

TRANSPORT FOR LONDON

BOARD

SUBJECT: RAIL AND UNDERGROUND ASSET BENCHMARKING

DATE: 29 JUNE 2011

1 PURPOSE AND DECISION REQUIRED

- 1.1 This paper provides an update on the benchmarking of Rail and Underground assets and programmes which has been carried out recently by TfL. The Board is asked to note the publication of the Rail and Underground Asset Benchmarking Initial Report.
- 1.2 The Finance and Policy Committee considered a paper on Rail and Underground Asset Benchmarking at its meeting on 25 May 2011.

2 BACKGROUND

- 2.1 London Underground (LU) and Tube Lines have been benchmarking the historic costs of maintaining assets under the PPP Contract since April 2006. Five annual reports were prepared under the auspices of the Office of the PPP Arbiter (OPPPA), known as the Joint Benchmarking Exercise. The reports included comparison of the unit costs of maintaining fleet, signals, track, stations, lifts and escalators for each of the nine lines on LU's network.
- 2.2 In the summer of 2010, OPPPA carried out a short study to assess future cost scenarios for the LU Infracos. OPPPA used its Periodic Review determination of Tube Lines as a basis for an efficient "glide path" for the next seven-and-a-half years and extrapolated the Bakerloo, Central and Victoria lines (BCV) and Sub Surface Lines (SSL). OPPPA concluded:

"London Underground is already forecasting significant cost savings for BCV and SSL and we consider that the quantum of cost represented in the 2010 AAMPs is moving towards good industry practice, assuming that service performance targets are achieved."
- 2.3 However, OPPPA's view was that further opportunities of up to £0.5bn may be available based on a comparison with international peer metros although:

"...this would involve alteration of established and heavily negotiated working practices. We acknowledge that it is unlikely that such major change will be achieved without the full support of Government and the Mayor of London."
- 2.4 Since the closure of OPPPA in October 2010, LU and Tube Lines have increased their focus on benchmarking, recognising its importance as a catalyst of future performance improvement and efficiency. The annual benchmarking report has been prepared, using the same protocols and methodology previously agreed with OPPPA (Appendix 1).

- 2.5 OPPPA did not publish the detailed Joint Benchmarking Exercise. However, a high level summary was included in the international benchmarking analysis commissioned by OPPPA from BSL (Management Consultants of the Lloyd’s Register Group)ⁱ. To provide greater transparency of LU and Tube Lines maintenance costs and efficiency initiatives, the unit cost benchmarks and detailed analysis are being published for the first time.
- 2.6 This report includes, also for the first time, the forecast maintenance unit costs to 2017/18, together with a commentary on the planned efficiencies, which substantially reduce the gap between LU and Tube Lines and bring both closer to the international peers.
- 2.7 TfL also recognises that the coverage of the current benchmarking does not fully extend to capital investment and sets out a detailed proposal for the benchmarking of capital projects - both the management of capital projects and the underlying unit rates related to renewal and upgrade activities. A study into the unit costs of track renewals has already commenced and LU has initiated a review of Communication Based Train Control (CBTC) signalling upgrades through CoMETⁱⁱ.
- 2.8 LU continues to participate actively in international benchmarking activities with other metros through its membership of CoMET and UITPⁱⁱⁱ.

3 KEY FINDINGS – ASSET MAINTENANCE BENCHMARKING

- 3.1 The report provides detailed analysis on the development of asset maintenance costs in LU (former Metronet) and Tube Lines from the start of the PPP Contract in 2002/03 through to 2017/18.
- 3.2 The analysis is set against the backdrop of performance, which is central to asset management planning and costs. The achievability of future efficiencies will need to be considered in the light of reliability trends.
- 3.3 Asset availability and performance has improved significantly over the past eight years. On average, asset availability has improved by 37 per cent over that period (as measured in Lost Customer Hours, LCH).

Table 1 – Improvement in availability since 2003/04

	2003/04	2010/11	Improvement since 2003/04
<i>LCH</i>			
BCV	700,174	474,650	32%
SSL	619,238	374,172	40%
JNP	984,868	591,457	40%
Total	2,304,280	1,440,279	37%

ⁱ International Benchmarking of the Costs and Performance of Maintaining and Renewing Metro Systems (March 2010).

ⁱⁱ CoMET is the Community of Metros international benchmarking forum, managed by Imperial College London.

ⁱⁱⁱ UITP is the International Association of Public Transport, an international network for public transport authorities and operators, policy decision-makers, scientific institutes and the public transport supply and service industry.

- 3.4 This reflects the significant improvements in asset reliability, for all asset areas, described in the following table:

Table 2 – Improvement in reliability since 2003/04

Asset	Reliability Measure	BCV	SSL	Tube Lines
		% improvement 2003/04 to 2010/11		
Fleet	MDBF ^{iv}	157%	173%	216%
Signals	No. Failures >2 minutes per million car KM	20%	9%	(25)% ^v
Track		38%	61%	53%
Lifts	MTBF ^{vi}		30%	37%
Escalators	MTBF		20%	48%

- 3.5 The current business plan includes around £1bn of maintenance efficiency initiatives.
- (a) LU's current Business Plan to 2017/18 reflects maintenance efficiency targets of £0.9bn (outturn). These efficiencies reduce the long run annual maintenance expenditure by £123m (in real terms) compared to the 2009/10 level of £401m.
- (b) The Tube Lines Business Plan to 2017/18 includes maintenance efficiencies amounting to £130m (outturn). These efficiencies reduce the long run annual maintenance expenditure by £17m (in real terms) compared to the 2009/10 level of £226m.
- 3.6 The planned efficiencies reflect the continuous improvement of maintenance regimes as well as opportunities resulting from the introduction of new, more reliable trains and signals and improved asset condition following capital renewal (for example, track) as well as increased mechanisation and improved contractual arrangements with maintenance suppliers.
- 3.7 These planned reductions reflect efficiency initiatives, net of any increases (for example, increased contract costs, increased asset usage or an increased density of assets resulting from capital investment) and are to be achieved while also delivering major upgrades and improving day-to-day asset performance.
- 3.8 The benchmarking analysis shows that, even after the planned efficiencies, gaps remain between the lines and also between London and international metros. The report sets out a programme of planned "drill-down studies" for each asset area, to investigate the differences in unit costs between LU and Tube Lines. The studies will consider underlying cost drivers (for example LU standards, maintenance regimes, resourcing levels) and identify opportunities for further improvements in cost and performance, where maintenance practices and culture are transferable from one line to another.
- 3.9 The acquisition of Tube Lines provides the first opportunity for detailed collaboration, free of the limitations imposed by the commercial arrangements

^{iv} MDBF is the Mean Distance between Failures.

^v The underlying performance of JNP signals shows an improvement of 39 per cent, excluding the recent performance issues relating to the new Train Based Transmission Control (TBTC) signalling system on the Jubilee line.

^{vi} MTBF is the Mean Time between Failures.

of the PPP Contracts. LU and Tube Lines have already begun to work closely and to explore openly the possible reasons for differences in unit costs between lines and to identify possible further efficiency initiatives.

4 CONSULTATION WITH IIPAG

- 4.1 This report is also the basis for providing benchmarking information to TfL's Independent Investment Programme Advisory Group (IIPAG).
- 4.2 The terms of reference for IIPAG has been revised in line with TfL's Spending Review 2010 funding settlement and includes the requirement to:
“direct a team undertaking benchmarking of the costs of maintenance and project delivery on the London Underground network, using data provided by London Underground and such other materials as the Group considers appropriate, including international benchmarking.”
- 4.3 IIPAG has made a preliminary proposal for the organisation of benchmarking within TfL. These proposals were provided for the meeting of the Finance and Policy Committee on 25 May 2011. IIPAG has also recruited a new part-time Adviser to direct benchmarking across TfL, together with a part-time specialist dedicated to benchmarking activities. TfL management will work with IIPAG to finalise these proposals and to develop an implementation plan.
- 4.4 As part of a series of consultations on benchmarking, a copy of the report has been provided to IIPAG^{vii}. IIPAG's comments were provided for the meeting of the Finance and Policy Committee on 25 May 2011. IIPAG has requested that further discussions take place within the business to agree the future direction and strategy for benchmarking across TfL.
- 4.5 The significant issues arising from the benchmarking analysis will be considered by the Rail and Underground Panel and regular summary reports will be provided to the Panel and the Finance and Policy Committee going forward.
- 4.6 Future reports will reflect the direction set by IIPAG.

5 RECOMMENDATIONS

- 5.1 The Board is asked to:
 - (a) NOTE the Rail and Underground Asset Benchmarking Initial Report, prepared by London Underground and Tube Lines; and
 - (b) NOTE that further discussions will be held with the Independent Investment Programme Advisory Group to agree the future direction of benchmarking across TfL.

6 CONTACT

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^{vii} IIPAG's detailed comments relate to version 1.5 of the report, issued on 24 February 2011.

RAIL AND UNDERGROUND ASSET BENCHMARKING, INITIAL REPORT

RAIL AND UNDERGROUND ASSET BENCHMARKING INITIAL REPORT



JUNE 2011

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INTRODUCTION

- 1 This is the first report prepared by the Rail and Underground benchmarking group. It is intended as a starting point for the provision of benchmarking information to support The Independent Investment Programme Advisory Group's (IIPAG) benchmarking work.
- 2 The report is presented in two parts:
Part A – a summary of recent benchmarking; and
Part B – proposed benchmarking priorities.
- 3 **Part A** describes recent benchmarking studies, including:
 - **The Sixth Asset Maintenance benchmarking report**
This continues work previously carried out under the ambit of the PPP Arbiter (as the Joint Benchmarking Exercise). The report compares the costs of maintaining each category of assets across each of the London Underground lines over the seven years to 2009/10. This year, the report has been extended to include projected unit costs to 2017/18, which reflect planned efficiencies. The high level objectives for further investigation over the next year are described for each asset area;
 - High Level Benchmarking Study comparing LUL and London Rail (LOROL);
 - A short study into the cost of new signalling control centres; and
 - Benchmarking with international metros through the industry organisations CoMET and Nova, including studies commissioned by LUL into fleet reliability, escalator management and maintenance management and practice.
- 4 **Part B** sets out the priority areas work during the coming year. These proposals have been developed within the Rail and Underground benchmarking group and reflect current understanding. The proposals include:
 - The development of a suite of benchmark measures to be used for **Capital Programme Delivery**, together with identification of key data sources and appropriate external peers (e.g. Crossrail, Network Rail). With the exception of the costs of new signalling systems and a piece of inconclusive analysis of track renewals, the benchmarking previously carried out by the PPP Arbiter did not encompass capital projects. This proposal addresses this gap and provides a basis for benchmarking both the management of capital projects and the underlying unit rates related to renewal and upgrade activities. A study into the unit costs of track renewals has already commenced.
 - A programme of “drill-down” studies in each area of asset maintenance, extending the datasets to include London Rail. The priority for the coming year will be to gain more in-depth understanding of the unit costs, productivity (resource utilisation) and related drivers (standards, working methods) within London. The aim of the studies is to identify opportunities for efficiencies which can be readily adopted within TfL; and
 - The on-going involvement in benchmarking with international peers through CoMET and NOVA.

5 Note: All values stated in this report are in constant 2009/10 price base unless otherwise stated.

PART A –RECENT BENCHMARKING

1 Benchmarking of LUL and Tube Lines Asset Maintenance

1.1 Summary

- 6 LUL and Tube Lines have participated in benchmarking of asset maintenance, working in conjunction with the Office of the PPP Arbiter (OPPPA) for the past five years. There have been two main strands of work:
- The Joint Benchmarking Exercise, which compares the costs of maintaining each of the Underground lines; and
 - International benchmarking, which compared the London Underground costs (BCV/SSL and Tube Lines) with a group of peer metros. This was carried out for OPPPA by external consultants BSL (Management Consultants of the Lloyd's Register Group)¹.
- 7 This benchmarking work has assisted LUL and Tube Lines to improve understanding of the drivers of maintenance costs and to develop and implement future cost reductions. For Tube Lines, this process occurred in conjunction with Periodic Review. LUL has addressed efficiencies for the BCV and SSL network areas largely through its asset management planning process. The efficiencies in the current Business Plans reflect the continuous improvement of maintenance regimes as well as opportunities resulting from the introduction of new, more reliable trains and signals and improved asset condition following capital renewal (e.g. track) as well as increased mechanisation and improved contractual arrangements with maintenance suppliers. These planned efficiencies are to be achieved whilst also delivering major upgrades and improving day-to-day asset performance.
- 8 In 2009/10, LUL spent £401m on asset maintenance and plans to spend £3,168m over the period up to and including 2017/18². Efficiencies amounting to £753m for BCV/SSL are included in the current BCV/SSL business plans for 2010/11 to 2017/18; of this total, £640m (85%) are attributable to cost categories included in the asset maintenance benchmarking and a further £113m is attributed to costs outside the benchmarking categories, including Civils, Fleet Overhauls and overheads.

¹ International Benchmarking of the Costs and Performance of Maintaining and Renewing Metro Systems (March 2010).

² Note, all costs are shown in 2009/10 constant prices unless stated otherwise. The planned efficiencies total £0.9bn outturn.

9 The composition of the planned efficiencies is shown in the following table:

£m, constant 2009/10 prices	Maintenance Capability and Support Services Review	Unit Rate reductions and other	Total Package Services contract	Maintenance Optimisation	Automated Track Measurement System	Total
Fleet & Trains	117.1	60.7	0.0	13.1	0.0	190.9
Track & Signals	205.9	30.6	23.9	0.0	22.8	283.3
Stations	76.3	26.8	63.0	0.0	0.0	166.1
Sub-total	399.3	118.1	87.0	13.1	22.8	640.3
Other maintenance efficiencies in Business Plan but allocated to non-Benchmarked cost categories						112.7
Total efficiencies						753.1

Table 1 – planned efficiencies 2010/11 and 2017/18 – BCV/SSL asset maintenance

10 The long-run sustainable cost reduction is targeted at £123m p.a. of which 60% is planned to be achieved by the end of 2012/13. Delivery against these targets is already being achieved. For example, the Maintenance Capability Programme (MCP) had, by P09 2010/11, delivered cost reductions of £24m p.a. This represents 40% of the targeted saving of £64m p.a. which is planned to be achieved from MCP by 2012/13. The phasing of the cost reductions is shown in the following graph:

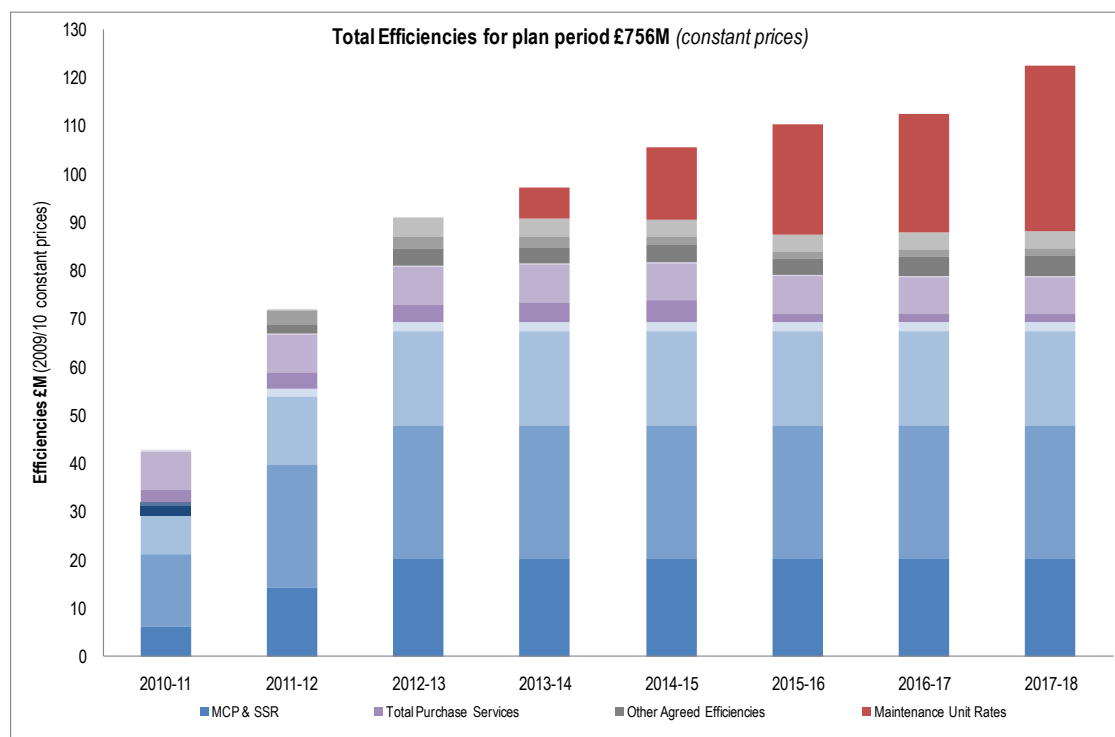


Figure 1 – planned efficiencies 2010/11 to 2017/18 – BCV/SSL asset maintenance

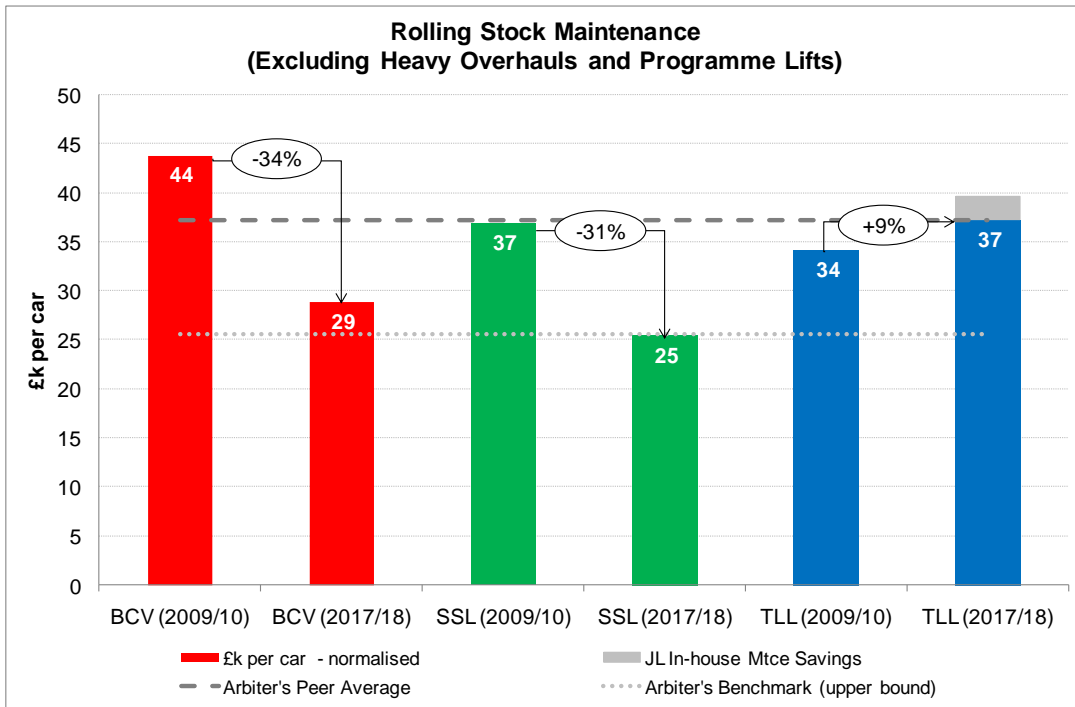
- 11 In 2009/10, Tube Lines spent £226m on asset maintenance and plans to spend £2,055m over the period up to and including 2017/18³. Tube Lines current plan for 2010/11 to 2017/18 includes efficiencies of £125m, made up as follows:

<i>£m, constant 2009/10 prices</i>	Maintenance Efficiencies
Fleet and Depots	47.7
Track	12.5
Signals (Operations)	29.7
Power	0.3
Stations	20.2
L&E	5.8
Civils	8.9
Total	125.1

Table 2 – planned efficiencies 2010/11 and 2017/18 – Tube Lines

- 12 Tube Lines' long-run sustainable cost reduction is targeted at £17m p.a. compared to the original budget (i.e. including civils, PEDs, Signalling mini capex and Station Services) of which approximately £14m p.a. are captured within the benchmarked costs. 100% of these cost reductions are planned to be achieved by the end of 2012/2013. Additional savings of approximately £14m over seven years are expected as a result of the recently announced decision to bring in-house the maintenance of the Jubilee line fleet.
- 13 The following graphs summarise the changes in the unit costs between 2009/10 and 2017/18 for track, fleet and signals maintenance. Together, these three areas represent c70% of benchmarked costs and c50% of total maintenance expenditure. The unit costs are shown in constant 2009/10 prices, are consistent with the data protocols for asset maintenance benchmarking and are after normalisation. The planned changes in unit cost are shown net of any increases resulting from, e.g. increased contract costs, increased asset usage or an increased density of assets resulting from capital investment.

³ Note, all costs are shown in 2009/10 constant prices unless stated otherwise. The planned efficiencies amount to £130m outturn.



Note: Tube Lines' costs include heavy maintenance element of Northern Line Train Services Contract and also include planned reductions of c£3.7m per annum from taking Jubilee line maintenance in-house; BCV/SSL costs exclude estimate of costs relating to heavy maintenance included within the price contracted with Bombardier for the new fleets (TSSSA)

Figure 2 - planned change in fleet maintenance unit rates between 2009/10 and 2017/18

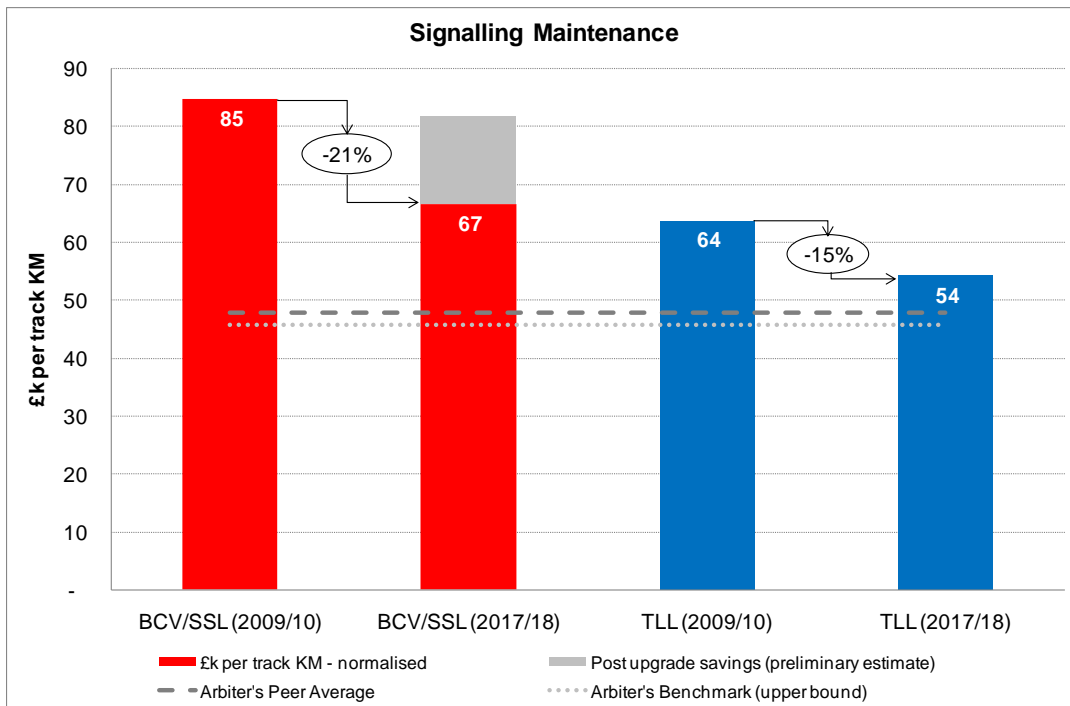


Figure 3 - planned change in signals maintenance unit rates between 2009/10 and 2017/18

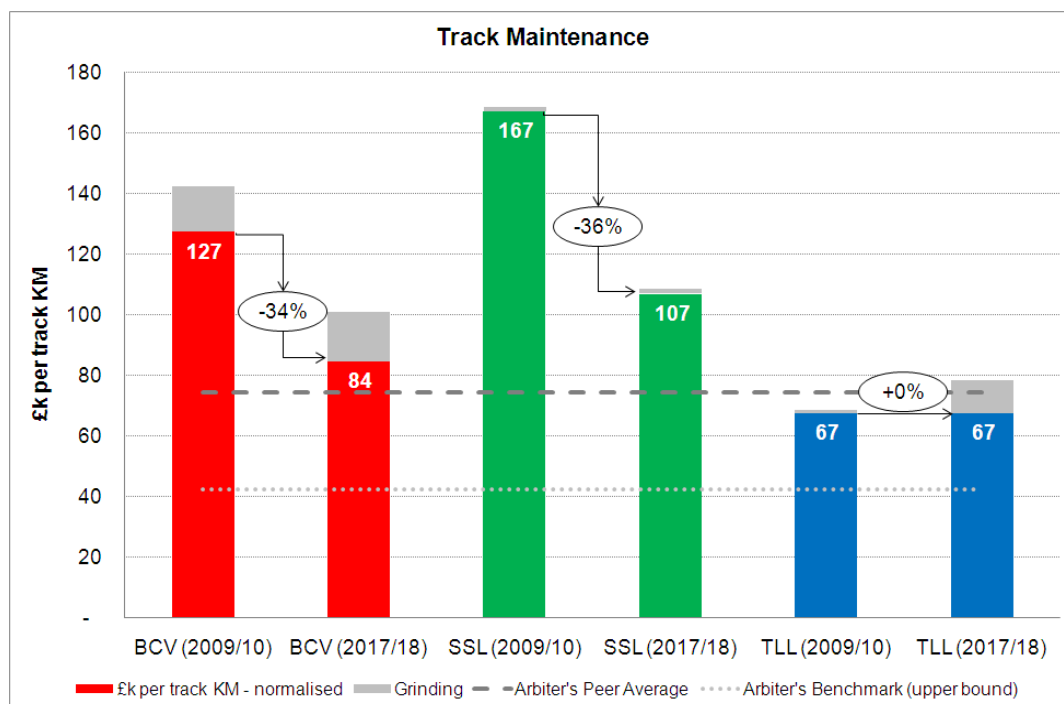


Figure 4 - planned change in track maintenance unit rates between 2009/10 and 2017/18

- 14 These graphs show that planned unit costs reduce significantly compared to 2009/10. Tube Lines fleet costs show small increases, mainly as a result of increased mileage, when new timetables are introduced following the signalling upgrades on the Jubilee and Northern lines. Evaluation of the possible post-upgrade savings in BCV/SSL signals maintenance costs is underway. Preliminary estimates indicate that a further c.£19m efficiencies may be achievable to 2017/18, amounting to an annual saving of approximately £8m in 2017/2018. This preliminary estimate is shown in Figure 3 above. The efficiencies described above and elsewhere in this report exclude the 10% stretch-target recently requested by TfL.
- 15 The development of future costs and planned efficiencies is described for each asset in remainder of this report.
- 16 While the unit costs included in BCV and SSL's current Business Plan reduce significantly, it is clear that variations between the three network areas remain, particularly for Track and Signals. Further investigation will be undertaken over the coming year to improve understanding of cost drivers and to identify opportunities for further cost reductions. This investigation will be carried out by the Benchmarking Analysis and Reviews team working in conjunction with the Maintenance Sponsors, LUL's Asset Performance Directorate (APD) and Tube Lines.
- 17 Two key factors will be taken into account when assessing the capacity for further efficiencies, and these are discussed below.

Performance

- 18 Asset availability and performance has improved significantly over the past eight years. Availability is a measure of day-to-day reliability based on whether Assets are available for service. On average, availability has improved by 37% over the past eight years (as measured in Lost Customer Hours).

	2003/04	2010/11	Improvement since 2003/04
BCV	700,174	474,650	32%
SSL	619,238	374,172	40%
JNP	984,868	591,457	40%
Total	2,304,280	1,440,279	37%

Table 3 – Improvement in Asset Performance since 2003/04

19 This reflects the significant improvements in asset reliability:

Asset	Reliability Measure	BCV	SSL	TLL
		% improvement 2003/04 to 2009/10		
Fleet	MDBF	157%	173%	216%
Signals	No. Failures >2 minutes per million car KM	20%	9%	(25)% ⁴
Track		38%	61%	53%
Lifts	MTBF	30%		37%
Escalators	MTBF	20%		48%

Table 4 – Improvement in Availability since 2003/04

20 Similarly, Ambience (which measures customers' perception of the travel environment on Trains and in Stations) has improved by an average of 2%.

21 Performance is central to future asset management planning and the achievability of future efficiencies will need to be considered in the light of reliability trends. This relates particularly to the Maintenance Unit Rate efficiencies of c. £105m, which included in the Business Plan from 2013/14 to 2017/18, but for which specific implementation plans are not yet defined.

International benchmark range

22 In the summer of 2010, OPPPA carried out a short study to assess the future cost scenarios for the London Underground Infracos. OPPPA used its Periodic Review determination of Tube Lines as a basis for an efficient "glide path" for the next seven-and-a-half years and extrapolated to BCV and SSL. OPPPA concluded:

"London Underground is already forecasting significant cost savings for BCV and SSL and we consider that the quantum of cost represented in the 2010 AAMPs is moving towards good industry practice, assuming that service performance targets are achieved"

23 However, the Arbitrator's view was that further opportunities of up to £0.5bn may be available based on BSL's view of the international benchmark range. However, OPPPA noted that:

"Change such as this would involve alteration of established and heavily negotiated working practices. We acknowledge that it is unlikely that such major change will be achieved without the full support of Government and the Mayor of London"

⁴ The underlying performance of JNP signals shows an improvement of 39%, i.e. excluding the recent performance issues relating to the new TBTC signalling system on the Jubilee line.

- 24 LUL had already recognised the scope for further efficiencies and has increased its maintenance efficiency targets by £0.2bn (outturn).
- 25 While BSL's work provides a useful starting point, significant further work is required to better understand the benchmark range, and to assess a reasonable and robust long term cost level to which LUL and Tube Lines should be aspiring, taking into account the constraints within which they operate (i.e. geographical, historical, technological, societal and financial).
- 26 LUL has three specific observations. First, BSL developed its own view of an international benchmark range, but did not form an opinion of the level of unit cost that it believed LUL or TLL should achieve at any point in time. As such, these unit rates may not be achievable within the constraints of the London Underground infrastructure and organisation, or there may be an insufficiently strong business case to do so. BSL's benchmark range was not adopted by the Arbiter in setting future costs at Periodic Review.
- 27 Second, BSL was not able to explain fully the variation between the London Infracos and the international peer group. For example, BSL was unable to explain with confidence 60% of the difference between the upper bound of the Track benchmark range and TLL's unit costs and 52% of the equivalent difference for BCV/SSL. In the absence of fuller understanding, it is not appropriate for LUL to adopt the BSL benchmark range as a target.
- 28 Third, the delta from the 2017/18 unit rate to the Arbiter's benchmark range is likely to comprise both additional structural factors which may make costs in London higher than other metros in the short to medium, and possibly the long, term.
- 29 This Section presents the key findings and analysis from Phase 6 of the Asset Maintenance Benchmarking, which compares maintenance costs and performance across the nine lines maintained by LUL and Tube Lines for each category of assets across over the seven years to 2009/10. More detailed analysis is set out in Appendix A.
- 30 Benchmarking is presented for each of the main assets: rolling stock & depots, signalling, track, stations, and lifts & escalators. As in previous years, civils assets have not been included, as the preparation of meaningful comparisons continues to prove difficult. However, this is an area for future development.
- 31 Each asset section presents the standard unit rate comparison, with an explanation of some of the differences between the lines and where there has been a significant change in the level of unit cost in the latest year of data. This is a continuation of the benchmarking previously carried out under the ambit of the PPP Arbiter (and known as the Joint Benchmarking Exercise) and uses the same protocols for costs and denominators. The Phase 6 report also adopts a consistent approach to assessing structural factors and normalisation of the data.
- 32 As well as presenting historical comparisons, each asset section shows a forecast of cost unit rates to 2017/18 and provides a commentary on the development of future costs and planned efficiencies⁵.
- 33 The acquisition of Tube Lines provides the first opportunity for detailed collaboration, free of the limitations imposed by the commercial arrangements of the PPP Contracts.

⁵ Future costs and planned efficiencies as included in the P09 Forecast submitted in December 2010.

LUL and Tube Lines have already begun to work more closely and to explore openly the possible reasons for differences in unit costs between lines. However, this analysis is at a very early stage and significant further investigation required. For each asset this report contains proposals to validate benchmark data and to understand whether the cost level and maintenance practices and culture is transferable from one line to another.

- 34 Based on the analysis carried out in Phase 6 of the Asset Maintenance Benchmarking a number of specific areas have been identified for further investigation through a series of drill down studies. These studies cover the broad range of assets maintained by LUL and Tube Lines, and for each asset area focus on an aspect of maintenance for which the analysis has identified the clear potential for improvement or efficiency savings. For asset areas which have been included in previous benchmarking studies (e.g. rolling stock, signalling, track), the drill down studies focus on key issues which have already been identified; for other asset areas the analysis is at an exploratory stage (e.g. stations, lifts). The proposals for the drill down studies have been reviewed by the Rail and Underground benchmarking group. However IIPAG has requested a further review of study prioritisation.
- 35 There are three main categories of investigation:
- improving data comparability and consistency;
 - investigating costs, productivity measure and related drivers and explaining the variations between lines; and
 - commissioning and using external benchmarking (e.g. from CoMET) where this will readily complement internal benchmarking information.
- 36 Readers of this report should bear in mind that all observations and assertions related to the BCV and SSL lines are the current understanding of the LUL Asset Performance Directorate (APD) and the LUL asset sponsors, and those related to JNP are the current understanding of Tube Lines, unless otherwise stated. All costs are in constant 2009/10 prices, unless otherwise stated.

1.2 Overview of 2009/10 maintenance expenditure

- 37 For 2009/10, the benchmarked data on BCV and SSL accounts for 76% of the total APD spend in 2009, the remaining 24% of costs is outside the scope of the benchmarking exercise. For Tube Lines, 68% of the total maintenance costs are captured in the benchmarks and 32% fall outside the scope of the benchmarking exercise. This is described by asset category in the following.

<i>£m 2009/10 prices</i>	BCV	SSL	TLL	Total
Fleet & Depots	59.8	40.3	54.6	154.7
Signals	17.7	26.7	22.1	66.5
Track	33.3	50.8	22.7	106.8
Stations	29.0	28.2	39.6	96.8
L&E	12.5	6.1	15.3	33.9
Sub Total	152.3	152.0	154.3	458.6
Civils	6.9	15.8	4.6	27.3
Fleet Maintenance levels 4-7	19.9	6.4	3.6	29.9
NL lease	n/a		36.5	36.5
All other Un-benchmarked	47.4		27.2	74.6
Total	400.8		226.2	627.0

Table 5 – Asset Maintenance Costs 2009/10

38 The split of activities varies by network area and is illustrated below.

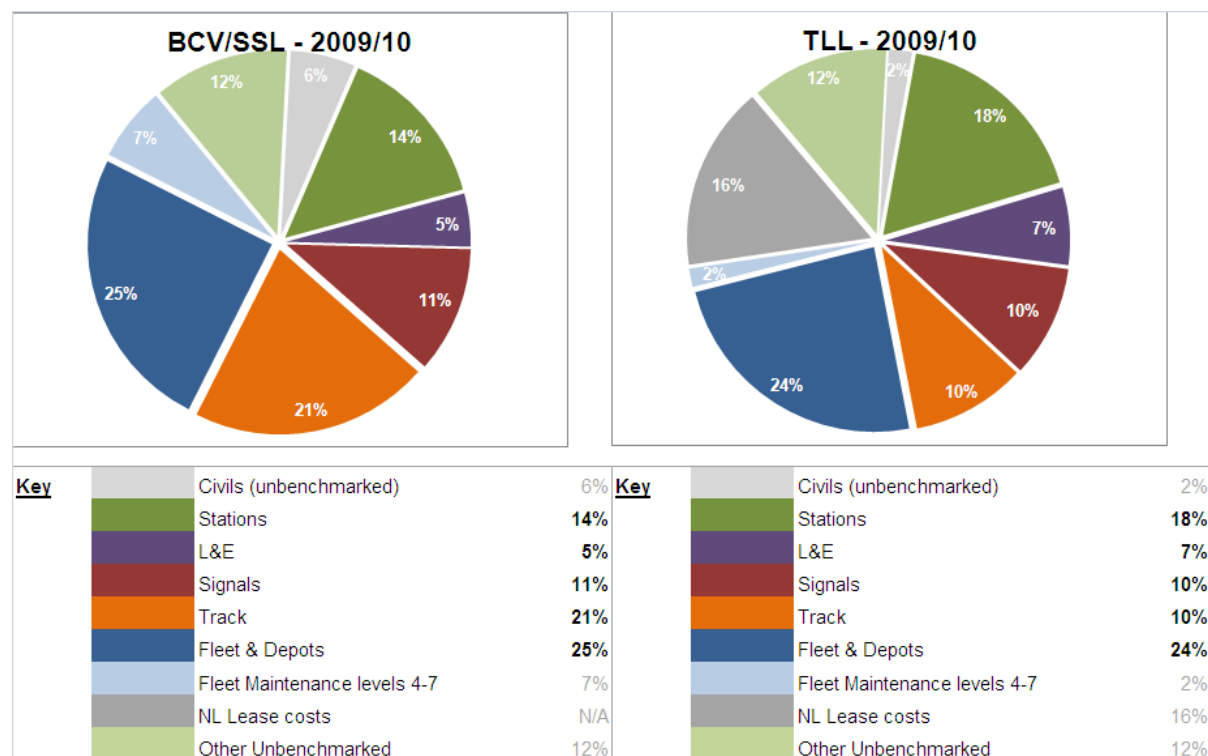


Figure 5 - Proportion of asset maintenance costs included in benchmark analysis

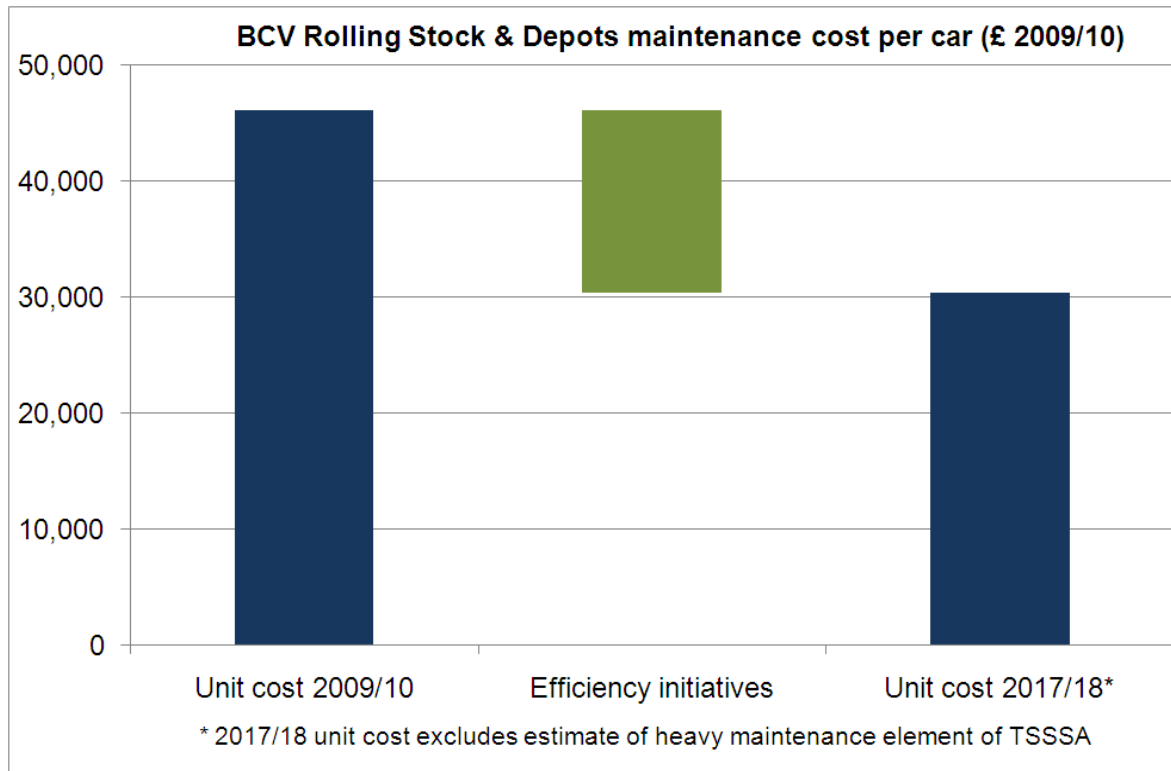
39 The costs related to Civils maintenance and certain heavy maintenance of fleet are not in the scope of the Phase 6 benchmarking exercise. Central overheads are also excluded.

1.3 Rolling Stock & Depots

40 LUL and Tube Lines are planning to spend £1.2bn on the maintenance of the Rolling Stock and Depots assets between 2010/11 and 2017/18, which accounts for 35% of all

benchmarked asset maintenance spend. This cost includes the cleaning and maintenance (levels 1, 2 and 3) of trains and the depot equipment used to maintain trains. It does not include periodic heavy maintenance such as programme lift or heavy overhaul or project works such as the installation of signalling related communications equipment, or Northern line lease payments.

- 41 The graphs below show for each of BCV, SSL and Tube Lines the change in rolling stock and depot unit rates (maintenance cost per car) between 2009/10 and 2017/18, summarising the total efficiency initiatives which are being implemented over this period and the total of any cost increases.



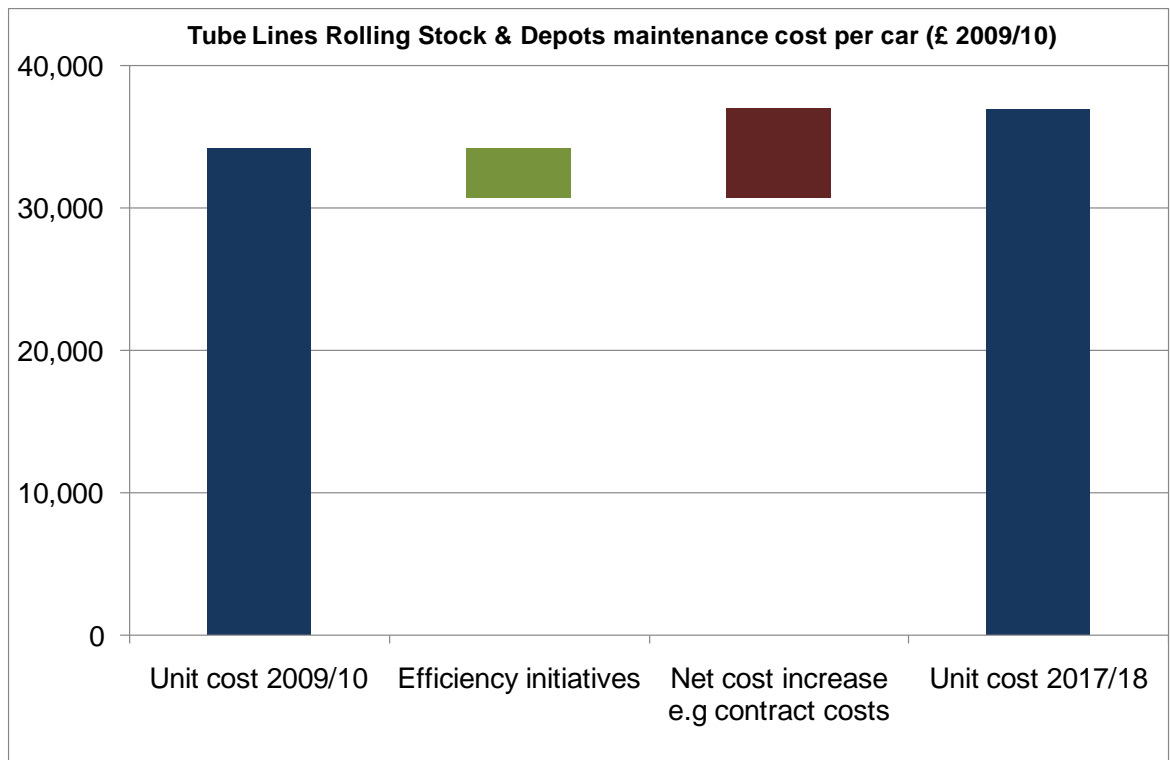
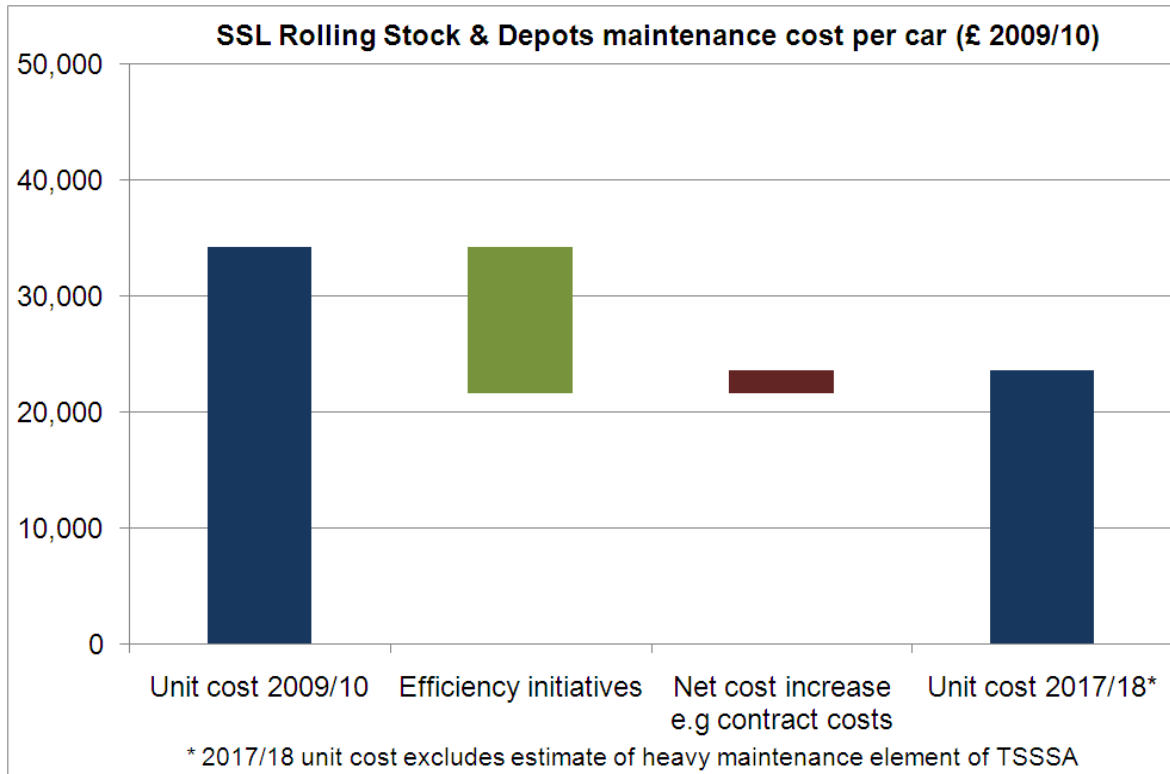


Figure 6 – Waterfall comparison (Rolling stock maintenance costs per car)

42 There is an overall reduction in unit rate of £15,800 per car on BCV and £10,600 per car on SSL over this period. This comprises reductions due to existing and planned efficiency initiatives (i.e. Maintenance Capability Plan, Maintenance Unit Rates, Maintenance Optimisation, Support Services Review) offset by a cost increase for SSL, which is currently understood to relate largely to the introduction of the Technical Support and Spares Supply Arrangement (TSSSA).

- 43 For Tube Lines there is an increase in unit cost of c. £3,000 per car. This is due to an increase in contract costs on both the Northern and Jubilee lines as a result of additional maintenance of TBTC equipment, extra mileage and new train declarations, offset by efficiencies as a result of savings from the optimisation of level 1 and 2 maintenance, improved use of the Maximo asset management system, and planned reductions from taking Jubilee line maintenance in-house (c. £2,400 per car).
- 44 Three specific areas have been identified for further work, to provide a better understanding of the differences in unit rates and to identify further efficiency opportunities:
- 45 The comparison of maintenance activities within the benchmarking unit rate has revealed significant variations between lines. Further work is required to understand whether these are issues relating to data capture, or whether certain fleets have lower unit rates for certain maintenance activities, and in particular labour arrangements for the in-house maintenance of different fleets.
- 46 The unit cost levels and reliability performance of the Piccadilly line fleet is 'best in class' in London. A drill down study is examining the maintenance practices and culture on the Piccadilly line to understand what opportunities exist to introduce good practices into other fleets and depots.

1.4 Signals and Power

- 47 LUL and Tube Lines are planning to spend c. £0.5bn on the maintenance of the Signals assets between 2010/11 and 2017/18, which accounts for c. 15% of all benchmarked asset maintenance spend. This cost includes inspection, preventative and corrective maintenance, routine change (i.e. component renewal), power maintenance and all related direct supervision and management costs. It does not include mid-life refurbishments, training costs, central overheads and project works such as the installation of signalling related communications equipment.
- 48 The graphs below show the change in signals unit rates (maintenance cost per km) between 2009/10 and 2017/18, summarising the total efficiency initiatives and the total cost increase for BCV/SSL and for Tube Lines.

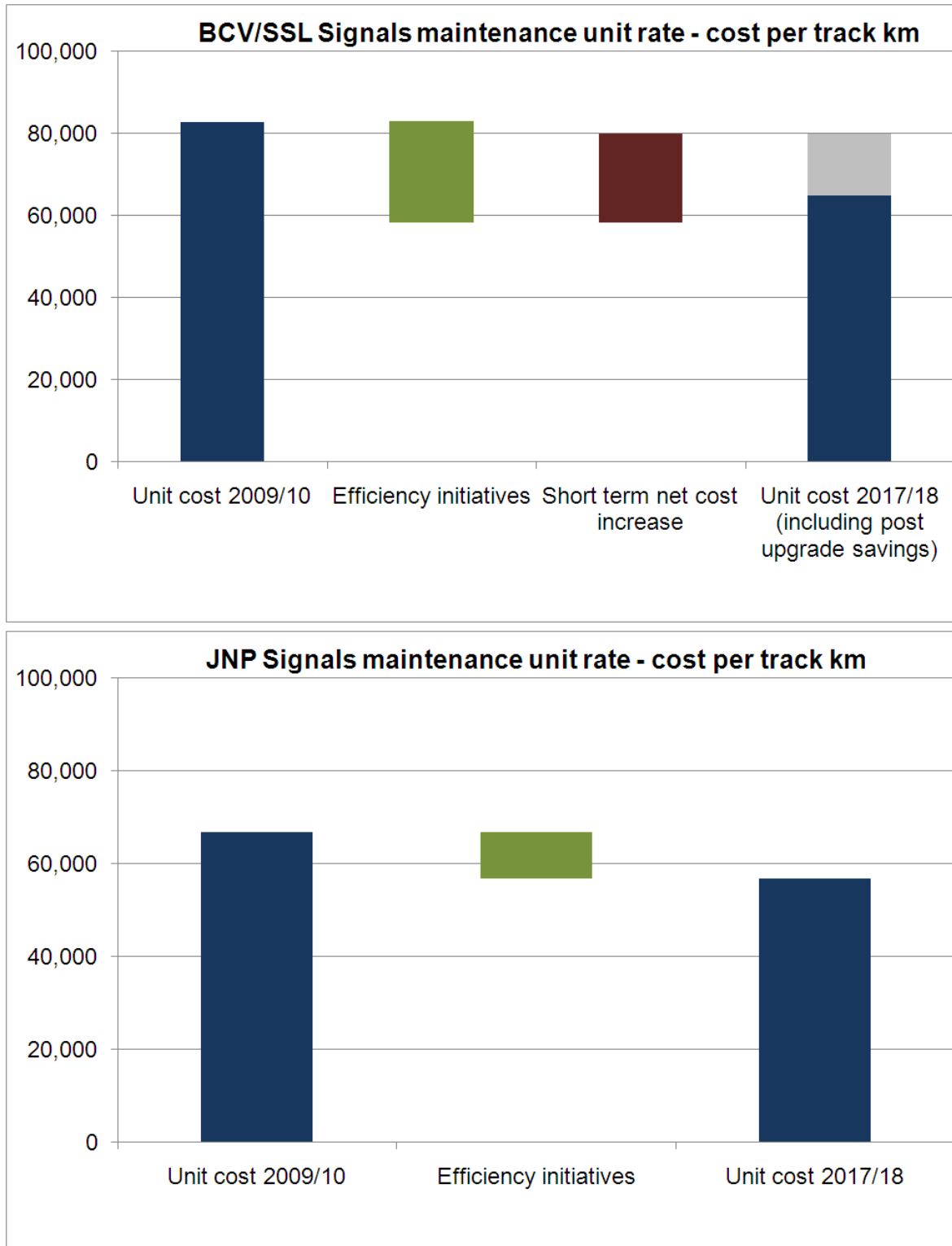


Figure 7 – Waterfall comparison (Signalling maintenance costs per track km)

49 There is a net reduction in the signals maintenance unit rate of £3,000 per track km for BCV/SSL over this period. This comprises a reduction due to planned efficiency initiatives (i.e. Maintenance Capability Plan, Maintenance Unit Rates and Support Services Review), which are offset by a cost increase which current understanding suggests relates largely to an increase in headcount in the ATC and C&I teams and the Central line workforce and additional spares for maintenance. However, the business plan does not yet reflect savings as a result of the delivery of the Signalling

Upgrade on the Victoria line (in 2013) and on the Sub-Surface Railway (in 2014). Evaluation of the possible savings is underway and preliminary estimates indicate that a further c.£19m efficiencies may be in the current business plan, amounting to an annual saving of approximately £8m in 2017/2018.

- 50 For Tube Lines there will be a reduction in unit cost of £10,000 per km over this period. This is due to a change from a line to an asset based maintenance structure; a reduction in grades due to technological requirements; changes to the signalling maintenance regime; and an alternative approach to ACATS wheel rail management.
- 51 A joint LUL-Tube Lines signalling maintenance study is already underway, to address some of the issues identified in this report, with the following objectives:
- Phase 1: Incident Response Time. This will examine the cost of response teams required vs. the cost of passenger disruption;
 - Phase 2: Signal maintenance pre-upgrade: This phase will review existing working practices of Technical Officers across all London Underground lines in order to share best practices, identify areas for improvement and explain any remaining differences with peers;
 - Phase 3: Post-Upgrade Organisation. This phase will focus on the organisation of signal maintenance post upgrades.
- 52 This study will focus, in particular, on achieving data comparability and consistency, and will make an internal comparison of costs, productivity measures and cost drivers.
- 53 Once the internal comparisons have been made, and understood, the study will compare the organisation of signal maintenance with other metros around the world, through the CoMET group, and suggest a good practice post-upgrade signalling organisation.

1.5 Track

- 54 LUL and Tube Lines are planning to spend £0.7bn on the maintenance of the Track assets between 2010/11 and 2017/18, which accounts for 20% of all benchmarked asset maintenance spend. This cost includes: direct and sub-contract labour, protection services, materials and track workshop costs, plant hire, track recording vehicle, ultrasonic testing, grinding and tamping costs, and engineering train costs. The activities include: track cleaning, vegetation control, compliance work, track lubrication and depot maintenance. It does not include fencing, emergency response, overheads, and costs that are considered 'one-off' or not part of planned maintenance cycles. It also does not include capital expenditure on full or partial track renewals.
- 55 The graphs below show the change in track unit rates: maintenance cost per (passenger service) track km from 2009/10 to 2017/18.

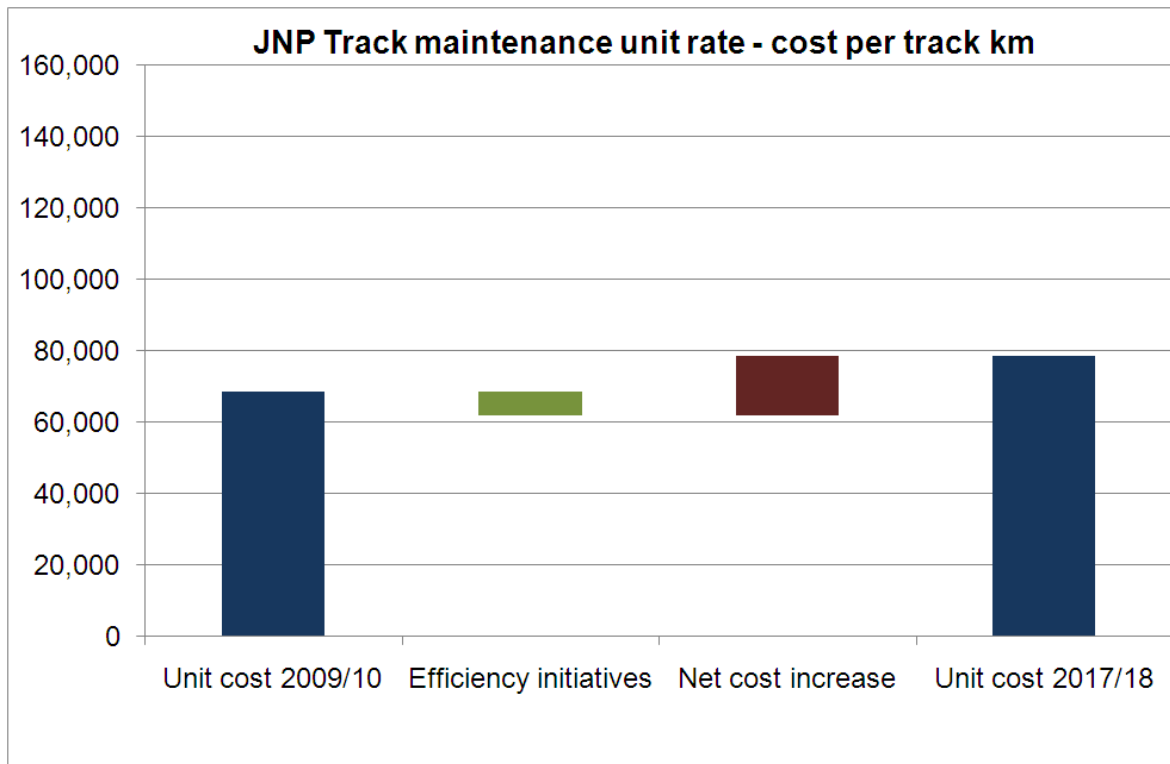
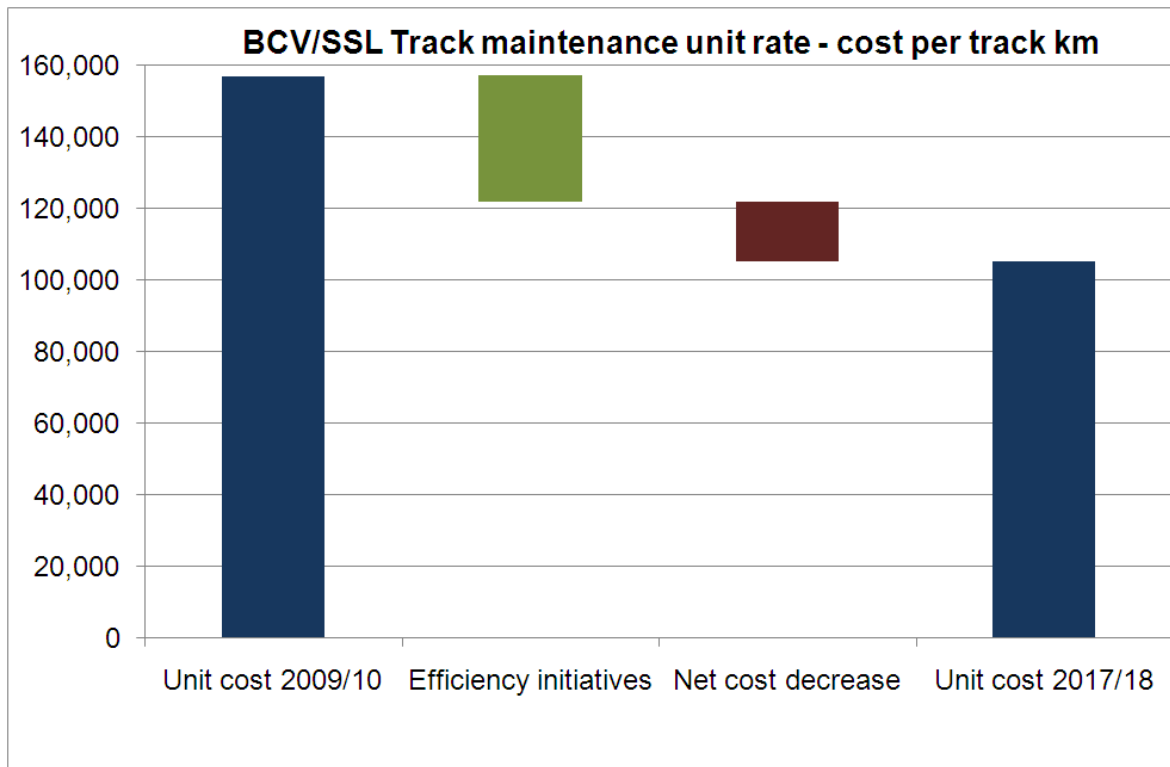


Figure 8 – Waterfall comparison (Track maintenance costs per track km)

- 56 Although the maintenance activities for BCV and SSL track are divided in relation to line areas (Bakerloo & Victoria, Central (including Waterloo & City), SSL North and SSL South), as many future efficiency savings are not split by line, the unit rate shown is a combined BCV/SSL rate.
- 57 There is a forecast reduction in the maintenance unit rate for BCV/SSL of £52,000 per track km from £157,000 in 2009/10 to £105,000 per track km in 2017/18, delivered through existing and planned efficiency initiatives; predominantly the Maintenance

- Capability Plan, Automated Track Monitoring System (ATMS), as well as other initiatives such as achieving lower Maintenance Unit Rates and savings from contract re-negotiation (TPS).
- 58 There is an overall forecast increase in the maintenance unit rate for Tube Lines of £9,900 per track km from £68,500 per track km in 2010/11 to £78,400 per track km in 2017/18. This predominantly relates to significantly increased volumes of grinding and tamping because of the increased rolling stock tonnage following the upgrades, and to other initiatives to improve track geometry and reduce track degradation.
- 59 The increases for Tube Lines are partially offset by planned efficiencies which include a move from a “Find-and-Fix” to a “Predict-and-Prevent” strategy for track faults using output from the Asset Inspection Train (AIT), and an improved approach to ultrasonic rail testing. Additionally, Tube Lines plan to use a risk based approach to increase the interval between inspections.
- 60 To provide a better understanding of the differences in unit rates and to identify further efficiency opportunities, LUL and Tube Lines plan to carry out two detailed investigations:
- 61 A drill-down study into track maintenance costs which will focus on determining the exact scope of works for discrete repetitive activities, e.g. manual inspections and servicing type activities that are being carried out by each maintenance organisation. In addition, this study will identify the asset regime, the treatment of overheads, and the risk strategies being employed by each maintenance organisations, and how these strategies interface with WLAM principles and the renewals programme.
- 62 A further exercise will be carried out to determine standard activities within track maintenance costs for accurate data collection and comparability. Analysis will also be undertaken on overhead costs (currently excluded from the asset maintenance benchmarking) to ensure comparable treatment is being made.

1.6 Stations

- 63 LUL and Tube Lines are planning to spend £0.8bn on the maintenance of the Stations assets between 2010/11 and 2017/18, which accounts for 22% of all benchmarked asset maintenance spend. This figure includes the maintenance costs for station services (communication, fire, electrical and mechanical (E&M) assets) and station premises including cleaning costs.
- 64 The graphs below show the change in station unit rates (average cost per station) between 2009/10 and 2017/18.

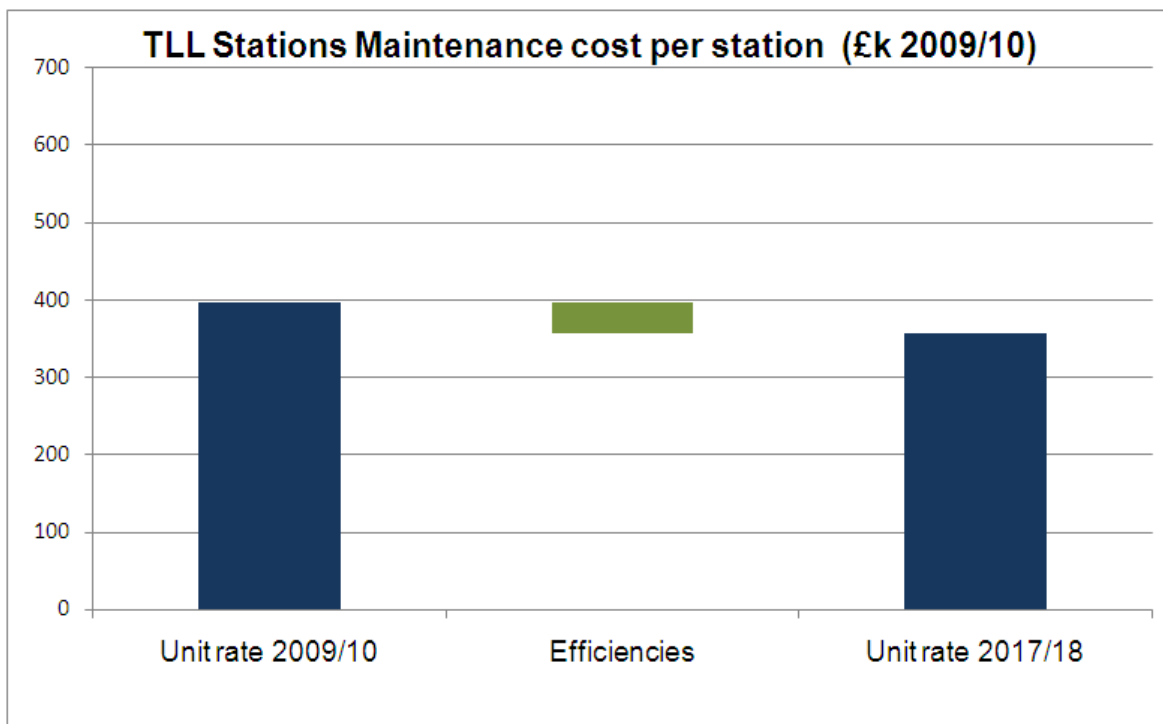
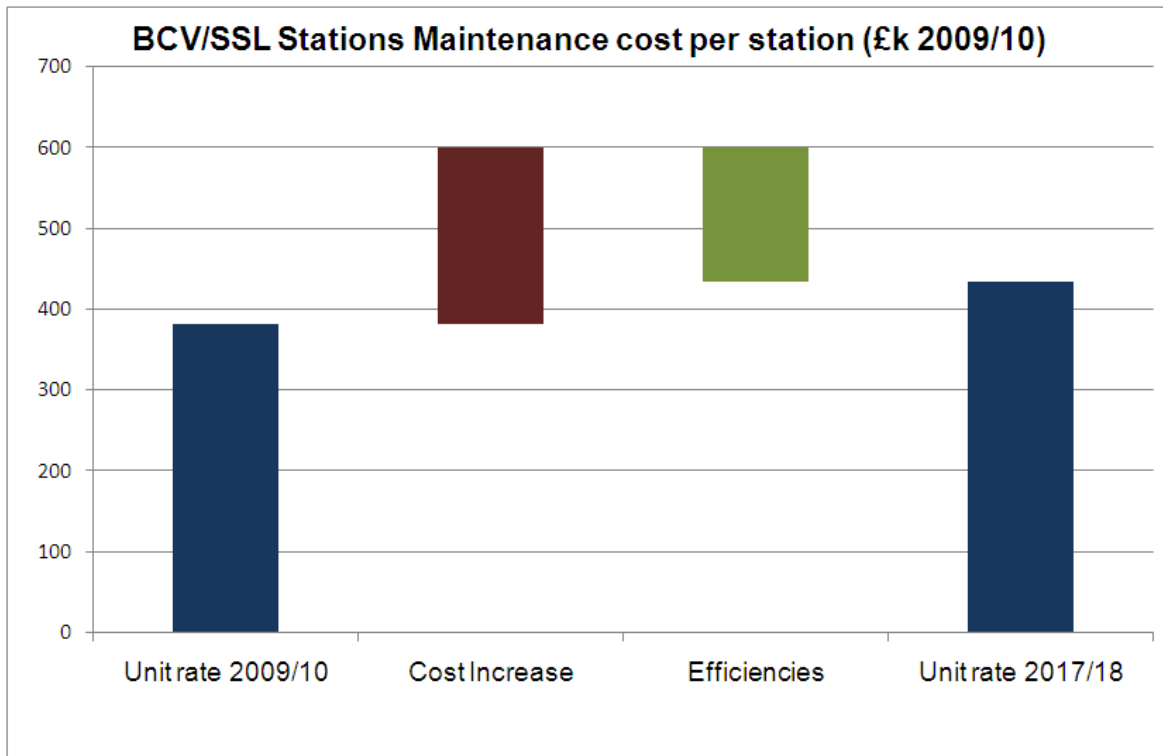


Figure 9 – Waterfall comparison (Stations)

- 65 The maintenance for BCV and SSL stations is contracted by asset group (premises, fire, communication and E&M) across both the BCV and SSL network areas, and therefore the unit rate shown is a combined BCV/SSL rate.
- 66 There is a forecast net increase in the maintenance unit rate for BCV/SSL of £52,800 per station from £381,500 per station in 2009/10 to £434,300 per station in 2017/18.
- 67 This cost increase relates predominantly to the expansion of existing stations and an increase in the number of station assets as a result of Crossrail and the station

- congestion relief projects. There is also a forecast increase in unit cost as a result of the renegotiation of the BCV/SSL maintenance contracts in 2013-15.
- 68 These increases for BCV/SSL are partially offset by planned efficiencies which include those in the Maintenance Capability Plan (MCP), together with the realisation of savings included within the current maintenance contracts.
- 69 There is a forecast decrease in the maintenance unit rate for Tube Lines which is to be delivered by combining the contracts for ambience and security, and the introduction of the Maximo asset management system to the management of premises assets, so that contractor involvement can be targeted more accurately.
- 70 To provide a better understanding of the differences in unit rates and to identify further efficiency opportunities the stations maintenance drill down study will be progressed in two phases.
- 71 The first phase will identify and analyse cost data at asset group level for the SSL, BCV and TLL station assets. The objective of the first phase will be to identify the optimum maintenance costs for each asset group with a subsequent analysis to identify efficiency opportunities which could be applied to the maintenance of all similar assets across the LUL network.
- 72 The second phase will focus on extending this analysis within the TfL group, including London Rail, and to external organisations, including international metros via the CoMET and Nova groups, maintaining similar assets for comparison and subsequent identification of efficiency opportunities. The second phase will also consider the relationship between asset performance and the cost of maintaining the assets.

1.7 Lifts and Escalators

- 73 LUL and Tube Lines are planning to spend £0.2bn on the maintenance of the Escalator assets between 2010/11 and 2017/18, this accounts for 6% of all benchmarked asset maintenance spend, and £53m on the maintenance of the Lift assets over the same period, which accounts for 1% of all benchmarked asset maintenance spend.
- 74 The graphs below show the change in unit rates (average cost per machine) between 2009/10 and 2017/18 for lifts and escalators respectively.

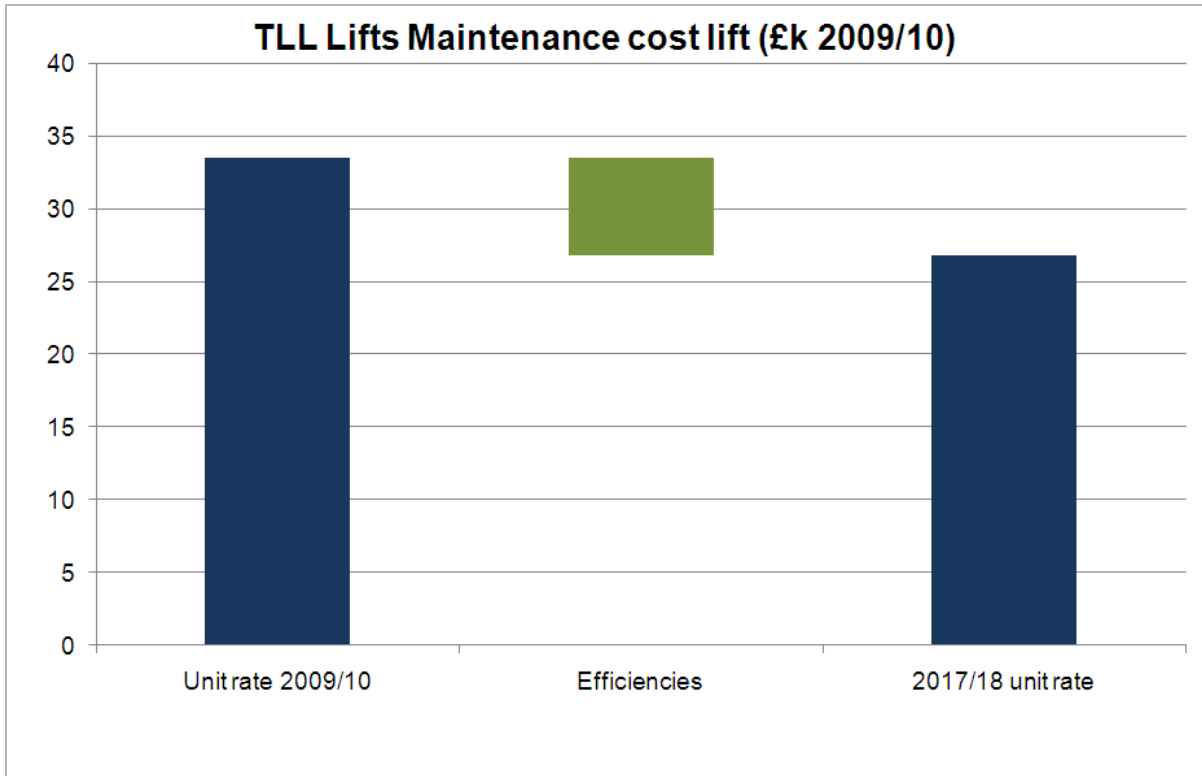
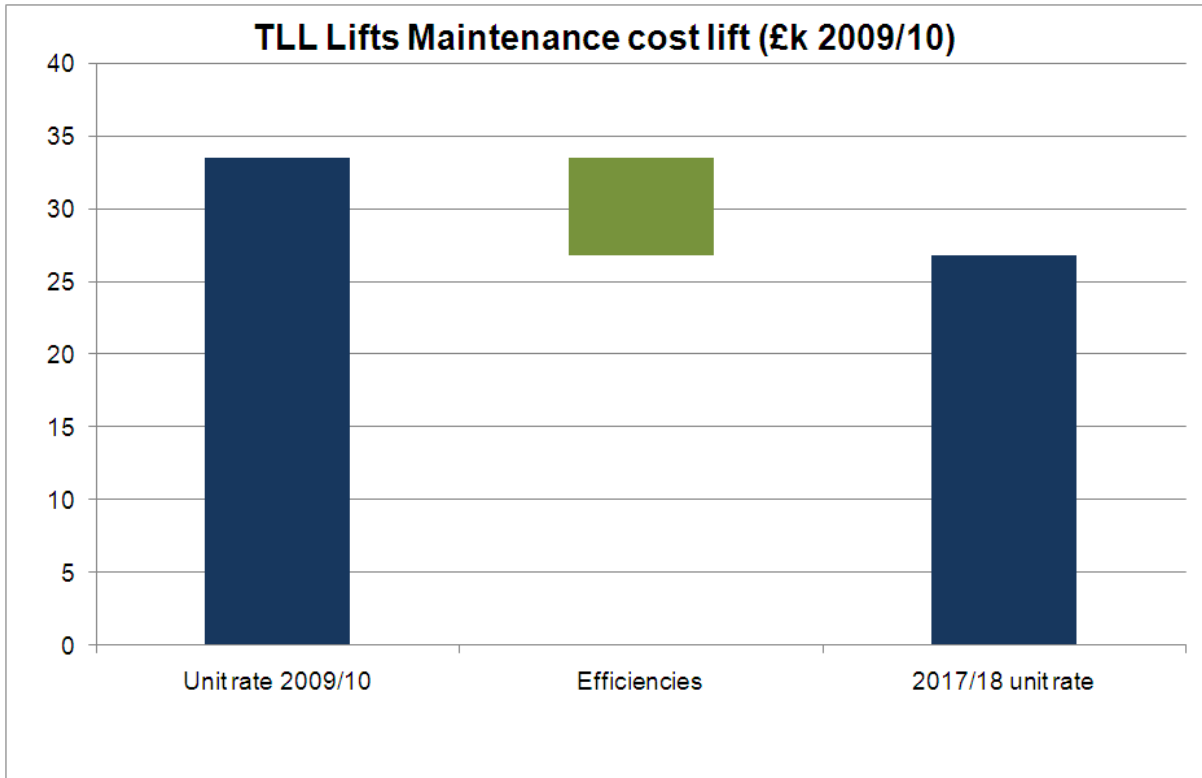


Figure 10 – Waterfall comparison (Lifts)

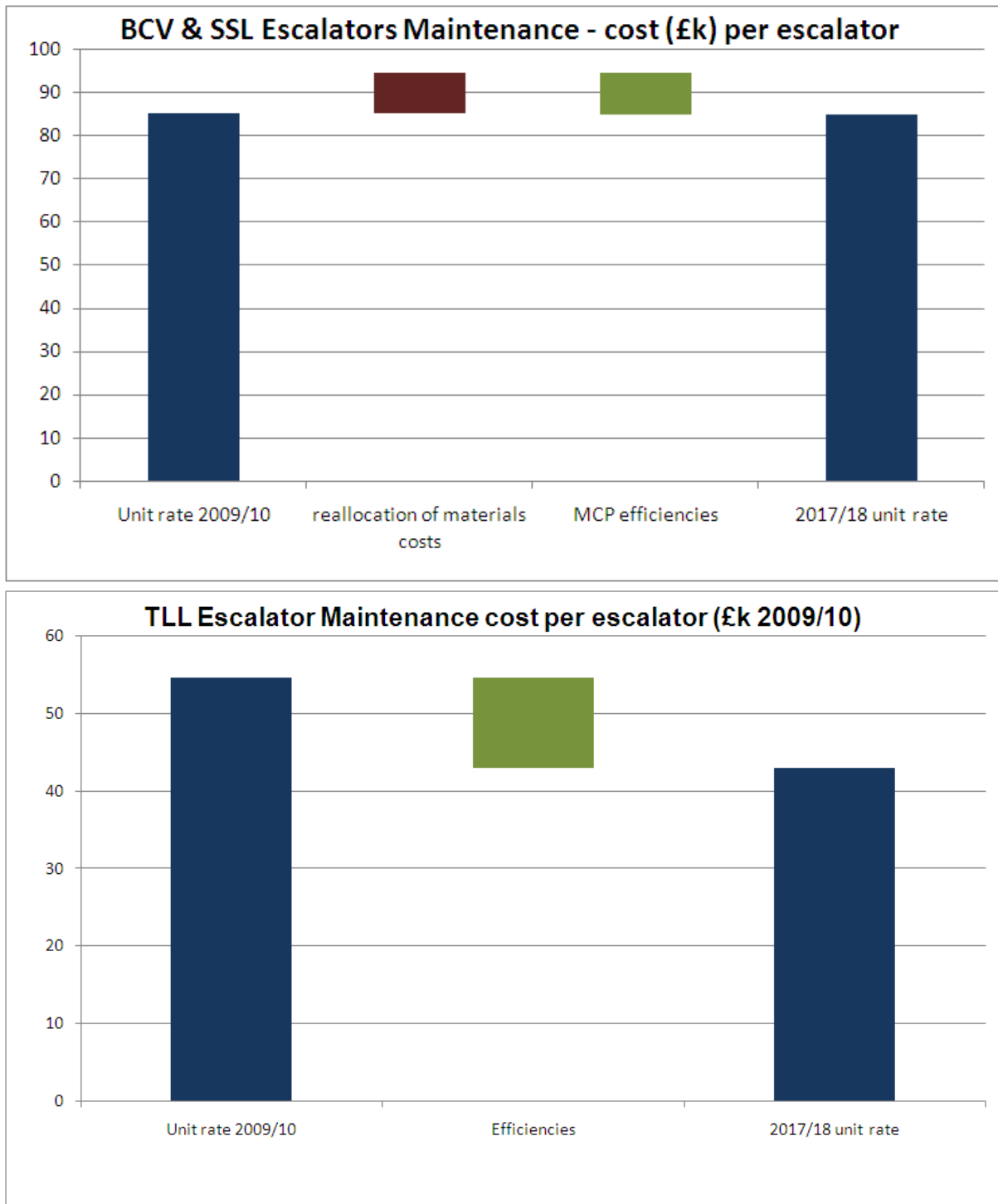


Figure 11 – Waterfall comparison (Escalators)

- 75 The graphs for SSL and BCV combine the maintenance costs of lifts and escalators on SSL and BCV to reflect the maintenance arrangements for the assets which are combined and not split by network area.
- 76 There is a net decrease in the forecast maintenance unit rate for BCV/SSL for escalators of £300 per escalator and a net increase for lifts of £1,000 per lift.
- 77 For escalators the unit cost increase is due to transferring maintenance materials costs from other budget areas, plus an element of payroll inflation. For lifts the unit cost

- increase relates mainly to payroll increases (pensions/NI), and to a lesser degree heavy maintenance requirements and the poor condition of assets taken over from the Otis Contract.
- 78 The increase in lift and escalator costs for BCV/SSL is partially offset by the current and planned efficiencies contained within the Maintenance Capability Plan. These include efficiency initiatives identified during the previous escalator benchmarking study undertaken as part of the preparations for PPP Periodic Review.
- 79 There is a forecast decrease in the maintenance unit rates for Tube Lines' lifts and escalators, with Tube Lines planning to achieve these savings by reducing the frequency at which maintenance interventions are carried out and through the introduction of extended engineering hours for lifts and escalators maintenance.
- 80 The escalators installed on the Jubilee Line Extension (JLE) are understood to be cheaper to maintain compared to the non-JLE type escalators installed across the rest of the LUL network, and this is believed to be one of the factors affecting the lower cost per escalator shown for Tube Lines above. Further analysis of this will be undertaken.
- 81 A drill down study is being undertaken to provide a better understanding of the differences in unit rates and to identify further efficiency opportunities for lift maintenance. This study is looking to understand the differences between BCV/SSL and Tube Lines' actual and forecast unit rates, and to identify best practice on the LUL/TLL network and recommend efficiency opportunities for implementation.
- 82 The study includes a review of maintenance activity costs, volumes and headcount, including overheads and management costs, and the split between maintenance and projects, to ensure that costs are treated in a similar way for comparison. The review also analyses the costs for planned maintenance, reactive maintenance and inspections and will identify the key differences for each and subsequent efficiency opportunities, as well as a review of access arrangements and how these compare across the three network areas in terms of usage, productivity and relationship to costs.
- 83 The study will also attempt to identify and understand the relationship between asset performance and maintenance costs and how asset performance is affected by asset condition.
- 84 The lift drill down study also includes a comparison with other metros, through the CoMET group, to identify good practices in maintenance and procurement as well as further opportunities for efficiencies. So far six other metros have agreed to participate.

2 High Level Benchmarking Study comparing LUL and LOROL

85 A high level benchmarking study has been conducted between London Rail (LR) and London Underground (LUL). The study comprises two main elements: (i) a high level operating model review by looking at total operating cost and revenues for LUL and LR, and (ii) a review of capital project costs and scope of the recent upgrade of ex-Silverlink stations - Kenton (project led by LUL) and Headstone Lane (project led by LOROL).

2.1 Initial findings - Operating Cost and Revenues:

86 Operating cost per Passenger Kilometre is marginally lower for LR than LUL, with both parties showing reductions over the plan period. For LR this reduction is primarily due to increased passenger projections whilst for LUL it reflects a predicted increase in passenger numbers combined with a cost reduction over the plan period.

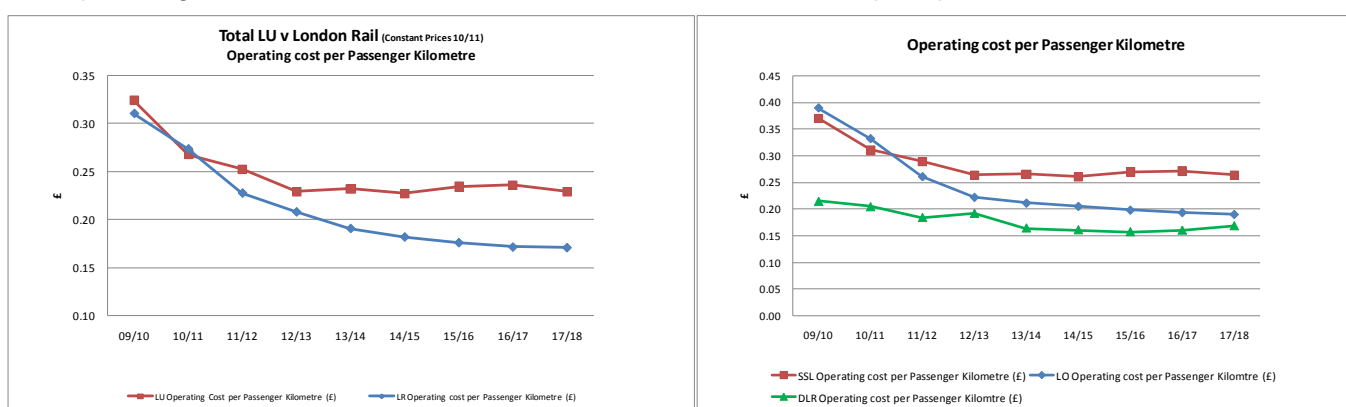


Figure 12 – Comparison of operating costs per passenger KM

Percentage change 2009/10 to 2017/18		
	LUL	London Rail
Operating Cost	-24%	10%
Passenger Kilometres	18%	30%
Passenger Journeys	16%	86%

Table 6 – Planned change in costs, passenger KM and number of journeys 2009/10 to 2017/18

87 Operating cost per train kilometre for LR is lower than LUL, whereas the operating cost per car kilometre for LUL is lower than LR. Both parties show reductions over the plan period. For LUL this is due to a projected increase in kilometres combined with a reduction in cost, whereas for LR it is due to a projected increase in kilometres combined with a smaller increase in operating cost over the plan period.

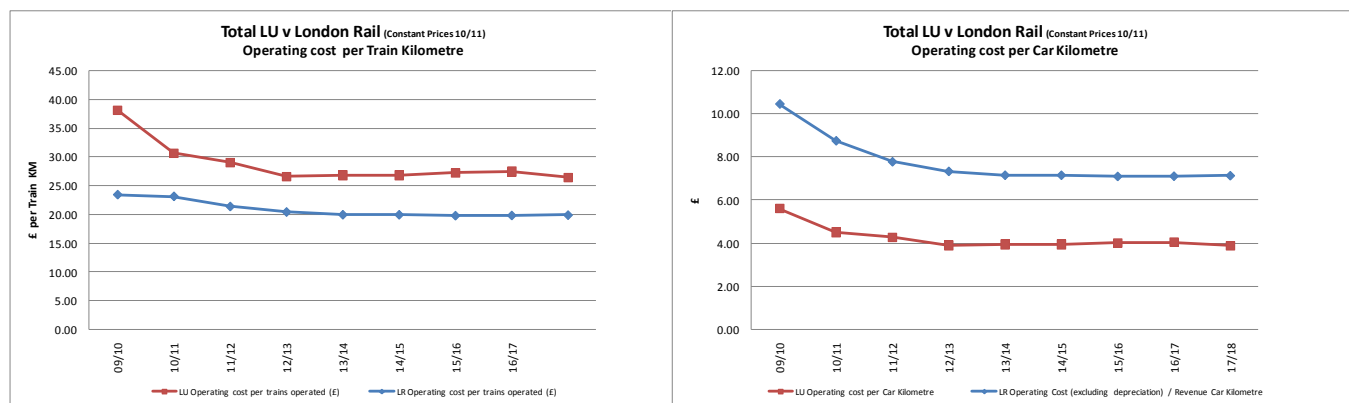


Figure 13 – Comparison of operating costs per train and car KM

Percentage change 2009/10 to 2017/18		
	LUL	London Rail
Operating Cost	-24%	10%
Train Kilometres	18%	30%
Car Kilometres	18%	61%

Table 7 – Planned change in costs, train and car KM

- 88 Fare revenue per Passenger Journey / Kilometre for LUL is significantly higher than the same for LR, with both show increasing trends over the plan period.
- 89 London Rail does not have the detailed level costs available from their concessionaires so it is not possible to fully evaluate the cost drivers for their expenditure.

2.2 Initial findings - Upgrade of ex Silverlink stations:

- 90 The refurbishment and upgrade of Kenton⁶ and Headstone Lane stations were chosen for this study as they are a similar size and layout and were in a comparable state of disrepair at point of handover from Silverlink. The Kenton station upgrade was delivered through a traditional design & construction management approach using three different delivery contractors and procured through four main contracts for 13 ex Silverlink stations, whilst the Headstone Lane upgrade was part of a single fixed price design and build contract to do 44 ex Silverlink stations to a specified output.
- 91 At face value it would appear that the upgrade of Headstone Lane was delivered more cheaply than that at Kenton. However, there are differences in the scope delivered and the method of contracting and delivery. Also given that the analysis has been undertaken using the original cost estimates⁷ for Headstone Lane compared to actual spend at Kenton, the unit rates should be viewed with caution, particularly at the detailed level. This makes it difficult to compare the unit rates at the aggregated level

⁶ Kenton station upgrade works are not typical of the station refurbishment and upgrade works carried out under the PPP during the first contract review period, or of the station asset stabilisation approach going forward for LU stations.

⁷ Detailed actual costs for each LOROL station are not available to LR so the upfront estimates for each station provided by the contractor as part of the fixed contract price for all 44 stations were used.

but still highlights some key differences in approach which resulted in cost differences between the two projects and which warrant consideration for future projects.

92 The key deliverable for both stations was the installation of communication systems (PA, CCTV, Customer Information Systems and Help Points), with 81% of the project spend being for communication systems at Kenton, and 52% at Headstone Lane. There are material differences in the scope and approach to station systems in terms of CER rooms, Cable Management Systems, CCTV, PA as well as station control points.

- LOROL, adopted group control of the communication systems with a degree of local control available 24 hours a day. As the LOROL group control room and the communication backbone to it were already in place, the costs for these⁸ are not reflected in the Headstone Lane station costs used in the study.
- At the outset LUL considered group control as an option for Kenton but this was deemed not to be justified due to the additional staffing requirements and there not being an existing communications backbone (e.g. Connect). Kenton therefore has a fully functional local Station Control Point, together with a local station staff intervention facility. This required more equipment to be installed at the station in comparison to Headstone Lane, and the provision of space to house it.
- LU refurbished and enlarged an existing dilapidated radio room, installing three communication equipment racks, air conditioning and a fire door meeting 60 minutes fire compliance. At Headstone Lane, only one equipment rack needed to be installed and this was done in a refurbished back room. No specific works were undertaken by LOROL on fire compliance with 30 minutes resistance assumed based on the existing structure, and no air conditioning was required due to the thermal footprint of the equipment⁹.
- LU installed structured cabling at Kenton whilst point to point cabling was installed at Headstone lane. Structured cabling is more expensive than point to point cabling upfront but more flexible and therefore potentially more efficient over the longer term. The main reason for installing structured cabling was the benefit of being able to proceed with the installation before finalising the communication systems design. However, Kenton was the first station where structured cabling was installed and it took the brunt of the learning curve of the contractors.
- There are also material differences in the CMS installed at each station, with LU installing bespoke GRP (Glass Reinforced Plastic) trunking whilst LOROL used galvanised trunking, which has both lower capital cost and minimal ongoing maintenance cost.

93 Whilst both projects focussed on customer aspects such as lighting, electronic train information displays & help points, and the provision of upgraded CCTV and PA systems, there was a material difference in the premises works undertaken.

- The Headstone Lane project refurbished customer facing aspects throughout the station such as seating, walls and ceilings, handrails for stairs, tactile flooring and repainting platform canopies. Due to budget cuts implemented during the latter

⁸ These were delivered by a separate project with costs not allocated to individual stations.

⁹ Less equipment required than at Kenton due to the group station control centre and the use of energy dissipating cabinets.

stages of the Kenton refurbishment works, and additional costs arising through poor contractor performance in the early stages of the project, works to refurbish customer areas were descope to only include the ticket hall area.

- There was a differing view taken by the two projects on spending upgrade money on landlord (Network Rail) assets, i.e. work on the platform canopies. LU made a decision not to spend money on these assets whereas LOROL spent money upgrading platform canopies where these were deemed to be in poor condition. The costs for this work was not part of the original business case, and is not included in the declared costs, and London Rail intends to recover an element of this cost from Network Rail.
- The approach to staff accommodation also differed between the projects resulting in material differences in both quality and quantity of staff accommodation and facilities. LOROL only undertook minor repairs to existing staff accommodation, whereas LUL provided new staff mess facilities to reflect the provisions at other LUL stations and the “Dignity at Work” guidelines. This required the renovation of severely dilapidated rooms on the platforms to provide space for the new facilities.

94 Both stations are measured by MSS but the absolute level of performance may not be comparable due to differences in MSS methodology. However both projects show notable performance improvements post refurbishment, with a slightly greater increase of 18% at Kenton against 13% for Headstone Lane.

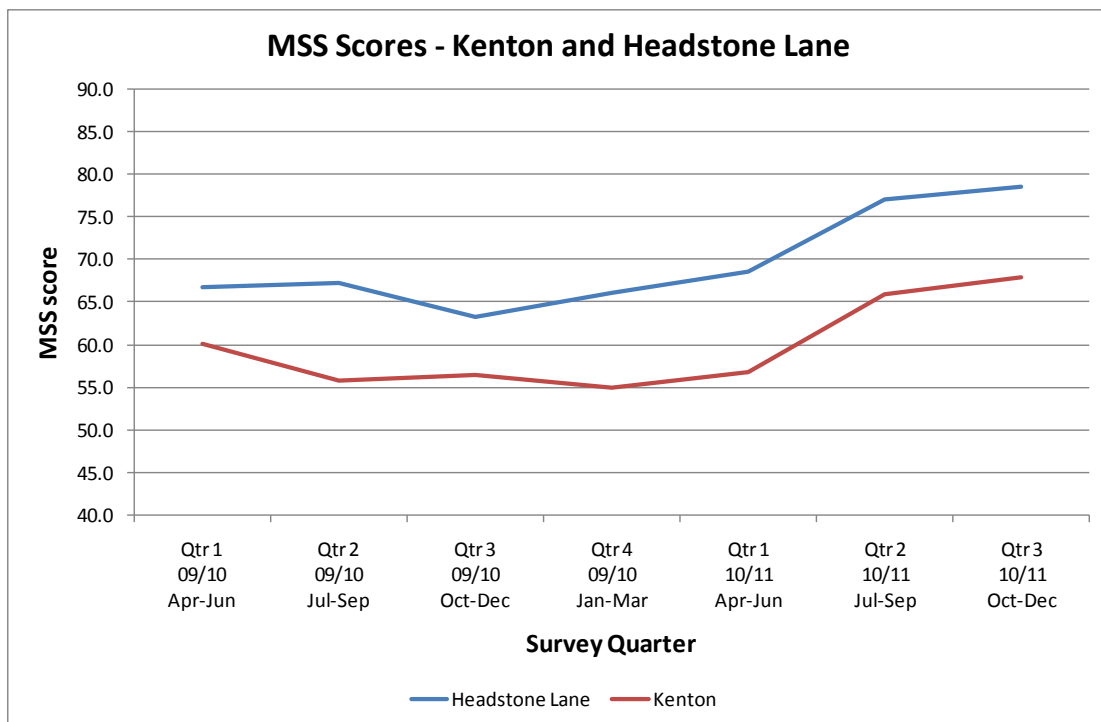


Figure 14 – MSS Scores

95 It can be seen that both stations deliver ambience benefits as a result of the projects, the quantum of benefit is greater at Kenton due to its larger improvement and higher number of users.

96 The approach to access for the two projects was generally consistent with both stations remaining open during traffic hours. At Headstone Lane works were undertaken through either segregated working during traffic hours, or working in engineering hours. For Kenton works were largely done in engineering hours but the

project team were able to undertake segregated working on platforms and rooms during the daytime following extensive demonstrations and agreement with operations staff and health and safety representatives.

- 97 The project deadline for Kenton was driven by the timeline for handover to maintenance of communication systems for all 13 ex-Silverlink stations within an agreed two year period from the date of transfer from Network Rail, this created a deadline of November 2009, and accordingly this date was identified as a TfL PAM. In retrospect, the imperative to meet this date resulted in the contracts being let before specifications and scope had been finalised. With subsequent poor contractor performance, both design work and on-site delivery, additional costs were incurred through the need for re-work and programme recovery. Although planned to take one year, the stop/start nature of the work, due to the design and on-site issues, extended the elapsed time on site at Kenton to approximately two years.
- 98 For Headstone Lane the handover date was a contractual date with liquidated damages. The handover of maintenance is due to happen when all 44 LOROL stations have been completed. The elapsed time on site at Headstone Lane for the station works was approximately one year.
- 99 The contract arrangements also differed between the two projects. The Headstone Lane upgrade was part of a fixed price design and build contract to a specified output. There is a single contract with LOROL to undertake works at 44 stations for a fixed price with emerging risk transferred to the contractor.
- 100 The Kenton station upgrade was delivered through a traditional design & construction management approach with three different delivery contractors managed by LU project, design & interface management. Four main contracts, each for all 13 stations, were let namely, one for design; one for advanced cabling and CMS; one for electrical and telecoms and one for premises.
- 101 The graphs below show the total cost for the two projects, including compensation events (or the estimated equivalent for Headstone Lane) and apportioned project management cost, as well as the total cost per square metre for the two stations.

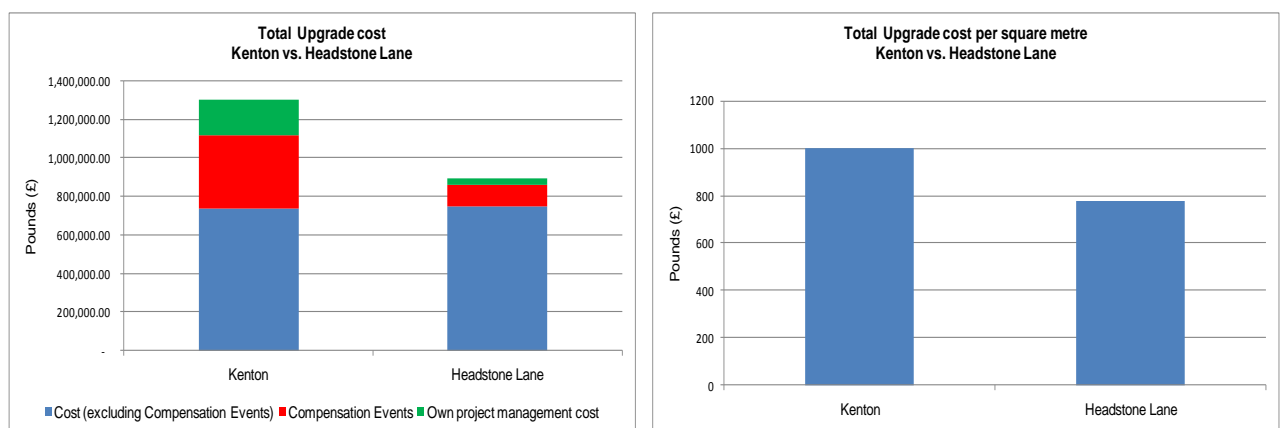


Figure 15 – Total project costs

2.3 Recommendations

- 102 Considering that the scope of works delivered differs materially there are still some valuable lessons that should be considered for future projects:

- LU should more actively consider the potential benefits of challenging LU operational, service delivery and technical standards;
- Following success on this project LU should pursue future opportunities to deliver station works during traffic hours;
- There should be more flexibility when decisions are made to meet agreed milestones when additional cost is required, when failing to do so would not compromise safety or service performance;
- There should be continued and more structured sharing, comparison and 'benchmarking' of scope, delivery etc. of similar projects in modes across the TfL group;
- Information on detailed costs to be provided by contractors and concessionaires needs to be clearly set out when contracts or concessions are let.

3 Comparison of new Signals Control Centre project costs

- 103 This section presents the findings of the benchmarking study on projected costs for the design and build of Hammersmith (Sub Surface Lines) Service Control Centre (SCC), including associated project management costs, compared to other SCCs recently constructed or currently under construction in TfL.
- 104 The other SCCs chosen for the study were Beckton (DLR), Highgate (Northern) and Osborne House (Victoria). In addition, a further scenario has been considered for Hammersmith including Piccadilly Line control.
- 105 The scope of this study is for the design and construction of the SCC and does not include any costs associated with signalling & control equipment in the SCC, cable management systems or the cost of purchasing the land.
- 106 Below is a table that summarises the results of the study. All costs are shown in 2009/10 constant prices unless otherwise stated:

	Beckton	Highgate	Osborne	Hammersmith	Ham (inc Picc)
Construction Costs (£000)	4,400	9,622	7,238	6,952	6,952
Total Cost of building (£000)	7,856	15,542	8,060	13,333	13,333
Area (Square metres)	1,707	2,125	1,344	2,658	2,658
Number of control desks	8	8	7	22	27
Number of staff	22	21	15	38	43
Total Cost per Square metre (£000/m ²)	4.6	7.3	6.0	5.0	5.0
Total cost per member of staff (£000)	357	740	537	351	310
Total cost per control desk (£000)	982	1,943	1,151	606	494
Construction cost per m ² (£000/m ²)	2.6	4.5	5.4	2.6	2.6
Construction costs per member of staff (£000)	200	458	483	183	162
Construction cost per control desk (£000)	550	1203	1034	316	257

Table 8 – Summary of SCC total cost benchmarking study

- 107 In order to provide a meaningful comparison of control centre costs a set of indicators, shown in the table above, have been developed. The key points are as follows:
- Total/Construction cost per m² – Beckton has the lowest unit cost at total cost level. The same is true at construction cost level, although Hammersmith is almost identical at around £2.6m per m². Highgate has the highest total cost unit rate at £7.3m per m², around 60% higher than Beckton;
 - Total/Construction cost per staff member accommodated – Hammersmith, the largest SCC accommodating the highest number of people has the lowest unit cost, particularly at construction level with the next cheapest (Beckton) around 9% higher. Hammersmith is even lower when including the additional staff for the Piccadilly Line, making it almost £500k per staff member lower than Highgate;. and

- Total/Construction cost per control desk – There is a large delta between the lowest and highest for this indicator, with Hammersmith (excluding Piccadilly Line) around a fifth of the cost of Highgate per control desk. Again, the additional 5 desks for the Piccadilly line mean the unit costs for Hammersmith are even lower.
- 108 In summary, Hammersmith is the least expensive in four out of the six indicators; Highgate is the most expensive in four out of the six indicators. Beckton is the least expensive in the two indicators looking at cost per m².
- 109 There are a number of reasons for this, which are discussed in more detail in the full report, and illustrated in the graph below:

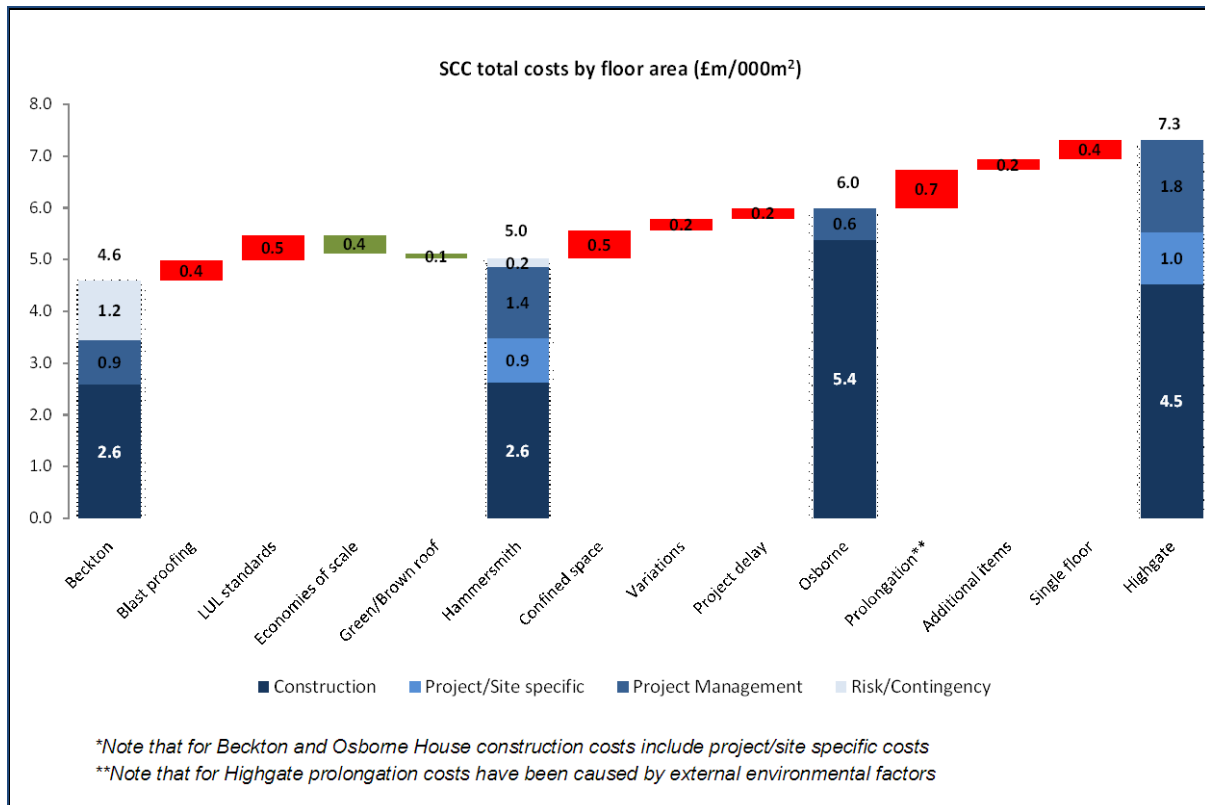


Figure 16 – Summary of SCC total cost benchmarking study – explanatory factors

- Economies of scale – Hammersmith is significantly larger in floor area than the others. Economies of scale lead to a lower cost per square metre;
- Blast proofing – Beckton SCC does not have any blast proofing built in to its structure, the other SCCs do;
- LUL standards – some elements of LUL standards have been adopted by Beckton SCC but there are some that have not due to cost constraints. For example standard 1-463 on Security Requirements for new service control centres;
- Confined space – The site at Osborne House was very tight for construction and therefore resulted in an additional layer of cost which is estimated at 10% of the total; and
- Prolongation Costs – Highgate SCC project incurred significant prolongation costs cause by site specific Environmental factors including bats and the discovery of hazardous materials (Japanese knotweed) and by one of Tube Lines' contractor's going into administration.

- 110 Overall, the conclusion of this short study is that the budgeted costs for the construction of Hammersmith SCC reflect competitively tendered market rates and the average unit cost is consistent with Beckton. However, the size of the control centre appears generous and the business will need to exercise control to ensure that scope changes do not lead to increases in total cost.
- 111 There does not appear to be any consistency across the projects on what proportion of control centre space is actually utilised for the control room however there is a clear positive correlation between line length and complexity and the number of controllers required.
- 112 A follow-up review will be conducted when the construction phase of the Hammersmith SCC project has been completed, which is scheduled to be 30 June 2011. If available further, more detailed data would help to isolate the effect of explanatory factors on the costs.

4 Benchmarking with International Metros

- 113 The Community of Metros (CoMET) is a programme of international metropolitan railway (metro) benchmarking. It comprises 12 of the world's largest metros, each with more than 500 million passenger journeys per year, including: Beijing, Berlin, Hong Kong, London Underground, Madrid, Mexico City, Moscow, New York, Paris Metro & RER, Santiago, Sao Paulo and Shanghai.
- 114 A sister group, Nova, comprises 15 smaller metros, including: Bangkok, Barcelona, Buenos Aires, Chicago, Delhi, Lisbon, Milan, Montreal, Naples, Newcastle, Rio de Janeiro, Singapore, Sydney, Taipei and Toronto.
- 115 Although CoMET and Nova set their own objectives and agenda, they work closely together, participating in each other's work and increasing the pool of knowledge.
- 116 The four main objectives of CoMET are to:
- build measures to establish metro best practice;
 - provide comparative information both for the metro board and the government;
 - introduce a system of measures for management; and
 - prioritise areas for improvement.
- 117 CoMET is a key avenue for enabling LUL to define its vision to be world-class. by providing:
- Examples of what other metros do to solve the problems we face - 'Learning from each others' challenges';
 - New ideas and suggestions;
 - Ability to check proposed courses of action; and
 - Opportunities to work collaboratively with other metros to look for solutions to challenges faced by members.
- 118 LUL is an active participant in CoMET and each year supports a number of case studies carried out by Imperial College London on behalf of the CoMET metros. In relation to asset management, LUL recently lead two CoMET case studies (rolling stock reliability and escalator management). LUL also participated in a Nova study into signalling system upgrade and replacement and is participating in the study on maintenance management practice.

Rolling stock reliability

- 119 Following on from a 2006 study, this study over two years covered new and ageing fleets, sub-systems and doors. The study objectives were to:
- focus on the actions metros have taken to improve the reliability of ageing and new fleets;
 - investigate the possibility to pursue development of common standards at sub-system level across metros as an aid to getting the best quality and price from the supply market;
 - develop further the statistical analysis of rolling stock reliability undertaken in the 2006 study, possibly including comparison of incidents at different delay thresholds, and of the factors relating to maintenance management and staff productivity;

- undertake further analysis of the reliability of sub-systems shown from the 2006 study to have high failure levels (e.g. doors, brakes and traction) to provide a greater understanding of the factors influencing reliability of these systems; and
- continue exchange of experiences between rolling stock experts.

Escalators management

120 The objectives of this study, which was jointly sponsored by LUL and Metro de Madrid, were to:

- provide an overview of escalators, their operations, characteristics, specifications and statistics within the metros, to understand how transferable strategies and models are between metros;
- understand escalator incident data reported by metros, the definitions applied and to standardise and benchmark reliability and availability statistics across metros as far as possible;
- develop indicators (and share any related condition monitoring practices) that could give early warning of incipient reliability issues;
- understand the factors that lead to escalator unreliability or reliability and availability;
- understand what needs to be done to improve escalator RAM (reliability, availability and maintainability);
- benchmark metros' escalator corrective and preventative maintenance costs, cost of major overhauls, energy consumption and its cost, identifying any best practices which have led to a reduction in costs or improvement in RAM;
- collect and review any readily available whole-life models for escalators (including energy costs) currently used by metros, and explore their applicability for adaption by other metros; and
- validate or modify the whole life model proposed in conceptual form in the 1999 report and investigate potential reductions in the whole life cost of escalators.

121 The report showed that LUL was considerable more expensive than other metros in both Capex and Opex expenditure and was followed by a drill-down study in 2009, commissioned by LUL, which included visits to a number of metros to validate questionnaire responses and to see first-hand the practices applied.

122 The outputs of the studies were instrumental in shaping the LUL escalator strategy which envisages LUL adopting similar escalators of a similar standard to other metros, changed overhaul periodicity and work content and changed maintenance practices leading to savings in LUL and Tube Lines estimated at c.£100m over 20 years.

Maintenance management and practice

123 The general aim of the study, which was initiated by MTR, was to consolidate previous relevant studies and look into holistic maintenance processes. Two phases of work will be undertaken. Phase 1 was carried out in 2010 (with the report due to be issued in May 2011) and covered:

- understanding and developing strategies on obsolescence and new technology and the opportunities for collaboration between metros e.g. information sharing, development of industry standards, technology selection, etc.;

- reviewing maintenance organisation and strategies and the effects of different levels of outsourcing; and
 - identifying new KPIs for maintenance benchmarking, especially to measure maintenance effectiveness.
- 124 Phase 2 will be carried out in 2011 and will develop Phase 1 to look at metros' maintenance strategies and practices in more detail and to address the following questions:
- How is maintenance organised in a modern technologically advanced metro (i.e. post-Upgrade)?
 - What are the key measures of maintenance effectiveness and efficiency used by other metros and reported at a senior management level?

Signalling system upgrades

- 125 This brief study was commissioned by Metro Rio and provided some qualitative commentary, but no quantification or cost analysis, on:
- the major drivers for signalling systems replacement and the factors taken into account when replacing a signalling system;
 - the aspects that should be evaluated in order to define whether to keep an existing signalling system, develop it to include new sections of line, or to move to a replacement of the system for the whole network (in the context of network expansion);
 - other metros' experience in changing signalling systems (e.g. how to deal with network expansion, the technological leaps and risks in this kind of project); and
 - a better understanding on how best to define the system to be used (e.g. moving block, CBTC and other technologies).
- 126 LUL also commissioned Imperial College London to undertake two Clearinghouse Studies pertinent to asset management:

Budgeting, planning, costing and reporting - 2010

- 127 This study was commissioned by LUL Finance who sought to understand how other metros budget, plan, cost and report maintenance activities. The overall level of response was disappointing (9 of 26 CoMET & Nova metros) and while there were some points of interest, no significant insights were, in this case, gained. The study outputs will be further considered as part of the exercise to determine LUL's way forward in this area.

Large Station Reconstruction - 2009

- 128 This study was undertaken to address concerns over the cost of the Tottenham Court Road station reconstruction works. Comparison was made with large station reconstruction works on selected metros. The benefits to LUL were:
- A useful database and good to establish contacts and share knowledge;
 - A useful understanding of major project issues on other systems and to see how objectives and issues are common; and
 - Reassurance that LUL's costs were well within the international range; it would be useful to understand final costs to validate LUL's approach on contingency.

129 In addition, LUL has commissioned and participated in other CoMET and Nova studies relating to service delivery:

- CoMET – Competitiveness and CO² (led by LUL), information during disruption, safety precursors and PTI, attendance, staff errors and performance development for front-line staff; and
- Nova - Train service reliability and Fares, Funding and Financing of metros.





PART B – BENCHMARKING PRIORITIES

130 This section sets out the proposed programme of future studies. These proposals have been developed within the Rail and Underground benchmarking group and reflect current understanding. The proposals include:

- The proposed approach to benchmarking Capital Projects;
- Drill-down studies into the unit costs and related cost drivers of the major areas of future expenditure, including Track Renewals, maintenance activities across all asset areas and international benchmarking with other metros.

5 Proposed approach to benchmarking Capital Programmes

131 Under the PPP, benchmarking was led by the OPPPA. Primarily, OPPPA concentrated on operational and maintenance activities, with limited work on Capital Programmes. However, OPPPA commissioned BSL to assess the international benchmarks for signalling upgrades. Following TfL's acquisition of Tube Lines, OPPPA was closed.

132 In September 2010, IIPAG presented its first report to the TfL Board., which noted:

“..... Project stage-gate reviews and discussions with senior TfL staff have provided IPAG with some insight into methods, durations and costs of work that have been undertaken/incurred in the recent past. However, it is more difficult to understand whether or not these practices and costs represent typical market outcomes, industry best practice or poor practice because there are few (if any) established routinely measured norms, and reliance is routinely placed on the personal experiences, preferences or expectations of the generally senior personnel involved.

This prevents any effective transfer of historic trends and best practices, or setting of stretch targets or use of peer pressure to drive change, safety and efficiency across the business. Intuitively, there must be unexploited opportunity to improve the business performance through some transparent and effective benchmarking, coupled to the practice of good leadership and collaborative teamwork.”

133 The overall aim of Capital Programmes benchmarking is to support the Capital Programmes Directorate (CPD) in LUL to become a “World Class Project Delivery Organisation”. The proposals that follow have been prepared by the CPD Programme Management Office and have been confirmed with the Rail and Underground benchmarking group.

134 This aim is supported by three primary objectives:

- Creating a contextually aligned organisational structure;
- Achieving optimal project delivery performance; and
- Focusing on target driven asset unit costs.

135 These primary objectives are supported by five secondary objectives:

- providing assurance to IIPAG on the benchmarking of Capital Programmes;
- Ensuring that a consistent approach to Capital Programmes benchmarking is established and managed efficiently;
- identifying key cost, process and performance drivers of projects, individual assets or activity types;

- Interrogating and establishing asset unit cost targets against which efficiencies can be measured; and
- Defining individual efficiency work streams.

136 A framework expressing these aims and objectives is shown below.

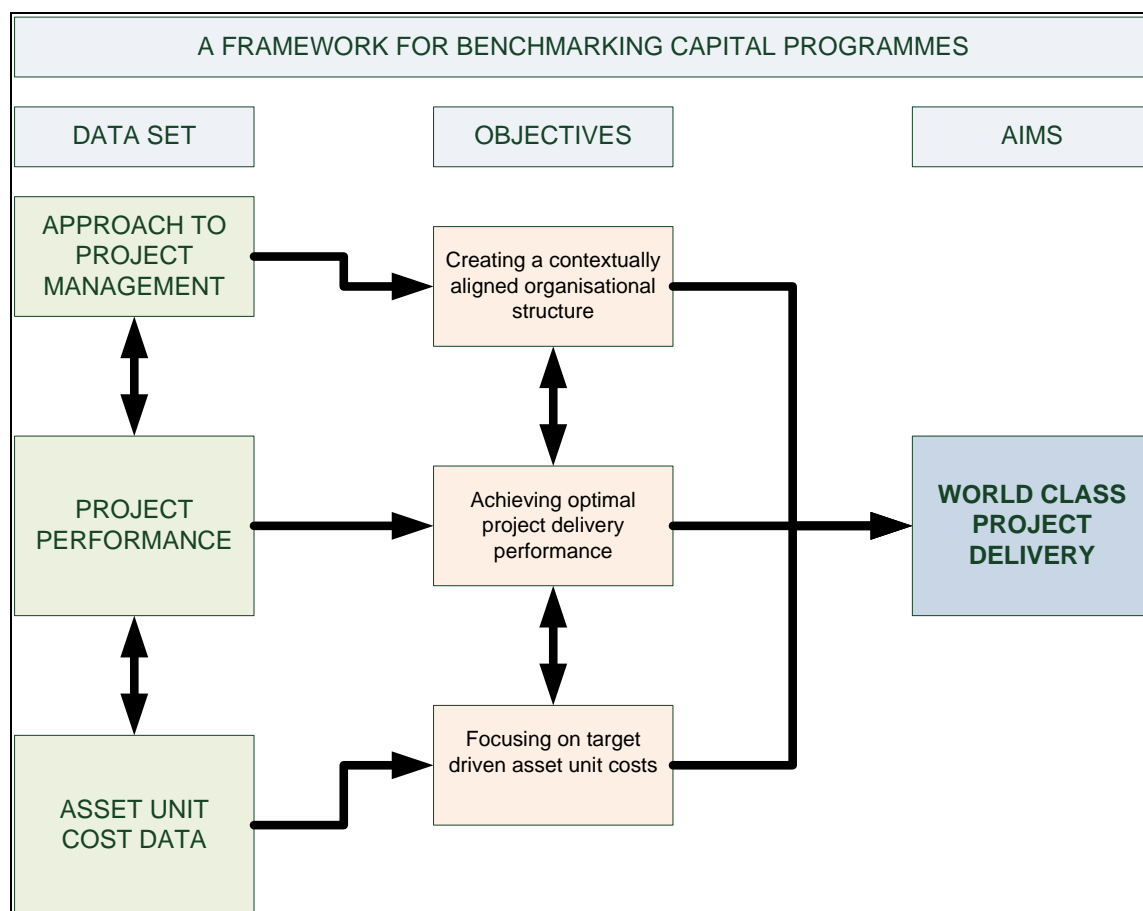


Figure 17 – Framework for benchmarking capital programmes

137 The CPD benchmarking data set consists of three categories of metrics. These have been developed through consultation with stakeholders and a review of project management literature. The three categories are:

- Approach to Project Management;
- Project Performance; and
- Asset Unit Cost Data.

5.1 Approach to Project Management

138 The purpose of the Approach to Project Management (AtPM) data set is to enable CPD to effectively measure itself as a programme/project management organisation against other like Capital Programme delivery organisations.

139 The metrics will concentrate on the “how” we do projects. They will facilitate the analysis of LUL’s programme/project organisation structure, size, processes, and governance.

140 The data set will be made up of both quantitative and qualitative metrics, but qualitative metrics will dominate this data set. At its highest level, the Core Level 1 metrics will enable CPD to identify the key contextual drivers that influence its delivery

behaviour and costs. A table showing the data set categories and their meta data can be found in **Appendix B**.

NR Client Forum

- 141 A Client Forum has been established by Network Rail. Members include Network Rail, London Underground, National Grid, Thames Water and BAE Systems.
- 142 An initial set of metrics was shared with the group in January 2010 as the basis for further joint working.
- 143 A similar data set of metrics has been used by the CPD Stations & Accommodation Programme team to benchmark itself against similar property infrastructure organisations. This will add to the analysis when available.
- 144 It is intended to roll out these metrics amongst the TfL family of organisations and other external organisations (such as the Highways Agency) who are willing to share data.

OGC P3M3 Maturity

- 145 The achievement of OGC P3M3 Level 3 maturity is a CPD target, to be achieved by mid 2011. The OGC maturity assessment is being undertaken by independent assessors Outperform, who will benchmark CPD against other organisations in its database.
- 146 Once achieved, the proposal is to then move to maturity Level 4 to support the aim of world class delivery. This level demands that an organisation quantitatively measures its project management process. Level 2, 3 and 4 metrics will be established that enable this measurement and benchmarking of process.
- 147 Work has commenced within CPD PMO to identify the early opportunities for process benchmarking.

The Cost of Project Management

- 148 A study will be carried out to assess the costs of project management within CPD and the scope of this study is currently being developed.

Beyond the NR Client Forum

- 149 Proposals are being developed to work with other private external organisations who specialise in benchmarking project organisations, to benchmark CPD as an organisation and the performance of their projects against non-metro organisations. No specific details have been finalised but an initial target plans to undertake a study in late 2011/2012. No study will commence without the confirmation of the Rail and Underground benchmarking group. Further investigations and research will be done to identify other external bodies or groups (Universities, Professional bodies etc.) that hold, share or have knowledge in benchmarking Capital Programme organisations.

5.2 Project Performance

- 150 The Project Performance data set metrics will closely align with the LUL CPD Scorecard KPIs, with the aim of measuring overall and individual programme or project performance against across CPD and against other TfL and external organisations (e.g. via the NR Client Forum).

- 151 These Level 1 metrics will include rail specific measures, for example the use of engineering hours and closures. Collaboration with Metro de Madrid¹⁰ has formed the basis of LUL's strategy for the use of closures when delivering the Line Upgrades.
- 152 The AtPM and Project Performance metrics combined offer a very strong analysis of our project management approach and its performance, but they do not provide all the analysis needed to continually improve the cost of replacing old or installing new assets. Work has already started with early discussions with the SSR Programme team.

5.3 Asset Unit Costs

- 153 The purpose of the Asset Unit Cost data set is to provide reliable and credible unit cost data for the replacement or renewal of an asset. It will enable sponsors to effectively estimate project budgets and set future targets for efficiencies.
- 154 The basis for the data set is the LUL Cost Estimating System, supplied by RIB. This system is now implemented in LUL to capture estimates, tender prices and final costs.
- 155 Analysis is underway to see where there are gaps in data capture. These analyses together will enable efforts to focus on:
- areas where the largest spend falls, and;
 - collecting additional data where gaps exist.

Infrastructure UK

- 156 LUL has participated in the recent study by Infrastructure UK, which reported on 21 December 2010. The report included assessment construction costs of railway stations in the UK compared to overseas and included detailed information for ten underground metro stations in London. The report¹¹ concluded:

“6.24 The data has shown that the UK stations studied are more expensive than the international stations studied, yet there may be mitigating factors which demonstrate better value for this capital cost (e.g. higher area/volume/passenger flow).

and

F.7 Taking the spatial and passenger flows into account, the UK stations are better value for money. Spatially, the UK clients are paying 8 percent £/m² and 10 percent £/m³ less than the average internationally benchmarked stations. Also the UK clients are paying 54 percent less per peak-time traveller.”

Crossrail, Thameslink and Network Rail

- 157 The RIB system is used by Network Rail and Crossrail. Discussions have been held with the NR Forum partners, LUL Crossrail team and Crossrail Delivery partner commercial teams.

¹⁰ Collaboration with Metro de Madrid was initiated by David Waboso in the summer of 2008, during his presidency of CoMET. A series of senior level technical visits followed during the autumn of 2008 which led to the signing of a formal memorandum of understanding in July 2009. Metro de Madrid presented to the London Assembly's Transport Committee on 3rd September 2009.

¹¹ HMT Infrastructure Cost Review, Technical Report
http://www.hm-treasury.gov.uk/d/cost_study_technicalnote211210.pdf

158 TfL and Network Rail have agreed to share certain benchmarking information and a formal agreement is being put in place to manage the exchange of data in a controlled manner and compliant with competition law constraints.

5.4 Track Renewals Benchmarking Study

159 A drill-down study has already started looking at the historic and projected costs of track renewal for different types of intervention. The purpose of this study is to provide an objective comparison between the whole-of-intervention track renewal intervention costs between Tube Lines and BCV/SSL.

160 The renewal interventions included within the scope of the study include: BTR, re-sleeper, Full Recon/Pit Blocks, Sleeper Popping, re-railing and full P&C renewal. Definitions for each intervention have also been developed to compare and contrast the activities undertaken within each intervention. The parties will also use a common template that splits costs been activities (management, pre-intervention, intervention, and post-intervention) and cost areas (labour, plant, materials, and trains), which will enable the parties to better understand cost differences.

161 Tube Lines and LUL each have varying delivery structures for the interventions. For example, LUL use an external contract (Balfour Beatty) for BTR and P&C, and an internal contract for tube based activities (Track Delivery Unit or TDU). In contrast, Tube Lines deliver all interventions through its internal projects unit, which heavily relies on external labour contracts. The resourcing and cost implications of these varying delivery structures will be assessed with a view to identifying efficiency opportunities.

5.5 Summary

162 The benchmarking of Capital Programmes is at an early stage but is developing fast. The next two months will see the growth of the team and the formal agreement to the two main terms of reference for the studies into the “Cost of Project Management” and the “Asset Unit Cost Targets”.

163 Interaction with existing and developing new contacts will carry on at a pace, as will the continuing work with the NR Client Forum where reports will be issued following each event.

6 Draft Benchmarking Programme 2011/12

164 A series of drill-down studies on each asset area have been reviewed and confirmed by the Rail and Underground benchmarking group, with particular emphasis on identifying opportunities to develop further cost efficiencies by:

- Improving data comparability and consistency;
- Investigating costs, productivity measures and related drivers and explaining the variations between lines. These studies will focus on comparing working practices, activity levels and resource utilisation to identify opportunities to make further efficiencies; and
- Commissioning and using external benchmarking where this will readily complement internal benchmarking information.

Improving data comparability and consistency

165 The work to prepare the Phase 6 Asset Benchmarking report highlighted a number of issues relating to the definition of the benchmark measures, the interpretation of the protocols and the capture of data required. These have come to light partly due to more open discussion and review with Tube Lines and partly as a result of internal validation.

166 An immediate exercise is to be carried out prior to the end of March 2011 to ensure alignment between LUL and Tube Lines and to ensure that data is captured so benchmark information can be readily and robustly prepared.

Investigating costs, productivity measures and related drivers

167 The benchmarking priority list for the next period incorporates the areas for further investigation identified for each asset area covered in Section 1 above.

168 In addition, benchmark measures will be defined for the major interventions and activities to enable comparison of elements of civils maintenance activity across TfL's Rail and Underground network.

169 The findings from these studies will be presented in the next report alongside a revised list of priorities.

7 Benchmarking with International Metros

170 The following studies are planned or ongoing in relation to asset management:

- **Maintenance Management and Practices.** This is Phase 2 of a two year CoMET study and is supported by LUL, Hong Kong MTR and Metro de Santiago. Phase 2 will be carried out in 2011 and will develop Phase 1 to look at metros' maintenance strategies and practices in more detail and to address the following questions:
 - How is maintenance organised in a modern technologically advanced metro (i.e. post-Upgrade)?
 - What are the key measures of maintenance effectiveness and efficiency used by other metros and reported at a senior management level?
- **Track Possession Planning & Management.** The objectives of the study, which builds on the 2003 Nova Infrastructure Maintenance Possession Management study, are to:

understand different ways track possessions are planned and managed;

understand the constraints that are on operators when undertaking track possessions;

learn how operators assess the cost-benefit of track possessions (efficiency [cost, time] vs. impact to operations/customers); and to

learn how different metros bundle elements of the work and then how they are resourced.

171 In addition, LUL is also participating in the following studies relating to service delivery and other activities:

CoMET 2010 Case studies

- Workshop for metros installing and operating CBTC systems
- Information in emergency situations (lead metro: Shanghai SMOC)
- Capitalising on CoMET & Nova Knowledge - Operations Management
- Station platform/train interface safety promotion (lead metro: Hong Kong MTR) with Accident Precursors Phase VIII

Nova 2011 Case Studies

- Delivering Front End Customer Services
- Passenger Flow (drill down of 2006 study)
- Measurement of Metro Efficiency using Stochastic Frontier Techniques

International Suburban Rail Benchmarking Group

172 A third rail benchmarking group for suburban rail operations was established by Imperial College London in 2010, along similar lines to CoMET and Nova, and London Rail is participating in this group. This group will produce its first results in 2011.



APPENDIX A – BENCHMARKING OF LUL AND TUBE LINES ASSET MAINTENANCE – DETAILED ASSET REVIEW

8 Asset Maintenance

8.1 Performance

173 It is not meaningful to look at the cost of providing and maintaining infrastructure without considering performance. This is because there is, or should be, a recognisable correlation between cost and performance. Whilst this relationship is not always well understood or clearly transparent it should inform the business proposition, particularly with regards to ‘what level of performance, or performance improvement’ are you actually seeking to attain. This will impact on the related cost (assuming a given level of efficiency).

174 First, performance is looked at against the key Service Output performance measures¹². The principal contractual measures considered are:

- **Availability:** a day-to-day measure based on whether Assets are available for service.
- **Ambience:** a measure of the quality of the travelling environment.
- **Service Points:** a measure of the reliability and fix times for Facilities (station systems such as DMIs, CCTV, PA, Help Points etc.) and Fault Rectification being the fix times for all other faults and defects reported on stations.

175 Second, performance is looked at against the relevant asset performance indicators. In this section at the network area level (e.g. BCV, SSL and Tube Lines) but at line level in the maintenance cost section.

Service Output Performance

Availability

176 The definition of Availability used in the Underground is rooted in the Performance Regime developed for the PPP. The measure counts all service disruptions lasting more than two minutes and takes into account the duration, location and time of day of the disruption, as well as expected passenger numbers affected, to estimate the total loss in terms of customer time. This is expressed as ‘Lost Customer Hours’ (LCHs)¹³ and as such is an incentive on reliability – particularly of fleet and signals and to a lesser extent track.

177 The graph and table below show the average LCH per Infraco per Period (excluding the impacts of industrial action) over the past eight years, also highlighting the performance improvement for BCV / SSL post Metronet Administration.

¹² These three measures are included in the PPP contract and continue to inform business performance measurement. These measures continue to be included commercial agreement between TLL and Amey for maintenance of the Jubilee, Northern and Piccadilly lines and form part of the pain/gain arrangement under that contract.

¹³ The NACHs values changed from Period 4 2010/11 to reflect NACHs 2014. Prior year LCH performance (based on NACHs 2006 values) has been recalibrated to make it comparable

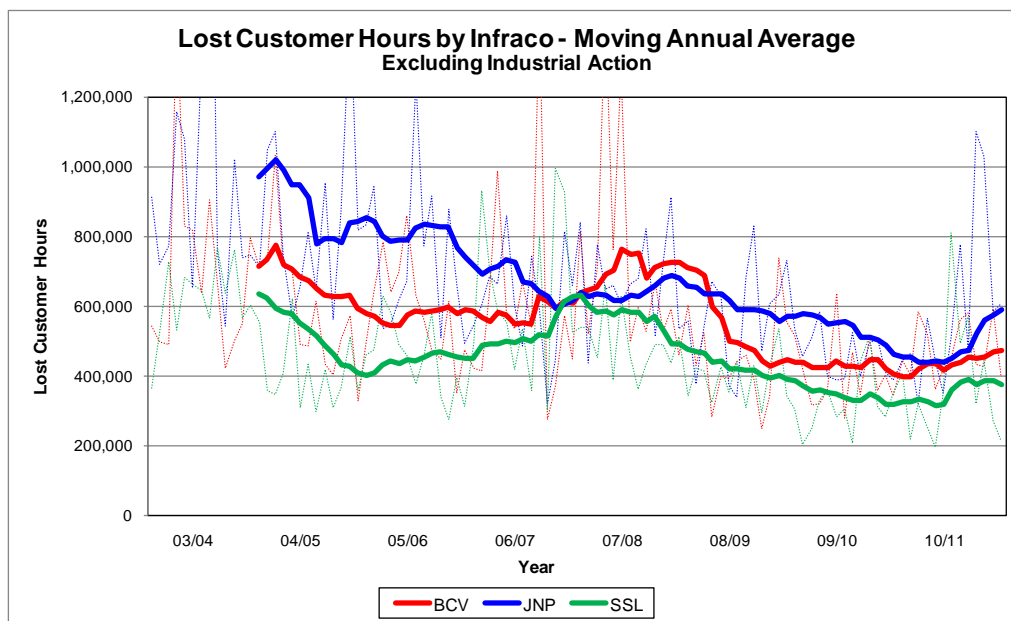


Figure 18 – Average LCH per Infraco per Period

	2003/04	2010/11	Better / (worse)
BCV	700,174	474,650	32%
SSL	619,238	374,172	40%
JNP	984,868	591,457	40%

Table 9 – Average LCH per Infraco per Period

Ambience

- 178 The Ambience measure is intended to reflect the customers’ perception of the travel environment on Trains and in Stations. A quarterly Mystery Shopping Survey (MSS) conducted by an independent accredited survey organisation assesses various aspects of the service, including: the condition of train seats, cleanliness of surfaces and train exteriors, levels of litter and graffiti, public address audibility, ride quality and in-car noise; lighting, train heating and ventilation, quality of signage, and condition of toilets and waiting rooms. Ambience is an incentive primarily on cleaning and work required to maintain customer facing assets in good order.
- 179 The graph and table below show the Ambience performance for each network area over the past eight years.¹⁴

¹⁴ The Ambience regime has changed from Period 4 2010/11 to increase the weighting of Station Ambience. Prior year Ambience performance has been recalibrated to take account of this. This will change the incentive structure for spend on ambience.

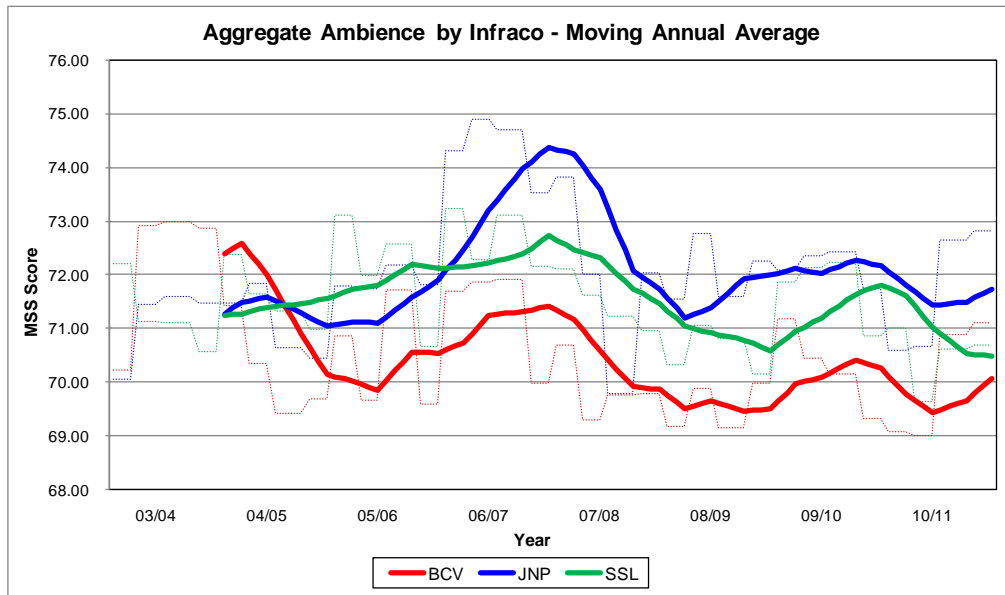


Figure 19 – Aggregate Ambience by Infraco

	2003/04	2010/11	Better / (worse)
BCV	72.31	70.08	(3%)
SSL	71.24	70.49	(1%)
JNP	71.17	71.75	1%

Table 10 – Aggregate Ambience by Infraco

Service Points

180 Service Points are levied for certain failures including:

- Facilities Faults: failure of customer-facing Assets such as CCTV, public address systems, train arrival indicators or help points. Each Infraco accrues Service Points for each Facilities Fault - based on the fact that it failed and the length of time it takes Infraco to rectify the failure.
- Fault Rectification Faults: failure to fix certain problems such as litter and spillages, cleaning faults, broken tiles, failed light bulbs etc. Each Infraco accrues Service Points for Fault Rectification failures where they take longer than the contractual standard clearance time to rectify any failure.

181 The graph and table below show the Facilities and Fault Rectification Service Points per station performance for each network area over the past eight years.

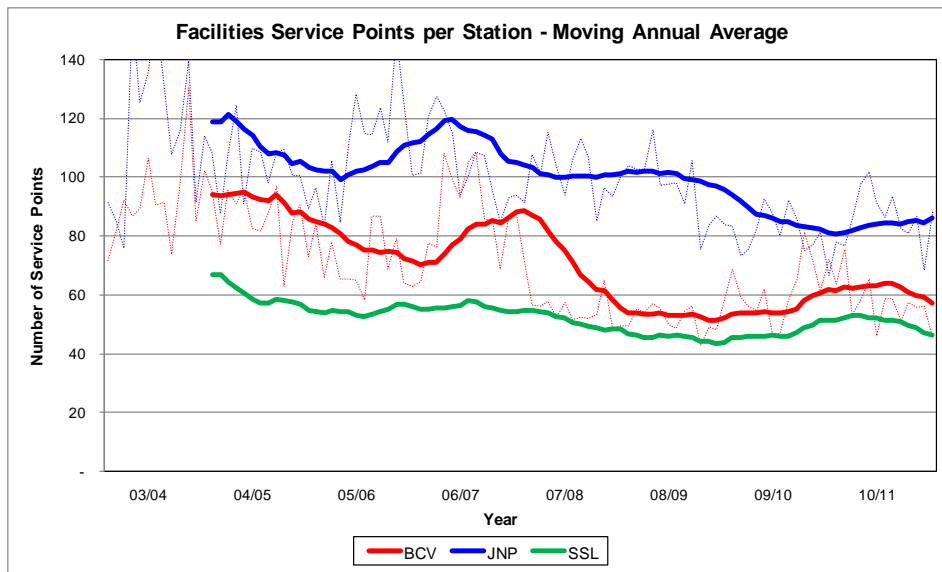


Figure 20 – Facility Service Points per Station

	2003/04	2010/11	Better / (worse)
BCV	92.3	57.5	38%
SSL	66.5	46.1	31%
JNP	117.4	86.1	27%

Table 11 – Facility Service Points per Station

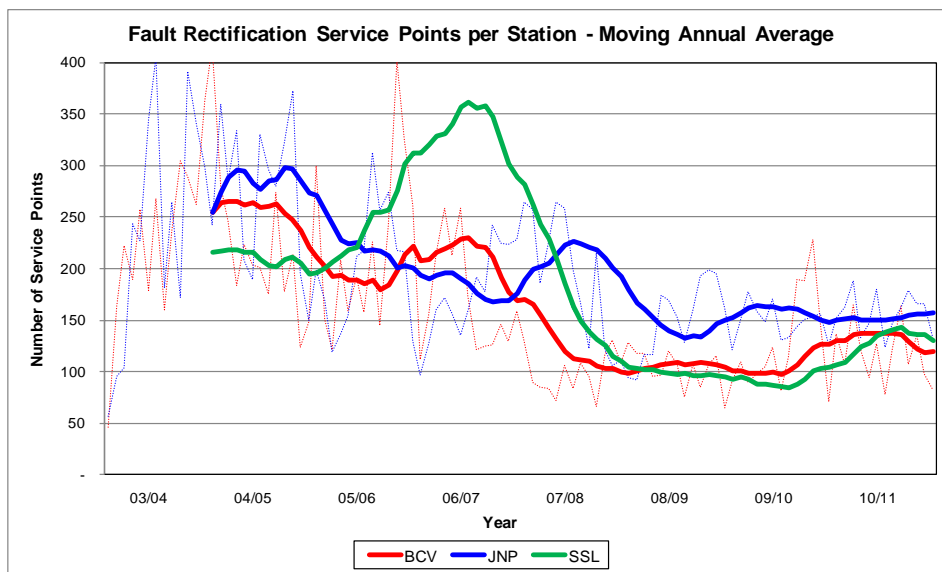


Figure 21 – Fault Rectification Service Points per Station

	2003/04	2010/11	Better / (worse)
BCV	226.4	118.6	48%
SSL	201.4	130.3	35%
JNP	240.2	156.5	35%

Table 12 – Fault Rectification Service Points per Station

Asset performance

182 The maintenance activity will directly impact asset performance and this section reviews performance across four key asset groups (rolling stock, signalling and control

systems, track, and lifts and escalators) to provide an insight into maintenance performance.

Rolling stock

183 Rolling stock reliability, expressed in terms of ‘Mean Distance between Failures’ (MDBF), has improved significantly for all three network areas over the past eight years: BCV - 157%, SSL - 173% and Tube Lines - 216%. This is described in the graph and table below.

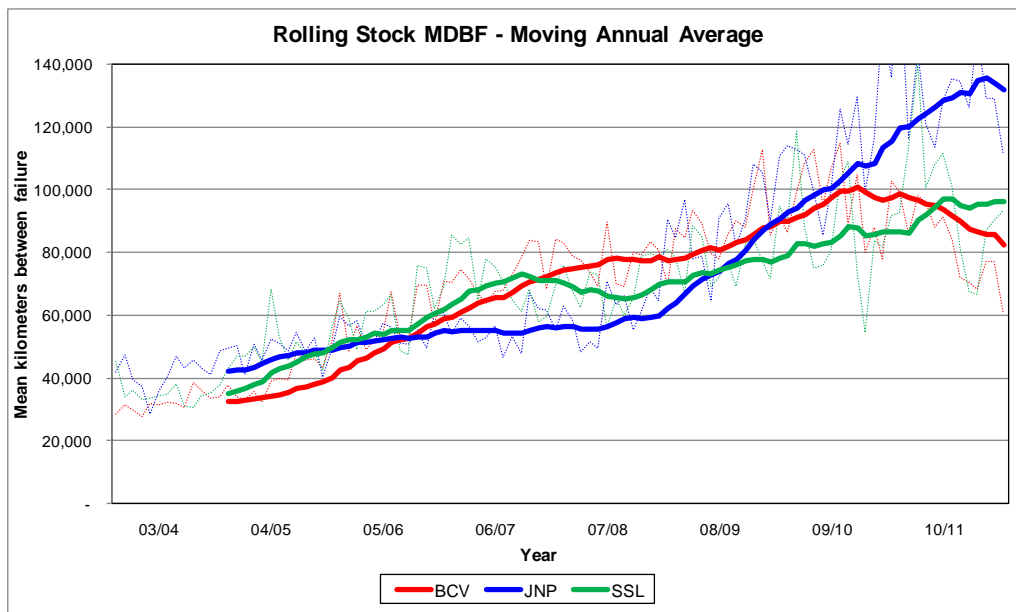


Figure 22 – Rolling Stock Car MDBF

	2003/04	2010/11	Better / (worse)
BCV	32,084	82,415	157%
SSL	35,325	96,603	173%
JNP	41,741	131,848	216%

Table 13 – Rolling Stock Car MDBF

Signalling and Control Systems

184 Signalling and Control Systems reliability, expressed in terms of ‘Number of Train Control Failures per million car kilometres’ (resulting in service disruption longer than 2 minutes), has improved for all three network areas over the past eight years, as shown in the graph and table below. The improvements achieved are BCV - 20%, SSL - 9% and TLL – (negative) 25%.

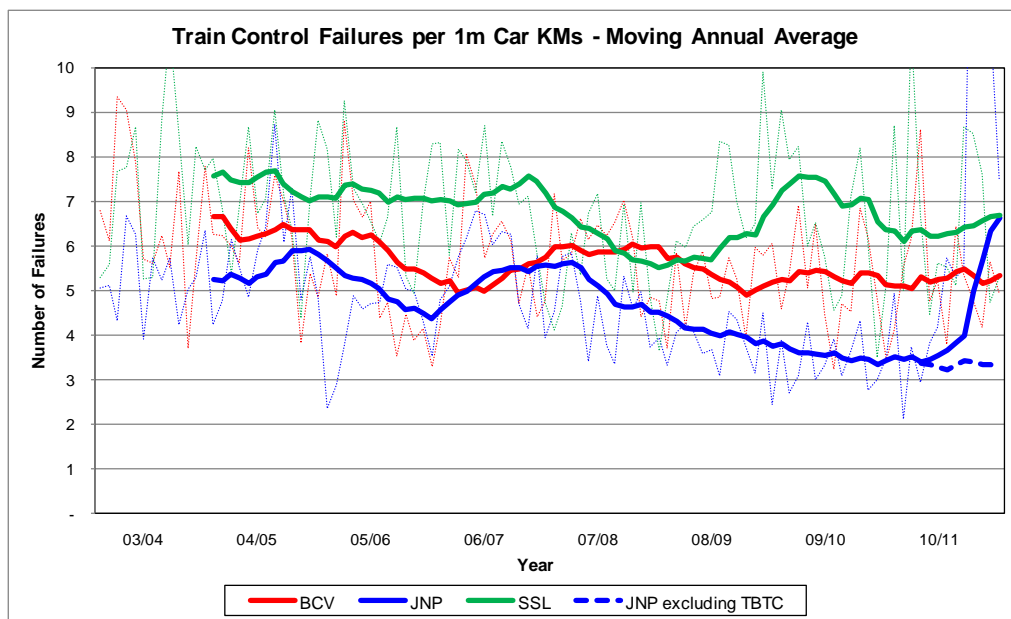


Figure 23 – Train Control Failures per m Car km

	2003/04	2010/11	Better / (worse)
BCV	6.7	5.4	20%
SSL	7.4	6.7	9%
JNP	5.3	6.7	(25%)

Table 14 – Train Control Failures per million car km

185 The figures for JNP include the recent performance issues relating to the new TBTC signalling system on the Jubilee line. Excluding these incidents, the average number of train control failures per million car kilometres in 2010/11 was 3.2, representing an improvement in underlying performance of 39% since 2003/04.

Track

186 Track reliability, expressed in terms of ‘Number of Track Failures per million car kilometres’ (resulting in service disruption longer than 2 minutes), has improved for all three network areas over the past eight years. The improvements achieved for the three areas are BCV - 38%, SSL - 61% and TLL - 53%. The lower rate of improvement for the BCV area reflects the better starting level, as set out in the graph and table below

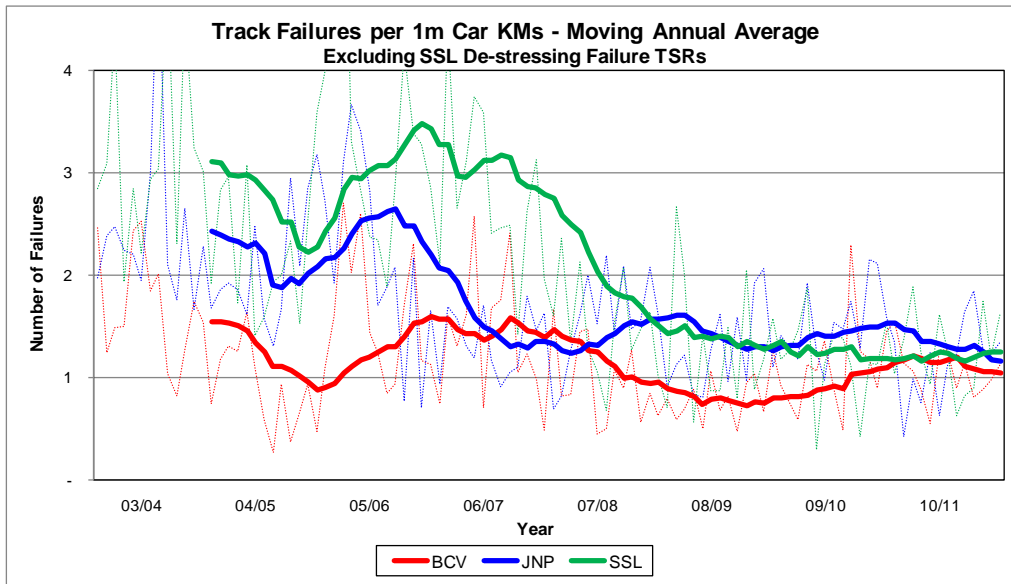


Figure 24 – Track Failures per million car km

	2003/04	2010/11	Better / (worse)
BCV	1.7	1.0	38%
SSL	3.2	1.3	61%
JNP	2.5	1.2	53%

Table 15 – Track Failures per million car km

Lifts and Escalators

187 Lift and Escalator reliability, expressed in terms of 'Mean Time between Failures' (MTBF), has improved for all three network areas over the past eight years. The improvements achieved for the network areas for Lifts are BCV/SSL - 30%, and TLL - 37%, and for Escalators are BCV/SSL - 20%, and TLL - 48%. These trends are shown in the graphs and tables below.

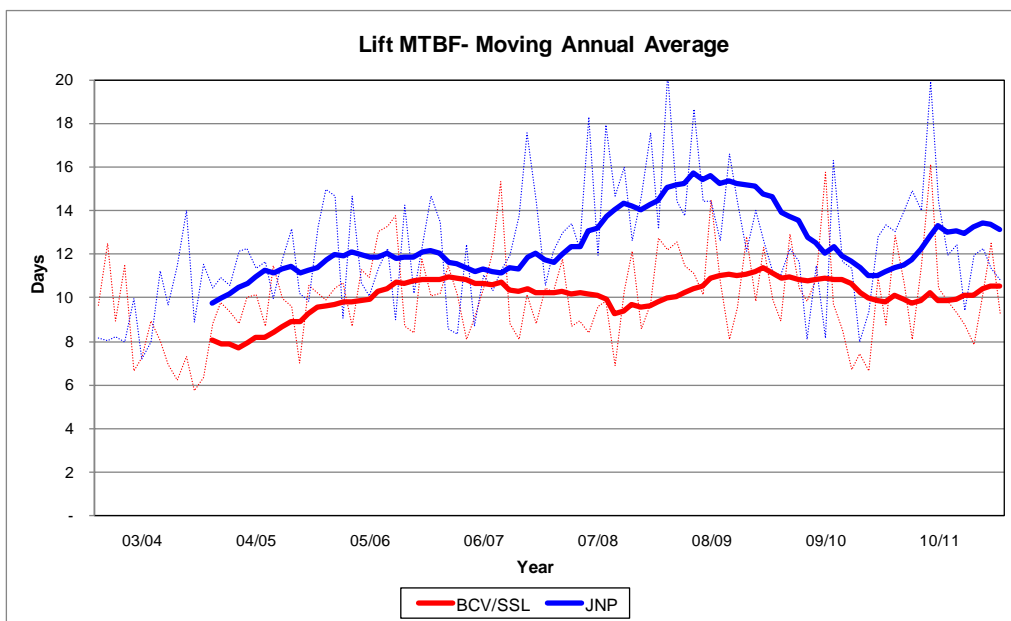


Figure 25 – Lift MDBF

	2003/04	2010/11	Better / (worse)
BCV/SSL	8.1	10.5	30%
JNP	9.5	13.1	37%

Table 16 – Lift MDBF

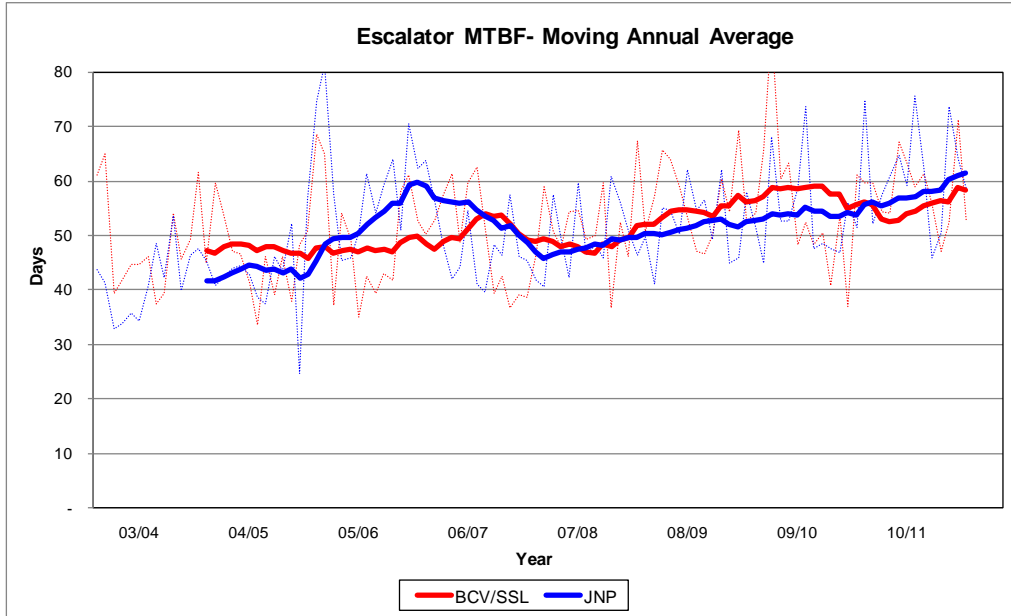


Figure 26 – Escalator MDBF

	2003/04	2010/11	Better / (worse)
BCV/SSL	48.4	58.2	20%
JNP	41.6	61.5	48%

Table 17 – Escalator MDBF

8.2 Rolling Stock Maintenance

- 188 LUL and Tube Lines are planning to spend circa £1.2bn on the maintenance of the Rolling Stock and Depots assets between 2010/11 and 2017/18, which accounts for 35% of all benchmarked asset maintenance spend.
- 189 Phase 6 of the asset maintenance benchmarking shows that in 2009/10 the unit cost per car of Rolling Stock and Depots varies from £25,700 on the Piccadilly line to £52,700 on the Central line, a range of £27,000 per car, before normalisation; and from £25,500 on the Piccadilly line to £48,100 on the Bakerloo line, a range of £22,600 per car after normalisation for statistically significant structural factors.
- 190 This section sets out the preliminary understanding of the reasons for this range of unit rates; provides LUL's and Tube Lines' forecasts of the maintenance cost unit rates to 2017/18, together with a summary of the ongoing efficiency initiatives which have been identified and are being implemented over this period; and identifies the key priorities for further investigation.

Rolling Stock Asset Base

- 191 The following table shows the number of trains operated on each line, both in 2009/10 and post the introduction of the new Victoria line trains, which are expected to have been introduced into service by November 2011, and the new trains on the Sub-Surface Railway, with all S8s accepted for service by August 2012 and all S7s accepted for service by January 2016.

192

	Bakerloo	Central	Victoria	Met	Circle/H&C	District	Jubilee	Northern	Piccadilly
2009/10									
Stock	72TS	92TS	67TS	A-stock	C-stock	D-stock	96TS	95TS	73TS
# cars	252	700	344	452	276	450	441	636	519
2017/18									
Stock	72TS	92TS	09TS	S8	S7	S7	96TS	95TS	73TS
# cars	252	700	376	464	371	560	441	636	519

Table 18 – Rolling Stock fleets – number of cars

Asset Maintenance Benchmarking Cost Comparisons

- 193 The graph below is a comparison of rolling stock and depot maintenance costs for the different lines maintained by LUL and Tube Lines, showing the variation in base unit rates for seven years of data from 2003/4 to 2009/10.

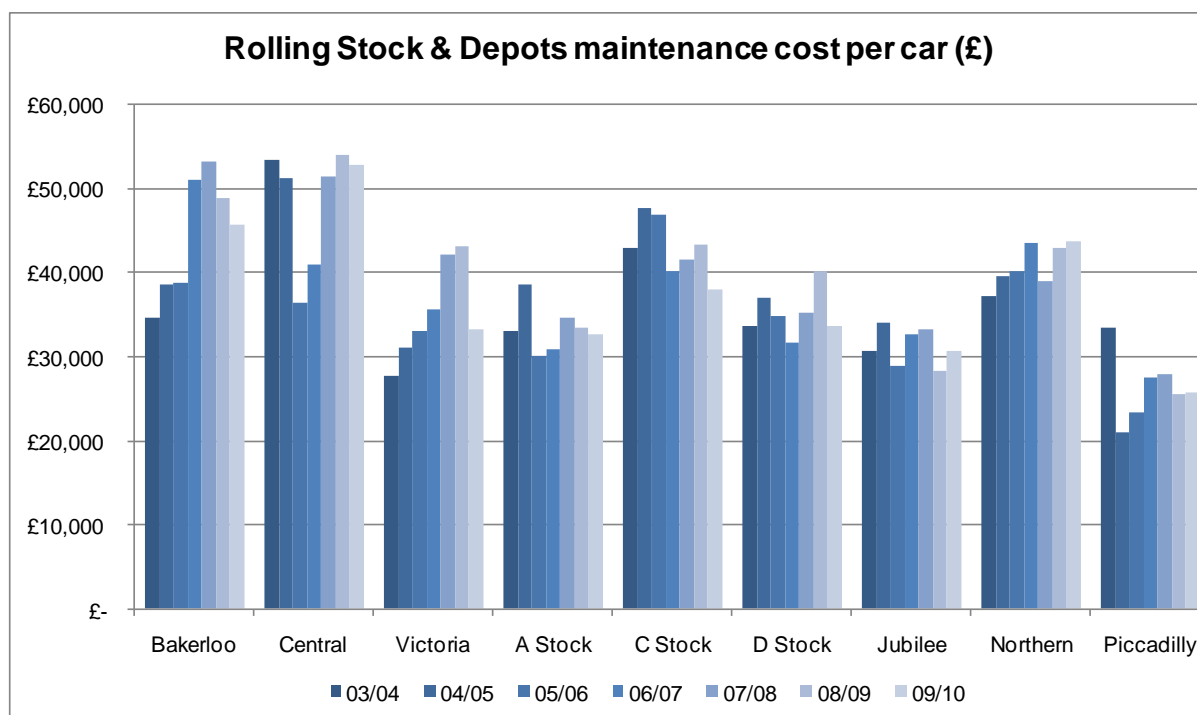


Figure 27 – Rolling Stock & Depots Unit Rate Comparison¹⁵

- 194 These costs are for the asset benchmarking fleet unit rate: rolling stock maintenance cost per car. This cost includes the cleaning and maintenance (levels 1, 2 and 3) of trains and the depot equipment used to maintain trains. It does not include periodic heavy maintenance such as programme lift (level 4) or heavy overhauls (levels 5, 6 and 7) or project works such as the installation of signalling related communications equipment, as these activities occur periodically and are not appropriate for year-on-year comparisons; however the impact of such interventions still needs to be understood.
- 195 Costs related to the maintenance of the new fleet of trains on the Victoria line are excluded as maintenance costs incurred relate to payments for the Technical Support and Spares Supply Arrangement (TSSSA) with Bombardier Transportation rather than for actual maintenance activities undertaken. Costs relating to the new Victoria line fleet will be included in future years of the asset benchmarking.
- 196 It has also not been possible to separate out the costs of heavy maintenance for the Northern line, and for some activities for the Jubilee line, which both have outsourced maintenance contracts with Alstom. The Northern line costs include an annualised proportion of programme lift and heavy overhaul costs as well as track and signal maintenance in the depots; and since 2007 there has been a performance bonus incentive scheme, aligned with the PPP Contract.
- 197 The graph above shows that there is a wide range of unit rates from £25,700 per car on the Piccadilly line to £52,700 per car on the Central line in 2009/10. Some of the possible reasons for this range are set out below, but further work is required to quantify these.

¹⁵ Rolling stock maintenance unit cost is currently reported on a 'per car' basis in the rail asset benchmarking, although the data is collected to allow comparisons to be made on a 'per car km' or 'per train' basis. It is proposed to revisit the issue of how best to present this analysis in Phase 7.

- 198 For the BCV/SSL fleets it is the current understanding of APD and the LUL asset sponsors that:
- The Bakerloo line fleet has higher than average costs due in part to fatigue cracking, largely due to the high level of track curvature on the line. It also has a higher than average proportion of its fleet outstabled, which results in a higher degree of unproductive time for train preparation.
 - The cost reduction on the Victoria line in 2009/10 is as result of a reduction in reconditioning work by the REW. With the start of the introduction of new trains, four 67TS trains have been removed from service, and are being cannibalised for parts, requiring less work by the REW.
 - There are multiple, well documented issues relating to the Central line fleet, including problems with water ingress, corrosion and traction issues. Three years ago, LUL opted not to carry out a major motor replacement and accepted that, as a result, there would be additional annual labour and materials costs for the life of the fleet to maintain availability and performance. The Central line also includes costs for the Waterloo & City line fleet.
 - The lines with smaller fleets, such as the Bakerloo, Hammersmith & City and Waterloo & City, also tend to have higher unit costs, as fixed costs such as depots are spread over a smaller number of cars.
- 199 The Piccadilly line fleet has the lowest unit rate on the network. Further work is required to understand the exact reasons, but Tube Lines' current understanding is that it is due in part to the design of the train and a maintenance regime that is based on hours operated and not calendar days.
- 200 It is proposed that further investigation is undertaken to identify if there are other learning points.

Performance

- 201 When considering comparisons of unit costs it is necessary to be aware of the relative performance of the fleets. The graph below shows the comparative performance of the different fleets, using the metric rolling stock service disruption incidents per car from the asset benchmarking.

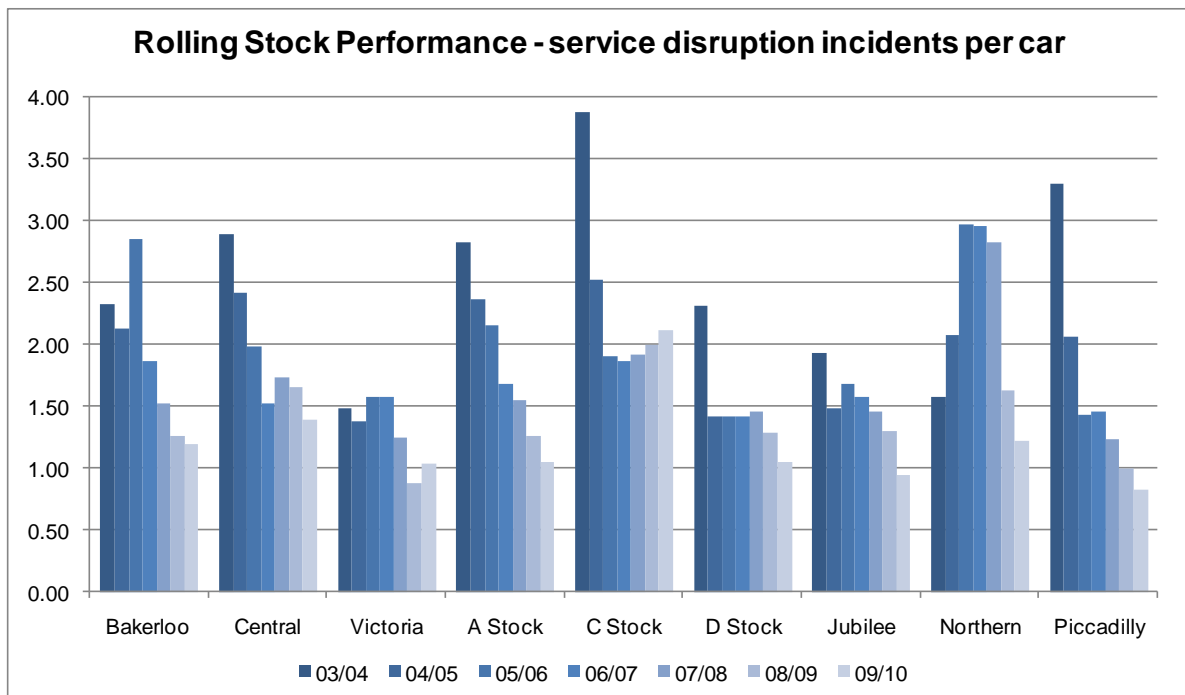
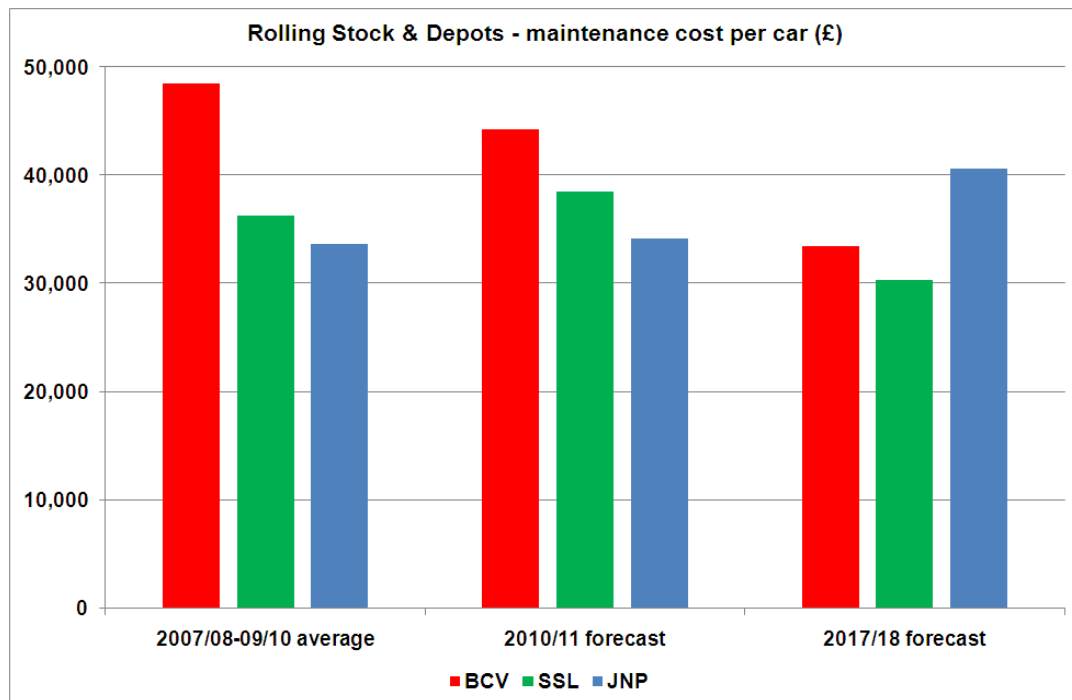


Figure 28 – Rolling Stock & Depots Performance (service disruption incidents per car)

Future Costs and Planned Efficiencies

- 202 BCV, SSL and Tube Lines all have planned efficiency initiatives to reduce the unit cost of maintenance over the next seven years. The following graph shows how the maintenance cost per car for rolling stock and depots is planned to change, showing the current unit rate as a three year average (2007/08-2009/10), together with the forecast for 2010/11 and 2017/18.
- 203 It should be noted that as a result of external contracts, the costs for heavy maintenance for the Northern line are included in the Tube Lines costs, and a proportion of heavy maintenance costs for the TSSSA are included in the BCV/SSL costs for 2017/18. The Tube Lines' costs also do not include planned reductions from taking Jubilee line maintenance in-house.
- 204 The efficiency initiatives which are included in the current business plans to achieve these cost reductions are outlined below.



Note: Heavy maintenance in Tube Lines costs for NLTSC in all years and in BCV/SSL costs for TSSSA in 2017/18

Figure 29 – Comparison of current and future fleet unit rates

205 The following graphs show the ‘waterfall’ from the current asset benchmarking unit rate in 2009/10 to that post planned efficiencies in 2017/18, for BCV, SSL and Tube Lines. The figures then show the adjustment for structural factors and the normalised unit rate for 2017/18. This is then shown in the context of the upper bound of the benchmark range determined by BSL in its international benchmarking report for the Arbiter.

BCV / SSL Efficiency Initiatives

- 206 The unit rate impact of efficiency initiatives for BCV and SSL are shown for the Maintenance Capability Plan, Maintenance Optimisation, Maintenance Unit Rates, the Support Services Review and other planned efficiencies.
- 207 Over the same period there are also cost increases relating to changes to activities as a result of the introduction of the new fleets with new maintenance regimes on the Victoria line and the Sub-Surface Railway, most notably the TSSSA with Bombardier.
- 208 As the TSSSA includes materials and support for heavy maintenance, which is excluded from the benchmarking unit rates, the waterfalls include an estimate of the proportion of the 2017/18 cost which equates to heavy maintenance under the TSSSA. This estimate is based on LUL’s current train maintenance regimes, and may underestimate the proportion of costs attributable to heavy maintenance.

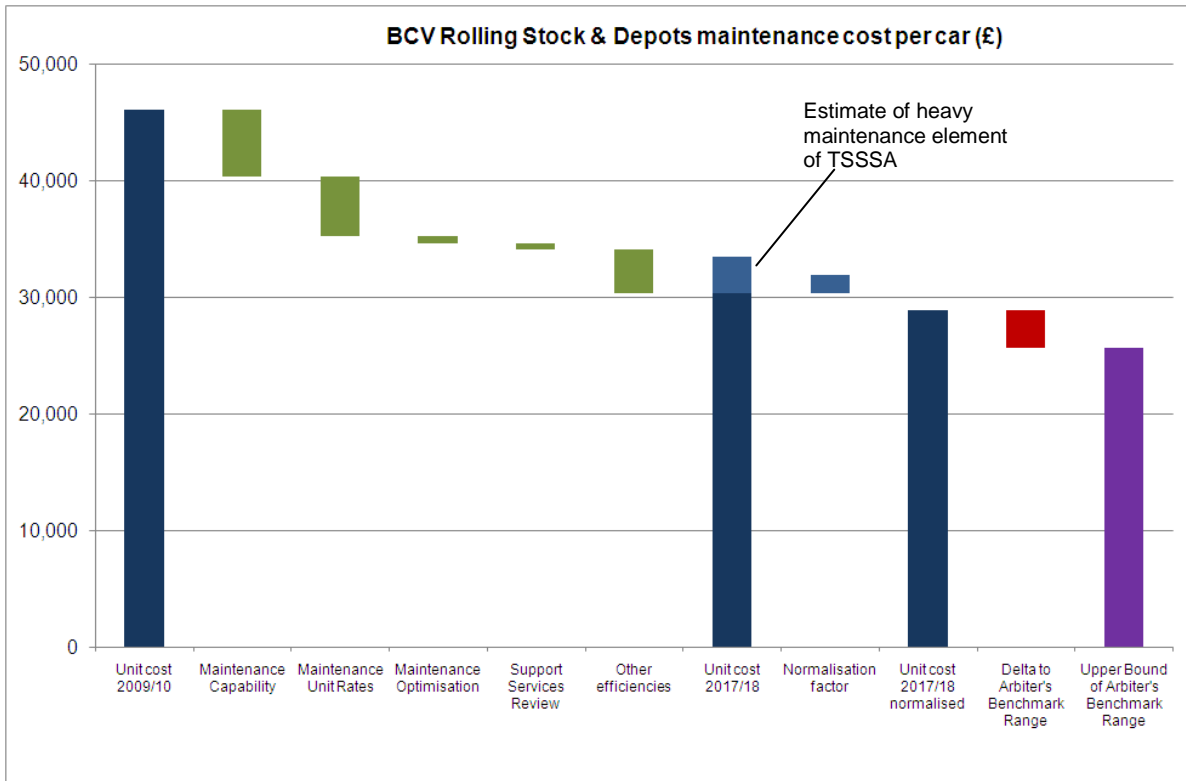


Figure 30 – Waterfall comparing BCV 2009/10 unit rate to 2017/18 and Arbiter 'benchmark range'

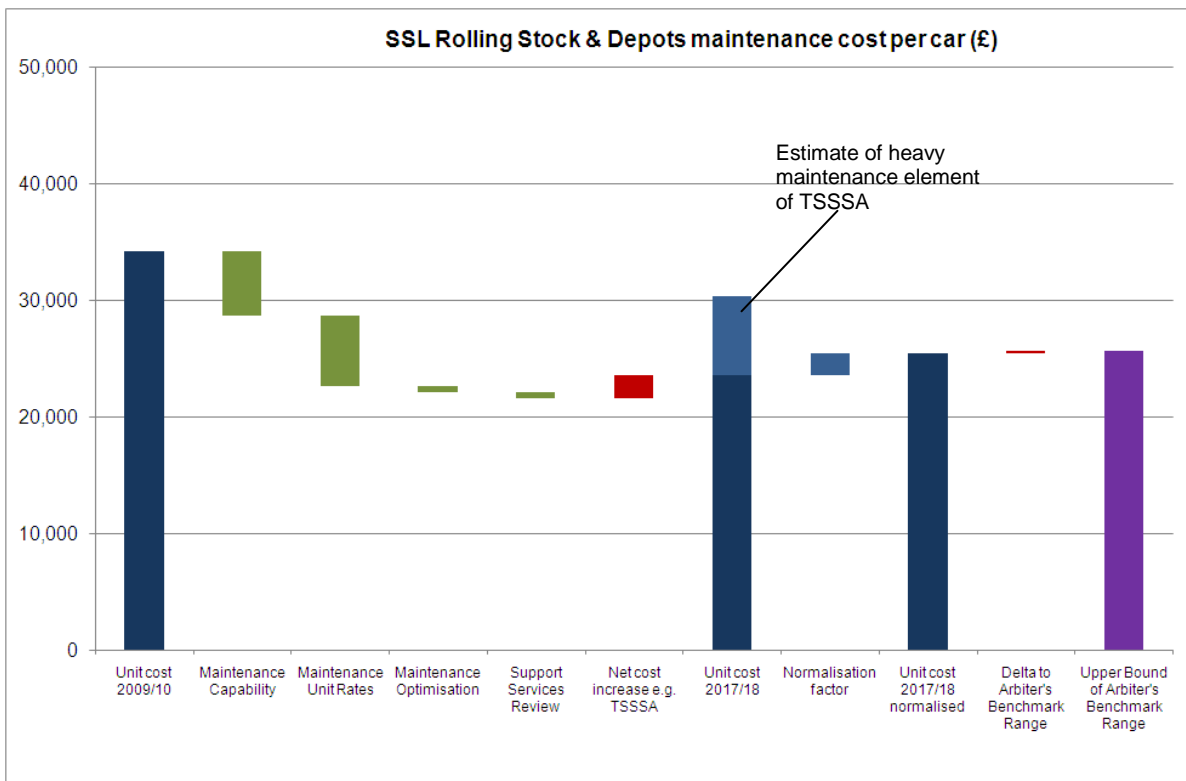


Figure 31 – Waterfall comparing SSL 2009/10 unit rate to 2017/18 and Arbiter 'benchmark range'

Maintenance Capability Plan (MCP)

209 LUL started to implement efficiency initiatives related to fleet and depots through the MCP in 2009/10, and achieved savings of £2.2m in that year and a further £3.5m by P9 of 2010/11. MCP is expected to deliver rolling stock and depots related savings of £18.9m p.a. by March 2013. These savings can be categorised as follows:

- Further maintenance optimisation (£0.7m) – changes to maintenance intervals to reflect the actual condition and performance of each fleet;
- Staff efficiencies (£3.7m) through reductions in vacancies and reductions in the use of agency staff;
- Depot rationalisation (£3.1m) – changes to Hammersmith as part of the Sub-Surface Railway maintenance strategy; Central line depot rationalisation;
- Maintenance reorganisation (£3.0m) – changes to maintenance rosters to ‘best in class’; ending of service delivery teams; consolidation and multi-skilling of call point staff;
- Materials management (£2.8m) – in-sourcing of materials management on the Central line; 8% reduction in materials costs across all fleets through cost controls and challenging standards; rationalisation of road vehicle fleet;
- Introduction of new fleets (£2.3m) provides the opportunity to implement new maintenance regimes (S-stock and 09TS) and reduce maintenance on old fleets prior to decommissioning.

Maintenance Optimisation

210 LUL is currently undertaking a programme of train maintenance regime optimisation, which is reviewing the prescribed intervention intervals for train preparation (level 1) and examination (level 2) maintenance and implementing changes as appropriate. Train preparation is being reduced by seven minutes per train, and level 2 maintenance activities are being moved, where practicable, from 14 to 28 days. Once this has been achieved, rosters can be changed to increase the savings from these changes. The 2011/12 rolling stock and depots AMP included savings of £1.4m-2.9m p.a., £13.1m by 2017/18, (£15.1m outturn) as a result of the fleet maintenance optimisation programme.

Maintenance Unit Rates and Support Services Review

- 211 The unit rates in 2017/18 also contain efficiency savings relating to Maintenance Unit Rate (MUR) initiatives and the Support Services Review.
- 212 Maintenance costs were reviewed as part of the strategic assessment of costs in April 2010, and the LUL Board agreed that further initiatives were required to reduce unit costs after MCP had been fully implemented. These savings have been included as the MUR.
- 213 The Support Services Review reviewed the delivery of back office functions across the whole LUL. The review resulted in a reduction in the numbers of support staff and these are reflected in the efficiencies shown here. These efficiencies are well defined, and are close to being fully embedded.

Net cost increase and other efficiencies

214 By 2017/18 the TSSSA will be in place for both the new Victoria line fleet and the new Sub-Surface Railway fleets. The ‘Net cost increase’ bar for SSL in Figure 5 is largely attributable to the net increase in cost resulting from the implementation of the TSSSA.

It should be noted that the 2009/10 and 2017/18 unit rates are not directly comparable, as the 2009/10 unit rate does not include any TSSSA costs, although some of the activities undertaken in 2017/18 by Bombardier will be included in the unit rate in 2009/10.

215 LUL has concerns over the scope and cost of the TSSSA and is looking at the opportunities to achieve savings from these contracts.

Tube Lines’ Efficiencies

216 Tube Lines’ average maintenance cost per car in 2017/18 is forecast to increase by approximately £6,500 per car from the 2009/10 rate. This is due to an increase in contract costs on both the Northern and Jubilee Lines as a result of additional maintenance of TBTC equipment, extra mileage and new train declarations. The change in unit rate also includes provision for a bonus paid to Alstom (approximately £1m per year) which was part of the contract change in 2007, in which performance for both Tube Lines and Alstom was aligned.

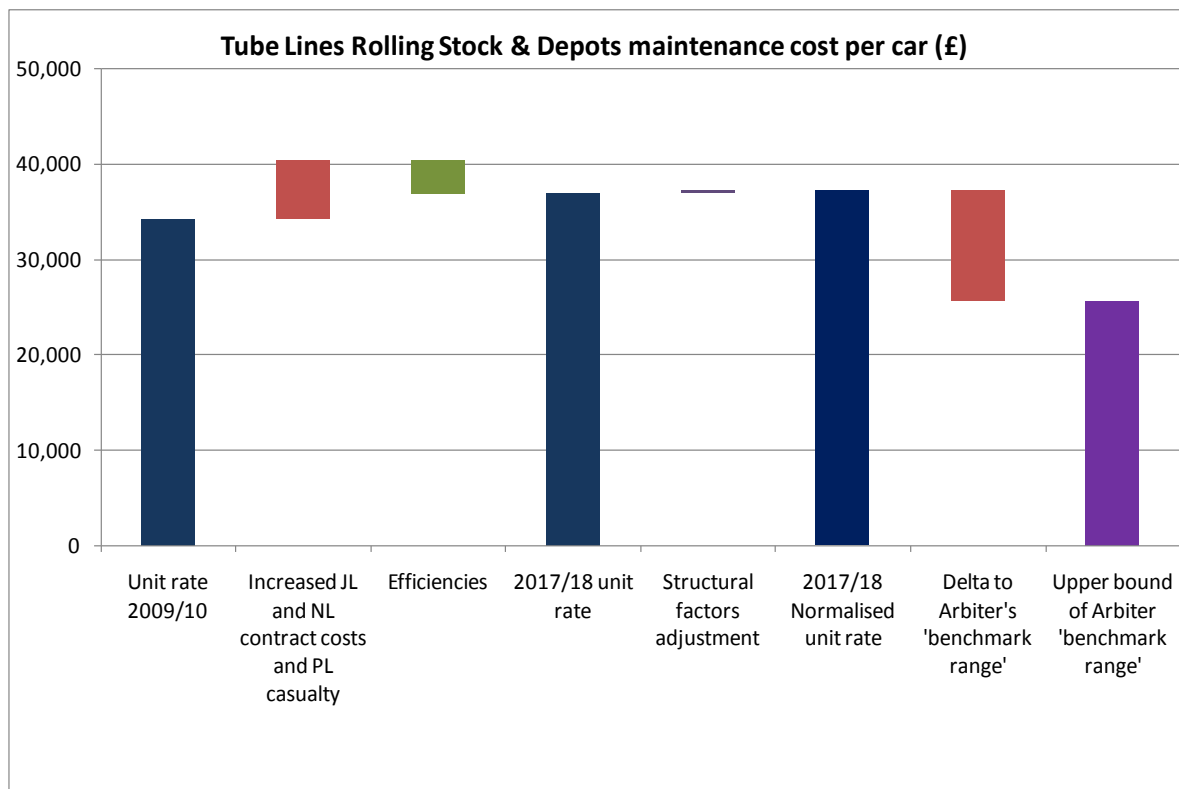


Figure 32 – Waterfall comparing Tube Lines’ 2009/10 unit rate to 2017/18 and Arbiter ‘benchmark range’

217 This increase in unit costs is partially offset by planned savings resulting from the optimisation of level 1 and 2 maintenance, implementation and improved use of the asset management system (Maximo) and the decision to bring in-house the maintenance of the Jubilee line fleet.

218 This system provides transparency throughout the fleet, and enables equipment based maintenance, which provides efficiencies in planned maintenance. This level of detailed monitoring brings about a proactive approach to recognise and measure key performance indicators prior to failure, again driving efficiencies in cost and

performance. This enables Tube Lines to undertake optimised decision making in achieving efficient and economic whole life asset management of equipment levels, fleet planning, work management, inventory, stores management and procurement. It also allows for the planning and scheduling of work, managing inventory and resources, and the analysis of cost and performance.

219 Further work is required to understand what effect the implementation of Maximo has had on the cost and performance of the Piccadilly line fleet.

Normalisation

220 The 2017/18 unit rate has been normalised to take account of the structural factors that were found to be significant in the Phase 6 asset maintenance benchmarking analysis, although it is recognised that these structural factors may change in the future.

Arbiter’s Benchmark Range

221 The waterfall graphs show the upper bound of the benchmark range of £25,600 per car, which was determined by BSL in its international benchmarking study for the Arbiter, broadly based on the normalised unit cost levels of the international peer metros.

Normalisation and Structural Factors

222 The Phase 6 Joint Benchmarking analysis identified two structural factors which are statistically significant and therefore could be used to normalise the unit rates: number of traction motors per car and number of door leaves per car (both measures of train complexity). The graph below shows the unit maintenance cost normalised for these two structural factors.

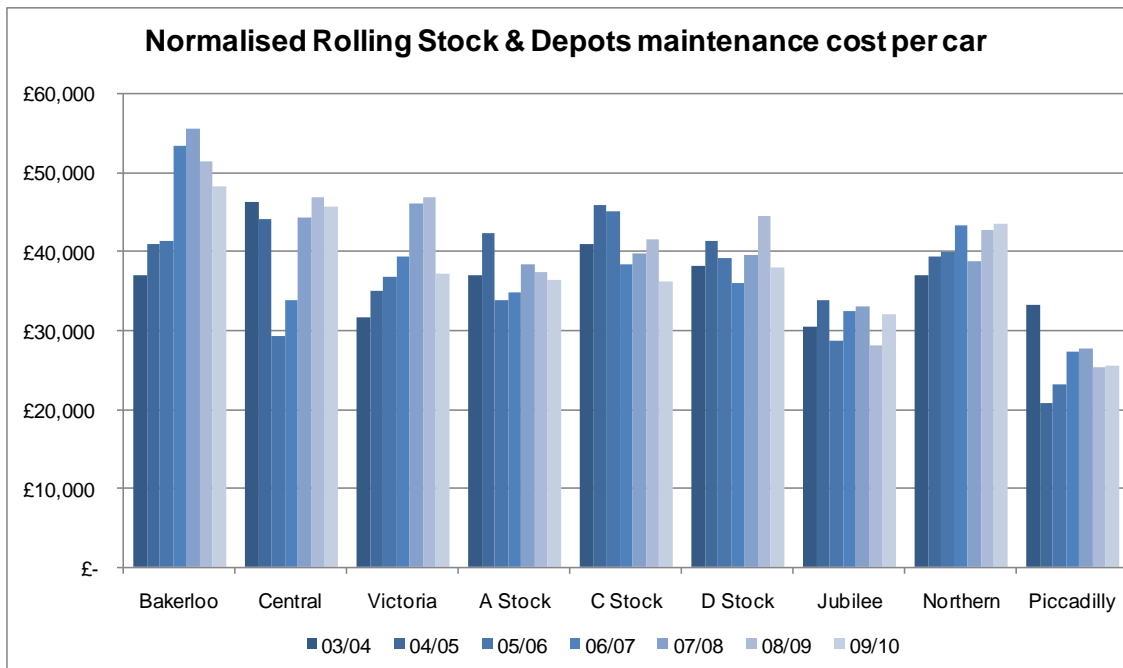


Figure 33 – Rolling Stock & Depots Normalised Unit Rate Comparison

223 The asset maintenance benchmarking analysis also examined a number of other structural factors but none of these were found to be statistically significant. Although in Phase 5, the proportion of the fleet used for peak service (a measure of availability

for maintenance), was also found to be statistically significant. However, a larger dataset (i.e. with additional years) might identify other structural factors as significant. It should also be noted that BSL, in its international benchmarking report for the Arbiter, identified the average distance between stations (a proxy for the duty undertaken by a train on a particular line) as the only significant structural factor.

- 224 After normalisation for structural factors, the size of this range is reduced by £4,400 to £22,600; a range from £25,500 per car on the Piccadilly line to £48,100 per car on the Bakerloo line.

Additional structural factors

- 225 The asset maintenance benchmarking analysis has normalised the unit rate to take account of a number of structural factors which have been determined to be statistically significant. However, there may well be other structural factors, which have not been identified, or more likely which cannot be shown to be statistically significant which make costs in London higher than other metros in the short to medium, and possibly long, term.
- 226 In its international benchmarking report for the Arbiter, BSL tested for a number of structural factors including vehicle complexity, distance operated and age of fleet, but the only factor it identified as significant was the average distance between station stops, which is a proxy for the duty cycle, as at this time many of the systems and sub-systems will have to operate; e.g. brakes, acceleration, door systems etc.
- 227 The current normalisation is based on vehicle complexity, but additional structural factors may be identified as significant as the size of the dataset increases and becomes more robust.

Areas for further investigation

- 228 Based on the benchmarking analysis, this section looks at what additional opportunities may exist which are not currently included in the business plans which deliver the level of unit cost shown by 2017/18, and makes recommendations for further drill-down studies and analysis to identify these opportunities.

Analysis of maintenance activities

- 229 The BSL report looked at a number of explanatory factors, and determined that it could explain c. 50% of the cost gap to its benchmark level by relative levels of labour cost (c. 30%) and by differences in maintenance inspection regimes (frequency of intervention) (c. 20%). The maintenance optimisation programme is addressing the issue of frequency of inspection, but further work is required to address the issue of labour cost.
- 230 The analysis presented so far in this report is based on the unit rate (maintenance cost per car) used in the asset benchmarking exercise. However this unit rate comprises a number of different activities, and it would be instructive to look at the cost of each of these activities e.g. Level 1-3 maintenance, casualty maintenance, cleaning, depot costs, overheads.
- 231 Future benchmarking analysis will look in detail at the collection and capture of data at the appropriate level of detail across all lines to better understand the differences in the unit rates between rolling stock fleets and the reasons for these.

London 'Best in Class' benchmarking

- 232 The asset maintenance benchmarking has shown that the unit cost levels and reliability performance of the Piccadilly line fleet is ‘best in class’ in London. Following TfL’s purchase of Tube Lines, there is now a real opportunity to examine in detail the maintenance practices and culture on the Piccadilly line to understand what opportunities exist to introduce good practices into other fleets and depots.
- 233 A very limited exercise was undertaken in 2007 to investigate this¹⁶, which presented three conclusions: “(1) changing the maintenance from time to condition/usage based would appear to be better practice which all the fleets could adopt; (2) maximising the scope of works each time a train is taken out of service for a programmed lift might be best practice; (3) a rolling heavy overhaul programme might be best practice compared to say a two year programme every nine years”.
- 234 Further work is required to identify and share possible good practice from the Piccadilly line with other fleets, and this is being pursued as an immediate opportunity through a drill down study.
- 235 This drill down study is being carried out to look at rolling stock maintenance approaches, practices and culture, to understand the reasons why the Piccadilly line fleet has the lowest maintenance cost and the highest reliability of all the fleets maintained by LUL and Tube Lines, and to identify the opportunities and possible barriers for the transfer of initiatives to other fleets and depots.

¹⁶ Joint Benchmarking Phase 3 - Piccadilly line Rolling Stock investigation, 2007

8.3 Signals Maintenance

- 236 LUL and Tube Lines are planning to spend c. £0.5bn on the maintenance of the Signals assets between 2010/11 and 2017/18, which accounts for c. 15% of all benchmarked asset maintenance spend.
- 237 Phase 6 of the asset maintenance benchmarking shows that in 2009/10 the unit cost of Signals per main track km varies from £62,000 on the Piccadilly line to £95,000 on SSL South a range of £33,000, before normalisation; and from £59,000 on the Piccadilly line to £88,000 on SSL South, a range of £29,000 after normalisation for statistically significant structural factors.
- 238 This section sets out the preliminary understanding of the reasons for this range of unit rates; provides LUL's and Tube Lines' forecasts of the maintenance cost unit rates to 2017/18, together with a summary of the ongoing efficiency initiatives which have been identified, and are being implemented over this period; and identifies the key priorities for further investigation.

Asset Base

- 239 For clarity, the signalling infrastructure equipment has been split into five categories to provide an overview of the assets, before the delivery of the Upgrades, as shown in Table 19 below¹⁷.

Signalling (number of)	Signals Signs and Indicators	Trainstops	Points	Track Circuits	Interlocking Systems	Total	Assets per KM (Main Line)	Density of Signals & Points
Bakerloo	633	121	20	154	8	936	39	27
Central & W&C	1,414	23	142	1,171	183	2,933	18	10
Victoria	284	1	32	500	8	825	17	7
SSL South	1,852	628	241	1,233	32	3,986	30	14
SSL North	1,611	571	213	1,201	24	3,620	21	12
Jubilee (Pre-TBTC Asset Base)	755	396	177	780	19	2,127	22	10
Northern (Pre-TBTC Asset Base)	1,233	641	171	1,043	16	3,104	26	12
Piccadilly	1,013	567	177	1,156	18	2,931	27	11
BCV/SSL	5,794.0	1,344.0	648.0	4,259.0	255.0	12,300	23	12
TLL	3,001.0	1,604.0	525.0	2,979.0	53.0	8,162	25	11

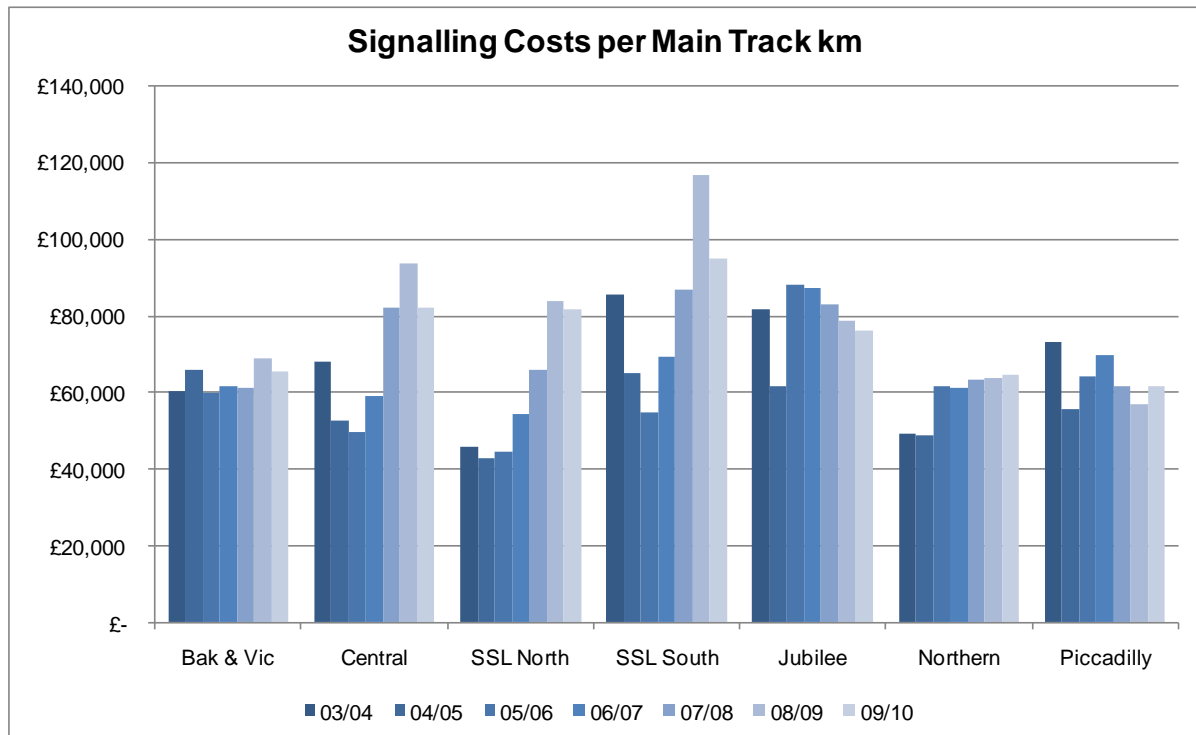
Table 19 - Signalling Asset Counts, Pre-Upgrade, without depots and sidings

Asset Maintenance Benchmarking Cost Comparisons

- 240 The asset maintenance benchmarking provides a comparison of maintenance unit rates, by line, across the LUL network for seven years of data from 2003/04 to 2009/10.
- 241 The following graph provides a comparison of Signalling & Power maintenance unit costs for the different lines maintained by LUL and Tube Lines.
- 242 This unit rate includes inspections, preventative and corrective maintenance for Signalling, routine change (i.e. component renewal), Power maintenance and all related direct supervision and management costs. It also includes the cost of the BCV/SSL Communication and Information team. It does not include mid life refurbishments, training costs, central overheads and project works such as the installation of signalling related communications equipment.

¹⁷ The higher density of assets on the Bakerloo line is due to a greater number of Signals, Signs and Indicators as a result of a high proportion of curved track.

243 It should be noted that the Central line costs include the Waterloo & City line costs. Also, the Bakerloo and Victoria line costs are combined as the two lines share the same signalling maintenance teams.



Note: Costs shown per km of running track, excluding depot track and sidings.

Figure 34 - Signalling unit rate: maintenance cost per main track km

Main variations between 2008/09 and 2009/10 unit rates

244 The Central line and SSL South unit rates have decreased by almost 20% over the last year. LUL attributes the decrease in unit rates to:

- The clearing of the backlog of inspections and preventative maintenance accumulated over the past years. This means that fewer resources are needed to perform the on-going maintenance;
- The allocation of more signalling resource to capital projects to support the delivery of the Upgrades.

245 Over the last four years, Tube Lines has consistently decreased its unit cost on the Jubilee line. It is Tube Lines' view that this has been achieved through the optimisation of travel times and the implementation of risk based maintenance which has reduced overtime.

246 The change in cost unit rate for the Piccadilly line between 2008/09 and 2009/10 is due to the fact that LUL paid Tube Lines to provide its existing signalling response team to cover for incidents between Acton Town and Barons Court in 2008/09 and stopped doing this in 2009/10.

Comparison of LUL and Tube Lines' unit rates

247 The asset maintenance benchmarking shows a wide range of unit rates from £62,000 on the Piccadilly line to £95,000 on SSL South.

248 LUL's current understanding is that this is due to differences in resource levels between BCV/SSL and Tube Lines.

249 Table 20 below summarises the initial analysis of the number of labour FTEs by work area.

	BCV	SSL	BCV/SSL	JNP
Main track km	<i>230km</i>	<i>305km</i>	<i>536km</i>	<i>331km</i>
TO depots (incl. Maintenance depots)	13	14	27	16
Main track km per TO depot	17.7	21.8	19.8	20.7
TOs	53	95	148	102
SOMs	14	13	27	29
Support staff	64	93	157	44
TO depot staff	131	201	332	175
Main track km per TO depot staff	1.8	1.5	1.6	1.9
<i>Average staff per TO depot</i>	<i>10.1</i>	<i>14.4</i>	<i>12.3</i>	<i>10.9</i>
S&E Team (Central Team)			82	31
Communication and Information			36	-
Incident Team			22	In TO depot
ATC Team Central Line			35	-
Other			3	6
Staff not allocated to TO depot			178	37
Main track km per staff not allocated to TO depot			3.0	8.9
Total staff			510	212
Main track km per staff			1.1	1.6

Table 20 – Comparison of FTE staff numbers

250 The Technical Officer (TO) depot density (i.e. km of track managed, on average, by each TO depot) is comparable across BCV and Tube Lines.

251 The average headcount of each TO depot is similar for Tube Lines and BCV, but higher for SSL.

252 However, the key observation is that the ratio of track km to signalling FTEs is 1.1 km for BCV/SSL compared to 1.6 km on Tube Lines, a difference of 45%.

253 LUL's current understanding of the reasons for this is described in the following paragraphs, and will be investigated in detail in the ongoing signalling maintenance drill down study.

Centralised Incident Team

254 BCV and SSL have a centralised incident team which means a larger proportion of the signalling resources are not allocated to a specific TO depot.

ATC team

255 The Central line is organised differently to the other lines. A dedicated Automatic Train Control (ATC) team located at Ruislip, deals with the train-borne and track side ATC Signalling equipment, in addition to the Central line TO depot organisation. Further work is required, and ongoing, to understand the rationale for having a different organisation.

256 On the Victoria line, currently the only other fully automated line, TOs cover all aspects of the Signalling trackside equipment including ATC; fleet maintainers deal with train borne signalling equipment; and repairs are undertaken by the REW.

257 In 2009/10 Tube Lines did not have ATC in operation on any of its lines and currently it has no plans to create an additional dedicated team to maintain Jubilee or Northern lines following the introduction of TBTC.

- 258 The cost of the ATC team represents £26,100 per track km on the Central line (or c. 32% of the Central line Signalling Maintenance costs). The cost of this team, for 2009/10, is £4.2m.

Communication & Information team

- 259 The LUL Communication & Information team is a technical specialist resource which provides first and second line maintenance for passenger information transmission and display. The LUL C&I team also provides second line support to Tube Lines. First line maintenance for the JNP lines is carried out within Tube Lines by its TO depot organisation, rather than a dedicated team. The costs and proportion of costs of the C&I team related to BCV/SSL and Tube Lines are summarised in Table 21 below.

2009/10 Joint Benchmarking 2009/10 Constant Prices	BCV/SSL	JNP
Costs		
C&I Team	2,192,314	176,188
Total	93%	7%

Table 21 – C&I Team

Routine change

- 260 Routine change is included in the BCV, SSL and Tube Lines costs. A much higher proportion of components are changed on SSL than on any of the other lines. A large part of routine change on SSL is the quantity of life-expired relays that require replacement. The volumes of these are greater on SSL than BCV, directly related to the type and age of the technology and the relays' life expectancy: over the same time period c. 9000 relays will require changing on SSL compared to c. 80 relays on BCV. The cost of routine changes for BCV and SSL are detailed in Table 22.

2009/10 Joint Benchmarking 2009/10 Constant Prices	BCV	SSL
Costs		
Routine Change	710,817	3,813,789
Unit Rates (signalling cost per main track km)		
Routine Change	3,086	12,496

Table 22 – Routine Change

Performance

- 261 When considering comparisons of unit costs it is necessary to be aware of the relative performance of the lines. Figure 2 below shows the comparative performance of the different lines, using the metric number of service affecting failures per km of running track.

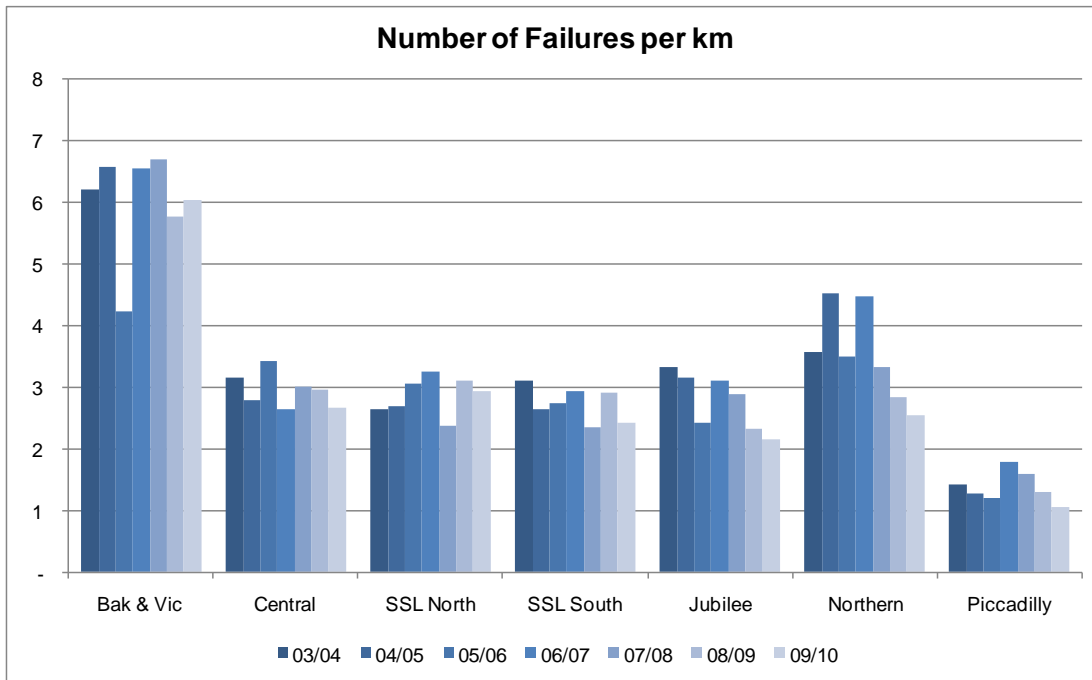
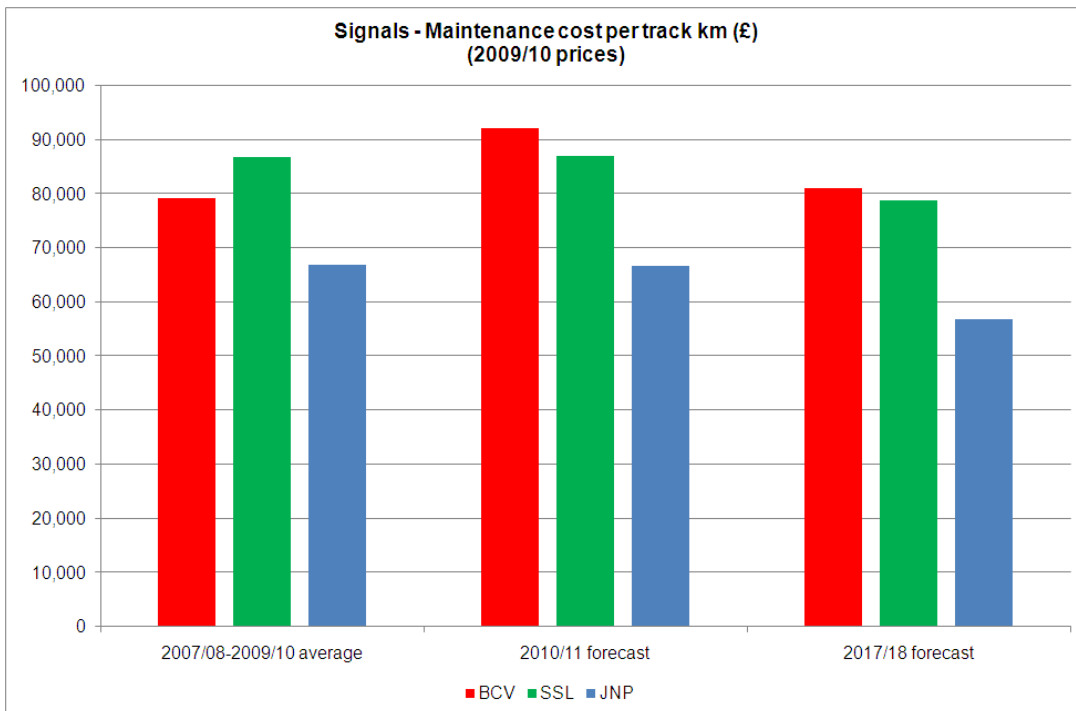


Figure 35 – Signalling Performance – Number of service affecting failures per track km

Future Costs and Planned Efficiencies

262 The following graph shows how the maintenance cost per km of running track is planned to change over the next seven years for each of BCV, SSL and Tube Lines. The reasons for the efficiency initiatives and cost increases which are included in the current LUL and Tube Lines Business Plans are outlined below.



Note: BCV and SSL costs for 2017/18 are before deduction of estimated post-Upgrade efficiency

Figure 36 – Comparison of current and future signalling unit rates

BCV/SSL Future Costs and Planned Efficiencies

263 The following waterfall graph shows, for BCV /SSL, the current asset benchmarking unit rate, the unit rate in 2009/10 and the normalised unit rate for 2017/18. The unit rate impact of efficiency initiatives for BCV and SSL are shown for the Maintenance Capability Plan (MCP), Maintenance Unit Rates and other efficiencies as well as the impact of cost increases.

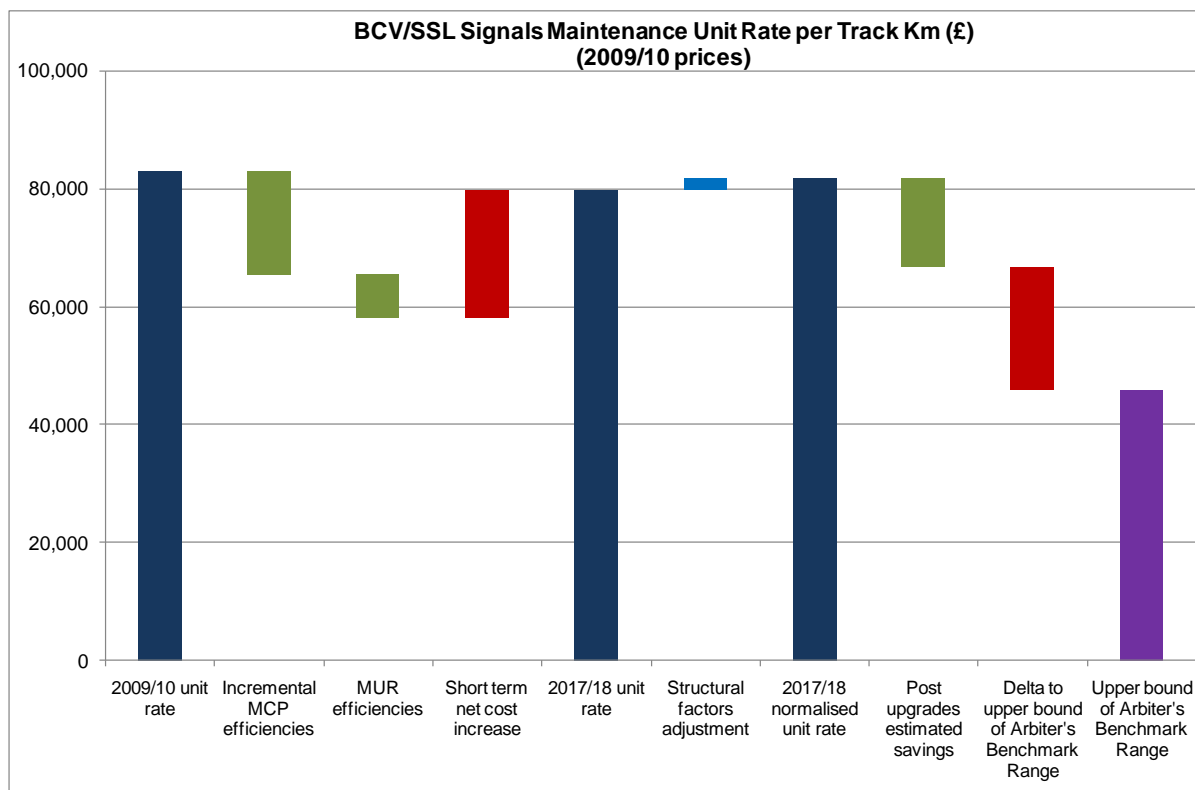


Figure 37 - BCV and SSL Maintenance cost per track km (£ 2009/10)

Maintenance Capability Plan (MCP)

264 The saving initiatives for the Signalling Asset Groups fall into three categories, listed below:

- Change of maintenance regime;
- Use of new technologies; and
- Change of working practices.

265 MCP savings initiatives are planned to deliver annual savings of c. £13.1m by March 2013 (all savings are over the next three years). Of these savings £3.7m were achieved in 2009/10.

Change of maintenance regime (£6.2m of savings)

266 Various saving initiatives look to optimise maintenance regimes and modify historic Category 2 Standards, such as MR-S-SIG-E7060 (Routine Change). Such initiatives include adopting Risk Based Maintenance (RBM) and rescheduling Signal maintenance to 80% of its current regime without affecting critical assets. Similarly, a review of Power standards is currently under way to reduce maintenance frequency on existing assets.

Use of new technologies (£1.1m)

267 The implementation of a new generation of technology (Victoria line Upgrade, Automated Track Monitoring System – ATMS) creates an opportunity for a substantial re-evaluation of the approach to signals maintenance. This is because:

- There will be significant reduction in the volume of line-side equipment, especially mechanical equipment;
- Both line-side and on-train equipment will become more standardised;
- The remote diagnostic capabilities of modern signalling systems should enable better preventative and corrective intervention, with the need for fewer locally based call staff, other than at critical locations.

Change of Working Practices (£5.8m)

268 Better utilisation of the on-duty staff is planned to deliver significant savings, through multi-skilling. Rosters will also be reorganised to increase staff utilisation and limit overtime. The focus is on improved resource planning that will optimise the use of staff without impacting on performance. Support teams will be merged to achieve a leaner organisation of Track & Signal Maintenance.

AMP Savings

269 The Asset Management Plans include savings related to the Maintenance Capability Plan and the Maintenance Unit Rates (MUR) initiatives, which mainly include a review of the standard times and Category 2 standards to study the feasibility of a reduction of the inspection cycles.

Cost increases

270 Further work is required to understand the cost increase between 2009/10 and 2017/18. Current understanding is that a proportion of this cost increase is due to an increase in headcount in the ATC and C&I teams and the Central line workforce and additional spares for maintenance. Other increases relate to the S-stock cab simulators.

271 Furthermore, Signalling assets such as the AC main, air main and train stops will become life expired and are scheduled to be changed, and although some concessions may be granted to move towards a risk based replacement programme, LUL's current plan, and costs are for a full replacement. Routine change programmes are included in LUL costs, and will be refined once the SSL upgrade starts.

272 The benchmarking unit rates include costs to maintain the legacy and the new signalling system in parallel on SSL from 2014 until 2018.

Further savings

273 The business has not yet factored in the savings as a result of the delivery of the Signalling Upgrade on the Victoria line (in 2013) and on the Sub-Surface Railway (in 2014). Evaluation of the possible savings is underway and preliminary estimates indicate that a further c.£19m efficiencies may be in the current business plan, amounting to an annual saving of approximately £8m in 2017/2018. This preliminary assessment includes the possibility of delaying routine change of assets that are to be removed under the SSL Upgrade.

Tube Lines' Signals Efficiency Plan

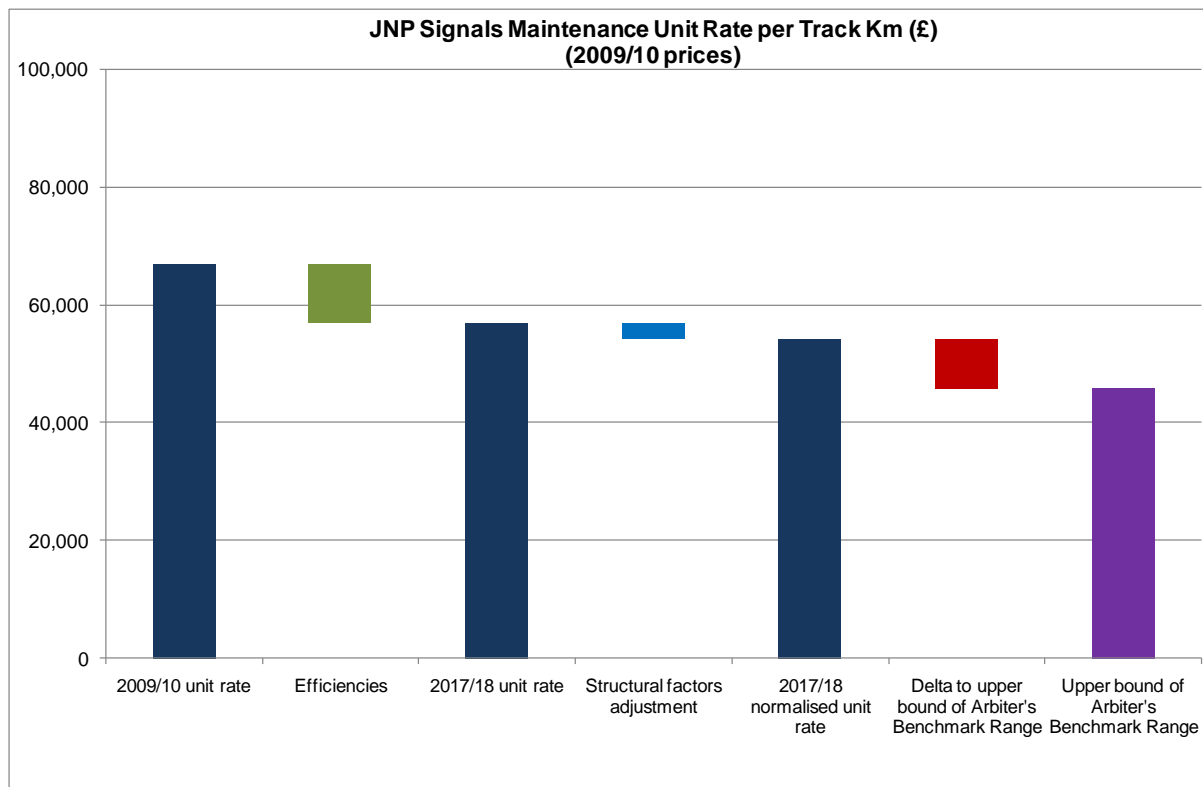


Figure 38 - Tube Lines' Signals Maintenance cost per track km (£ 2009/10)

274 The changes in cost profile in JNP over RP2 will be driven by the following major factors:

- Change of maintenance structure from Line Based to Asset Based.
- Reduction in grades due to technological requirements.
- Change of Maintenance Regime.
- Alternative approach to ACATS wheel rail management.

Change of maintenance structure from Line Based to Asset Based

275 The maintenance and response activities have been re-organised into separate departments within the signal team. This has allowed staff levels in maintenance to be determined from bottom up. This has identified areas where staff can be reduced.

Reduction in grades due to Technological requirements

276 The new TBTC systems have made redundant specific grades of staff. This in combination with a full complement of Technical Officers in the maintenance department has identified areas where a grade can be removed. This grade is Senior Technician (signals).

Change of Maintenance Regime

277 A review of Cat 1 and 2 standards has been conducted. This is going to move by stages from 12 week cycles to 16 week cycles to 24 week cycles for specific traditional assets. A similar study of the TBTC suppliers recommended maintenance activities is underway to seek to reduce where appropriate maintenance activities. Reduction in Routine Change activities are also being considered on assets that are due to be decommissioned due to the NL upgrade.

Alternative approach to ACATS wheel rail management

278 The original advice from projects for the management of the NL and JL ACATS systems has been reviewed in the light of the Signals Team organisational changes and a better understanding of the TBTC systems operational parameters. This has allowed a new approach to the management of the system releasing resource.

Normalisation

279 The 2017/18 unit rate has been normalised to take account of the structural factors that were found to be significant in the Phase 6 Asset Maintenance Benchmarking analysis, although it is recognised that these structural factors may change in the future, especially with the delivery of the Upgrades.

Arbiter's Benchmark Range

280 The waterfall graphs show the upper bound of the Benchmark Range for signalling maintenance cost, as determined by BSL in its international benchmarking study for the Arbiter, to be £46,000 per track km, broadly based on the normalised unit cost levels of the international peer metros.

281 However based on this analysis, there remains a considerable delta between the planned unit rate in 2017/18 and the benchmark range determined by BSL in its international benchmarking report for the Arbiter. Further work is required to understand to what extent this is because the Arbiter's benchmark range is based on more modern signalling systems compared to the LUL and TLL signalling assets in 2017/18.

Other Efficiency opportunities

282 There are likely to be a number of efficiency opportunities which are not currently included in the LUL Business Plan which delivers the level of unit cost shown by 2017/18. For BCV and SSL for example, further analysis is required to understand the potential for headcount reductions following the delivery of the Upgrades.

283 The analysis presented so far in this report is based on the unit rate (maintenance cost per km of track) used in the asset benchmarking exercise. However, as shown in the following graph, this unit rate comprises a number of different activities, and it is instructive to look at the built up of these unit rates. The unit rate (maintenance cost per km of track) for each line, can split into five cost categories: Preventative maintenance and Inspections, Corrective maintenance, Power Maintenance, Routine Changes and Overheads.

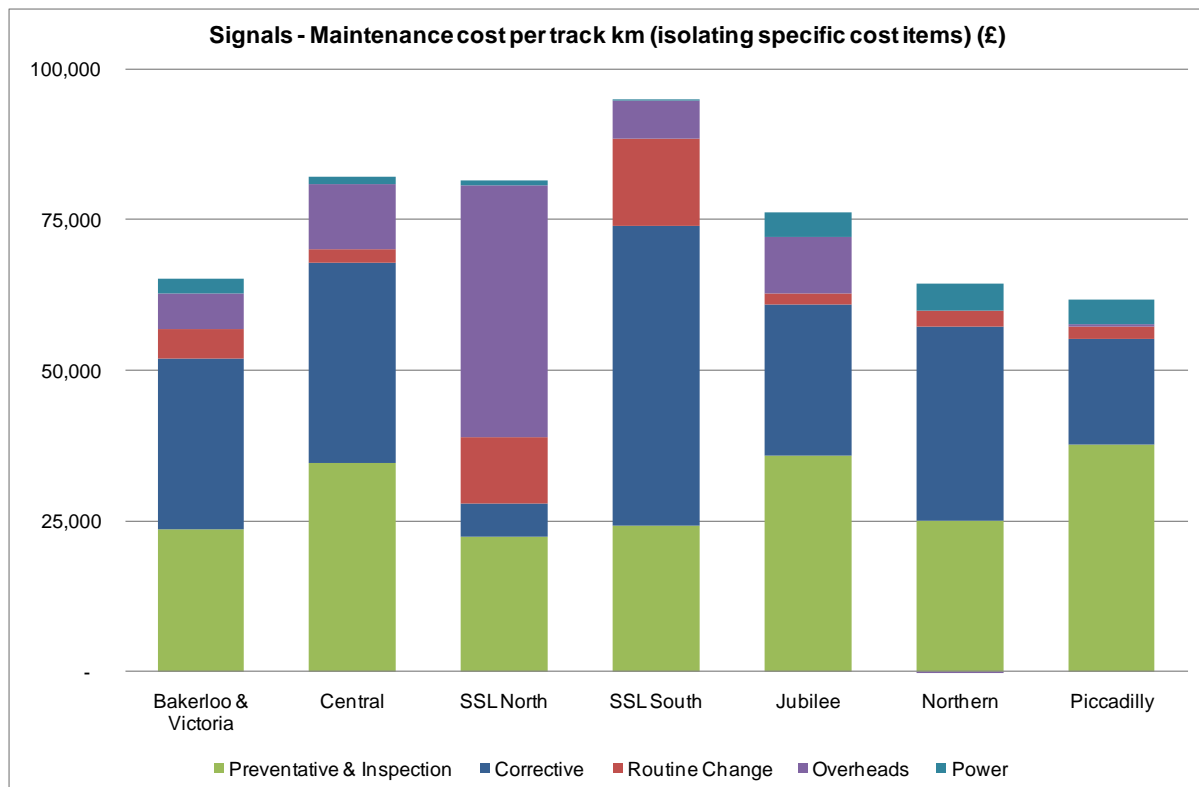


Figure 39 – Signals maintenance cost per track km by activity

- 284 There are considerable differences in the unit rates of the different cost categories, and these need to be investigated. For example:
- The breakdown of costs on BCV and SSL needs to be further refined, in particular because no adjustment has been made to the “overheads” cost of SSL North. ;
 - The Central line unit rates are higher because of the existence of two parallel structures doing the maintenance (TOs and ATC team);
 - BCV and SSL have a dedicated C&I team, which has no equivalent on Tube Lines;
 - The allocation of costs needs to be reviewed to ensure the consistency of the scope of the activities.
- 285 It is also important to note that the maintenance regimes and asset strategies are not the same across the three network areas, and therefore there are opportunities for optimisation.
- 286 Tube Lines uses a risk based approach to routine change, extending the change timescales in the Standard to accommodate Signalling system renewal. Following an Engineering Regulatory Notice (ERN) issued on BCV/SSL for non-compliance to the routine change standards, replacement is presently included until 2018 for SSL. This will be refined in two ways: on SSL, ad-hoc concessions might be granted to move towards a similar risk based replacement programme as opposed to a complete replacement programme, and, once the SSL Upgrade is finalised, the progressive introduction of the new Signalling system from 2014 will reduce the scope of Routine Change. The unit costs in LUL’s plan are for a full replacement at this stage.
- 287 The maintenance regimes are not necessarily aligned across organisation, which could mean that there is room for optimisation.

288 Tube Lines and LUL consider that there may be opportunities to reduce the current number of TO depots following the upgrade of the signalling systems. Further analysis is needed to understand how the number of TO depots and their location could be optimised. This will be carried out as part of the Signalling drill-down study.

Normalisation and Structural Factors

289 The Phase 6 asset maintenance Benchmarking identified one structural factor, which was statistically significant: the density of point ends, and the following graph shows the normalised signalling maintenance unit rates adjusted to take account of this structural factor.

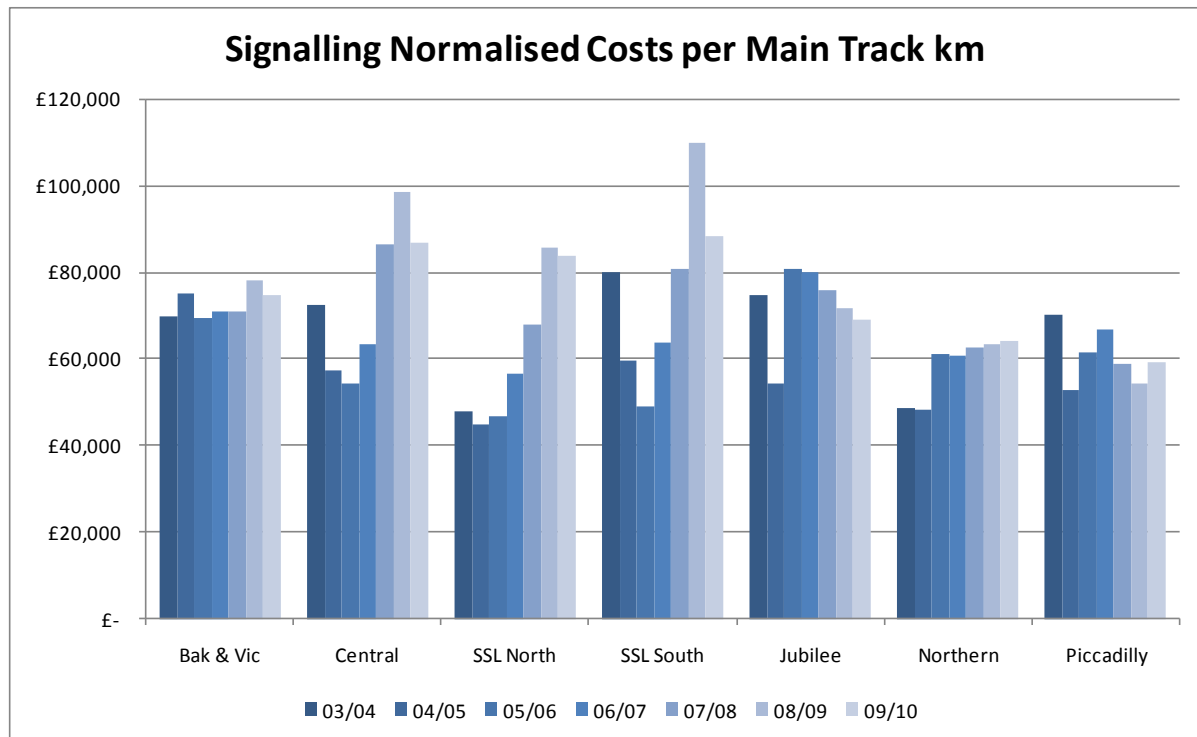


Figure 40 – Signals normalised maintenance cost per track km

290 The impact of the normalisation is mainly to increase BCV costs, because of a lower density of point ends on BCV. The data still shows a wide range of unit rates from £59,000 on the Piccadilly line to £88,000 on SSL South.

Structural factors

291 The following potential structural cost drivers were tested by BSL in 2009 to assess their impact on Signalling Maintenance costs but none of these emerged as having a significant correlation with total Signalling maintenance costs:

- Signal density;
- Train stops density;
- Point density;
- Track circuit density;
- Track utilisation.

292 The use of Signalling Equivalent Units (SEU) was mentioned as a potential cost driver in BSL benchmarking report dated 2010 for Signalling Maintenance. It should be

noted that this was at odds with BSL's conclusion in 2009. BSL subsequently normalised the maintenance costs for the density of SEUs.

- 293 The interface with Network Rail further adds to the complexity of BCV and SSL. The quantification of this factor needs to be explored.
- 294 The Arbiter did not recognise any correlation between the maintenance costs and the performance regime. However, Phase 5 of the asset maintenance benchmarking, raises the possibility that signalling preventative maintenance and response times are driven by the level of LCH and hence penalties incurred, i.e. that contract behaviour is a greater driver of cost than asset performance, despite the fact that there is no obvious correlation between the Signalling maintenance cost per track km and the Lost Customer hours per track km.

Areas for further investigation

- 295 A joint LUL-Tube Lines signalling maintenance study is already underway, to address some of the issues identified in this report, with the following objectives:
- Phase 1: Incident Response Time. This will examine the cost of response teams required vs. the cost of passenger disruption;
 - Phase 2: Signal maintenance pre-upgrade: This phase will review existing working practices of Technical Officers (TOs) across all London Underground lines in order to share best practices, identify areas for improvement and explain any remaining differences with peers;
 - Phase 3: Post-Upgrade Organisation. This phase will focus on the organisation of signal maintenance post upgrades.
- 296 Particular focus will be on achieving the following:
- Data comparability and consistency: a review of the signalling maintenance activities will be undertaken to ensure that comparison is made on a like for like basis. For example, inclusion/exclusion of power and routine maintenance activities;
 - Internal comparison of costs, productivity measure and related drivers. This will encompass: an analysis of organisational size and structure between BCV/SSL and Tube Lines, particularly number and distribution of TOs; and a comparison of unit rates across the network.
- 297 Once the internal comparisons have been made, and understood, the study will compare the organisation of signal maintenance with other metros around the world, through the CoMET group, and suggest a good practice post-upgrade signalling organisation.

8.4 Track Maintenance

- 298 LUL and Tube Lines are planning to spend circa £0.7bn on the maintenance of the Track assets between 2010/11 and 2017/18, which accounts for 20% of all benchmarked asset maintenance spend.
- 299 The asset maintenance benchmarking shows that in 2009/10 the unit cost of Track varies from £62,400 per track km on the Piccadilly line to £205,700 per track km on the SSL South lines. This is a range of maintenance costs of £143,300 per track km, before normalisation; and from £63,400 per track km on the Northern line to £204,800 per track km on SSL South lines, a range of £141,400 per track km after normalisation.
- 300 This section sets out the preliminary understanding of the reasons for this range of unit rates; provides LUL's and Tube Lines' forecasts of the maintenance cost unit rates to 2017/18, together with a summary of the ongoing efficiency initiatives which have been identified and are being implemented over this period; and identifies the key priorities for further investigation.
- 301 Efficiency savings plans developed by BCV/SSL significantly reduce but do not eliminate this gap. The BCV/SSL unit rate is forecast to decrease by £52,000 per track km from £157,000 per track km in 2009/10 to £105,000 per track km in 2017/18. The Tube Lines' unit rate is forecast to increase by £9,900 per track km from £68,500 per track km in 2009/10 to £78,400 per track km in 2017/18.
- 302 BCV/SSL and Tube Lines have different asset strategies, and during the development of this report, it has become increasingly apparent that the boundary between maintenance and renewals is different. Without understanding and explaining differences in asset strategy, scope and volume of maintenance, the backlog of maintenance and renewals work (and associated risk), and structural factors (i.e., curvature, asset residual life) it is not possible to determine relative levels of efficiencies of each line.
- 303 Further work is required, and ongoing, to understand the maintenance components; particularly for track refurbishment and heavy maintenance.

Track Asset Base

- 304 The following table sets out the passenger service track km and the percentage of curved track with check rail.

Track Assets 2009/10	Passenger Service Track Km	% of Curved Track with Check rail
Bakerloo & Victoria	72	9%
Central (incl. W&C)*	159	2%
BCV	230	
SSL North	172	2%
SSL South *	133	3%
SSL	305	
Jubilee †	96	0%
Northern	122	6%
Piccadilly	114	3%
JNP	331	

Table 23 –Track Asset Base (as at 1st April 2009)

* Central Line includes the Waterloo & City Line; SSL South includes District, and parts of the Piccadilly Line maintained by SSL.

† Jubilee Line includes the parts of the Metropolitan Line maintained by Tube Lines.

Track Asset Maintenance Benchmarking Cost Comparisons

- 305 The Phase 6 Asset Maintenance Benchmarking Report provides a comparison of track maintenance unit rates, by line, across the LUL network for seven years of data from 2003/4 to 2009/10.
- 306 The Asset Maintenance Benchmarking protocols for track maintenance resource costs include: direct and sub-contract labour, protection services, materials and track workshop costs, plant hire, track recording vehicle, ultrasonic testing, grinding and tamping costs, and engineering train costs.
- 307 The scope of the track maintenance activities include: track cleaning, vegetation control, compliance work, track lubrication and depot maintenance. The scope of the activities that are excluded are fencing, emergency response, overheads, and costs that are considered 'one-off' or not part of planned maintenance cycles.
- 308 The maintenance cost protocols also exclude capital expenditure for track refurbishment, e.g. re-rail, track lift or re-ballast for improved track geometry, and spot re-sleeper.¹⁸
- 309 The following graph shows the track maintenance unit costs per track km (excluding depots and sidings) across the lines maintained by LUL (BCV/SSL) and Tube Lines (JNP).

¹⁸ Pages 86 and 91 of Phase 5 Report.

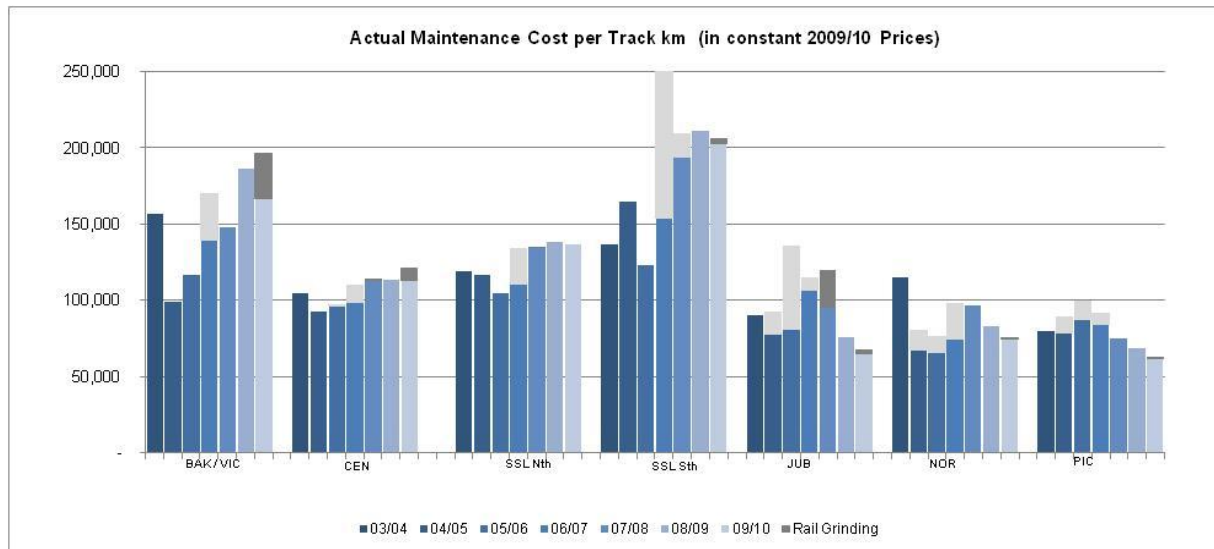


Figure 41 – Actual Track Maintenance Costs per Track km (in 2009/10 constant prices)

Note: For 2009/10, the dark grey stacked area represents an adjustment for rail grinding.

See the note below for the light grey stacks for previous years.¹⁹

- 310 Including rail grinding for BCV/SSL there is a wide range of track unit rates from £62,400 per track km on the Piccadilly line to £205,700 per track km on the SSL South lines. This is a range of maintenance costs of £143,300 per track km.
- 311 The Asset Maintenance Benchmarking data shows that the Jubilee and Piccadilly lines have the lowest unit rates on the network.
- 312 The Bakerloo and Victoria lines and SSL South have higher average unit rates than Tube Lines.
- 313 LUL's current understanding of the reasons for these differences include scope differences (e.g. additional grinding), contrasting asset strategies and volumes (e.g. 'heavy maintenance'), and varied asset residual life. These issues will be investigated in detail in the track maintenance drill down study.
- 314 A detailed comparison between BCV/SSL and Tube Lines is hindered by the lack of volume data available in Ellipse (APD's enterprise asset management system) and further frustrated by the transfer of cost management data from Ellipse to SAP in 2009/10 (LUL's account management system). Maximo (Tube Lines' enterprise asset management system) is able to provide volumes of work at a low level of detail (sub-activity), but is undergoing re-configuration to record costs at this same level of detail.
- 315 Consequently, significant further work is required to fully understand the scope of maintenance work undertaken and to achieve meaningful analysis.

¹⁹ For earlier years, for BCV/SSL, the light grey areas represent track compliance works in 2005/06 and 2006/07, and Prevention of Buckling (POB) works also in 2006/07. Tube Lines has track compliance works for all lines in 2005/06, 2006/07 and 2007/08, the costs of termination of a contract on the Jubilee Line in 2005/06 and costs associated with a derailment on the Northern Line in 2005/06. In 2007/08, the grey area on the Northern line comprises rail defect removal, life extension on P&C, and track lowered sites.

Performance

316 The following graph below shows the number of service disrupting incidents per track km (SDi per track km) across the lines managed by LUL (BCV/SSL) and Tube Lines (JNP).

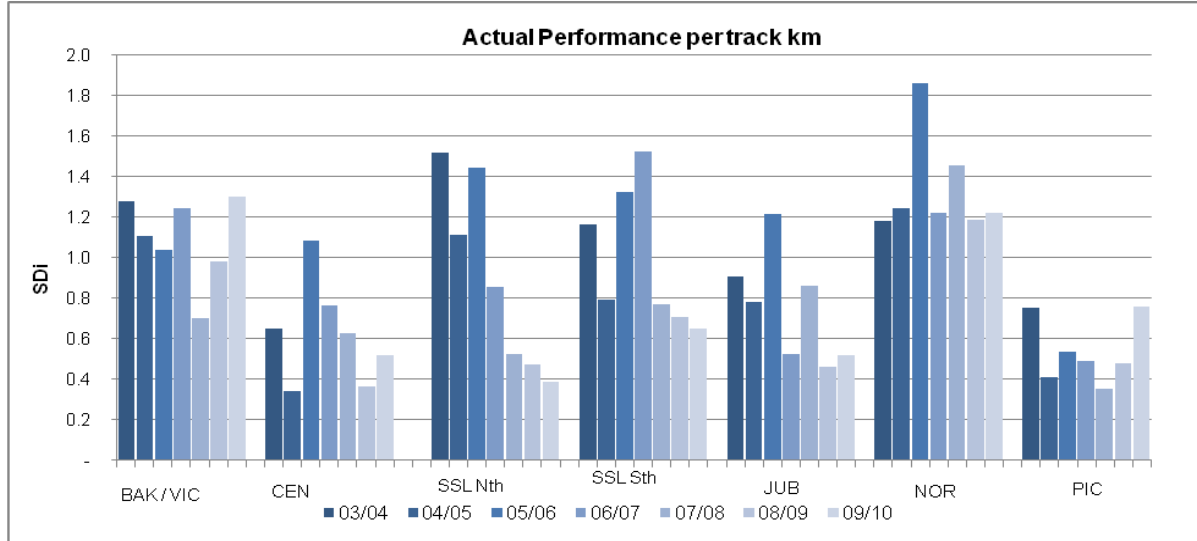
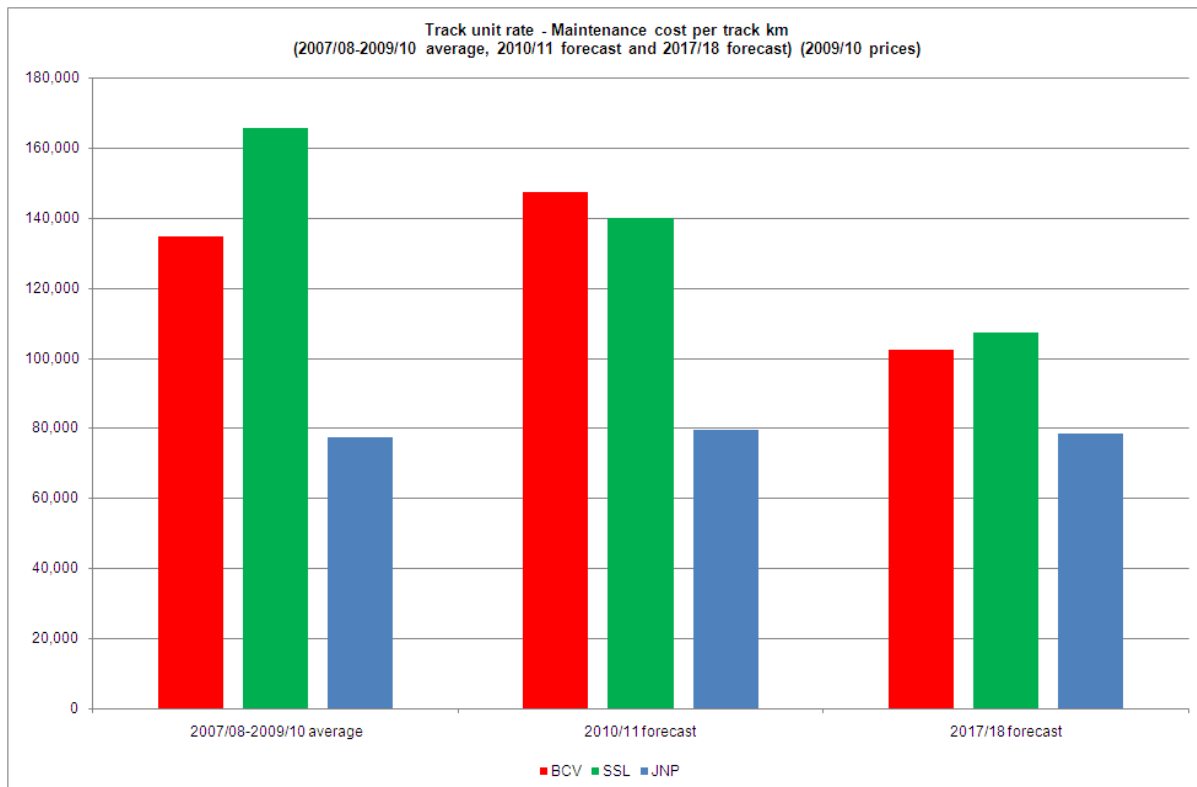


Figure 42 - Actual Track Performance per track km
 Note: Excludes the effect of POB on performance in 2006/07.

Future Costs and Planned Efficiencies

317 The following graph shows how the maintenance cost per track km for track, which is forecast to change over the next seven years for BCV, SSL and Tube Lines (JNP). The efficiency initiatives which are included in Budgets (e.g. the BCV/SSL Plan) to achieve these cost reductions are outlined below.



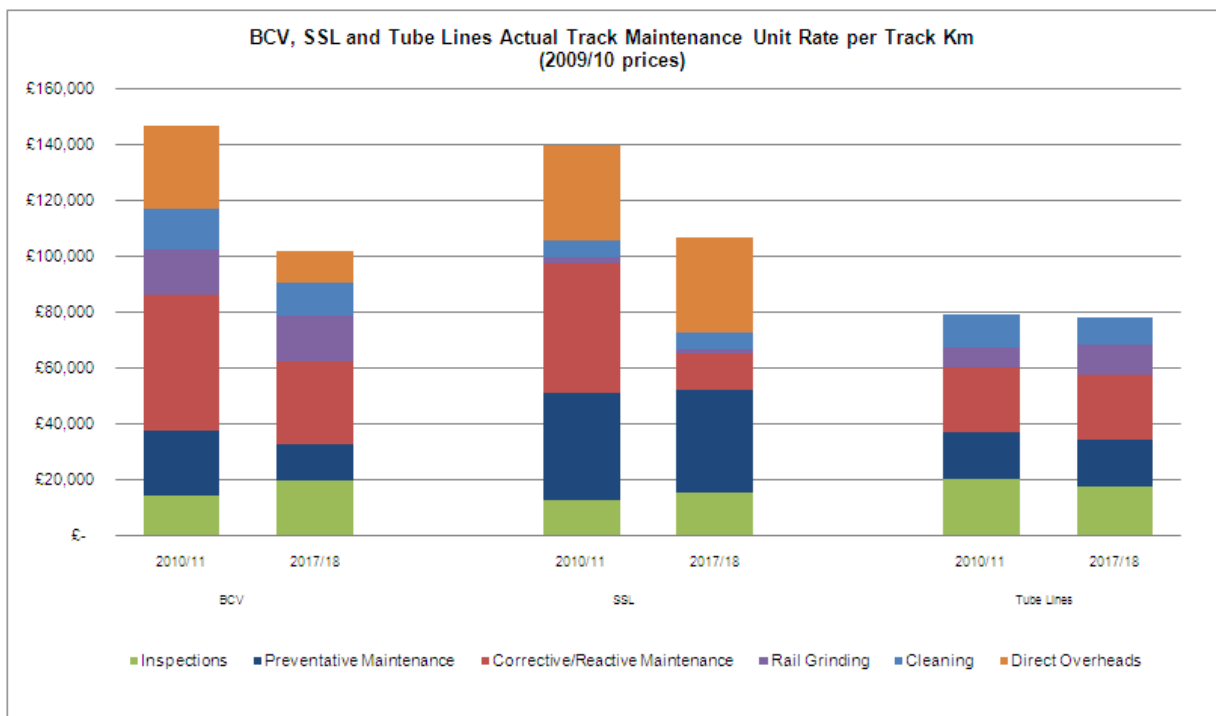


Figure 43 – Actual Maintenance Costs per Track km to 2017/18 (in 2009/10 constant prices)

Note: Tube Lines is forecasting 2010/11 rate to be the same as the 2011/12 rate, and 2017/18 to be the same rate as 2016/17.

318 The following graph also sets out the parties’ forecast unit rates in 2010/11 and in 2017/18, and splits out costs for various activities that are included in Asset Maintenance Benchmarking: inspections, grinding, preventative maintenance, reactive/corrective maintenance (and direct overheads in the case of BCV/SSL).

**Figure 44 – Forecast Maintenance Costs per Track km (2010/11 and 2017/18)
(in 2009/10 constant prices)**

Note: Tube Lines is forecasting its 2017/18 unit rate to be the same rate as the 2016/17 unit rate.

- 319 The BCV/SSL unit rate for track is forecast to decrease by £52,000 per track km from £157,000 per track km in 2009/10 to £105,000 per track km in 2017/18.
- 320 For BCV only, the unit rate for track is forecast to decrease by £42,300 per track km from £144,500 per track km in 2009/10 to £102,200 per track km in 2017/18. For SSL only, the unit rate for track is forecast to decrease by £59,300 per track km from £166,500 per track km in 2009/10 to £107,200 per track km in 2017/18.

BCV/SSL Efficiency Initiatives

- 321 The unit rate impact of efficiency initiatives for BCV/SSL (combined as some savings apply to both organisations) is shown for the Maintenance Capability Plan (MCP) efficiencies and from increased scope of renewals, Automated Track Monitoring System (ATMS), initiatives such as achieving lower maintenance unit rates (MUR), and savings from contract re-negotiation (Total Purchase Services or TPS). It also shows an adjustment for structural factors (based on those identified in 2009/10²⁰) and the normalised unit rate for 2017/18.

²⁰ The asset base will change over time (i.e. renewals and further asset residual life degradation); therefore it is likely that the structural factors will also change by 2017/18. Nevertheless, our current estimate is to normalise for the percentage of track with check rail only.

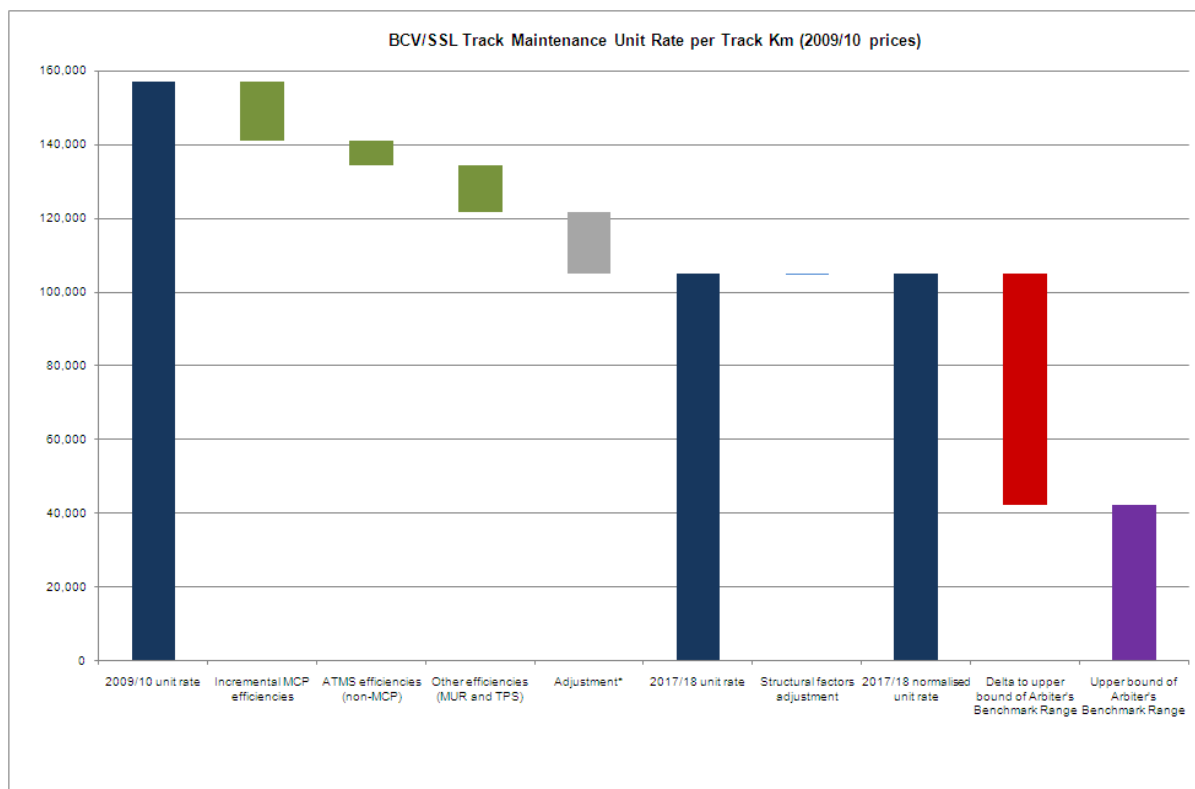


Figure 45 – Waterfall comparing BCV/SSL 2009/10 unit rate to 2017/18 and the Arbiters' 'Benchmark range' (in 2009/10 constant prices)

* See the footnote below explaining the Adjustment.²¹

Increased Capital Renewals and MCP Efficiencies

322 LUL started to implement efficiencies and achieve savings through the MCP in 2009/10, and along with the benefits from a continuing programme of capital renewals, is forecast to deliver savings of £14.5m (£27,100 per track km) p.a. in 2017/18. Of these savings £5.9m (41%) were achieved in 2009/10.

323 These initiatives can be summarised as follows:

- Capital renewals – track asset residual life will improve as a result of the continued programme of capital renewals. This in turn will result in a reduction in the levels of corrective maintenance and improved performance;
- Maintenance regime optimisation – various saving initiatives will optimise the existing maintenance regimes, and further reduce inspection frequencies (e.g. reducing the frequency of manual patrols or less litter picking). This will include getting better at sharing ideas and successful ways of working (e.g. adopting practices already used on other underground lines or used by Network Rail). This may result in the need to challenge or amend some LUL Standards;
- Staffing efficiencies and improved working practices – initiatives will be introduced to reduce staff numbers by removing already existing staff vacancies, and also

²¹ This Adjustment captures the efficiencies not specifically listed in this paper, and the effect of changes in volumes or the actual timing of when efficiencies are implemented during each financial year. It allows the reconciliation between the 2009/10 unit rate, the listed efficiencies, and the forecast 2017/18 unit rate.

reducing contract labour/agency staff (e.g. developing the competence of existing staff through multi-skilling);

- Reduced overhead costs – within track and signals asset areas, savings will be achieved by removing of duplication and streamlining of requirements (e.g. integration of projects and combining maintenance support functions within the joint asset management team);
- Improving the utilisation of equipment (including approved under LUL Standards) – increased mechanisation of inspections, and using a DISAB machine (plant which replaces ballast) to remove wet beds more frequently to reduce maintenance costs. Furthermore, a greater reliance on the Connect Radio network will also reduce mobile phone and other communication costs; and
- Improving materials management and storage, and better transport logistics – better use of local storage areas, and transport and fleet utilisation improvements.

Automated Track Monitoring System (ATMS)

- 324 The installation of ATMS equipment to passenger trains will allow daily high frequency track geometry inspections, including measuring track geometry and the location of faults. This will enable early identification of defects, establish degradation rates, enable better planning of works prior to fault, and enable the monitoring of the impact following interventions. The introduction of ATMS will lead to a reduction in manual inspections and, through improved planning, a corresponding reduction in corrective maintenance. ATMS equipment is planned to commence operation in late 2011.
- 325 ATMS is expected to deliver savings of £3.5m (£6,600 per track km) p.a. in 2017/18.

Other Initiatives (MUR and TPS)

- 326 Lower maintenance unit rates (MUR) for activities are assumed, which involves, paying less for materials and lower unit rates for current activities.
- 327 Total Purchase Services (TPS) involves efficiencies from consolidating and reducing the number of external suppliers. In addition, it involves re-negotiating labour supply contracts (i.e., achieving lower schedules of rates).
- 328 Adjusting for these MUR and TPS initiatives delivers savings of £6.7m (or £12,500 per track km) p.a. in 2017/18.

Tube Lines Efficiency Initiatives

329 The Tube Lines unit costs increase from 2009/10 to 2017/18.

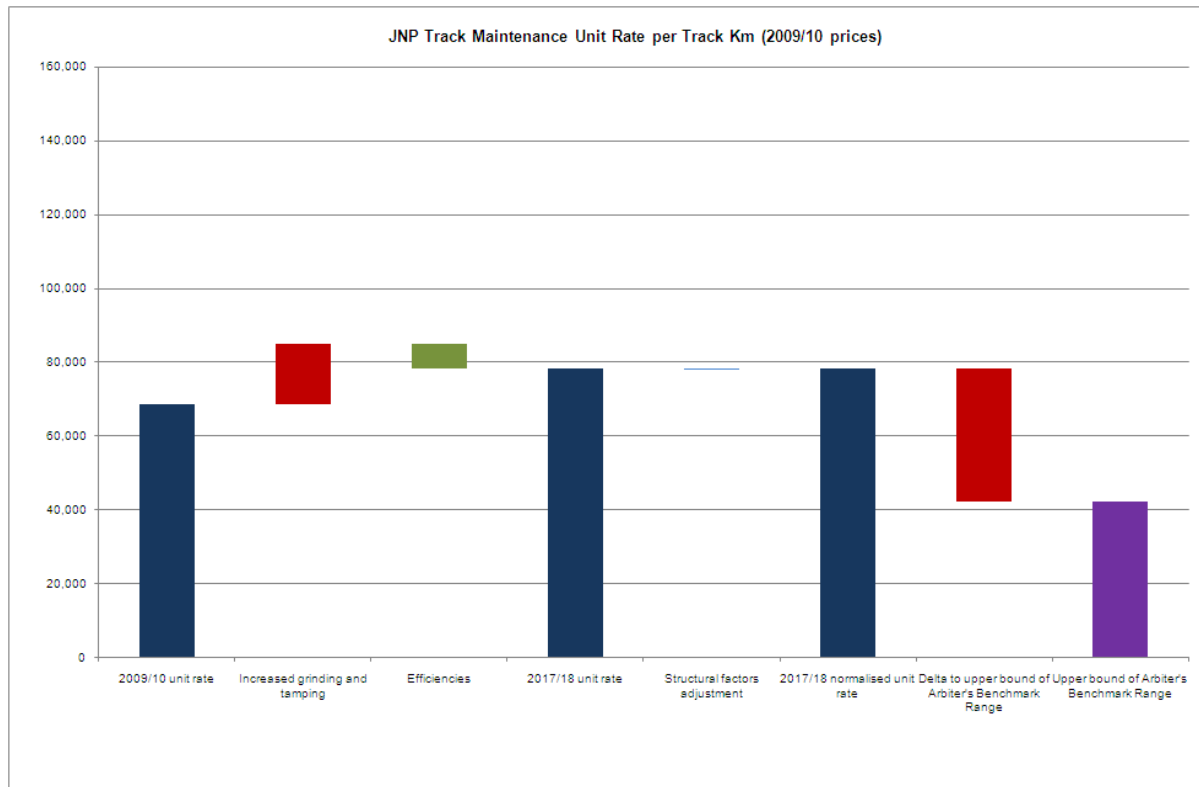


Figure 46 – Waterfall comparing Tube Lines 2009/10 unit rate to 2017/18 and the Arbiter's 'Benchmark range' (in 2009/10 constant prices)

- 330 The waterfall graph above shows that there remains a 'delta' of £36,000 per track km the Tube Lines forecast unit rate in 2017/18 and the upper bound of the Arbiter's benchmark range as determined by BSL in its international benchmarking report.
- 331 Tube Lines' unit rate for track is forecast to increase by £9,900 per track km from £68,500 per track km in 2009/10 to £78,400 in 2017/18. The volumes of grinding and tamping that are planned over this period are significantly increased compared to historic volumes. These volumes are due to addressing the increased tonnage following the upgrades, and to improve track geometry and reduce forces driving track degradation.
- 332 Tube Lines has planned efficiency savings that will be achieved through a move from a "Find-and-Fix" to a "Predict-and-Prevent" strategy for track faults using output from the Asset Inspection Train (AIT) and an improved approach to ultrasonic rail testing. Additionally, a risk based approach will be taken to the determination of inspection frequencies in conjunction with LUL resulting in an average increase in inspection intervals, and a consequential saving.

Normalisation and Structural Factors

- 333 There are structural differences between lines, over which management has little or no influence in the short to medium term. In order to take account of these structural differences, asset maintenance benchmarking assesses and then normalises the unit rate data.

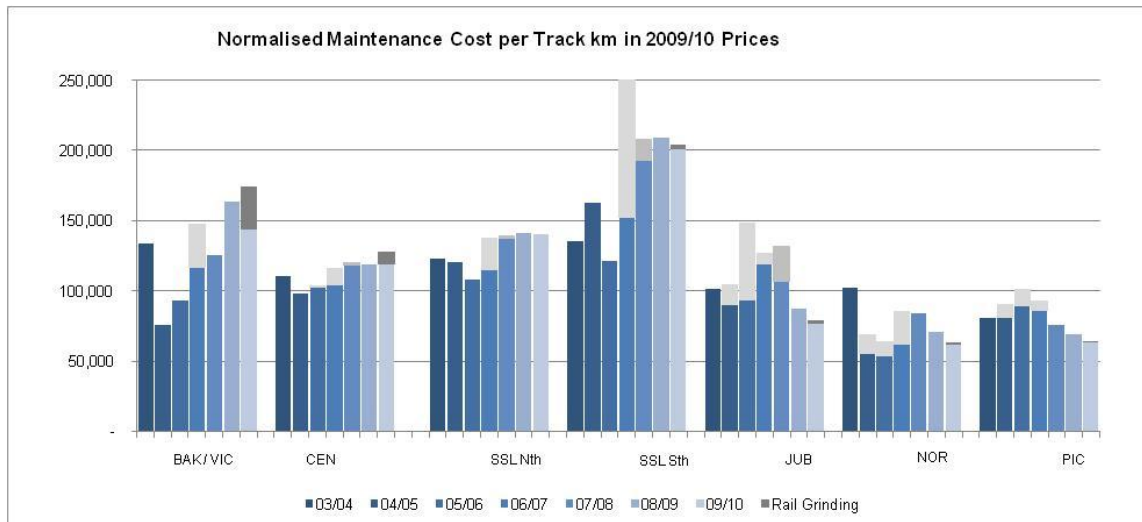


Figure 47 – Normalised Track Maintenance Costs per Track km (£/km) across the lines managed by LUL (BCV/SSL) and Tube Lines (JNP) (in 2009/10 constant prices)

Note: For 2009/10, the (non-normalised) dark grey area represents an adjustment for rail grinding.²²

- 334 The Phase 6 Asset Maintenance Benchmarking data has been normalised to reflect the percentage of the passenger service track that has check rail installed in curved areas. This is the only structural factor which is considered statistically significant, based on current understanding of the available cost and volume data.
- 335 In previous years, normalisation adjustments have also been applied for the percentage of the passenger service track that is sub-surface (as opposed to open or tube). While it is accepted by the parties that sub-surface track suffers many of the disadvantages of ballasted track in the open, and few of the access advantages due to being in a partly-enclosed environment, there are concerns that the impact is overstated due to the small sample size (i.e., only two lines with sub-surface track), and therefore this structural factor has not been used in the Phase 6 normalisation.
- 336 After normalisation for structural factors and including rail grinding, the size of this range is £141,400 per track km; from £63,400 per track km on the Northern Line to £204,800 per track km on the SSL South Lines. Excluding rail grinding, after normalisation for structural factors, the size of this range is £139,100 per track km; from £62,300 per track km on the Northern Line to £201,400 per track km on the SSL South Lines. This is a decrease in the range and change in the lowest cost line: the lowest was the Piccadilly Line, but now it is the Northern Line.

²² For earlier years, for BCV/SSL, the (non-normalised) light grey areas represent track compliance works in 2005/06 and 2006/07, and prevention of buckling works also in 2006/07. Tube Lines has track compliance works for all lines in 2005/06, 2006/07 and 2007/08, the costs of termination of a contract on the Jubilee Line in 2005/06 and costs associated with a derailment on the Northern Line in 2005/06. In 2007/08, the grey area on the Northern line comprises rail defect removal, life extension on P&C, and track lowered sites.

Additional Structural Factors

- 337 There may be other structural factors, which have not been identified, or more likely, cannot be shown to be statistically significant. As the parties provide increasingly disaggregated data by cost activity, new structural factors may emerge.
- 338 Moreover, as the asset residual life profile of the track changes with increased levels of renewals (including updating WLAM models with revised residual life data) this may affect the statistical significances of the structural and explanatory factors. Going forward, all aspects of the data book (track km, asset age and residual life, percentage tube, open or sub-surface, percentage bull-head or flat-bottom rail etc) will be fully reviewed to re-assess and validate as to whether there other structural factors that should be taken into account for normalisation.
- 339 BSL, in its International Benchmarking Report for the Arbiter (16th March 2010, pp 37-53) identified track utilisation was the only significant structural factor.²³ This is similar (but not identical) to 'passenger kilometres by line', which was tested during Asset Maintenance Benchmarking, but not identified as a significant structural factor.
- 340 Other structural factors that were tested by BSL, but not proven to be significant, included density of point ends. This analysis may change once only the various discrete repetitive maintenance activities are compared across lines, and scope differences due to track refurbishment or heavy maintenance activities are isolated.

Arbiter's Benchmark Range

- 341 The waterfall graphs above show the upper bound of the benchmark range of £42,300 per track km, which was determined by BSL in its international benchmarking study for the Arbiter, broadly on the normalised unit cost levels of the international peer metros.

Further Analysis of Maintenance Activities

- 342 There are likely to be a number of efficiency opportunities which are not currently included in the BCV/SSL plan to 2017/18. Based on the benchmarking analysis, this section looks at what these opportunities might include, and makes recommendations as to further studies and analysis to identify these opportunities.
- 343 The BSL Report (16th March 2010) also looked at a number of explanatory factors, which may explain the difference between BCV/SSL and Tube Lines' and the Arbiter's 'Benchmark range'. BSL determined that it could explain c. 48% of the cost gap for BCV/SSL to the upper bound of the Arbiter's 'Benchmark range' by relative levels of labour rates/productivity, inspection regime, asset residual life, and finally, access and tube tunnels and other.
- 344 As outlined above, BCV/SSL are tackling many of these suggested savings from BSL via maintenance regime optimisation (i.e., changes to maintenance intervals/frequency) and reducing staffing (including sub-contract or agency), however, further investigation is required to ensure that all of BSL's recommendations have been fully explored. BSL did accept, however, that such adjustments would take a long time to implement and those changes would require co-operation with stakeholders.

²³ Track utilisation which represents the intensity of the usage of the track asset: the more car-km travelled along a particular route length, the higher the wear on track.

345 BSL also suggested a range of other factors that may explain the cost difference between the London lines and the Benchmark range e.g. the proportion of ballast track, and the larger proportion of track with tight radius curves (i.e. check rail); methods for transport of materials to site; the length of track that is maintained or renewed at a time; organisation of staff gangs; rail grinding strategy; tunnel water ingress; use of machinery and mechanisation; and finally, the use of maintenance sub-contracting.

Areas for further investigation

- 346 The parties recognise that further work is needed to ensure comparisons of unit rates for a similar scope of works can be made; to identify further structural factors; and to consider the range of factors identified by BSL to drive costs lower. Regardless of the level of efficiency the Arbiter and BSL concluded may be possible, many lines on the London Underground network are currently above the level of the range of the lower cost lines. Therefore further work needs to be completed to understand these cost differences.
- 347 To facilitate this analysis, two separate initiatives to improve track maintenance data comparability will be undertaken.
- 348 First, a joint exercise will be completed to establish standard activities with suitable scale limits applied to define inclusion or exclusion from the underlying cost of maintenance (i.e. re-railing > 90m is heavy maintenance or spot re-railing < 90m is maintenance). These definitions can be included in the AGS and also used to revise the standard activities recorded in Ellipse/Maximo.²⁴ Analysis will also be undertaken on overhead costs (excluded from Asset Maintenance Benchmarking) to ensure comparable treatment is being made by both parties.
- 349 Second, a drill down study into track maintenance costs will be undertaken which will focus in particular on determining the exact scope of works or discrete repetitive activities (e.g. manual inspections and servicing type activities e.g. track cleaning) that are being carried out by each maintenance organisation. In addition, this study will identify the asset regime, the treatment of overheads, and the risk strategies being employed by each maintenance organisations, and how these strategies interface with WLAM principles and the renewals programme. This drill-down study should make it possible to determine the scope of all the various discrete repetitive maintenance activities, and how unit rates for these similar activities vary across all lines. Once a clear and comparative scope is determined, analysis of labour costs (i.e., FTE staff costs per track km) will be carried out, which will assist with the understanding of the most efficient lines for certain activities (e.g. manual patrols and inspection costs per km).
- 350 In parallel, a greater focus will be placed by APD on ensuring that all work orders are processed within the asset fault and enterprise asset management system alongside the costs incurred during completed and closed work orders. This will also include a greater emphasis on the booking of time to work orders or work areas/activities (e.g. costs being fully attributable to heavy maintenance, or any inspections/maintenance

²⁴ The most cost effective time to implement changes to Ellipse/Maximo is likely to be at the point of the software upgrade.

carried out within depots) with monitoring through metrics incorporated into the Balanced Scorecard.

- 351 Ellipse is likely to have its software upgraded in the near future with improved functionality, which will ensure the system can provide data that is more 'user friendly' for analysis (e.g. discrete repetitive activity cost comparisons from a benchmarking perspective). Steps will also be taken to separate out cost data for each line. For illustration, combining data for the Bakerloo and the Victoria lines masks the Victoria line's better performance, as there is no check rail on the Victoria line, and 28% on the Bakerloo.
- 352 LUL and Tube Lines are currently completing a track renewals unit rate study, which compares the unit rates for different track interventions. The parties will also identify which delivery organisation (projects or maintenance) completes which particular activities or interventions.

Annex 1 – Track Asset Base

353 The following table includes details of the aspects of the asset base that have been identified as structural factors (i.e. the percentage curved track with check rail) and other key aspects (i.e. track in tunnel (either sub-surface or tube) and the length of track (both passenger service/running and for the depots and sidings). The density of P&C units is also included as it is understood that this may impact on maintenance costs. Going forward, during Asset Maintenance Benchmarking, greater focus will be placed on the asset age and residual life, which is not included in the Table below.

Track Asset Base	Passenger Service/Running Track					Depot & Sidings		Total
	Km	Rail type (BH)	% Curve - Check	% Sub-surface	Density of P&C	Km	% of Track Km	Km
Bakerloo & Victoria	72	65%	9%		0.76	21	23%	92
Central*	159	64%	2%		1.07	51	24%	210
BCV	230					72	24%	302
SSL North	172	49%	2%	19%	1.24	34	17%	207
SSL South*	133	66%	3%	31%	1.81	20	13%	153
SSL	305					55	15%	360
Jubilee †	96	31%	0%		1.85	13	12%	109
Northern	122	62%	6%		1.41	32	21%	153
Piccadilly	114	62%	3%		1.55	27	19%	141
JNP	331					72	18%	403

Table 24 – Key Aspects of Track Asset Base 2009/10 (excluding Asset Condition)

* Central Line includes the Waterloo & City Line; SSL South includes District and the parts of the Piccadilly Line maintained by SSL.

† Jubilee Line includes the parts of the Metropolitan Line maintained by Tube Lines.

8.5 Stations Maintenance

- 354 LUL and Tube Lines are planning to spend circa £0.8bn on the maintenance of the Stations assets between 2010/11 and 2017/18, which accounts for 22% of all benchmarked asset maintenance spend.
- 355 Phase 6 of the asset maintenance benchmarking shows that in 2009/10 the unit cost per Station varies from £332,000 to £440,000, a range of £108,000 before normalisation; and from £366,000 to £423,000, a range of £57,000 after normalisation.
- 356 This section sets out the preliminary understanding of the reasons for this range of unit rates; provides LUL's and Tube Lines' forecasts of the maintenance cost unit rates to 2017/18, together with a summary of the ongoing efficiency initiatives which have been identified and are being implemented over this period; and identifies the key priorities for further investigation.

Stations Asset Base

- 357 The current stations maintenance expenditure relates to maintenance for 250 stations and covers assets relating to premises, fire protection systems, communication systems, electrical systems and mechanical systems.

Line	No. Stations	Notes
Bakerloo	11	Oxford Circus included
Central & W&C	44	
Victoria	10	
District	41	
Metropolitan	44	Wood Lane included
Jubilee	24	
Northern	40	
Piccadilly	36	
TOTAL	250	

Table 25 – Number of stations by line

Stations Asset Maintenance Benchmarking Cost Comparisons

- 358 The Phase 6 asset maintenance benchmarking provides a comparison of maintenance rates, by Infracore grouping, across the LUL network for six years of data from 2004/5 to 2009/10.
- 359 The following graph below shows a comparison of the average maintenance costs per station for each of the six years based on actual costs. This figure includes the maintenance costs for station services (communication, fire, mechanical and electrical assets) and premises, including cleaning costs.

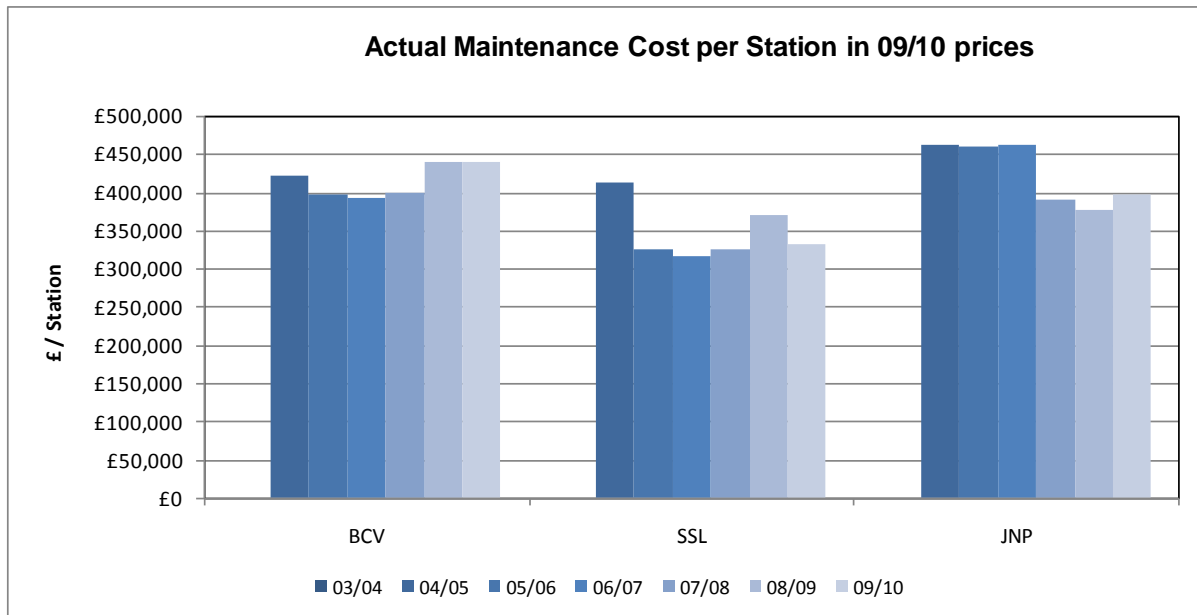
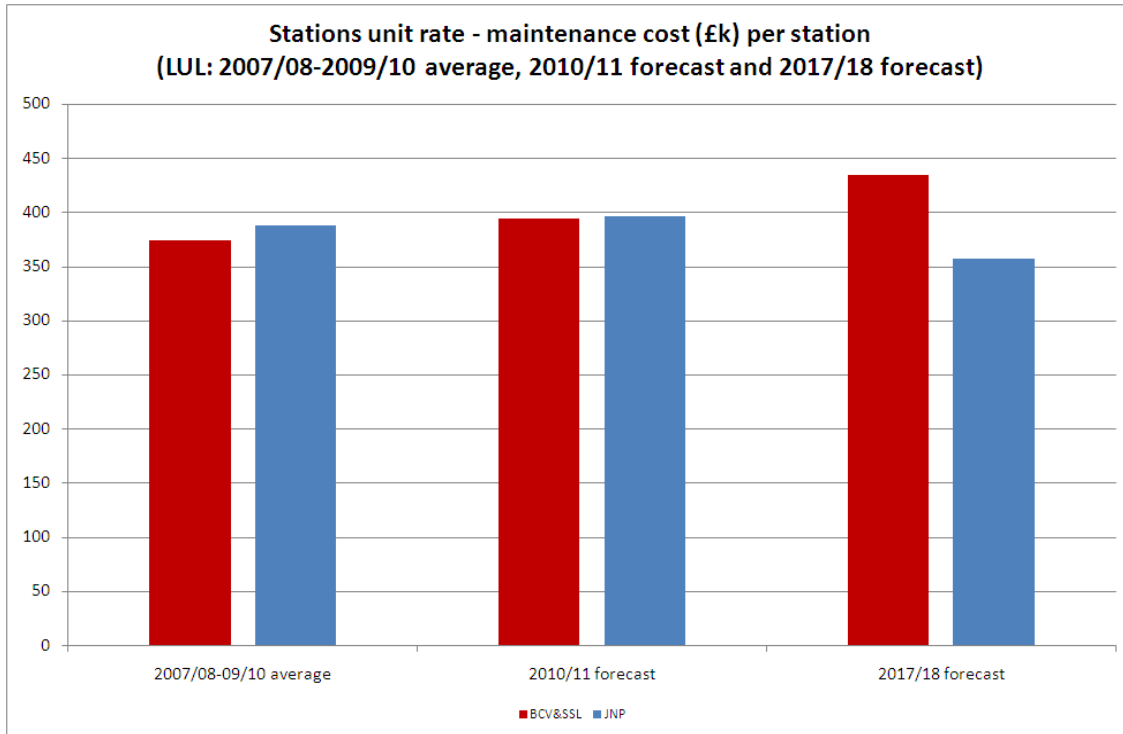


Figure 48 – Station Maintenance Costs per Station (09/10 prices)

- 360 The data shows a range between the average station maintenance cost for 2009/10 of £332,000 to £440,000, a variance of £108,000. This variance can partly be explained by structural differences between the Infraco groups, the key factor being the varying station sizes, in particular the Jubilee Line Extension stations. The Phase 6 asset maintenance benchmarking takes this into account as a structural factor used to normalise the data, which is explained later in this report.
- 361 It is noted that there is some inconsistency in cost allocation for station maintenance costs across BCV/SSL and Tube Lines, e.g. the inclusion of costs for assets such as line side buildings, depots, tunnel telephones and OPO CCTV differs between BCV/SSL and Tube Lines. This is an area which requires further work.

Future Costs and Planned Efficiencies

- 362 The graph below shows the average station maintenance cost for the last three years (2007/08-2009/10), the 2010/11 forecast and the forecast cost for station maintenance in 2017/18. These are expressed as the average maintenance cost per station.



Note: Tube Lines advise that JNP maintenance costs forecast for 2010/11 are the same as 2009/10 costs.

Figure 49 – Station unit rate: maintenance costs per station (09/10 prices)

BCV/SSL Future Costs and Planned Efficiencies

363 The following graph shows the change in the station unit rates between 2009/10 and 2017/18 for BCV/SSL. The cost increases and efficiencies shown are explained below.

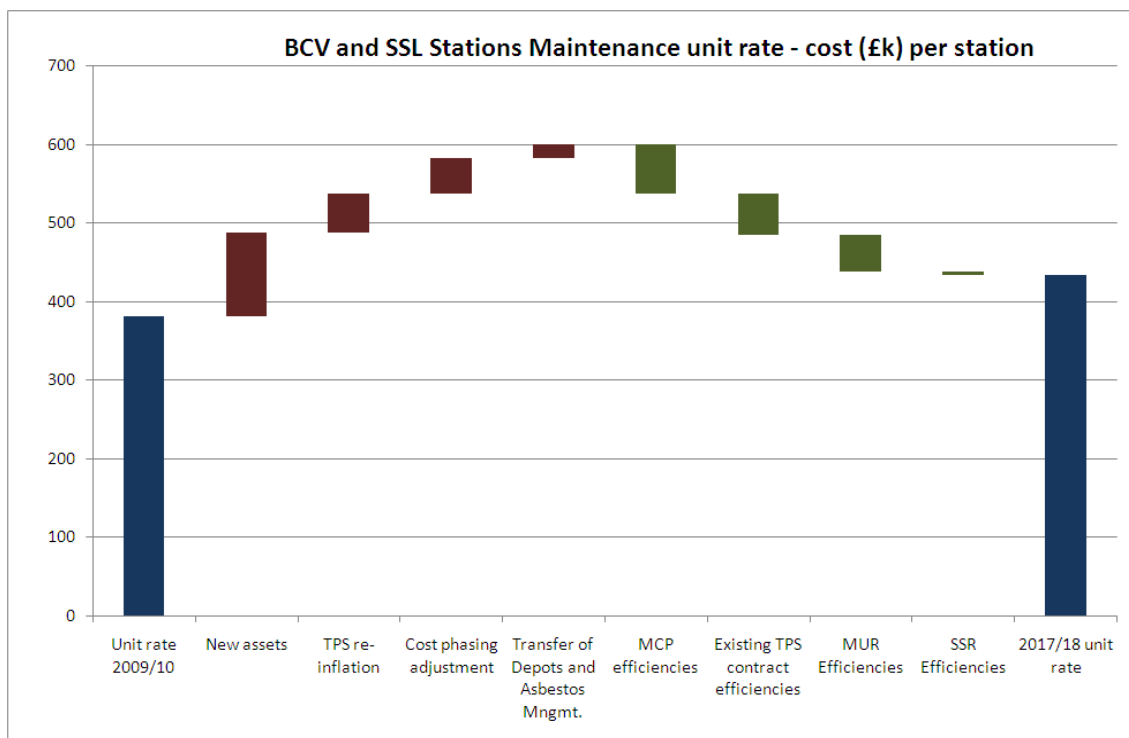


Figure 50 – BCV/SSL Stations Maintenance Unit Rate – cost per station (09/10 prices)

Future contract prices

- 364 The BCV and SSL maintenance costs primarily relate to the four maintenance contracts (the Total Packaged Services (TPS) contracts) which have been introduced for maintaining premises, fire systems, communication systems and electrical & mechanical (E&M) systems. Each of the four contracts cover assets across both BCV and SSL rather than being Infraco or line based and therefore, the waterfall graph above combines the stations unit rate cost of BCV and SSL.
- 365 In addition, the maintenance unit rate for BCV and SSL is forecast to increase by £52,800k per station, from £381,500 per station in 2009/10 to £434,300k in 2017/18. This predominantly relates to the increased number of station assets being delivered by Crossrail and the congestion relief projects, giving an increase of £17m over the period. This increase is due to the expansion of the existing stations and the corresponding provision of additional assets which impacts the unit rate used of maintenance cost per station. Additional forecast increases in station maintenance costs relate to the renegotiation of the BCV/SSL TPS maintenance contracts in 2013-15, an increase of £8m over the period. The current TPS contract prices are set at fixed prices, which are not indexed for the duration of the contracts. Therefore it is expected that the cost of the renegotiated contracts will reflect the impact of inflation over the period of the existing contracts.
- 366 The increase in unit rate is also attributable to transferring some costs for depot maintenance to the stations budget to align with the TPS contracts giving an increase of £2m over the period; and for works relating to asbestos management, an increase of £1m over the period. There is also a cost phasing adjustment which has been applied in the 2017/18 financial year.

Maintenance Capability Plan (MCP) and other efficiencies

- 367 The increased contract prices are partially offset by planned efficiencies which are being delivered through the Maintenance Capability Plan (MCP) and further efficiencies as outlined below.
- 368 The Maintenance Capability Plan includes savings for stations maintenance which started to be achieved in 2009/10 and will total £9.5m for the year 2017/18. The savings primarily relate to improving organisational efficiency and utilising cost reduction mechanisms within existing contracts. Other savings consider changes to strategy, revising current contractual arrangements to reduce contractual costs and reducing overhead costs.
- 369 £1.8m of the identified savings relate to achieving greater organisational efficiency within the Asset Performance Directorate (APD). Changes to realise £0.6m of these savings have already been implemented with no adverse impact on performance.
- 370 A saving of £3.5m is expected to be achieved through utilising cost reduction clauses within existing contracts. Changes to existing contracts, including moving to performance based contracts, is expected to realise a saving of £0.3m.
- 371 A review of team on-costs such as those for stationery and IT is expected to achieve a saving of £1.4m. The remainder of the identified savings relate to changes to ways of working, such as more automated and remote working and use of extended engineering hours; savings as a result of the reductions in the minor works budget and a further review of all non committed funds. This is expected to realise a saving of £2.2m.

372 Further efficiencies over and above MCP are also forecast to be delivered. These include the realisation of efficiencies being delivered as part of the current TPS contracts (£7.9m); reductions in the APD maintenance unit rates (£7.2m); and efficiencies being realised through the Support Services Review (£0.6m).

Tube Lines' Efficiencies

373 The following graph shows the same graph for JNP with information provided by Tube Lines. The efficiencies shown relate to combining the contracts for ambience and security, and the introduction of Maximo on premises assets so contractor involvement can be targeted more accurately.

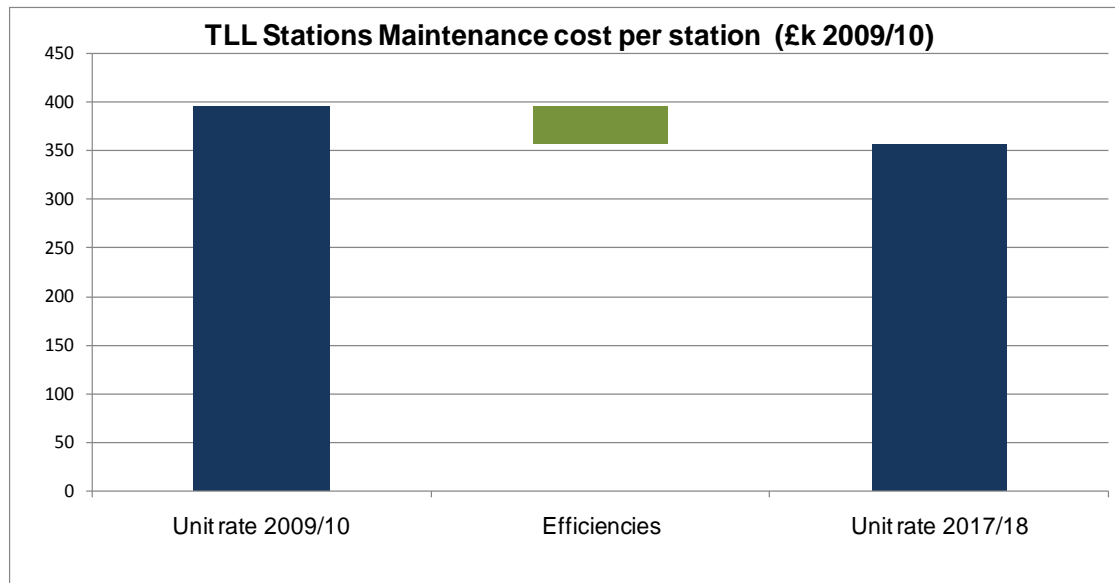


Figure 51 – Tube Lines Stations Maintenance Unit Rate – cost per station – JNP (09/10 prices)

374 Unlike some other asset areas the international benchmarking undertaken by the PPP Arbiter did not include an analysis of good practice and associated costs for stations assets therefore at this time there is no external comparator with which to compare LUL and Tube Lines costs.

Normalisation and Structural Factors

375 The Phase 6 asset benchmarking analysis identified one structural factor which is statistically significant and therefore could be used to normalise the data, this being station size (measured in square metres).

376 The following graph shows the normalised maintenance costs per station when adjusted for size.

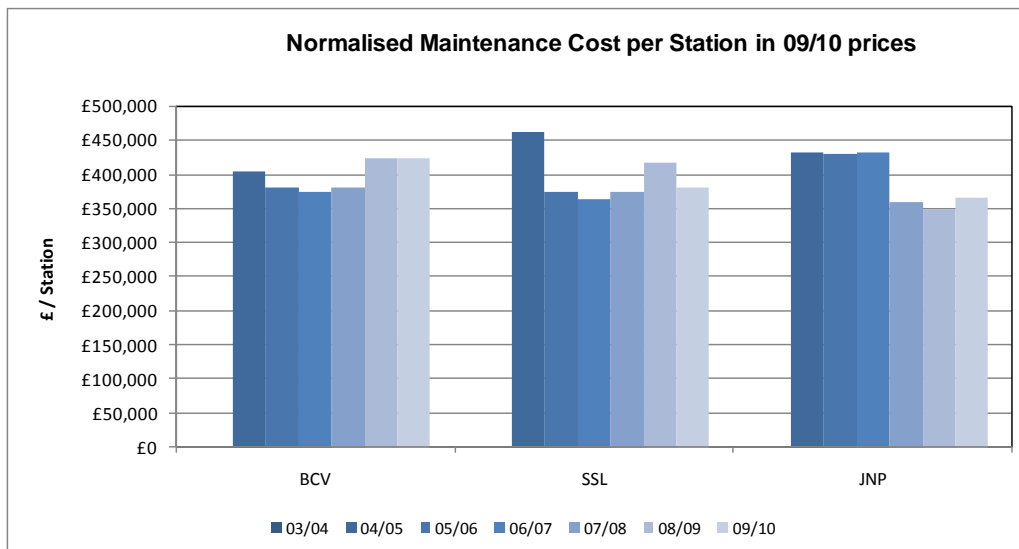


Figure 52 – Normalised Maintenance Costs per station (09/10 prices)

- 377 By taking into account the differing sizes of stations the normalised data shows that the range of costs per station for 2009/10 becomes £366,000 to £423,000, a reduced variance of £57,000.
- 378 The Phase 6 asset benchmarking analysis also examined a number of other structural factors, including whether the station is in the open or sub-surface, and whether the station has listed status. None of these other factors were found to be statistically significant at this level of analysis.
- 379 As previously noted there are some differences attributable to the fact that cost allocation for station maintenance costs across BCV/SSL and Tube Lines is not consistent, e.g. costs for line side buildings, tunnel telephones, OPO CCTV, etc.
- 380 To better understand the cost drivers for station maintenance costs it will be necessary to compare the costs at asset group level, i.e. premises, electrical, mechanical, communication and fire protection systems. This level of analysis will also reflect the maintenance contract arrangements which are let on an asset group basis.
- 381 The following graph shows the maintenance costs per station split out into these asset areas, with cleaning costs shown separately. The “Average” data column shows the mean cost per asset group for the four years shown.

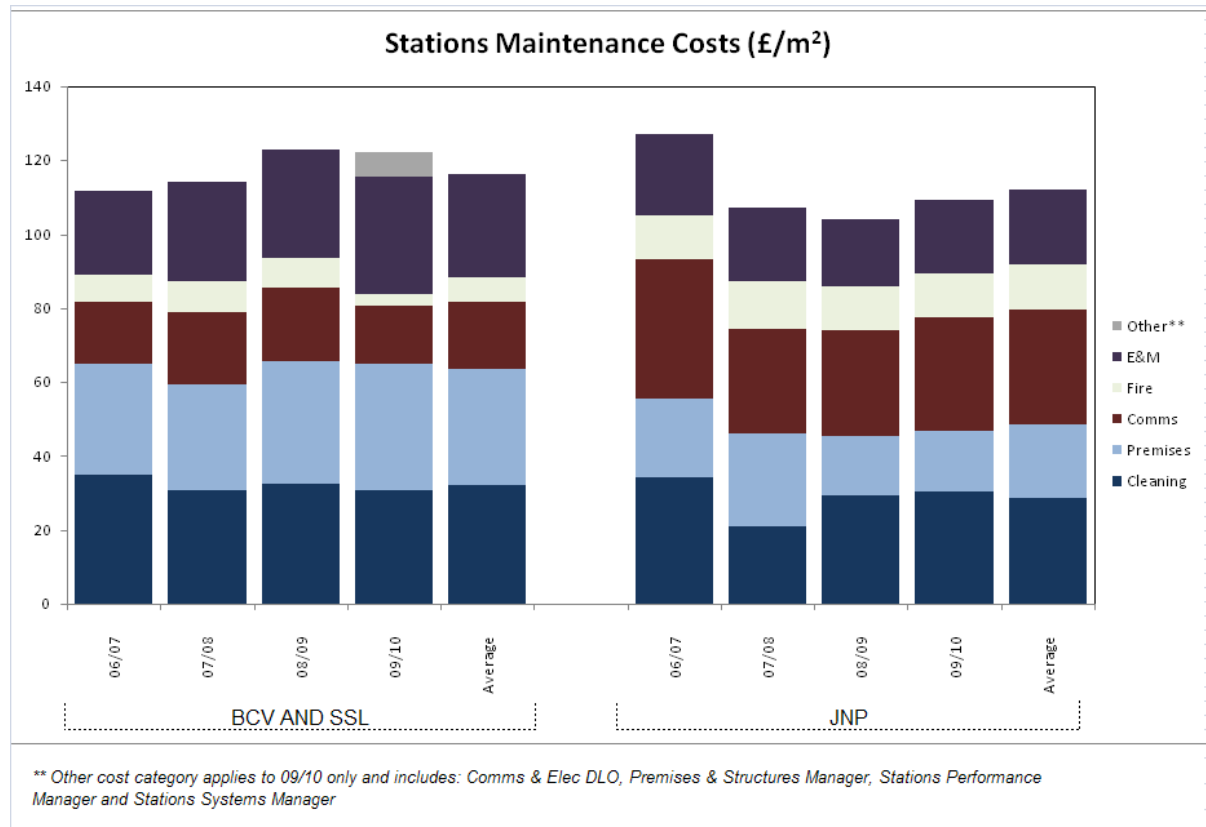


Figure 53 – Stations Maintenance Costs at asset group level

- 382 This shows that the cleaning costs across the three Infracos are broadly comparable; premises maintenance costs and E&M maintenance costs are lowest for Tube Lines, with communication and fire asset maintenance costs being lowest for BCV/SSL.
- 383 Further analysis will be carried out to separately identify other material elements of cost; for example, tunnel telephone, tunnel lighting systems and OPO CCTV equipment. Also, future benchmarking studies will separately identify the costs relating to the maintenance of the Silverlink stations.
- 384 The costs are shown as cost per square metre as this is believed to provide a better representation of the costs at the asset group level rather than cost per station. It is recognised however that further analysis will be required to understand the best level of comparison for each of the asset groups, i.e. cost per area is expected to be most relevant for premises and cleaning costs, but other factors such as being a sub-surface station will affect the cost of maintaining communication and fire assets.

Areas for further investigation

- 385 It is proposed to review the cost differences identified above for the station asset groups for each of the Infraco areas. This will provide an understanding of the reasons for the variances and identify best in group for each of the asset areas. It is proposed that from this the potential for suitable further efficiencies can be considered.
- 386 The level of detail in the current data will be reviewed to ensure the viability of benchmarking at the asset group level, e.g. E&M, communication systems, fire systems, premises, etc, rather than at Infraco group level or by line. This will enable comparison and benchmarking at a unit rate commensurate with the contractual

- arrangements in place for maintaining the assets and lead to the identification of cost drivers at the asset group level.
- 387 Subsequent to this review it is intended that the analysis is expanded to capture data for similar maintenance expenditure from within the TfL group, e.g. Overground, DLR, and to identify suitable comparators externally to TfL, e.g. Network Rail.
- 388 To ensure that the comparison of station maintenance costs is reliable a review will be undertaken of the allocation of stations maintenance costs across the three Infraco areas to provide for consistency of capturing and allocating cost data. This will ensure that the asset bases are comparable and that the maintenance costs, including overheads and management costs are allocated in a consistent way.
- 389 The relationship between asset performance and maintenance costs needs to be understood at asset group level, particularly in relation to services assets, e.g. CCTV and other communication equipment. Therefore, one work stream will involve an investigation to better understand and to review the relationship between varying station maintenance costs and the associated impacts on, and risk to, asset performance.
- 390 The stations maintenance drill-down study will be progressed in two phases. The first phase will identify and analyse cost data at asset group level for the SSL, BCV and TLL station assets. The objective of the first phase will be to identify the optimum maintenance costs for each asset group with a subsequent analysis to identify efficiency opportunities which could be applied to the maintenance of all similar assets across the LUL network.
- 391 The second phase will focus on extending this analysis within the TfL group, including London Rail, and to external organisations, including international metros through the CoMET and Nova groups, maintaining similar assets for comparison and subsequent identification of efficiency opportunities. The second phase will also consider the relationship between asset performance and the cost of maintaining the assets.

8.6 L&E Maintenance

- 392 LUL and Tube Lines are planning to spend £0.2bn on the maintenance of the Escalator assets between 2010/11 and 2017/18, which accounts for 6% of all benchmarked asset maintenance spend, and £53m on the maintenance of the lift assets over the same period, which accounts for 1% of all benchmarked asset maintenance spend.
- 393 Phase 6 of the asset maintenance benchmarking shows that in 2009/10 the unit cost of Escalators varies from £55,000 to £86,000, a range of £31,000 per escalator before normalisation; and from £59,000 to £78,000, a range of £19,000 per escalator after normalisation.
- 394 The asset benchmarking also shows that in 2009/10 the unit cost of Lifts varies from £36,000 to £57,000, a range of £21,000 per lift before normalisation; and from £33,000 to £51,000, a range of £18,000 per lift after normalisation.
- 395 This section sets out the preliminary understanding of the reasons for this range of unit rates; provides LUL's and Tube Lines' forecasts of the maintenance cost unit rates to 2017/18, together with a summary of the ongoing efficiency initiatives which have been identified and are being implemented over this period; and identifies the key priorities for further investigation.

L&E Asset Base

- 396 The lifts and escalators asset base currently consists of 408 escalators and 140 lifts.

	Number of escalators	Number of lifts
Bakerloo	24	11
Central & W&C	72	13
Victoria	33	5
District	21	12
Metropolitan & H&C*	32	12
Jubilee	127	38
Northern	56	28
Piccadilly	43	21
TOTAL	408	140

*Note: including Wood Lane

Table 26 – Number of Escalators and Lifts

L&E Asset Maintenance Benchmarking Cost Comparisons

- 397 Phase 6 of the asset benchmarking provides a comparison of maintenance rates, by Infraco grouping, across the LUL network for six years of data from 2004/5 to 2009/10.
- 398 The following graphs show a comparison of the actual maintenance costs per machine.

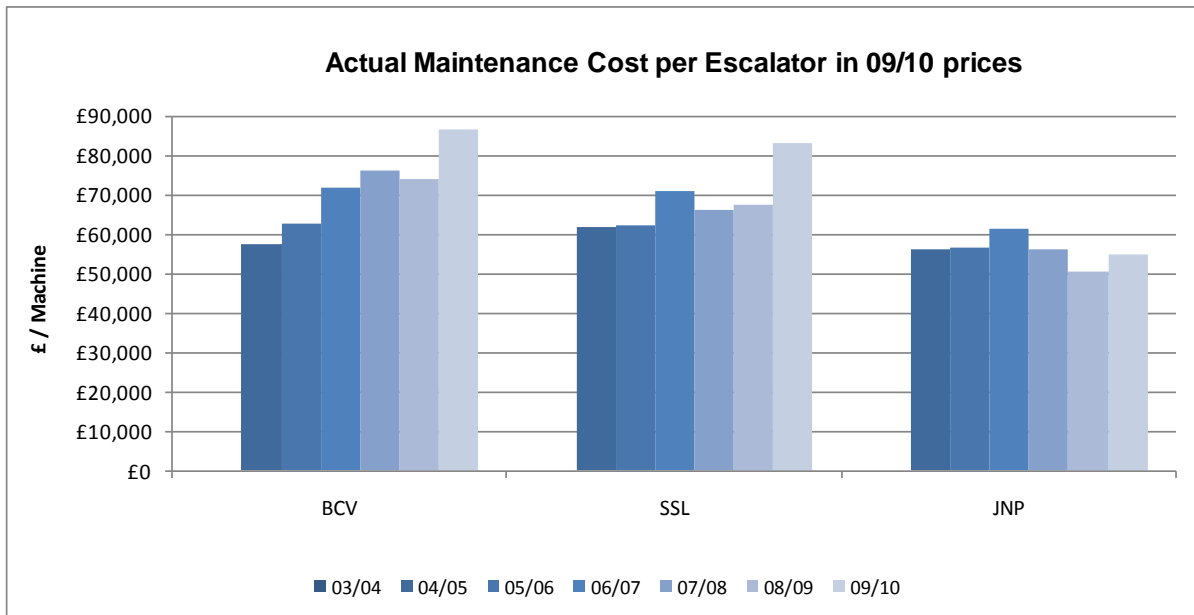


Figure 54 – Escalators Actual Maintenance Costs in 09/10 prices

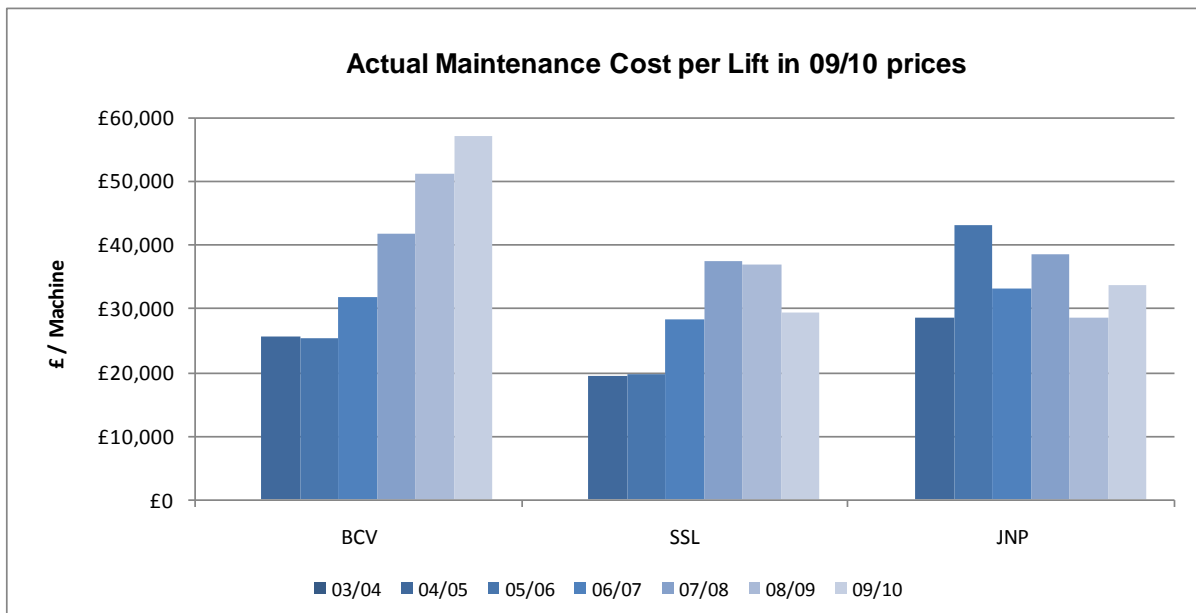


Figure 55 – Lifts Actual Maintenance Costs in 09/10 prices

399 For 2009/10 the maintenance cost per escalator ranges from £55,000 to £86,000, a variance of £31,000 per escalator, with the maintenance cost per for lift ranging from £29,000 to £57,000, a variance of £28,000 per lift. This variance can partly be explained by structural differences between the assets across the network areas, these are outlined later in this report.

Performance

400 The following graph compares the performance of the escalators across the network. The metric is the same as used for previous phases of the asset maintenance benchmarking, being the number of service disrupting incidents per escalator. The graphs show an improving trend for all three network areas.

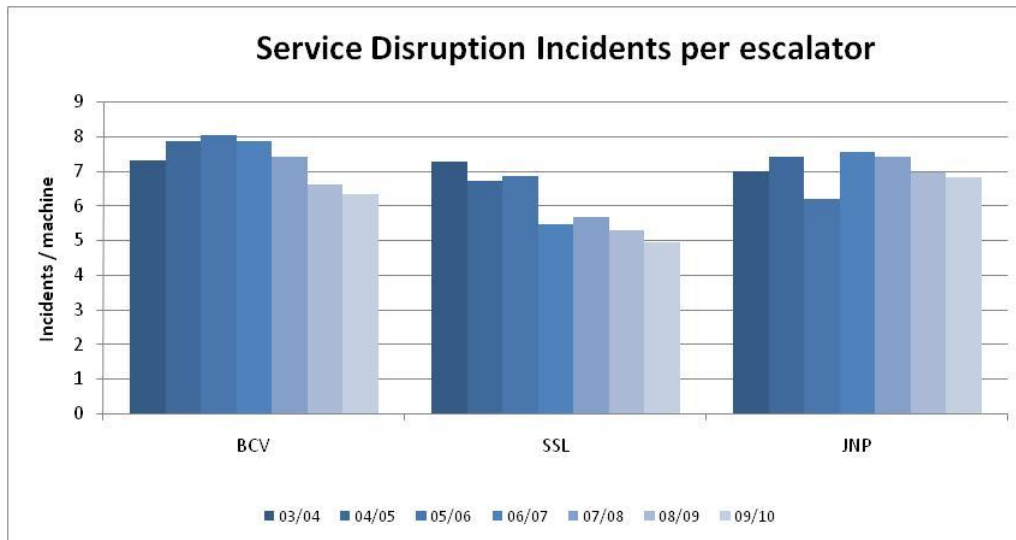


Figure 56 – Escalator Performance – incidents per escalator

401 The following graph shows the service disrupting incidents per lift. There is a generally improving performance trend across all three network areas, although for all three areas performance in 2009/10 worsened.

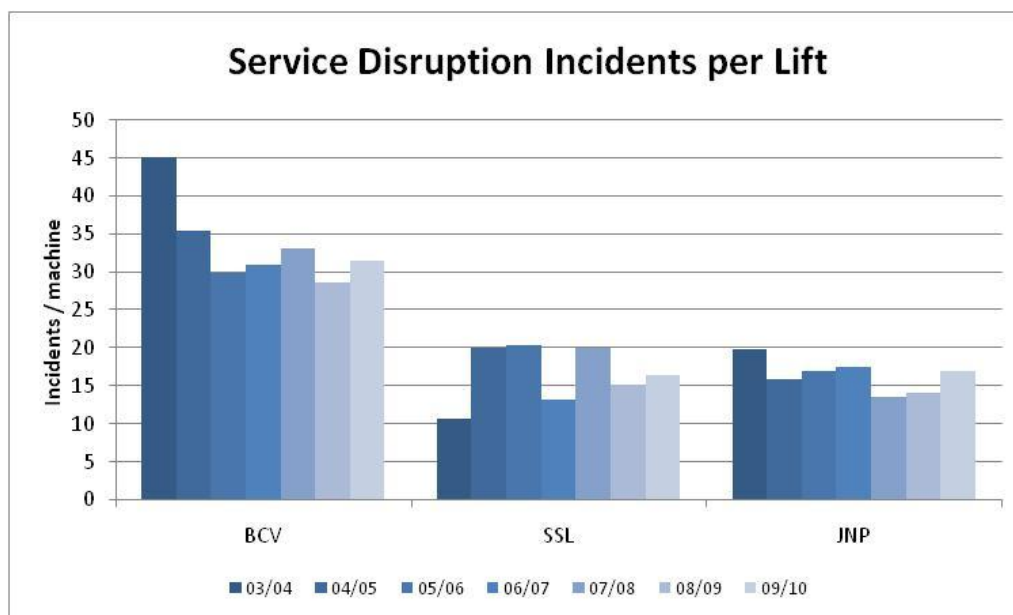
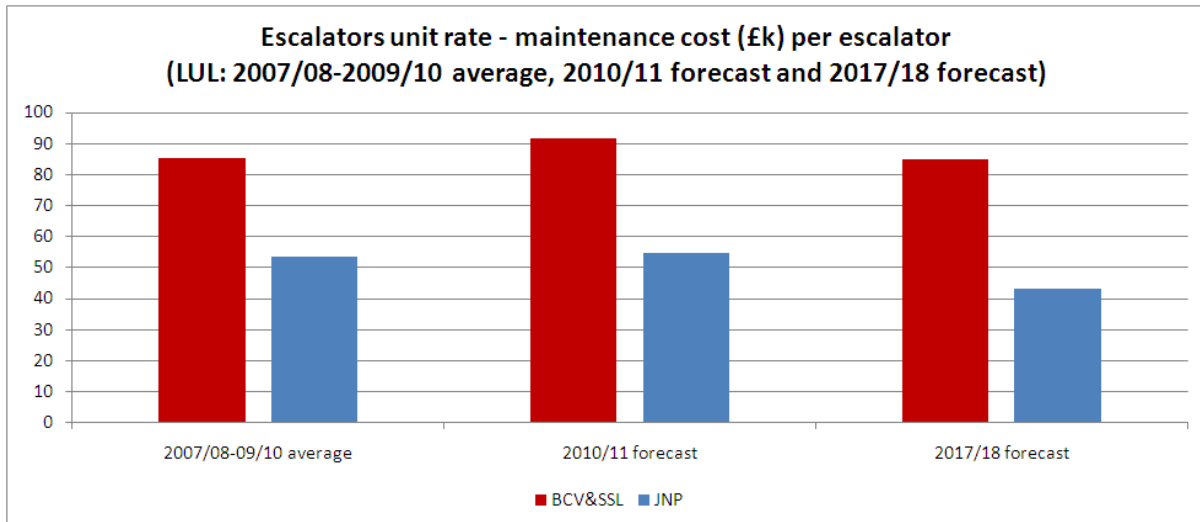


Figure 57 – Lift Performance – incidents per lift

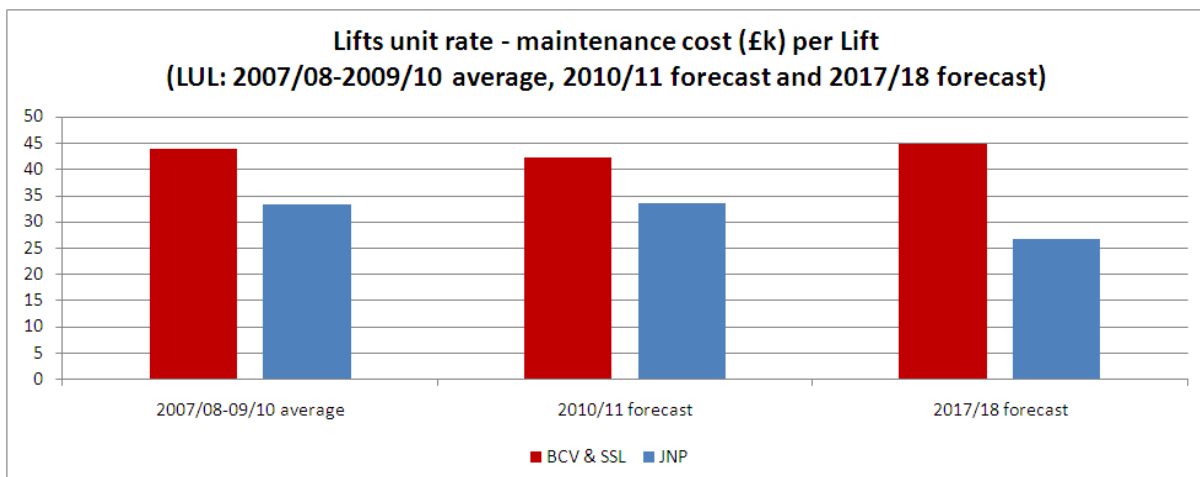
Future Costs and Planned Efficiencies

402 The following graphs show for lifts and escalators respectively the average maintenance costs for the last three years, the 2010/11 forecast and the forecast cost for lifts and escalators maintenance in 2017/18.



Note: Tube Lines advise that JNP maintenance costs forecast for 2010/11 are the same as 2009/10 costs.

Figure 58 – Escalator unit rate: maintenance costs per machine (09/10 prices)



Note: Tube Lines advise that JNP maintenance costs forecast for 2010/11 are the same as 2009/10 costs.

Figure 59 – Lift unit rate: maintenance costs per machine (09/10 prices)

- 403 The analysis combines the maintenance costs of SSL and BCV lifts and escalators to reflect the maintenance arrangements of the assets which are not split by Infraco.
- 404 There is a forecast increased cost in the maintenance unit rate for SSL and BCV for lifts and a slight decrease for escalators. For escalators the MCP efficiencies are almost completely offset by an increase due to a transfer of maintenance materials purchases from other budget areas, plus an element of payroll inflation, which equates to £2.0m in 2017/18, or £9,000 per escalator. For lifts the increase relates to payroll increases (pensions/NI), in part to heavy maintenance and in part due to poor condition of assets taken over from the Otis contract. Given the relatively small asset base, these increases have a disproportionate effect on the unit rate in comparison to other asset areas with greater numbers of assets. This increase equates to £0.7m in 2017/18, or £8,000 per machine.

405 The following graphs show for the escalator and lift assets, for BCV/SSL and Tube Lines, the unit rate in 2009/10 and in 2017/18. The costs and efficiencies which explain the difference between these unit rates are described below.

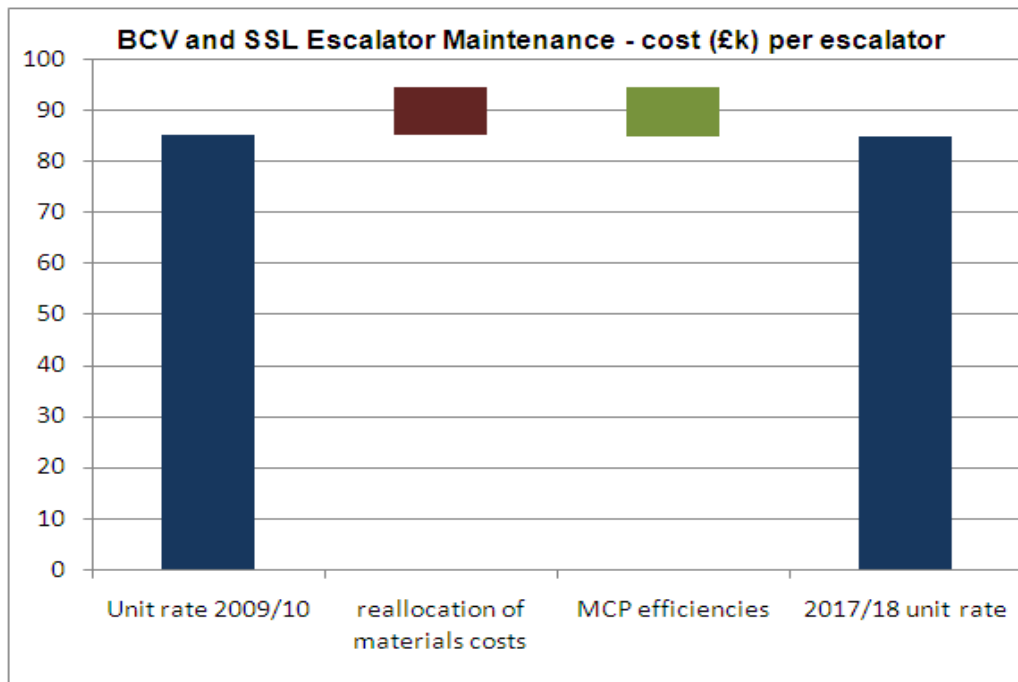


Figure 60 – BCV/SSL Escalator Maintenance unit rate–cost per escalator (09/10 prices)

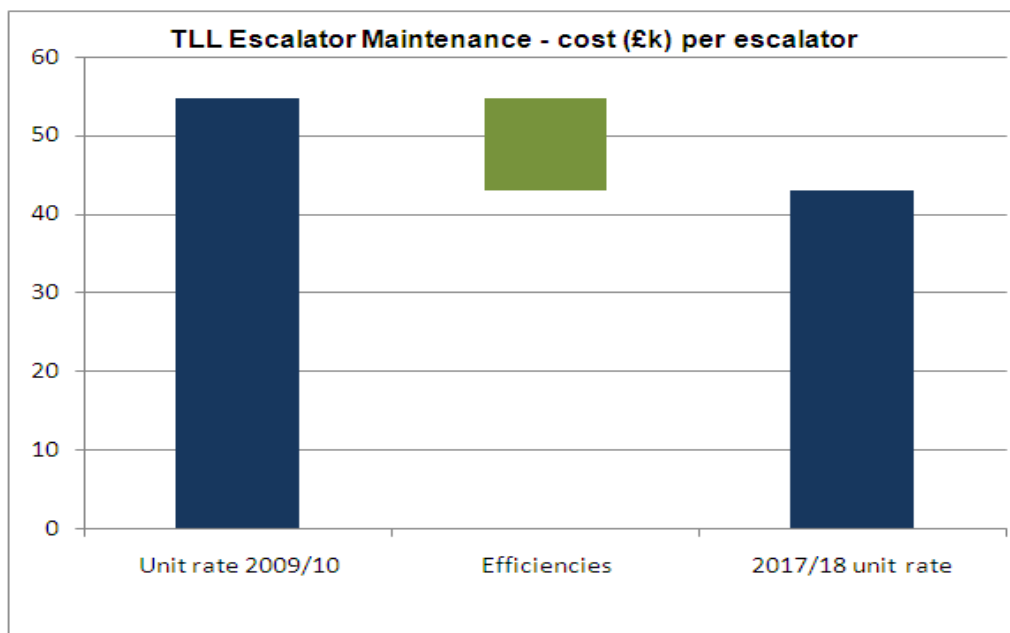


Figure 61 – Tube Lines Escalator Maintenance unit rate–cost per escalator (09/10 prices)

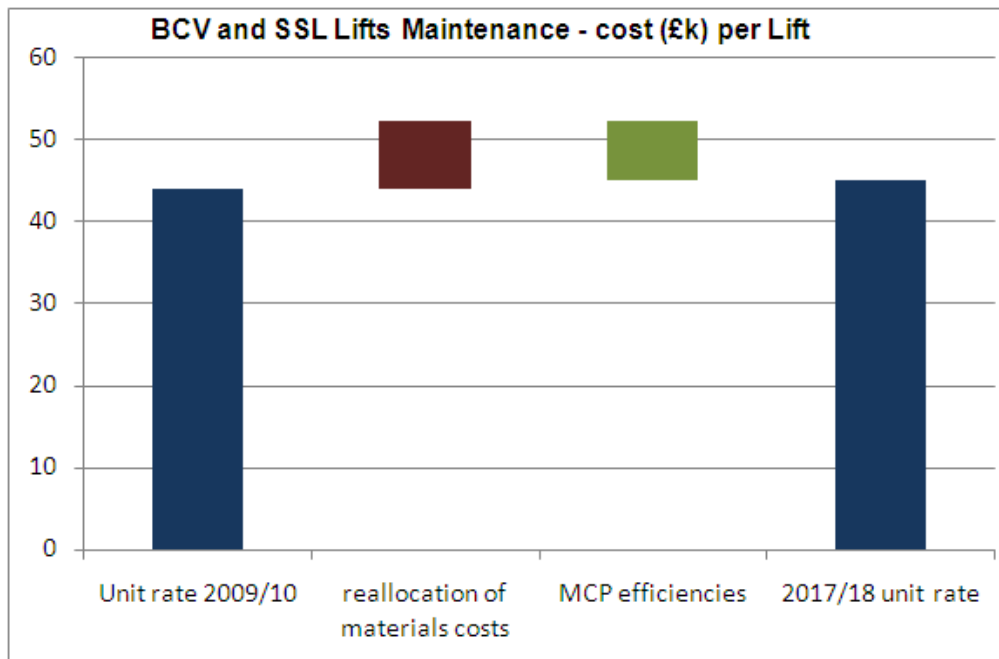


Figure 62 – SSL/BCV Lift Maintenance unit rate–cost per lift (09/10 prices)

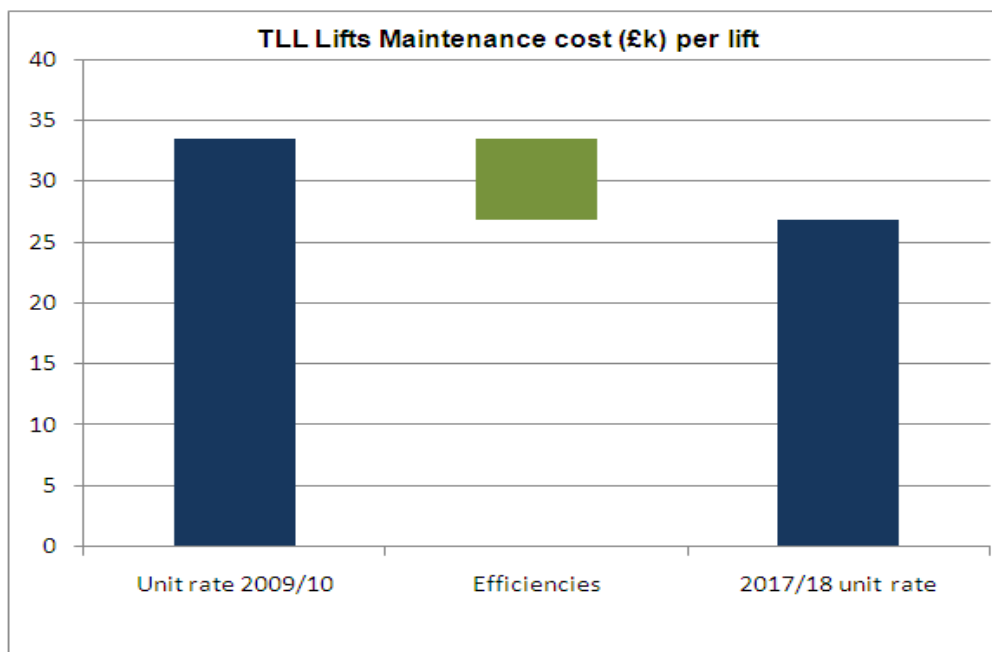


Figure 63 –Tube Lines Lift Maintenance unit rate–cost per lift (09/10 prices)

BCV/SSL Maintenance Capability Plan (MCP) and other efficiencies

406 The increase in lift and escalator costs is partially offset by the planned efficiencies which will be delivered through the Maintenance Capability Plan (MCP). MCP includes efficiencies for Lifts and Escalators maintenance which started to be achieved in 2009/10 and will total £2.4m for the year 2017/18. The savings primarily relate to amending the current contractual arrangements with other savings relating to achieving greater organisational efficiency within the APD and changes to the maintenance strategy (e.g. reduction in frequency of escalator inspections and dust tray cleaning and use of extended L&E closures to optimise productivity).

407 £1.3m (54%) of the identified savings relate to amending current contractual arrangements including bringing work in-house and renegotiating existing contracts.

408 A further saving of £1.0m (44%) is expected to be achieved through organisational efficiencies and changes to strategy relating to activities such as dust tray cleaning.

Tube Lines' Efficiencies

409 The Tube Lines efficiencies as shown in the figures above will be achieved through the following:

- DUST TRAYS: Reduction in the frequency of Escalator Dust Tray cleaning across applicable sites on the JLE and Non-JLE assets, previously specified in the Cat1 Standard as twice weekly.
- STEP INSPECTIONS: Reduction in frequency of NDT on escalators, moving to a more risk based approach.
- SHAFT INSPECTIONS: Reduction in frequency of shaft inspection on escalators, moving to a more risk based approach.
- L&E Extended Closures (LEEC), extends the engineering hours from 01:00-05.30 to 23.30-0630 across applicable escalator assets.
- TWICE WEEKLY INSPECTIONS: Reduction in the TLES twice weekly inspection visits.

410 Unlike some other asset areas the international benchmarking undertaken by the PPP Arbiter did not include an analysis of good practice and associated costs for lifts or escalators therefore at this time there is no comparator with which to evaluate LUL and Tube Lines costs.

Normalisation and Structural Factors

411 Phase 6 of the asset maintenance benchmarking analysis identified one structural factor for escalators and one structural factor for lifts which are statistically significant and therefore could be used to normalise the data. For escalators this factor relates to the age of the machine, and for lifts it is the loading proxy which relates to the passenger usage.

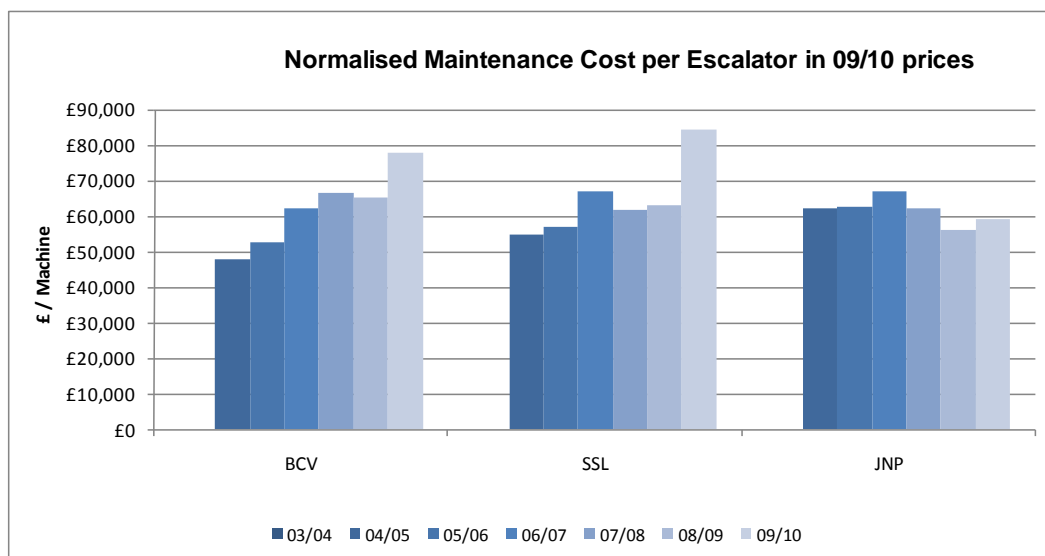


Figure 64 – Normalised Maintenance Costs for escalators in 09/10 prices

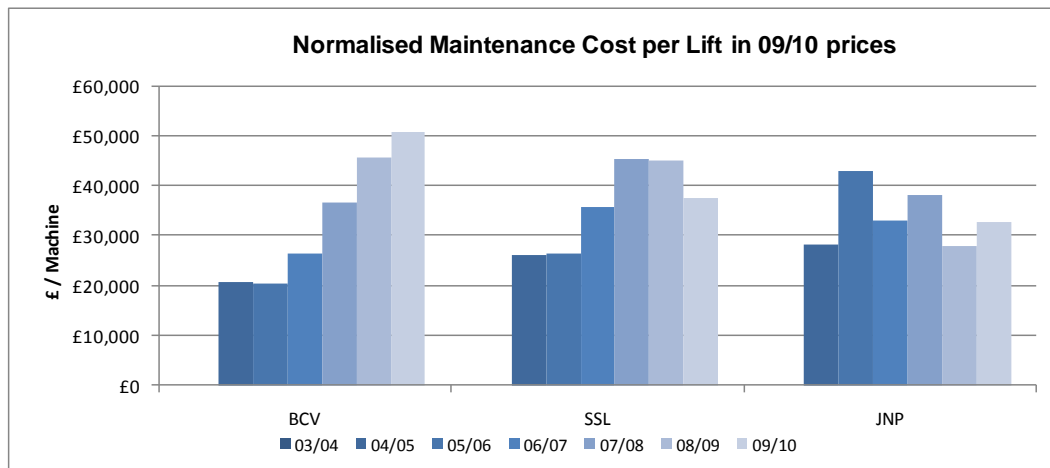


Figure 65 – Normalised Maintenance Costs for lifts in 09/10 prices

- 412 The graphs above show the normalised maintenance costs per machine when adjusted for the structural factors outlined above.
- 413 With the data normalised by taking into account the above factors it can be seen that the range of costs for escalators for 2009/10 per machine is £59,000 to £84,000, a reduced variance of £25,000. The normalised range of costs for lifts becomes £33,000 to £51,000, giving a reduced variance of £18,000. The JLE escalators are understood to be cheaper to maintain compared to the non-JLE type escalators installed across the LUL system, so this is likely to be one of the factors affecting the lower cost per machine shown in the graph above. The impact of this will be evaluated as part of the future drill down study.
- 414 The asset benchmarking analysis also examined a number of other structural factors, including vertical rise, passenger flow and number of steps for escalators; and for lifts age, vertical rise and the ratio of SMVT (Secondary Means of Vertical Transportation) and PMVT (Primary Means of Vertical Transportation) machines. None of these other factors were found to be statistically significant.

Areas for further investigation

- 415 The escalators across the LUL network vary in type, the most significant difference being JLE type and non-JLE type machines. Similarly for lifts a number of different types exist across the network, examples being traction lifts, hydraulic lifts and stair lifts.
- 416 The maintenance costs for lifts and escalators consist of costs for preventative maintenance, planned maintenance and inspections.
- 417 It is proposed to review the cost differences for lifts and escalator maintenance through comparing costs across SSL, BCV and JNP. A review will be undertaken to understand the best level of detail to compare the maintenance costs of lifts and escalators, taking into account the different types of machines, and the costs of planned and reactive maintenance for each. This review will also consider the necessary level of granularity required in cost data to facilitate comparison at the required level and the ability and benefits of collecting this data if not already available. It is proposed that from this review the potential for suitable further efficiencies can be considered.

- 418 As part of preparations for the PPP Periodic Review a study was undertaken comparing LUL's escalator strategy with other national and international metros. The findings of this work will be used to further analyse and benchmark the maintenance costs for escalators across LUL.
- 419 Subsequent to this review it is proposed to expand the analysis to capture data from similar operational expenditure from within the TfL group, where appropriate, and to identify suitable comparators externally to TfL, e.g. Network Rail. In line with this a review is being initiated to benchmark lift costs by way of sharing data with the CoMET and Nova metros to identify differences in costs and strategies.
- 420 The relationship between asset performance and maintenance costs needs to be understood for lifts and escalators. Therefore one work stream will involve an investigation to better understand and to review the relationship between varying maintenance costs and the associated impacts on, and risk to, asset performance.
- 421 A drill down study is being undertaken to provide a better understanding of the differences in unit rates and to identify further efficiency opportunities for lift maintenance. This study is looking to understand the differences between BCV/SSL and Tube Lines' actual and forecast unit rates, and to identify best practice on the LUL/TLL network and recommend efficiency opportunities for implementation.
- 422 The study includes a review of maintenance activity costs, volumes and headcount, including overheads and management costs, and the split between maintenance and projects, to ensure that costs are treated in a similar way for comparison. The review also analyses the costs for planned maintenance, reactive maintenance and inspections and will identify the key differences for each and subsequent efficiency opportunities, as well as a review of access arrangements and how these compare across the three network areas in terms of usage, productivity and relationship to costs.
- 423 The study will also attempt to identify and understand the relationship between asset performance and maintenance costs and how asset performance is affected by asset condition.
- 424 The lift drill down study also includes a comparison with other metros, through the CoMET group, to identify good practices in maintenance and procurement as well as further opportunities for efficiencies. So far six other metros have agreed to participate.

APPENDIX B – CAPITAL PROJECTS BENCHMARK MEASURES (DRAFT)

Metric Name & Level	Metric UoM	Metric Data Source	Metric Description	Metric Purpose	LU Comparator	Local Comparator	National Comparator - Rail	National Comparator - Infrastructure	Global Metro Comparator	
Core Level 1 Metrics:					Internal benchmark	Tube Lines, DLR, London Overground	Network Rail	BAA, Utilities, etc	CoMET Organisations	
APPROACH TO PROJECT MANAGEMENT										
Scale and Complexity of Project Delivery										
Number of Personnel in Infrastructure Projects & Track [Asset Mgmt] - P8	nr	PMO	provides the total count of internal personnel (total nr from staff composition below) within an organisation that are booking their costs	To obtain a broad view of the size and scale of comparable organisations. The data is part of a Client Forum established by Network Rails and includes 5 large infrastructure companies who all undertake their own in-house project management and have a desire/need to learn, benchmark and understand what each other does. it is not the intention to make direct quantitative comparisons with the data but more to lead to further investigation and study around the "Approach to Project Management" that each organisation takes.						
Annual Investment Spend - P8 FYF (IP & Track Only)	£	FINANCE	Total forecast spend on the "live" projects							
Gross OPEX Costs - P8 FYF (IP & Track only)	£	PMO	what it costs to employ the people in item 1							
Administration of Projects (as a % of overall project delivery cost)	%	PMO	what this is a % of the overall cost							
Current number of 'Live' projects (IP & Track Only)	nr	PMO	total number of projects currently funded							
Total Anticipated Final Cost of 'live' projects - 'Order Book' (IP & Track Only)	£	FINANCE	estimated final cost of those projects							
Number of Current Major Projects (>100m)	nr	FINANCE	those projects that exceed £100m							
Funding Arrangements	n/a	FINANCE	an explanation of how projects are funded.							
Approach to Project Management										
Organisation Structure	n/a	PMO	A selection of questions that explore how an organisation structures itself, in terms of people and processes, to deliver the work described in the scale and complexity section		To obtain a broad view of the size and scale of comparable organisations. The data is part of a Client Forum established by Network Rails and includes 5 large infrastructure companies who all undertake their own in-house project management and have a desire/need to learn, benchmark and understand what each other does. it is not the intention to make direct quantitative comparisons with the data but more to lead to further investigation and study around the "Approach to Project Management" that each organisation takes.					
Number of Management levels from CEO to Project Manager (Band 3)	n/a	PMO								
What is the most senior Project post in the organisation, and how does this relate to the CEO?	n/a	PMO								
Budget Responsibility	n/a	PMO								
Project Methodology	n/a	PMO								
Project Life Cycle	n/a	PMO								
Authority Review Points (Stage Gates)	n/a	PMO								
Project Control Cycle	n/a	PMO								
Do you measure Project Maturity? If so, which model do you use?	n/a	PMO								
What is your current project maturity?	n/a	PMO								
Workload Definition	n/a	PMO								
Management of Change	n/a	PMO								
Project Delivery Organisations formally recognised	n/a	PMO								
Project Management Role formally recognised	n/a	PMO								
Project Management Career path	n/a	PMO								
Do you operate a Talent Management Programme?	n/a	PMO								
Performance Incentivisation?	n/a	PMO								
Competence Assessment	n/a	PMO								
Corporate Affiliation with Project Management Professional Body	n/a	PMO								
Sponsor competence Assessed	n/a	PMO								
Schedule Adherence (Index)	n/a	PMO								
Project Management Systems										
Finance	n/a	PMO	Which computer systems are used to support the project management oprocess across the business	To obtain a broad view of the size and scale of comparable organisations. The data is part of a Client Forum established by Network Rails and includes 5 large infrastructure companies who all undertake their own in-house project management and have a desire/need to learn, benchmark and understand what each other does. it is not the intention to make direct quantitative comparisons with the data but more to lead to further investigation and study around the "Approach to Project Management" that each organisation takes.						
Risk	n/a	PMO								
Planning	n/a	PMO								
Project Performance Reporting	n/a	PMO								
Change Management	n/a	PMO								
Estimating	n/a	PMO								
Staff Composition in Investment Projects Delivery Teams & Asset Mgmt Delivery Teams (Track Only) - (number in brackets refers to number of staff associated with Track)										
Admin & Support (incl. Legal)	nr	SAP / PMO	Includes all staff working on projects involved in administration, document control,	To obtain a broad view of the size and scale of comparable organisations. The data is part of a Client Forum established by Network Rails and includes 5 large infrastructure companies who all undertake their own in-house project management and have a desire/need to learn, benchmark and understand what each other does. it is not the intention to make direct quantitative comparisons with the data but more to lead to further investigation and study around the "Approach to Project Management" that each organisation takes.						
Commercial	nr	SAP / PMO	includes all commercial procurement staff including commercial managers, cost							
Construction & Site Management	nr	SAP / PMO	includes all staff managing the construction works themselves from night supervisors to							
HSEA	nr	SAP / PMO	all HSE staff							
Planning & Programme Controls	nr	SAP / PMO	includes all planners, reporting and all other PMO staff (excl. PA's, secretaries, and doc							
Project Engineering	nr	SAP / PMO	includes all those engineers suopervising or managing engineering, including, Discipline							
Project Management	nr	SAP / PMO	includes all grades of project management from APM to programme manager.							
Design Engineering	nr	SAP / PMO	includes those engineers actually undertaking design							
Displaced	nr	SAP / PMO	includes those currently in a pool, waiting to be reassigned							
Risk & Value	nr	SAP / PMO	includes all risk management & value management							
Graduates	nr	SAP / PMO	includes those graduates on the PM Graduate Scheme							
Geographical spread of PM staff - No of IP Locations	nr	PMO	shows the geographical sprweed of staff if greater than one city							
Quality Index - % of projects against which Technical Non-Compliances have been raised	%	?	?							
PROJECT PERFORMANCE										
Functional Area - Project Controls & Finance										
Annual Capital Investment forecast Accuracy	%	SAP	P1 forecast Annual spend v's P13 Actual spend	Shows our ability to accurately estimate our work rate and its cost, thereby improving cashflow forecasts						
Average Annual CPI	Nr	MPD	The average score over the year	Explains how good we are forecasting what our work will cost in a given period of time						
Average Annual SPI	Nr	MPD	The average score over the year	Explains how good we are forecasting how long our work will take for a given amount of cost						
Average variance EFC v Original Authority	%	SAP	The % variance between the actual final costs and original EFC for those projects completed within the financial year	Explains our ability to accurately estimate the total costs of projects						
Annual Risk Utilisation as a % of Forecast	%	SAP	The % of risk we used in the year (P13 actual) based on the total we forecast to need in P1	Explains our ability to accurately forecasts the amount of risk money required and our ability to mitigate risks						
Annual Contingency Utilisation as a % of Forecast	%	SAP	The % of contingency we used in the year (P13 actual) based on the total we forecast to need in P1	Explains our ability to forecast prime costs and the amount of change we have on a project						

Metric Name & Level	Metric UoM	Metric Data Source	Metric Description	Metric Purpose	LU Comparator	Local Comparator	National Comparator - Rail	National Comparator - Infrastructure	Global Metro Comparator
Core Level 1 Metrics:					Internal benchmark	Tube Lines, DLR, London Overground	Network Rail	BAA, Utilities, etc	CoMET Organisations
Milestones Achieved v Milestones forecast	Nr	MPD	A % of completed milestones against forecast to be complete between P1 and P13	Explains our ability to accurately forecast and manage delivery of our workload					
Functional Area - Commercial Procurement									
Total Number of Contracts Awarded on time	Nr	S&C	Total number of contracts actually awarded by P13 against forecast at P1	A measure of our ability to manage the procurement process, the clarity of our documents and supply chains ability to meet our bid timescales					
Total No and value of notified disputes	Nr	S&C	Taken as an annual average	Its a measure of clarity and cohesion of our contract documentation (including terms, scopes, specifications and standards)					
Total value of Variations as a % of total contract let value	%	S&C	the value of variations as a percentage of the value of contracts let.	The amount of change that goes on during a project, not necessarily client scope change					
Functional Area - HSE									
RIDDOR Lost Time Injury (LTI) Frequency Rate (Over-3-day Lost Time Injuries)	Nr	SQE	Total LTIs in year at end of period 13	To measure accident and injury frequency rates					
Major Injury Frequency Rate	Nr	SQE	Total Major Injuries in year at end of period						
Fatality Frequency Rate	Nr	SQE	Total Fatalities in year at end of period 13						
ASSET UNIT COST DATA									
Asset Specific Costs - TRACK									
Ballast Track Renewal	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Ballast + Formation Renewal	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Re-rail + Ballast + Formation Renewal	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Re-Railing	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Re-Railing + Re-sleeper	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Re-Railing + Re-ballast	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Re-ballast	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Deep Track Renewal - Rail, sleeper, slab	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
DTR - Rail & Sleeper Pop	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Check Rail	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Pit Block	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Track Drainage	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Conductor Rail	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Points & Crossings	Nr	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Asset Specific Costs - PROPERTY									
Station Enhancement	m2	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Station Refurbishment	m2	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Depot	m2	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Commercial Property	m2	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Train Crew Accommodation	m2	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Lifts & Escalators	£/nr	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Fire Systems	m2	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Fare Collection	nr	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Lineside Buildings	m2	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Control Centre	m2	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Asset Specific Costs - POWER									
11kV Substation	nr	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
22kV Substation	nr	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
11kV AC Switchboard	nr	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
22kV AC Switchboard	nr	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
2.5 MW Transformer Rectifier	nr	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Earthing / Auxiliary Transformer	nr	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
LVAC Switchboard	nr	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
750 DC Switchboard	nr	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
11 KVa Feeder Cable	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
22 KVa Feeder Cable	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Signalling Supply Point	nr	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Asset Specific Costs - CIVILS & STRUCTURE									
Foot Bridge	m2 dec	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Overbridge	m2 dec	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Covered Way	m2 dec	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Underbridge	m2 dec	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Viaduct	m2 dec	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Cutting	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Embankment	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Retaining Wall	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Drainage	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Station Drainage	nr	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Miscellaneous Structures	nr	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Fencing / Barriers	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Spiral Staircases	nr	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Tunnels & Shafts - new build	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Tunnels & Shafts - refurbishment	m	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Asset Specific Costs - SIGNALLING									
Conventional Resignalling	SEU	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
ATC Resignalling	SEU	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Controls	SEU	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Interlockings	SEU	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Trackside Equipment	SEU	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Minor Works	SEU	RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Asset Specific Costs - COMMUNICATIONS									
CCTV Systems		RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
PA Systems		RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Security Systems		RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Op Information Systems		RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Telecommunications		RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Asset Specific Costs - ROLLING STOCK									
Passenger Rolling Stock		RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					
Engineering Rolling Stock		RIB	See RIB for detail	Asset Unit Cost data for project budget estimating					