included within the project to reduce dust?

L.3.7 Energy use

Will energy consumption increase or decrease as a result of this project?

- Have energy efficient options been investigated? (e.g. pumps, motors, air handling units etc.)
- Is there scope for a Combined Heat and Power application?
- Can low emissivity glass be used?
- Is there an opportunity for incorporating renewable energy technology?
- For refurbishment and new build, does the project include metering of the site?

L.3.8 Water consumption

Will water use increase or decrease as a result of this project?

- Can 'greywater' be recycled? (there may be issues with storage)
- Can rainwater be collected from site?
- For refurbishment and new build, does the project include metering of the site?

L.3.9 Habitats

Will any natural habitats be disturbed as a result of this project?

- Are there any tree preservation orders?
- Is the presence of any protected species suspected at the site?
- How will these issues be dealt with? (eg. species relocation, instructions to contractors etc.)
- Can the timing of the project be adjusted to avoid a nesting season?
- What reinstatement works will be undertaken as part of the project?
- Does the project provide opportunities for enhancing the wildlife value of the site?

L.3.10 Heritage

Does the project have an impact on sites of heritage importance?

- Does the project include works on a building that currently has, or is being considered for, national or local 'Listed' status?
- Is the site adjacent to buildings that are 'Listed'?
- Does the site contain any features of significant design or architectural value?
- Is the site within a conservation area?
- What measures will be taken to ensure that the heritage value of the site is preserved?

L.3.11 Materials

Does the project involve the use of hazardous or other environmentally sensitive materials?

- Are any of the following materials involved: Mercury, Asbestos, HCFCs, Halons, Solvents (degreasing, cleansing etc.), other cleaning chemicals, acids, Cadmium, lead, nickel, zinc, chromium?
- Are there alternatives that are more environmentally acceptable? (e.g. galvanising rather than cadmium plating)
- Are there independently environmentally certified materials that could be used? (e.g. Forest
- Stewardship Council timber)

L.3.12 Storage of hazardous materials

Will the project result in long term storage of hazardous materials? eg. fuels, oils, antifreeze

- What are the additional materials now being stored?
- How are they to be stored?
- Are additional bunds, interceptors, etc. required?
- Is the storage facility sited near to the point of use?

L.3.13 Modal shift

Will the project produce a significant modal shift? (i.e. greater than 1m trips p.a.)

- Approximately what level of modal shift is expected?
- What levels of local, and overall, emission reduction will this result in?

L.4 IDENTIFYING THE BEST PRACTICABLE ENVIRONMENTAL OPTION

Where the appraisal raises significant environmental issues, the following general principles should be applied:

- Identify best practice within the industry (or industry in general).
- Identify costs and whether they would be any higher for TfL to apply
- If cost not excessive i.e. not greater than the benefits generated by adopting the option (see section L5) adopt this option and state reasoning in business case
- If cost considered excessive state why this is considered to be the case and make a qualitative statement to this effect in the business case.

L.5 QUANTIFICATION

Quantification of environmental impacts may be appropriate where major projects or policy questions are being considered. At present, a number of methodologies for quantifying environmental considerations in appraisals have yet to be agreed by the DfT. However, many environmental considerations can be captured by full consideration of efficiency gains and disposal costs in the initial benefit-cost equation.

Research is continuing with the aim of developing more widely accepted methodologies which could be included in the main appraisal, but in the meantime, any proposed valuations of environmental impacts should be checked with TfL Business Case Development.

Some of these valuations cannot be included in the main appraisal, and should be included as further information to supplement the business case.

Contact Ryan Taylor [redacted] regarding what is permissible to include in the main appraisal.

Note: If a project risks a considerable erosion of TfL's environmental performance, or offers a considerable improvement which cannot be quantified under existing BCDM methodologies, please contact Neil Kedar (Group Planning, [redacted]

L.6 NOISE

Noise, commonly defined as "unwanted sound", can disrupt communication and concentration, increase stress, and impair sleep quality. There is uncertainty over long term health effects, and transport noise is most commonly assessed using self-reported annoyance. The World Health Organisation defines noise annoyance as "a feeling of displeasure evoked by noise". Recent European legislation (Directive 2002/49/EC) and the Mayor's London Ambient Noise Strategy are focussing attention on the need to reduce noise pollution.

Transport is a major noise contributor. Whilst "annoyance" is subjective and will vary amongst individuals, a 'Community response rate' to particular noise levels and sources can be derived. The 'Annoyance Response Relationship' between noise level and the percentage of people expressing annoyance, for free flowing daytime road traffic and conventional daytime rail operation is contained in DfT WebTAG guidance

http://www.dft.gov.uk/webtag/documents/expert/unit3.3.php

and reproduced in Figure L6.3 .

Illustrations of noise levels corresponding to some well known sounds are shown in Figure L6.1 and explanations of the most commonly used noise measurement terminology, reproduced from PPG24, can be found in Figure L6.2.

L.6.1 When should Noise impacts be evaluated?

a) New activity: for some TfL projects, it will be reasonable to assume that impact on ambient noise levels will be very limited or zero. This includes projects that generate noise less than 45 dBA Leq (or more than 10 dBA below existing background levels – whichever is lower). All other projects should be assessed for noise.

(Those that generate daytime noise levels 10 dBA above existing road or rail noise or existing background levels will require particularly strong justification and, normally, specialist input to assess noise levels and seek noise mitigation. In the context of the overall objective to reduce noise levels, projects involving an increase of 1 dBA or more, and generating residential façade levels of 68 dBLA10,18 hour / 65 dBLAeq, 18 hour or more, should also normally receive specialist acoustic input.

Night-time operations are particularly sensitive, and projects likely to increase night-time noise levels will normally require specialist input.)

b) Intensification of existing activity: a change in continuous background noise of less than 1 dBA Leq is unlikely to be perceptible in normal conditions. A 1 dBA change equates to an increase/decrease in free flowing road traffic volume of +25%/-20% respectively. Any change of 1 dBA or more should be assessed. Rail operations typically comprise noise "events" and not a constant background level. The relationship between altered levels of activity and noise annoyance will therefore be more complex. (It should also be noted that noise changes are cumulative. For this reason a series of less than 1dB(A) increases could warrant consideration of mitigation measures.)

c) In all cases: the level of pre-existing background noise together with the type of noise generated (e.g. tonal or impulsive noise, see Glossary) and particular local sensitivities such as the presence of older people's housing, schools or hospitals, relatively quiet open spaces, or features of special soundscape interest such as flowing water, will be important considerations.

For these reasons, project sponsors are strongly encouraged to consult with local authority Environmental Health Officers at an early stage. The EHO should also be able to advise if a noise assessment will be necessary for construction work. Resources allocated to the assessment of noise impact should be commensurate with the scale of both the project and estimated noise impact.

L.6.2 How should Noise impacts be measured?

An assessment of the change in noise and the population affected should be determined. The on-line computerised London Noise Map (see www.LondonNoiseMap.com) can provide an initial view of the current situation. It shows streets and buildings colour coded in 5dB bands (using dBLA10,18 hour).

The WebTAG calculator can be found in 2.1.1 of Unit 3.3.2 (HTML version, not the pdf version, as it does not include links). This Excel spreadsheet can be saved as a working file. It calculates the estimated total number of people annoyed, without and with the project, and will also calculate monetised social benefits / disbenefits in 2002 prices.

The calculator requires very specific inputs, which may not be readily available. It requires the changes in the number of households per 3dB band from without the project to with the project, in the form of a crosstabulation. It also requires units of dBLAeq,18 hour –see L6.3 below for conversion from dBLA10,18 hour. In the excerpt below, 20 households are shown as moving from the 48-50.9 band to the 45-47.9 band:

	With Scheme	<45	45-47.9	48-50.9
Without Scheme				
<45				
45-47.9				
48-50.9			20	

Data needs to be entered into two tables, for the opening year of the project and for 15 years after the opening year (e.g. 2010 and 2025). The calculator automatically performs a 60-year appraisal, and if the opening year is specified as 2010, it ends in 2069.

A raw monetised benefit is calculated for the opening year (Year 0) and for Year 15. The years in between are linearly interpolated, and Years 16 59 are assumed to be the same as Year 15.

Calculations for the two specified years are performed by relating each of the input tables to a table of noise impact values in 2002 prices. An excerpt is shown below:

£ per household per annum, 2002 prices and values									
Do-Minimum noise, dB	Do-Something noise, dB								
	<45	45-48	48-51	51-54	54-57	57-60	60-63	63-66	66-69
<45	0	-14.0	-59.0	-127.8	-220.2	-329.8	-469.8	-633.4	-820.8
45-48	14.0	0	-45.1	-113.8	-206.3	-315.9	-455.8	-619.5	-806.8
48-51	59.0	45.1	0	-68.8	-161.2	-270.8	-410.8	-574.4	-761.8

Using the same example as above, the 20 households moving from the 48-51 band to the 45-48 band if the project is carried out would be valued, in 2002 prices, as: 20 x £45.1 = £902 p.a.

Annual benefits are subject to discounting in the usual way, at a rate of 3.5% p.a. for the first 30 years and 3% p.a. subsequently. The calculator discounts from the standard WebTAG base year 2002. A variable increase in value per year is also applied, as follows:

Range of years	Real GDP growth, % per annum	Household growth, % per annum	Value growth 'adjustment factor'	Growth in values of noise change, % per annum
2002-2003	2.25	0.75	1.0000	1.4888
2003-2004	2.50	0.75	1.0000	1.7370
2004-2005	3.50	0.75	1.0000	2.7295
2005-2006	3.25	0.75	1.0000	2.4814
2006-2007	2.75	0.76	1.0000	1.9750
2007-2011	2.50	0.76	1.0000	1.7269
2011-2021	2.25	0.67	1.0000	1.5695
2021-2031	1.75	0.33	1.0000	1.4153
2031-2032	2.00	0.17	1.0000	1.8269
2032-2036	2.00	0.17	0.8571	1.5417
2036-2051	2.00	0.00	0.8571	1.7143
2051-2061	1.75	0.00	0.8571	1.5000
2061 onwards	2.00	0.00	0.8571	1.7143

Only the final column is used by the calculator (but the table shows how this column, which is real GDP growth per household taking into account the discount rate reduction after 30 years, is derived). As an example, the raw 2002 value would be adjusted for discounting and for growth to a 2004 benefit by:

Value2004 = Value2002 x 1/(1.035)2 x (1+1.4888/100) x (1+1.7370/100)

The total benefit produced by the calculator then requires two further adjustments. Firstly the raw monetised values are directly related to UK household incomes, and where local incomes are different the supplementary guidance provides a table of indices which are compared to the UK index of 100. The relevant indices for London are:

London	121
Inner London	127
Inner London - West	164
Inner London - East	106
Outer London	117
Outer London - East and North East	112
Outer London - South	120
Outer London - West and North West	119

and the relevant definitions are:

Inner London—West	Camden, City of London, Hammersmith and Fulham, Kensington and Chelsea, Wandsworth, Westminster
Inner London—East	Hackney, Haringey, Islington, Lambeth, Newham, Southwark, Lewisham, Tower Hamlets
Outer London—East and North East	Barking and Dagenham, Bexley, Enfield, Greenwich, Havering, Redbridge, Waltham Forest
Outer London—South	Bromley, Croydon, Kingston upon Thames, Merton, Sutton
Outer London—West and North West	Barnet, Brent, Ealing, Harrow, Hillingdon, Hounslow, Richmond upon Thames

As examples, the UK value would be mutiplied by 121/100 for a London-wide scheme, or 106/100 for a Hackney scheme.

The second adjustment that may be needed is conversion of the calculated total benefits or disbenefits in 2002 prices to prices for a later year. For this, use the GDP Deflator index (Appendix C5), e.g. for 2004 prices:

multiply by GDP Deflator2004 / GDP Deflator2002

What if the available data is not in a format suitable for the calculator?

The supplementary guidance describes various instances, including:

a) 'Lower resolution' data using 5dB bands

If the noise levels are recorded in 5dB or other bands, then the data should be gathered in two tables similar to those used by the calculator. Then the steps performed by the calculator need to be performed manually, using a spreadsheet set up on similar lines. The guidance provides the following table of values based on 5dB bands instead of 3dB bands.

£ per household per annum, 2002 prices and values								
Do-Minimum noise, dB	Do-Something noise, dB							
	<45	45-49.9	50-54.9	55-59.9	60-64.9	65-69.9	70-74.9	75-80
<45	0	-26.4	-127.8	-295.0	-528.2	-827.3	-1192.2	-1623.1
45-49.9	26.4	0	-101.4	-268.7	-501.9	-801.0	-1165.9	-1596.8
50-54.9	127.8	101.4	0	-167.3	-400.5	-699.6	-1064.5	-1495.4
55-59.9	295.0	268.7	167.3	0	-233.2	-532.3	-897.2	-1328.1
60-64.9	528.2	501.9	400.5	233.2	0	-299.1	-664.0	-1094.9
65-69.9	827.3	801.0	699.6	532.3	299.1	0	-364.9	-795.8
70-74.9	1192.2	1165.9	1064.5	897.2	664.0	364.9	0	-430.9
75-80	1623.1	1596.8	1495.4	1328.1	1094.9	795.8	430.9	0

b) Data without cross-tabulations

If the data do not give the change in noise level for each household between the without-scheme and with-scheme scenarios, and instead give only the total number of households in each band for each scenario, a 'cascade' method is described, assuming:

- minimum movement by individual households between noise bands;
- start by allocating households to the lowest noise band.

	Without Scheme	**With Scheme**
<45	14	22
45-47.9	25	36

In the above example, there is an increase of 8 in the number of households at levels of <45dB between DM and DS. All of these households are assumed to have come from 45-47.9dB (the next category up). The 45-47.9dB without-scheme category in then adjusted accordingly:

	With Scheme	<45	45-47.9	48-50.9
Without Scheme				
<45		14		
45-47.9		8	17	

Now, looking at the remaining 17 households, these are not enough to supply the corresponding with-scheme total of 36, so as before the remainder is supplied from the next category up:

	With Scheme	<45	45-47.9	48-50.9
Without Scheme				
<45		14		
45-47.9		8	17	
48-50.9			19	

The process continues, each time moving the minimum number of households to the next category as necessary and maintaining the correct row and column totals, until the cross-tabulation is complete.

There is clearly potential for error when the noise change cross-tabulation is ‘constructed’ from noise band data of this type, and if this approach is used in valuing noise change, the assumptions made should be reported with the appraisal results.

c) How should noise impacts be presented?

A brief explanation of the scheme impact should be provided. Reference should be made to any particular noise issues identified and/or addressed (e.g. schools or other community facilities affected, and night time impacts if any, which are not included in annoyance response relationship data).

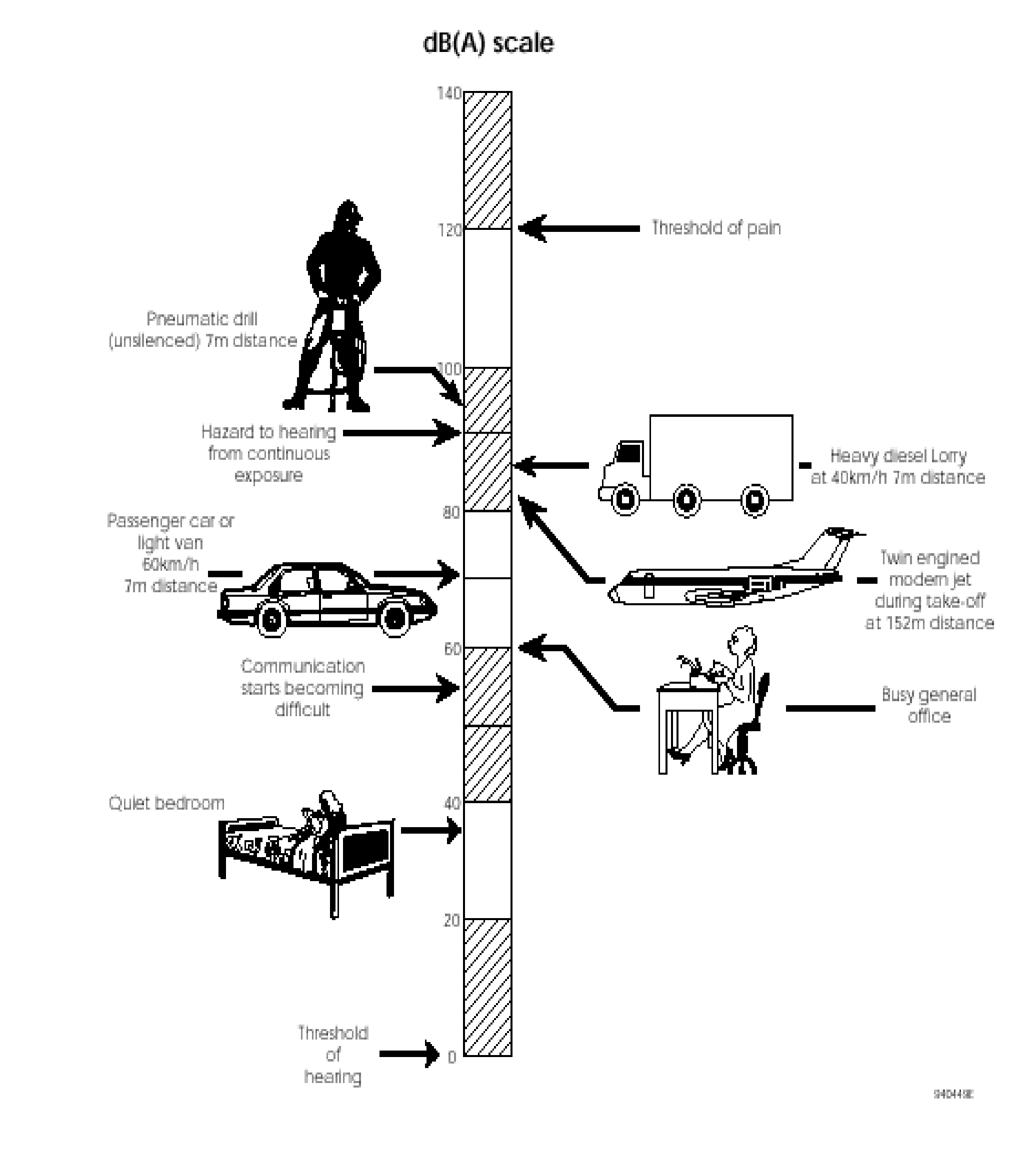
The present value of monetised social costs for all years in the appraisal period is calculated. If the impact represents increased noise this monetised value is negative and is termed ‘social disbenefit’, while if there is reduced noise the value is positive and is termed ‘social benefit’. The value is added to any other social benefits produced by the project before the benefit:cost ratio is calculated.

For presentations in DfT format, the entry in the Assessment column of the Appraisal Summary Table should be the present value of monetised social costs, prefaced by “PVB (Residential) =” (and the same value goes in the appropriate row of the ‘Analysis of Monetised Costs and Benefits’ table). In the Quantitative column, the numbers of people annoyed in Year 15, without the scheme and with the scheme, should be reported. In the Qualitative column, an assessment should be given of the impact of noise changes on non-residential locations such as recreational land, public space, workplaces, schools and hospitals. This column should also be used to describe any changes in night time noise if night noise is disproportionately affected by the project or Plan, since night time noise is excluded from the 18 hour LAeq noise measure used as the basis for the Quantitative and monetary analysis.

For fuller details see the relevant WebTAG unit – includes the link to the relevant WebTAG calculator spreadsheet:

http://www.dft.gov.uk/webtag/documents/expert/unit3.3.2.php

Figure L1: Levels of Typical Common Sounds dB(A)



L.6.3 Glossary

Decibel (dB):	a unit of level derived from the logarithm of the ratio between the value of a quantity and a reference value. It is used to describe the level of many different quantities. For sound pressure level the reference quantity is 20 Pa, the threshold of normal hearing is in the region of 0 dB, and around 120 dB is the threshold of pain. A change of 1 dB is only perceptible under controlled conditions.

dB(A) or dBA:	decibels measured on a sound level meter incorporating a frequency weighting (A weighting) which differentiates between sounds of different frequency (pitch) in a similar way to the human ear. Measurements in dB(A) broadly agree with people's assessment of loudness. A change of 3 dB(A) is the minimum perceptible under normal conditions, and a change of 10 dB(A) corresponds roughly to halving or doubling the loudness of a sound. The background noise level in a living room may be about 30 dB(A); normal conversation about 60 dB(A) at 1 metre; heavy road traffic about 80 dB(A) at 10 metres; the level near a pneumatic drill about 100 dB(A).
Hertz (Hz):	unit of frequency, equal to one cycle per second. Frequency is related to the pitch of a sound. Impulsive noise: having a high peak of short duration or a sequence of such peaks. Intermittent noise: the level drops to that of the background noise several times during the assessment period, with a change of at least 5 dB.
LA10,T :	the A weighted level of noise exceeded for 10% of the specified measurement period (T). It gives an indication of the upper limit of fluctuating noise such as that from road traffic. LA10,18h is the arithmetic average of the 18 hourly LA10,1h values from 06.00 to 24.00.
LA90,T :	A weighted noise level exceeded for 90% of the specified measurement period (T). In BS 4142: 1990 it is used to define background noise level.
Leq:	the equivalent continuous sound level -the sound level of a notionally steady sound having the same energy as a fluctuating sound over a given period.
LAeq,T :	the equivalent continuous sound level having the same energy as a fluctuating sound over a specified measurement period (T). LAeq,T is used to describe many types of noise and can be measured directly with an integrating sound level meter. It is written as Leq in connection with aircraft noise.
LAmax :	the highest A weighted noise level recorded during a noise event.
Lden :	day, evening and night levels combined using a complex formula which weights according to a 12-hour day, 4-hour evening and 8-hour night, taking account of the logarithmic scale on which the three figures lie. (This gives relatively more weight to the higher figures.)
Low-frequency noise:	containing major components within the low frequency range (20Hz-250Hz) of the frequency spectrum.
Night period:	23:00 to 7:00 (in relation to air transport, this is a period during which the noisiest types of aircraft may not be scheduled to land or to take off)
Tonal noise:	containing a prominent frequency and characterised by a definite pitch.

L.6.4 Annoyance Response Curves for Road and Rail Traffic Annoyance

Road noise $L_{Aeq\ 18h}$ dB	% annoyed	Rail noise $L_{Aeq\ 18h}$ dB	% annoyed
<45	0	<45	0
45	3	45	3
46	4	46	4
47	4	47	4
48	5	48	5
49	5	49	5
50	6	50	6
51	7	51	6
52	7	52	7
53	8	53	8
54	9	54	8
55	10	55	9
56	11	56	10
57	13	57	11
58	14	58	12
59	15	59	13
60	17	60	15
61	19	61	16
62	21	62	17
63	23	63	19
64	25	64	20
65	27	65	22
66	30	66	23
67	32	67	25
68	35	68	27
69	38	69	29
70	41	70	30
71	44	71	32
72	47	72	34
73	50	73	36
74	52	74	38
75	55	75	40
76	58	76	42
77	61	77	44
78	64	78	46
79	67	79	48
80	69	80	50
81	72	81	52
>81	75	>81	55

Note: where road noise impacts are recorded in units of LA10,18 hour they may be converted to LAeq,18 hour for the purposes of this table by:

$_{LAeq,18\ hour} = LA10,18\ hour\ -^{2.5\ dB(A)}$

L.7 AIR QUALITY

Poor air quality damages health and quality of life and is thought to cause an estimated 1,600 accelerated deaths and 1,500 hospital admissions in London every year (Air Quality Strategy - GLA). The EU has set binding targets for the reduction of air pollution to levels at which health is not affected, and these have in turn shaped the UK's national air quality targets.

Within London, the Mayor together with the local authorities have statutory responsibility for air quality and must achieve air quality objectives for seven polluting gases. In those locations where the objectives are unlikely to be achieved, Air Quality Management Areas must be designated. The declaration of an AQMA requires the relevant local authority to review the potential abatement techniques available to achieve the air quality objectives and develop an Action Plan.

It is anticipated that the most problematic objectives to achieve will be those relating to Nitrogen Dioxide (NO2) and suspended air particles (PM10) – particles of less than 10 microns diameter. Road traffic accounts for almost 60% of NO2 emissions and 70% of PM10 emissions (when knock-on effects are included).

L.7.1 When should Air Quality impacts be evaluated?

An air pollution assessment should be commensurate with the scale of the project. The following guidelines should be followed.

However, if in doubt regarding the level of assessment appropriate, project sponsors should contact David Vowles, GLA Senior Policy Officer, Air Quality on [redacted]

- Highway schemes which alter traffic volumes by less than 10% will not require detailed assessment unless there are particular local sensitivities, for example, traffic congestion, (WebTAG Unit 3.3.3, Section 1.3.2).
- Where a project is expected to have an impact in an AQMA, project sponsors should contact the relevant local authority Environmental Health Officer to ensure the project is consistent with the relevant AQMA Action Plan.
- In general, where the air pollution impact of a project is not neutral, some form of assessment and quantification of the impacts should be attempted.

L.7.2 How should Air Quality impacts be measured?

The target date for achieving the National Air Quality Objective for PM10 is 2004, and for NO2 is 2005. There are also more stringent PM10 targets for London to be achieved by 2010. The assessment should be undertaken by comparing the without-scheme and the with-scheme levels for the relevant 'Objective Year', or, where a scheme opens after these dates, for the scheme opening year. Where project impacts are expected to build from a low initial base in the opening year, an assessment of their impacts when the build up period is complete should be made.

For smaller projects, particularly those where small scale impacts are expected to be dispersed across a wide geographic area, it may be sufficient to simply record the an estimation of the overall change in emission levels. (For example, converting the LBSL ancillary vehicle fleet from diesel power to a cleaner fuel could be quantified in terms of a change in the overall annual PM10 and NO2 emissions from the fleet, using best estimates of emission rates based on existing knowledge of fleet usage and vehicle performance.)

Where impacts are anticipated on a particular corridor or corridors, a screening approach similar to that suggested within DfT WebTAG Unit 3.3.3 (and in more detail in DMRB Vol 11 3.1) should be used. This initial assessment determines if more detailed and specialised air quality modelling is appropriate. The approach is to assess the area adjacent to the route in 50m bands up to a maximum of 200m (beyond which there will be assumed to be no effect) simply to see how many properties are likely to be affected positively or adversely, and to check whether any AQMA is included.

If there is reason to believe the impacts are likely to be significant, a second stage follows where detailed modelling provides estimated impacts totalled across the four bands using the following data:

Distance from road centre	No. of properties in band	Impacts measured at this distance from road centre	PM_{10} annual mean	NO_2 annual mean
Up to 50 m		20m		
50 m to 100 m		70m		
100 m to 150 m		115m		
150 m to 200 m		175m		

L.7.3 How should Air Quality impacts be presented?

The scheme impact is summarised as the difference the scheme produces in the annual mean g/m3 at each distance, multiplied by the number of properties in that band, and totalled over the four bands.

A qualitative comment must be provided if the proposal:

- affects air quality within an Air Quality Management Area; or
- leads to an increase of more than 1 g/m3 in annual mean PM10 levels at 20 m from the road centre; or
- leads to an increase of more than 2 g/m3 in annual mean NO2 levels at 20 m from the road centre and the with-scheme level is more than the Air Quality Strategy objective of 40 g/m3 for NO2.

For fuller details, see the relevant WebTAG unit:

http://www.dft.gov.uk/webtag/documents/expert/unit3.3.3.php

L.8 GREENHOUSE GASES

A greenhouse gas is any gas whose molecular structure is such that it will not impede the Sun's energy reaching the Earth's surface (inbound shortwave solar radiation), but will absorb a proportion of the returning energy later released by the earth (outbound long wave heat radiation). As the level of greenhouse gases has increased over the past 200 years due to man made processes, so the natural temperature balance has been disturbed.

The UK has a legally-binding target known as the Kyoto Protocol, to cut the emissions of a basket of six greenhouse gases to, on average, 12.5% below 1990 levels, between 2008 and 2012. The Government also has a domestic goal to achieve a 20% reduction in emissions of carbon dioxide (CO2), the most important greenhouse gas, below 1990 levels by 2010. Two other of the six greenhouse gases of importance to climate change are nitrous oxide, emitted when catalytic converters are used, and methane. A widespread shift from petrol and diesel to other fuels will have implications for CO2, as well as other greenhouse gases (e.g. methane emissions from natural gas powered vehicles).

As CO2 is considered the most important greenhouse gas, it is used as the key indicator for the purposes of assessing the impacts of transport options on climate change, although the focus is on changes in the equivalent tonnes of carbon released as a result of implementing a transport scheme. (For appraisal purposes, it is assumed that all carbon present in the fuel will be released as CO2 although in reality some of the carbon will be released as particles or hydrocarbons.)

Emissions expressed in units of CO2 can be multiplied by the factor 12/44 to give the amount of carbon released. (The atomic weight of carbon is approximately 12 while the molecular weight of CO2 is approximately 44.)

In London, the Mayor's Climate Change Action Plan includes a Green Transport Programme, which focuses on the 22% of London's emissions which are due to ground-based transport. The plan sets out how annual transport emissions can be cut from the forecast levels in 2025 by 4.3 million tonnes of CO2 or 1.2 million tonnes of carbon. There are three broad strands in this plan: changing the way Londoners travel by increasing the relative attractiveness of the more sustainable modes; encouraging drivers of all types of vehicle to adapt their driving style to achieve better fuel efficiency; and seeking technological improvements in the efficiency of engines, vehicle designs, vehicle control systems, and energy sources.

L.8.1 When should the impact on Greenhouse Gases be evaluated?

As described above, transport contributes significantly to the burning of carbon based fuels in London. The 2006 estimate of ground-based transport emissions is 9.6 million tonnes of CO2 which is broken down as follows:

Car & motorcycle	49%	Underground	4%
Road freight	23%	National Rail	4%
Ground-based aviation*	11%	Taxi / Private hire vehicles	4%
Bus	5%		

**Emissions from aircraft whilst taxiing and during the take-off and landing cycle (i.e. below 1,000m altitude)*

An appraisal of the change in CO_2 production should be made for any transport project which significantly alters private and/or public transport traffic volumes, or creates modal shift. It should also be considered when evaluating the impact of projects where replacement of existing technologies or infrastructure will generate a significant change in energy use and therefore CO_2 production, for example on stations and in offices.

L.8.2 How Should Greenhouse Gas impacts be measured?

The monetary value for the change in carbon emissions should be calculated. Monetary values are calculated per tonne of carbon released into the atmosphere.

The amount of fuel consumed, and therefore the amount of carbon emitted, per vehicle kilometre varies considerably by vehicle type. Therefore, for all modes, predictions of emissions will be more accurate the more disaggregated the data is on traffic flow by vehicle type. For example, for National Rail, data disaggregated by individual engine types will lead to more accurate estimates of emissions. Similarly for roads, more disaggregated data on traffic flow by vehicle type (e.g. car, light goods vehicle, rigid HGV, articulated HGV and coaches/buses) will lead to more accurate estimates. Grossly aggregated data can lead to significant errors and expert opinion may be required in order to determine the validity of any conclusions drawn from numerical differences in calculated emissions.

WebTAG provides some guidance specific to roads and National Rail. For road traffic, Unit 3.5.6 (section 1.3.5) provides a formula

$$a + b.v + c.v^2 + d.v^3$$

for calculating fuel consumption in litres per km at any given average speed v kph. The parameters a, b, c, d are tabulated for vehicle categories, e.g. petrol car, diesel car, average car, petrol light goods vehicle, etc. Then Unit 3.5.6 (sections 1.3.7 to 1.3.9) provides a table showing the estimated grams of carbon emitted per litre of fuel, with the predicted mix of fuel varying from 2007 to 2020 and onwards, as the amount of bio fuels in the mix increases. (This is due to the Renewable Transport Fuel Obligation which comes into effect in April 2008, requiring all transport fuel suppliers to ensure that by 2010, 5% of their total fuel sales is made up of bio fuels. Broadly speaking, the carbon emitted from burning bio fuels is equal to the carbon absorbed from the atmosphere by the crop as it grows. However, the crop has to be cultivated, harvested, processed and transported; each of these steps itself results in the consumption of fuel and emission of carbon. In calculating the recommended emission factors, WebTAG assumes bio fuels save 50% of carbon relative to conventional fuels in 2005 and this increases linearly to 75% in 2020.)

For National Rail, DfT (pending the outcome of current research) provides a Rail Emissions Model from 2001, which gives CO_2

emissions per km for each type of diesel train, with assumptions for typical distances separating stations.

The approach to carbon valuation in Government has undergone a major review, concluded in July 2009. The new approach moves away from a valuation based on the damages associated with impacts, instead using as its basis the cost of mitigation. More precisely, the new approach will set the valuation of carbon at a level that is consistent with the UK Government's targets in the short and long term. Previously the valuation of carbon had been based upon an estimate (drawn from the Stern Review) of the damages associated with the climate impacts of emissions, known as the Shadow Price of Carbon.

In December 2008, the EU Climate and Energy Package was agreed. This splits emission reductions into the 'traded' sector, those emissions covered by the EU Emissions Trading Scheme (ETS), and the 'non-traded' sector (those emissions not covered by the scheme). The presence of separate targets in the Traded and Non-Traded sectors means that different carbon valuations are required for each sector in order to preserve target-consistency.

Power stations and aviation lie within the EU ETS, but domestic transport, such as provided by TfL, and the energy requirements of buildings are not covered by the EU ETS. Therefore a 'non-traded price of carbon' should normally be used for TfL projects. The following table shows the 'non-traded price of carbon' to be used, for selected years from 2009 to 2060. The figures represent the value of preventing the emission of a tonne of CO2, or an equivalent amount (tCO2e) of any other greenhouse gas that has the same impact as a tonne of CO2. Values increase approximately linearly until 2030, then much more steeply until 2050, and then stay constant. (This reflects the fact that values are currently based on the aim of reaching the 2050 target, but in due course the post-2050 values are likely to be increased, and in fact non traded carbon values are expected to be reviewed by June 2011 with further reviews of occurring every five years.)

VALUING REDUCTIONS IN NON-TRADED SECTOR EMISSIONS

Price (£) per tCO2e in 2009 prices   Examples for selected years

Year	**2009**	**2010**	**2020**	**2030**	**2040**	**2050**	**2060**
Low	25	26	30	35	68	100	100
Central	**51**	**52**	**60**	**70**	**135**	**200**	**200**
High	76	78	90	105	203	300	300

(The central estimates will normally used, but low and high estimates may be used for sensitivity tests. Future monetised savings from reduced emissions should be discounted in the usual way.)

For more detail on the Department of Energy and Climate Change guidance, refer to:

http://www.decc.gov.uk/en/content/cms/what_we_do/lc_uk/valuation/valuation.aspx

This provides a link to the very detailed paper 'Carbon valuation in UK policy appraisal: a revised approach', and also one to the much simpler summary 'A brief guide to the new carbon values and their use in economic appraisal'.

L.8.3 How should Greenhouse Gas impacts be presented?

A brief description of the reason for the change, together with the absolute change (tonnes pa) should be presented. Where possible, a percentage change should also be calculated, (e.g. x% reduction in CO2 emissions from a particular vehicle fleet).

The present value of monetised social costs for all years in the appraisal period is calculated. If the impact represents increased carbon emissions this monetised value is negative and is termed 'social disbenefit', while if there are reduced emissions the value is positive and is termed 'social benefit'. The value is added to any other social benefits produced by the project before the benefit:cost ratio is calculated.

For presentations in DfT format, the entry in the Overall Assessment column of the Appraisal Summary Table should be the present value of monetised social costs for all years in the appraisal period (and the same value goes in the appropriate row of the 'Analysis of Monetised Costs and Benefits' table). The Quantitative Measure is the total change in tonnes of carbon over the appraisal period (a positive number indicating an increase in carbon emissions, and a negative number a decrease). The Qualitative Comment should be used to indicate any special features of the appraisal, along with an indication of the key drivers which are responsible for any change in conditions. Any uncertainties involved in the calculation of emissions should also be identified in the qualitative column.

Important note: In analyses done for the DfT using the software package TUBA, the greenhouse gas impacts will be automatically calculated, but currently only for changes in private transport on highways. It follows that greenhouse gas impacts arising from changes in highway traffic should not be calculated separately from the impacts automatically generated by TUBA, while public transport impacts currently have to be calculated outside TUBA.

For fuller details see the relevant WebTAG unit – includes the links to the relevant WebTAG spreadsheet calculators:

http://www.dft.gov.uk/webtag/documents/expert/unit3.3.3.php

L.8.4 Carbon Reduction Commitment

The Carbon Reduction Commitment (CRC) is a mandatory emissions trading scheme that aims to incentive energy (and carbon) savings in large, non energy intensive public and private organisations. It is enabled via the Climate Change Act which became law in November 2008. The scheme is expected to come into force on 1st April 2010 and to run on financial years. As a Climate Change Bill commitment, the scheme is aiming for an 80 per cent reduction in carbon dioxide (CO2) emissions by 2050.

The scheme is compulsory for large organisations using more than 6,000 MWh/year of half-hourly metered electricity, which translates to roughly £500,000 in electricity bills, and is aimed at encouraging these large organisations to reduce their fixed source energy consumption i.e. all electricity, gas, oil, coal etc. Transport fuel use has been excluded due to the potential for the CRC to act as a perverse incentive towards other less carbon efficient forms of transport. However, energy for street lighting is included.

Purchased green electricity does not count as zero carbon under the CRC and so it is not possible to avoid qualification for CRC by changing the way in which the organisation procures electricity through the grid. However, to encourage the use of carbon saving measures, green energy generated on-site from renewable sources, will be zero rated for CO2 emissions. There are two parts to the scheme:

- Cap and Trade: An emissions trading scheme which enables organisations to purchase allowances (1 tonne of CO2 per allowance) to cover their total annual related energy-related CO2 emissions. Those participants who cut their emissions will be able to sell their excess allowances, while those that increase their emissions will need to buy more allowances. Initially there will be no limit on the number of allowances available, but in later phases of the scheme the number of allowances will be capped and will reduce each year.
- League Tables: An annual league table published to highlight those organisations making positive progress and to 'name and shame' the worse ranking organisations.

Initially the CRC will operate with an emissions allowance price set at a fixed price expected to be £12 per tonne of CO2. From 2013 onwards there will be a limit on the number of allowances available for organisations to buy and the price will be will be set by the market demand. It is expected that the market will cause the price to rise substantially from £12 per tonne, financially penalising those organisations that are not reducing their emissions.

The potential financial impact for TfL, with emissions based on 2007/08 consumption data, is currently estimated to be in the order of plus or minus an amount up to about £1m p.a. in the early years, in broad terms.

Note. This guidance is for information only. CRC considerations should not be included in quantified appraisals, partly because details of the government's scheme are yet to be finalised, and partly because the uncertainty associated with trading systems is likely to make it impossible to incorporate CRC impacts into conventional cost benefit analysis.

A Carbon Valuation Tool is being developed within LUL to assess the impacts of projects, including the value of reducing energy use and the value of reducing emissions, based on the standard value per tonne of Carbon.

A CO_2 tool is maintained within TfL Planning. This is a spreadsheet-based model of carbon dioxide emissions from the transport sector in London. This allows the impact of both individual and collective CO_2 reduction policies, such as those outlined in the Mayor's Transport Strategy, to be quantified in relation to future CO_2 reduction targets.

For further information on environmental impacts in appraisals, and in particular CO_2 reductions, contact Helen Woolston, [redacted]

L.9 JOURNEY AMBIENCE

Where possible values of improvements, from consumer research, should be used to monetise the benefit of improving various aspects of the journey. For example, Appendix E4 provides a selection of attributes of Underground and Bus journeys, with valuations of improvements to different levels.

WebTAG provides more general guidance on ambience:

http://www.dft.gov.uk/webtag/documents/expert/unit3.3.13.php

The WebTAG methodology has journey attributes split into three categories, two of which have further sub-categories:

- facilities and information (known as 'Traveller care')
    - cleanliness
    - facilities
    - information
    - environment
- views of surroundings during journey
- stress-related
    - frustration with inability to make normal progress on a journey
    - fear of potential accidents
    - uncertainty about the correct journey route.

The assessment of each of these is on a simple scale of Better/Neutral/Worse (as compared to the base option).

L.10 PHYSICAL FITNESS

This impact will include an assessment of the extent of increase in walking and cycling generated by a project. WebTAG guidance is provided in:

http://www.dft.gov.uk/webtag/documents/expert/unit3.3.12.php

The focus is on estimating how many extra people convert to journeys of over 15 minutes walking or cycling, the assumption being that the return trip achieves a 30 minute level of activity threshold per day. Although this is the focus, the number of new walking or cycling trips of less than 15 minutes (or return trips of less than 30 minutes) is also recorded.

L.11 TOWNSCAPE

WebTAG guidance is provided in:

http://www.dft.gov.uk/webtag/documents/expert/unit3.3.8.php

Impact on townscape is particularly relevant to London, and in some ways corresponds in importance to the landscape impact of certain national transport schemes. Contributions, including possible contributions under alternative “enhanced” options, to improved urban design should be assessed under this impact. An indication of the townscape appearance both before and after the preferred scheme should be provided, with pictures where appropriate, and the strength of public support for the proposed design should be verified. (See also section 2.3.3 of the BCDM.)

L.12 OTHER ENVIRONMENTAL IMPACTS

For WebTAG guidance on these impacts, see

Landscape (unlikely to be relevant in London –see Townscape above)

http://www.dft.gov.uk/webtag/documents/expert/unit3.3.7.php

Heritage of historic resources

http://www.dft.gov.uk/webtag/documents/expert/unit3.3.9.php

Biodiversity

http://www.dft.gov.uk/webtag/documents/expert/unit3.3.9.php

Water environment

http://www.dft.gov.uk/webtag/documents/expert/unit3.3.11.php

L.13 REGENERATION (‘WIDER ECONOMIC IMPACTS’)

For WebTAG guidance on Wider Economic Impacts see:

http://www.dft.gov.uk/webtag/documents/project-manager/unit2.8.php

Key points in this guidance are as follows.

- The regeneration impact is defined quite narrowly, as the increase in employment enabled by the transport proposal in a regeneration area.
- A regeneration area is not simply an area of opportunity, but an officially defined area of disadvantage. (Typically this would be an area defined in a Regional Economic Strategy, e.g. the London Plan, as being among the 20% most deprived areas in the Region.)
- While the total increase in employment in a regeneration area can be indicated in the qualitative assessment, the summary assessment is based only on increased employment for residents of the area.
- It is not necessary to show that this increased employment is an overall net increase (unless there is potential abstraction of jobs from another regeneration area). By the same token, it is not admissible to add the net economic value of any jobs created to the transport benefits to form a

single economic benefit. (What is being measured here is a distributive, not an additional, impact. And apart from this, it is likely that there would be costs other than transport costs associated with the creation of new jobs, which would need to be included in an overall cost benefit analysis.)

- It is necessary to show why transport is effectively a constraint on increased employment in the area (and thus why transport improvements will lead to new employment opportunities).
- Any project in a regeneration area with expenditure over £5m requires an Economic Impact Report (EIR) to be prepared. This involves a separate, more detailed submission but the principles are the same as for Wider Economic Impacts in general. In particular, a survey of employers may be needed to support the forecast that improved transport would lead to growth in employment. Guidance is included within the above WebTAG reference.

L.14 EQUALITY AND INCLUSION

There is no specific section in WebTAG on equality and inclusion although clearly the assumption is that such impacts can be addressed in various parts of an appraisal, e.g. “Encouraging social inclusion is an explicit component of the Government’s policies on transport … The Appraisal Summary Table provides the framework for assessing the impact of a particular strategy or plan on objectives for social inclusion. The Qualitative Impacts column on the AST may be used to highlight for particular sub-objectives the effects on different social groups. The supporting analyses of distribution and equity may be useful in assessing what these particular impacts are” –excerpt from 1.2.5 in the following unit:

http://www.dft.gov.uk/webtag/documents/project-manager/unit2.5.php#02

While the Accessibility sub-objective (see below) is intended to assess impacts on general accessibility to the transport network, the Equality and Inclusion entry in TfL’s framework will focus on accessibility for people with mobility impairment, accessibility for people in deprived areas, and aspects of services in general that could have an impact on disadvantaged groups –whether inadvertently adding to disadvantage or alternatively presenting an opportunity to help redress disadvantage. (See also section 2.9 of the BCDM.)

L.15 OTHER NON-ENVIRONMENTAL IMPACTS

For WebTAG guidance on these impacts, see:

Reliability (in TfL public transport projects, usually monetised under Journey Time social benefit, as improvement in Excess Waiting Time)

http://www.dft.gov.uk/webtag/documents/expert/unit3.5.7.php

Option values (much more of an issue in rural projects, where potentially there may be no public transport option)

http://www.dft.gov.uk/webtag/documents/expert/unit3.6.1.php

Severance

http://www.dft.gov.uk/webtag/documents/expert/unit3.6.2.php

Access to the transport system

http://www.dft.gov.uk/webtag/documents/expert/unit3.6.3.php

Transport Interchange

http://www.dft.gov.uk/webtag/documents/expert/unit3.7.php

Integration with land-use policy

http://www.dft.gov.uk/webtag/documents/expert/unit3.7.2.php

Integration with other government policies

http://www.dft.gov.uk/webtag/documents/expert/unit3.7.3.php

APPENDIX M Estimation of Staffing on-costs and Overheads

M.1 ON-COSTS

Staffing ‘on-costs’, defined here as Pension and National Insurance payments incurred by the employer, will vary slightly from Business Unit to Business Unit, but are likely to be:

Pension at 15.15% (3.05 x employee contribution, which is 5%)

National Insurance at approx. 8%

The total is therefore approximately 23%.

M.2 OVERHEADS

‘Overheads’ are defined here as all other costs associated with adding or reducing staff. When estimating the marginal cost of adding or reducing staff from existing Business Unit costs, it is useful to construct a table of existing annual cost along the following lines:

M.3 APPORTIONING OVERHEADS

Overhead		A Fixed	B Project dependent	C Proportional to number of staff	D Recruitment or Release only
Recruitment	Advertising		x[1]		
	Agency fees		x		
	Interview and assessment				x
Release	Severance payments				x
	Redeployment cost				x
Training	Special initial training				x
	Course fees			x	
	Room hire / other resources		x[2]		
Other HR	Occupational Health	x			
	Other			x	
IS / IT	Hardware support	x			
	Software support	x			
	Systems development		x		
	Licences (e.g. SAP)			x	
	Renewal of obsolete equipment			x	
	Consumables			x	
Commun-ications	Advertising / campaigns	x			
	Events	x			
	Design	x			
	Internal comms			x	
	Other external	x			
Other administr-ation	Property insurance	x[3]			
	Legal (including HR legal)	x			
	Furniture and equipment			x	
	Compensation payments		x		
	Stationery and expenses			x	
Accommodation					x[4]

1 Based on number of recruitment drives
2 Mainly depending on the number of courses
3 For insurance based on "square footage" it would be directly proportional to staff numbers
4 Broadly speaking rent and rates are proportional to "square footage", although this assumes that no existing space is available for new recruits, and that existing space can be relinquished when staff are released

From this table the total marginal cost for each addition or reduction in the number of staff would be the sum of:

1) the total of column C divided by the number of existing staff

2) a judgement on how much 'project-related' expenditure in column B could affected by additions or reduction in staff, divided by the number of existing staff

3) the total in column D divided by the anticipated number of staff recruited / release in the year to which the budget referred (or if no release costs are included in this annual budget, the estimated redundancy or redeployment cost per person).

Note that the fixed costs in column A do not contribute to the marginal cost.

M.4 EXAMPLE OF APPORTIONING

In an example derived from an actual budget (for about 1000 staff) the overheads could be broken down as follows:

Overhead	A Fixed £000	B Project dependent £000	C Proportional to number of staff £000	D Recruitment £000
Recruitment		264		59
Training		212	1174	100
Other HR	103		95	
IS / IT	1163	700	1423	
Communications	777		77	
Other administration	4421		1797	
Accommodation			6024	
Total	6464	1176	10590	159

Note: the standard TfL accommodation cost of £6024 per workstation is based on 123 sq.ft. (net internal area divided by number of workstations).

And with the assumptions that the annual budget allows for a 5% turnover of staff (i.e. 50 staff), and about 50% of project related expenditure is proportional to staff numbers, an estimate of the marginal cost of recruiting additional staff for a new operation would be:

Marginal cost of recruitment + Marginal ongoing cost of a new member of staff

= (159 / 50) + ((50% x 1176) + 10590) / 1000

= 3.2 + 11.2 = £14.4k

To this would be added an estimate of the additional equipment required (assuming that, for example, departmental I.T. costs are mainly based on maintenance, support and replacement costs rather than additional assets). An estimated cost of additional equipment might be £3k per person, making the total extra marginal cost of recruitment £17.4k per person for the first year, and £11.2k for following years.

Note that the above calculations are only an illustration of the way that marginal costs can be estimated from existing costs. The main principle to be observed is to avoid including fixed costs unrelated to the number of staff employed.

In the absence of any better evidence (or where the small numbers of staff involved do not warrant further analysis) the figure of £11.2k (2003 prices) could be used as an ongoing marginal annual cost, but ideally the methodology above will enable any given proposal to produce a better estimate of staff overheads, specific to that proposal, and in particular taking account of any detailed accommodation plans.

M.5 SUPPORT SERVICES RATE CARD

TfL Support Services have produced a rate card that summarises the latest unit rates for office accommodation, IM and HR costs. The most recent version is available through the Business Case Source page:

http://source.tfl/OurCompany/541.aspx

The rates as at May 2013 are as follows:

Standard Cost Per Employee		**First Year £**	**Subsequent Years £**
Office Accommodation			
Standard Items:-	Average annual cost per workstation (or Equivalent).	7000.00	7000.00
	Office Furniture and set up costs per workstation	1500.00	
Menu Items	"Crate" move per head	150.00	150.00
I.M.			
Standard Items:-	Standard PC (Desktop, monitor, 2 patch cables, keyboard, mouse, 2GB RAM, DVD drive & standard flat screen monitor	650.00	24.00
	Standard VoIP phone install (plus possible user licence of £1000 if new users to platform)	1300.00	
	Standard Mobile	43.50	18.00
	Microsoft Office Professional Licences	150.00	50.00
	Standard SAP Licences (Employee Self Service)	130.00	30.00
Menu Items	Thin Client PC	0.00	15.00
	NEC standard TFT flat screen monitor	130.00	28.00
	Standard laptop with CD/DVD RW Screen size 14.1", weight from 2kg (dependent on peripherals) Includes carry case, Kensington lock, additional power supply 2G RAM, DVD drive	570.00	50.00
	Standard A4 Black and White Printer	220.00	60.00
	Standard A4 Colour Printer	255.00	60.00
	Standard analogue phone install	80.00	
	Standard digital phone install	300.00	

Standard Cost Per Employee		**First Year £**	**Subsequent Years £**
Menu Items (con't)	Blackberry	170.00	£1.50 / mth voice tariff, + £15 /mth Blackberry tariff, +£10 / mth Blackberry Managed service (paid centrally)
HR			
Menu Items	NPL Average daily hire charge rates:-		
	Pay Band 1	100.00	100.00
	Pay Band 2	250.00	250.00
	Pay Band 3	375.00	375.00
	Pay Band 4	500.00	500.00
Total "Standard" Items for Business Planning purposes		**10773.50**	**7122.00**
	SAY:-	**£11k**	**£7.5k**

Notes:-
1) In the absence of any known or anticipated specific specialist requirements, the "Standard" Item price should be used as the cost per workstation for Business case and planning purposes, supplemented with any "Menu" items where applicable.
2) Where the user of this Rate Card envisages any specialist requirements which either dictate certain aspects of the service provision, or limit the scope of where or how the service may be provided, the user is requested to seek specific cost advice from the Service Provider.
3) All rates quoted are average rates generally applicable where services are provided in the context of a competitive and "free" market place. These rates are therefore provided for guidance to be used in the preparation of Business Cases only, and should not be relied upon as robust budget provision, which should always be sought from the Service Provider
4) NPL rate card charges will vary due to the nature of the role and duration – for further assistance with the NPL rate card, please call the NPL recruitment team on 83399'

APPENDIX N RISK AND CONTINGENCY STANDARD

N.1 INTRODUCTION

This standard replaces the previously separate Project Risk Provision and Optimism Bias Standard (September 2011) and sets out how TfL manages financial provisions for uncertain events that may occur during the life of projects. Each of the operating businesses within TfL will apply this standard through their own project and programme procedures.

The purpose of the process is to ensure that TfL make adequate provision for uncertain and unforeseen events in its project business plans, budgets and forecasts, and that such sums set aside for this purpose are appropriately and consistently controlled.

To ensure appropriate financial provisions are made for projects a thorough assessment of the potential risks faced by a project is essential. It is expected that projects will operate a frequent structured assessment of risks and undertake a quantitative risk assessment including Monte Carlo simulations where appropriate.

The intention is that the use of money set aside for managing foreseen risks and emerging unforeseen circumstances should be controlled at the most appropriate level of the organisation, whilst at the same time providing appropriate visibility of such transactions.

On 25 May 2011, the approach laid out in this standard was approved by the Finance and Policy Committee.

N.2 SCOPE

The standard applies to all investment projects with an estimated final cost (EFC) in excess of £5 million. (However, the risk quantification guidance is also recommended for projects with an estimated total cost between £1m and £5m.)

The requirements set out in this document complement and are additional to the requirements of local project and programme management procedures.

The standard is designed to ensure that projects, programmes and delivery portfolios comply with the TfL Project and Programme Management Policy – which defines the principles by which TfL projects and programmes should be managed.

N.3 DEFINITIONS

Project:	A unique set of coordinated activities, with definite starting and finishing points, undertaken to meet specific objectives within defined time, cost and performance parameters.
Programme:	A temporary structure to co-ordinate, direct and oversee the implementation of a set of projects and activities in order to deliver outcomes and benefits related to the organizations strategic objectives.
Delivery Portfolio:	A grouping of an organisation's activities [or schemes or small works], likely to be agreed annually, taking into account resource constraints.
Risk provision:	A provision within the total project budget or forecast that is to be used (in accordance with operating business procedures) to deal with anticipated events of uncertain outcome. This provision is calculated by a Quantified Risk Analysis of identified risks.
Contingency:	A provision controlled by senior management for the uncertainty inherent in the estimation of costs and risks.
Optimism Bias:	A quantity to be added to costs and risks in the business case to take account of systematic cost estimation bias shown by past projects in the transport and other sectors.

N.4 PROJECT RISK PROVISION PROCESS

N.4.1 Project Creation & Risk Calculation Methods

All applicable projects should undertake the following steps when they are created:

- Estimate the base cost of the project
- Identify, record and quantify the risks directly associated with the project
- Conduct a quantitative risk analysis (QRA) on the identified risks that have a cost impact, which provides:

  a) a risk provision, to be included in the project forecast in addition to base costs
  b) a provision in the business case for optimism bias, allowing for the uncertainty inherent in the estimation of costs and risks.

N.4.1.1 Estimation of base cost

The base cost should be calculated on an outturn (i.e. inflated) basis. The Programme Management Office (PMO) will periodically issue guidance as to the expected level of tender price inflation for use in project estimates. Base cost estimates are usually subject to some uncertainty, therefore in general it is preferable to specify a range of estimates for each significantly large cost element rather than a single 'point' estimate. Various distributions could be applied but an obvious simple range of estimates for a cost element is: Minimum, Most Likely, and Maximum. Estimates such as this can be included in a Monte Carlo analysis and will ensure a more comprehensive assessment of cost variability than is possible by looking only at risk events. (As with the risk provision – see below – the P_{50} or the 'expected value' from this analysis would be used as the base cost from which the EFC is built up). Where a single point estimate of base cost is used, an estimate of the risk reflecting the potential variability of base cost should be included in the QRA (but note that is often difficult to estimate this risk convincingly without considering the variability of cost elements).

N.4.1.2 Estimation of risk provision

The risk analysis should cover the full scope of the project, regardless of which stages have project authority or funding, and regardless of the funding sources. The cost impact of a possible risk event, if it occurs, should again be specified as a range of figures, rather than a point estimate. In other words, although the lowest cost impact of a risk event is zero, because that event may not actually happen, if it does happen the cost could be specified in terms of Minimum, Most Likely, and Maximum.

The risk provision should be set at P_{50}, or the expected value (i.e. the mean result, known as 'P_{Mean}').

Where risk mitigation is planned, the likely post-mitigation probability and impact should be used as the basis for calculating the risk provision. However, it cannot necessarily be assumed that mitigating actions will be completely successful. Some types of proposed mitigation may have uncertain outcomes, while some might have a definite positive outcome, and therefore there is a spectrum of likely outcomes between zero or low mitigation effect and full or high mitigation effect:

Low mitigation

At this end of the scale, for example, a risk could involve extra expenditure to deal with utility company infrastructure, such as telecommunications cabling. If mitigation of this risk consists of planned attempts to negotiate away the need to undertake the works, then virtually all the current risk should remain until negotiations are completed, since it is often very uncertain whether or not the negotiations will be successful.

High mitigation

At the other end of the scale, if mitigation of a risk consists of purchasing an asset or a service which will definitely remove the risk (provided this purchase has been included in the base cost and there is no particular uncertainty about procurement), then the post-mitigation risk should be virtually zero.

If the project is at an early stage and a QRA has not yet been undertaken then a best estimate of the risk provision should be used.

This would generally be expected to be between 20% and 40% of base cost but will depend upon the individual circumstances of each project.

N.4.1.3 Phasing of risk provision

Generally, phasing of risk provision should be pro-rata to the amount of future base cost spend forecast to occur by the end of each project stage.

For example if 80% of expenditure occurs in the implementation phase of a project then 80% of the risk provision should be forecast in the implementation stage and the remaining 20% forecast in earlier stages.

If in the view of the sponsor / project manager this places excessive risk provision in the early stages then it is permissible to pro-rata risk provision over the period of implementation only.

N.4.1.4 Estimated Final Cost and Project Authority

Risk provision, but not management contingency, will be held as part of the project estimate. The estimated final cost (EFC) of each project will be the sum of the base cost estimate plus the risk provision at P_{50} or P_{Mean} (post mitigation) in outturn (budget) prices. Management of the risk provision will be the responsibility of the project manager or project director as set out in local procedures.

When project authority is granted the amount of authorised expenditure will be calculated as base cost plus risk provision, i.e. excluding management contingency.

N.4.2 Estimate of Optimism Bias for Business Cases

A value to reflect the uncertainty in estimates of base cost and risk provision (Optimism Bias) should be included in the business case. This should be calculated from the QRA, as either P_{80} - P_{Mean} or P_{80} - P_{50} depending on whether P_{Mean} or P_{50} has been used for the main estimate. (Ideally P_{80} - P_{Mean} will be based on a Monte Carlo analysis of both risk events and base costs, if the estimating uncertainties in base cost have been analysed, see 4.1.1 above.)

However, where a project has not reached single option selection and no QRA exists, the estimate of optimism bias will be based on the following broad categories of project type.

Rail, Light Rail, Tram (excl. rolling stock), Bridges, Tunnels & Information Technology	**66% of base**
Stations and Terminal Buildings	**51% of base**
Bus, Cycle and Pedestrian and Road Schemes, Off-track facilities & Rolling Stock	**44% of base**

Note that these percentages (similar to those used by the Department for Transport) are applied to the total of base cost and risk provision, and are additional to any estimate of risk provision. On production of a QRA the provision should be updated as set out above.

(By the time of the single option selection, a QRA should have been carried out, but if not, PMO should be consulted about the appropriate estimate to be submitted.)

In the Business Case Narrative, it should be clear what the key risks are, and approximately how much risk provision is included to cover each of them. Explanation will be needed if, for some reason, no money has been included to cover a significant cost risk. Note that the amount of risk provision for individual risk events should be expressed as P_{Mean} rather than P_{50}, since while P_{50} gives a reasonably representative view of a set of risks, it usually gives a misleading representation of an individual risk.

[Note also that one difference between the cost estimates for budget purposes and for business case analysis is that it is standard practice in appraisals to strip out Retail Price Inflation from forecast cost increases in future years. In other words, appraisals include only 'real terms' inflation increases.]

A diagram illustrating the relationship between Base Cost, Risk, and Optimism Bias estimate, which also illustrates how the required outputs can be produced, is shown in Annex A

N.4.3 Contingency

In order to ensure TfL holds sufficient funding to address any reasonable increase in project costs due to uncertain events, a contingency will be held by each area of the organisation. The total level held in each operating business will be agreed with the MD Finance each quarter.

There will be no contingency held against any individual project. Any request by a project to utilise the contingency held by a business area will be treated as a request for a variation in the project authority and approval will be required from the original approving individual or body (MD Finance for projects between £5m and £25m EFC, Commissioner for projects between £25m and £50m EFC, Finance and Policy Committee for Projects between £50m and £100m EFC and the TfL Board for projects over £100m).

Where projects are wholly or partially externally funded, and there is a clearly defined amount of contingency agreed with third parties as part of the project estimate, then the contingency should be held centrally but ring fenced for the project. Any contingency no longer required will be released back to any third parties in accordance with individual contractual agreements. EFC and forecast will include base cost and risk only.

N.4.4 Project Authorisation

All risk provision (which should include all sums not specifically allocated to deliver the specified scope of work) included in a submission for project authority must be explicitly identified. At each stage in the project lifecycle, the remaining risk provision should cover the full scope of the project, regardless of which stages have project authority or funding, and regardless of the funding sources.

Where a project's cost estimate includes inflation figures or risk estimates that are derived on a basis that differs from Corporate guidance, an explanation of this will be required as part of the relevant Gate review.

When approval of a project is sought it will be necessary to demonstrate that there is adequate provision in the budget/business plan for the costs of the project. Where a project is unbudgeted it will be necessary to demonstrate that both the estimated final cost and any increase in the overall level of contingency held by a business area is affordable.

N.4.5 Project Forecasting and Business Planning

As a minimum, each quarter, with the re-forecasting of the estimated base cost to complete, a re-quantification of known risks should be undertaken to update the risk provision. Where identified risks have occurred these should be removed from the risk assessment and included in base costs (via local approval), similarly where risks have passed without occurring they should be zeroed in the quantitative risk analysis (but retained in the risk register for audit trail purposes). The forecast EFC may indicate from time to time that project's authority or budget is likely to be exceeded, as some risks materialise, but similarly may reduce if other risks fail to materialise at a later date. When the EFC appears likely to stay higher than the authority or budget - after routine fluctuations have been taken into account - measures will need to be taken to ensure that the overspend does not undermine the balanced forecast for the operating business. Such measures will include conducting value management activities within the project itself and, if that does not solve the problem, seeking supplementary authority to draw from other funding sources including underspend on other projects and the contingency budget of the operating business.

Note that any additional authority would not normally be required in these cases until the next gate review. However additional budget may need to be sought as part of the business planning or budgeting process.

Potential breaches of authority are more critical. If the current forecast - again after routine fluctuations have been taken into account - indicates that the existing authority will be exceeded before the next review is scheduled, or if the project needs to commit expenditure above existing authority, supplementary authority must be sought immediately.

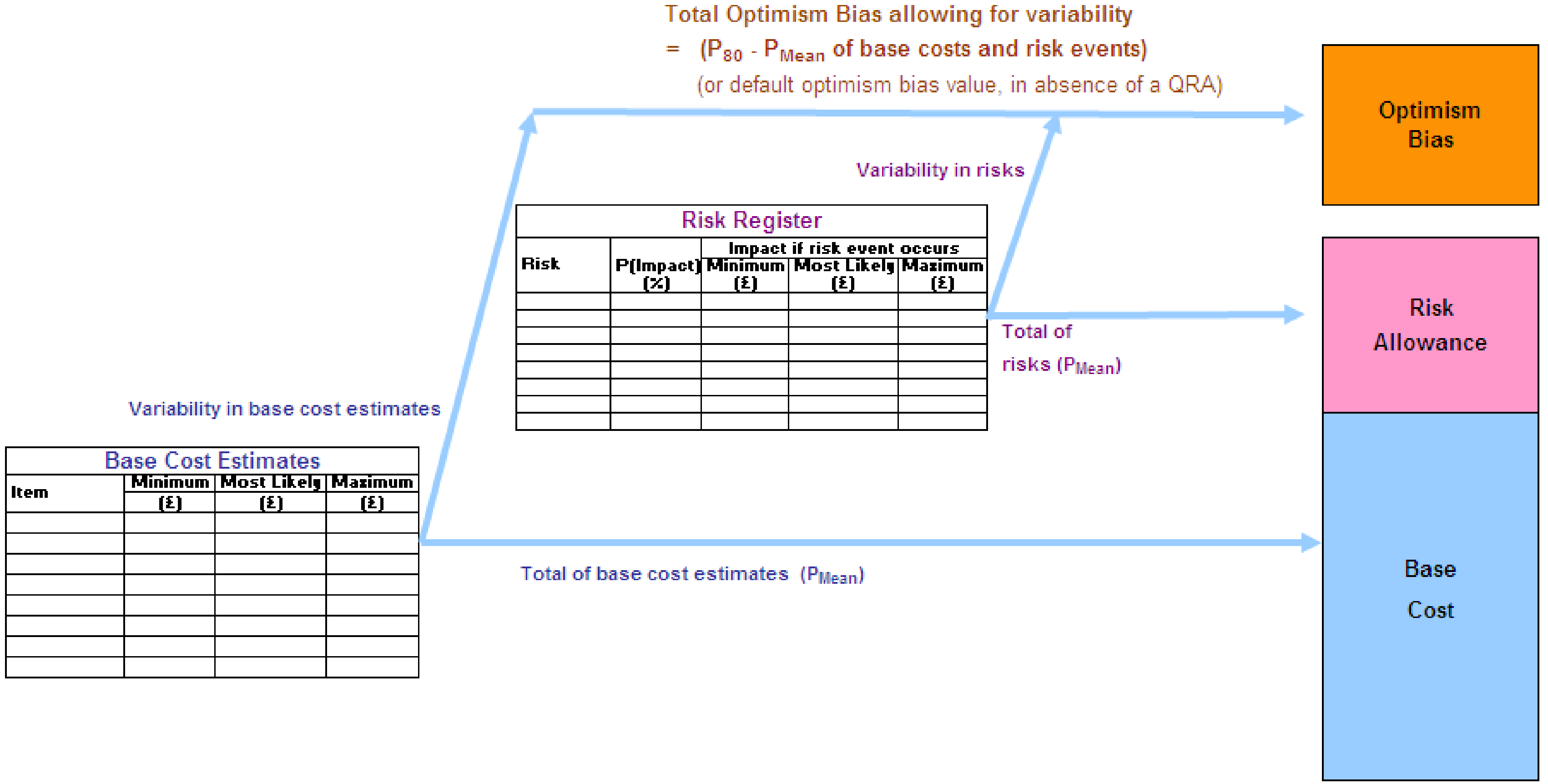
N.4.6 Principles of Risk Management

For an outline of the principles of risk management, see the Pathway Risk Management Handbook.

N.5 REFERENCE DOCUMENTS

- Corporate Project and Programme Management Policy
- Corporate Gateway Approval Standard
- TfL Guidance on Tender Price Inflation
- Pathway Risk Management Handbook

Annex A: Components of Project Cost Estimate for Business Case



Notes a) Common practice is usually to provide 'point estimates' of cost elements, but the recommended approach above allows a fuller analysis of the overall uncertainty in the Estimated Final Cost. (Including base cost uncertainty as a risk is another option but is less satisfactory.)

b) As a further illustration, in the package '@Risk' the following four types of formula would be needed to produce the analysis above:

1. Cost element (assume Minimum £5000k, Most Likely £6000k, Maximum £9000k)
   Formula: =RiskTriang(5000,6000,9000)
2. Risk event (assume 20% probability of occurrence, then Minimum £1000k, Most Likely £1200k, Maximum £2000k)
   Formula: =RiskDiscrete({0,1},{0.8,0.2}) * RiskTriang(1000,1200,2000)
3. Estimated Final Cost (assume the total of all the above cost element and risk event cells is in cell T100)
   Formula: =RiskMean(T100)
4. Optimism Bias (P_{80} – P_{Mean}, again assuming the total of all the above cost element and risk event cells is in cell T100)
   Formula: =RiskPercentile(T100,0.8) – RiskMean(T100)

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(Where multiple references are given, the main one is in **bold**.)