

Date: 19 October 2022

Item: Piccadilly Line Upgrade - Stage 1 Progress Update

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**This paper will be considered in public**

**1 Summary**

- 1.1 This paper updates the Committee on progress with delivery of Stage 1 of the London Underground (LU) Piccadilly Line Upgrade (PLU), following its authorisation in May 2018, and the previous annual update in July 2021.
- 1.2 Supplementary information is included in Part 2 of the agenda for Members. This information is exempt and is therefore not for publication to the public or press by virtue of paragraph 3 of Schedule 12A of the Local Government Act 1972 in that it contains information relating to the business affairs of TfL.

**2 Recommendation**

- 2.1 **The Committee is asked to note the paper and the exempt supplementary paper on Part 2 of the agenda.**

**3 Background**

- 3.1 The Piccadilly line contributes more than 10 per cent of LU's total ridership with pre-pandemic demand of over 200 million annual trips. The line provides key transport links between North and West London serving Heathrow Airport, the West End and St Pancras International station.
- 3.2 The existing rolling stock fleet on the Piccadilly line was introduced in the mid-1970's and is over 45 years old. The upgrading of the Piccadilly line is a TfL priority in view of very high levels of historic and projected demand, the age and condition of the existing rolling stock, and the inherent capacity constraints of the existing signalling system and limited fleet size.
- 3.3 The PLU was established as part of the wider Deep Tube Upgrade Programme to replace life-expired trains and signalling systems and to maximise capacity on the Piccadilly line to meet existing and future demand. The PLU is scheduled to be delivered in two key stages:
  - (a) **Stage 1** – Infrastructure upgrades and enabling works to support the introduction of 94 new trains to replace the existing rolling stock fleet: and
  - (b) **Stage 2** – Replacement of the existing signalling system and procurement of up to 18 additional trains to enable higher frequency services with highly reliable automatic train operation.

- 3.4 In May 2018, the Committee approved:
- (a) Programme and Project Authority of £3,294m for the procurement of new rolling stock and associated infrastructure enabling works for the introduction of new trains on the Piccadilly line; and
  - (b) Procurement Authority of £1,657m for the award of a contract for the design, manufacture, and supply of 94 new Piccadilly line trains to Siemens Mobility Limited (SML) with a Fleet Services Agreement for whole life maintenance support.
- 3.5 In July 2021 the overall Programme and Project Authority was reduced by £300m, from £3,294m to a total of £2,994m to reflect the progressive reductions in Estimated Final Cost for the Stage 1 PLU Programme since May 2018.
- 3.6 Since the previous update to the Committee in July 2021, the TfL Business Plan and Budget has remained under severe financial pressure following the impact of the coronavirus pandemic on TfL's ridership and revenues. Despite these pressures and challenges around resources, the delivery of PLU Stage 1 and the schedule for introduction of the new trains remains on target and as reported in 2021. However, several preceding milestones have slipped, mainly due to unavailability of key resources compared with the previous forecast.
- 3.7 Good progress continues to be made on PLU through continued collaboration and innovation. Key achievements include the commencement of new train manufacture by Siemens Mobility Limited. in Vienna, delivery of new train stabling facilities at South Harrow and the design and installation of infrastructure enabling works across the Piccadilly line. The new Siemens manufacturing facility in Goole, Humberside, is also progressing well, where half of the new trains will be assembled.
- 3.8 This paper provides a summary of progress achieved since July 2021 and the opportunities being pursued to reduce schedule risks and improve delivery efficiency.

## **4 Programme Benefits**

- 4.1 Prior to the pandemic, significant crowding was already prevalent on the Piccadilly line due to the capacity constraints of the existing trains and signalling. As Tube demand recovers, peak crowding is expected to return to pre-pandemic levels in the early 2030s and to increase further as population and employment grows with economic recovery.
- 4.2 The PLU is core to the Mayor's Transport Strategy, enabling increased public transport capacity, more environmentally-friendly services that contribute to carbon reduction, and a more pleasant customer experience – which will contribute to increased ridership. PLU Stage 1 and the (currently unfunded) Stage 2 signalling upgrade will enable wider economic growth, both in London and across the UK through more than 25,000 jobs across the UK in the primary, secondary, and tertiary supply chains. Improved services will support the construction of more than 61,000 new homes in the vicinity of Piccadilly line stations.

- 4.3 Stage 1 of the PLU will deliver essential asset renewals with the replacement of the life-expired Piccadilly line trains, enabling the following key benefits:
- (a) longer, more spacious and fully accessible walk-through trains;
  - (b) an uplift of peak services from 24 trains per hour (tph) to 27tph, with the increased fleet size, to achieve a 23 per cent overall increase in peak service capacity from current levels;
  - (c) improved service performance and very high levels of reliability from modern rolling stock and sub-systems;
  - (d) a greatly enhanced customer experience through the introduction of air-cooling, improved customer information and security systems; and
  - (e) improved energy efficiency, reducing annual energy consumption by more than 20 per cent compared with today's Piccadilly line service, enabling decarbonisation.
- 4.4 Stage 2 of the PLU, if funded in future, will deliver further service enhancements through a line-wide signalling upgrade, including:
- (a) significant reductions in customer journey times;
  - (b) improved service reliability through automatic train control (as in operation on the Jubilee, Northern and Victoria lines);
  - (c) fleet and signalling capability for a peak service of up to 36 tph in the central area – as now achieved on the Victoria line - to deliver a 64 per cent overall increase in peak capacity from today's service.

### **Progress Since Previous Update**

- 4.5 Since the previous report in July 2021, and following the removal of Covid restrictions, the programme and its supply chain partners have made good progress towards delivery of the Stage 1 upgrade scheme.
- 4.6 The Stage 1 programme remains on target for the first new trains to enter passenger service in summer 2025. Infrastructure enabling works have now progressed to the implementation stage with commencement of physical works across all Piccadilly line sites.
- 4.7 Since the previous update the PLU programme has continued to experience resourcing difficulties, with availability unable to keep pace with planned resource demand. This issue has been made more acute due to problems in recruitment and retention of staff in key roles, which is a symptom of the current highly competitive market for critical skills in the rail sector.
- 4.8 Whilst the resourcing challenge has been mitigated partially through internal prioritisation of resource, collaborative and strategic resource planning and creation of frameworks for external resourcing services, critical path activities have been impacted. This has resulted in misalignment of the infrastructure and train delivery programmes. Mitigations are being explored to recover these

slippages and/or lessen the impact on the train introduction schedule.

### **New Trains**

- 4.9 The new, higher capacity Siemens trains will be fully accessible and feature walk-through interiors, saloon air-cooling (for the first time on a deep tube train) and all-double doorways to improve boarding and alighting. Modern audio/visual communication systems will include digital display screens for customer information and advertising, a new CCTV system for the train operator to view the platform and train interface from the driving cab and improved customer security cameras.
- 4.10 Following achievement of the key Tier 1 Final Design milestone in 2021, the manufacturing contract with Siemens Mobility Limited has progressed further with the start of assembly of the first new vehicles in Vienna during autumn 2021.
- 4.11 The first vehicle underframes and bodysells have been assembled and finished in the TfL corporate livery scheme for 'first in type' acceptance prior to series production.
- 4.12 Siemens have progressed with the procurement and manufacture of key sub-system elements of the train, including underframe equipment, the propulsion system and train door system. The first fully assembled train is scheduled for completion by summer 2023 and will then undergo an extensive programme of pre-delivery reliability proving at Siemens' Test and Validation centre in Westphalia, Germany.
- 4.13 Despite the resourcing challenges referred to above, the programme currently remains on target to receive the first train to London for testing on the Piccadilly line in summer 2024 with the first train scheduled to enter passenger service in summer 2025.
- 4.14 Construction of Siemens' c.£200m UK train manufacturing facility in Goole, East Yorkshire is nearing completion with the train assembly hall to commence production in early 2024. This facility is creating an estimated 700 skilled jobs. It has also enabled an estimated 250 jobs during construction and up to 1,700 indirectly in the supply chain. The new UK rail manufacturing facility will support around 80 graduates and apprentices and will be complemented by the recently opened Rail Accelerator and Innovation Solutions hub for Enterprise (RaisE) campus for industry research and development. Once completed, it is expected that approximately 50 per cent of the new Piccadilly line trains will be assembled at the new UK facility in Goole.

### **Infrastructure works**

- 4.15 Following a competitive procurement, a new High Voltage (HV) Power framework is now in place and with two suppliers (Balfour Beatty Rail Limited and UK Power Network Services Limited.) now engaged, the first two work packages have commenced. This framework will enable design and delivery of the critical sub-station and distribution network upgrades required to support new train introduction. Initial focus is on provision of additional power system capacity at Sudbury Hill, Northfields, and Cockfosters sub-stations to support the upgrades to the train maintenance depots and stabling facilities. Additionally, upgrades are

being progressed at Hyde Park Corner and Leicester Square sub-stations to enable new train operation.

- 4.16 Complex upgrade work is also underway at Manor House where an existing TfL telephone exchange is being relocated to enable the installation of a new HV power coupling transformer. Enabling works are also underway at Cobourg Street in readiness for new HV equipment installation.
- 4.17 Modifications to the existing signalling system are underway to ensure compatibility with the new trains. These works include the re-positioning of lineside signals and installation of additional signal indicators to ensure visibility from the new, longer trains at all locations. Additionally, 76 legacy 'delta'-type track circuits have been replaced with a new design of train position detector. This is necessary to ensure the existing safety signalling system is not affected by electro-magnetic interference (EMI) generated by the new trains.
- 4.18 Surveys and designs are underway for the localised platform modifications needed to provide level access to the new trains for wheelchair users at step-free stations to meet Rail Vehicle Accessibility Regulations (RVAR) requirements. An innovative new "platform hump" solution is being developed which will use lightweight Fibre Reinforced Polyester materials instead of concrete. This will drive further cost efficiencies, as well as reduce installation times, safety risks and the carbon footprint of the delivery programme.
- 4.19 Following design development, implementation has also commenced for the new One Person Operation Closed Circuit TV (OPO CCTV) system with the first installation at Caledonian Road station. This system will improve safety through transmission of high-quality digital images of the Platform-Train Interface (PTI) to both the train operator and the line control centre to ensure the safe departure of the train from the platform.

### **Depots and Stabling**

- 4.20 Following extensive site clearance, groundworks and drainage improvements, major construction work has taken place at South Harrow sidings. This upgrade has expanded the site from an original six train capacity to 12 longer sidings to accommodate the new rolling stock, increasing stabling capacity on the line.
- 4.21 The upgrading of track, power supplies, signalling, security fencing, track drainage and access walkways have progressed. Significant delays were encountered due to adverse weather conditions and repeated flooding of the site during the winter period. The first four new stabling sidings have now been commissioned and were returned to service in July 2022. The remaining eight new sidings are on schedule for completion and handover in February 2023. Whilst the expansion of the site has required the removal of some vegetation, the final scheme will increase biodiversity by 48 per cent compared with the original site through creation of new grassland, scrub enhancement and replanting.
- 4.22 The first stage of the train maintenance depot upgrades at Northfields and Cockfosters has commenced with the installation of three new sidings to the West of Northfields station. These new sidings will augment stabling capacity on the line and facilitate the start of extensive reconstruction work at Northfields depot.

- 4.23 Detailed design is progressing for modern, efficient, and environmentally sustainable train maintenance and stabling facilities for the expanded fleet of new trains. The upgraded depots will feature 'green roof' designs for rainwater harvesting and storage to provide 'grey' water for depot services and train washing. Large roof-mounted solar panel arrays will provide low voltage power supplies for heating and lighting in the depot complex.
- 4.24 Extensive site clearance work and procurement has commenced at Cockfosters Depot to enable construction of a new Wheel Turning facility as part of the first stage of enabling works for the depot upgrade.

### **Operational Readiness**

- 4.25 Planning and preparations have continued to ensure sufficient, trained train operations and maintenance staff are available for the introduction of new trains on the Piccadilly line. Operational readiness plans are being developed covering staff recruitment and familiarisation in line with the delivery schedule for driving simulators and the first new trains during 2024.
- 4.26 Operational leads are working closely with the project team and Siemens to understand new equipment maintenance regimes, and the facilities and skills required for maintenance and servicing of the new trains.

### **Innovation opportunities**

- 4.27 Development funding was secured from Innovate UK in 2019 for the PLU Programme to join the National Skills Academy for Rail (NSAR) Transport Infrastructure Efficiency Strategy (TIES) 'Living Lab' initiative. This helped to part-fund three demonstrator projects focusing on Technology and Modern Methods of Construction, which have now been successfully delivered. These were:
- (a) **Scalable Modular Equipment Rooms** – a prototype installation of scalable, factory-made equipment enclosures which offer faster, safer, and more efficient site installation with potential for 30 per cent savings over conventional constructions. Design and construction for the prototype has been completed and the equipment room is on display at our Innovation Spotlight Centre at TfL's Tunnelling and Construction Academy (TUCA) in Ilford. This innovation will allow further cost reductions for Signalling Upgrades and is ready to roll-out further subject to funding for future upgrade schemes;
  - (b) **Deep Tube Cooling Panel** – a prototype, low maintenance platform air cooling solution for deep tube stations for installation and testing in a live station environment; A prototype was installed at a disused platform at Holborn station to evaluate its performance in a tube station environment. This innovative design for platform air cooling is being developed for both the Piccadilly line and wider network application as a potential design solution for reducing platform area temperatures and to enable future train service level enhancements under Stage 2 of the line upgrade. An earlier prototype is on display in the Innovation Spotlight Centre at TUCA. The next step will be to install and prove this innovative solution in an operational platform environment (currently expected to be at Knightsbridge), subject to future funding; and

- (c) **Automated Cable Management Design** – software development is being undertaken for an automated design of complex cable management and support systems. This will reduce design costs by up to 70 per cent and improve safety and sustainability through reduced installation time on site. The software was successfully developed and proven to feasibility stage. TfL intends to develop this further and embed in our new ways of working for any future upgrade schemes.
- 4.28 Several other live innovation opportunities are also being progressed including lightweight platform humps, aluminium DC power cables, a train-mounted laser system for infrastructure gauge clearance survey and digital twinning of the Piccadilly line railway.
- 4.29 Following the successful delivery of the PLU Demonstrator Projects, the concept of the 'Living Lab' has been expanded as a pan-TfL initiative. This is a key enabler of our Capital Efficiency Plan and will ensure the benefits can be harnessed across TfL, allowing prioritisation of Problem Statements and alignment with TfL's wider Asset Strategy.
- 4.30 A key enabler of the TfL Living Lab concept will be our ability to access time and expertise from Industry Innovation Hubs and Accelerators. As such we have now formalised our partnership with Siemens and the University of Birmingham at RAISE (the new Railway Innovation Centre at Goole). As a first step in this partnership, we have now started to share problem statements linked to our Capital Efficiency Plan and expect to see output proposals by the end of 2022.

## **5 Efficiencies and Savings**

- 5.1 Since the July 2021 update, the PLU Programme has continued to refine the scope, specification, and cost of Stage 1 delivery to identify further efficiency savings, risk, and uncertainty reductions. Headline movements in the Stage 1 Estimated Final Cost (EFC) (at P6, 2022) are detailed in Table 1 below.

**Table 1: PLU Stage 1 EFC position and movements since July 2021**

<b>Authority Position</b>	<b>£(m)'s</b>	
Original Authority - Initial development	£	154
Stage 1 - Authority (May 2018)	£	3,141
<b>Programme &amp; Project Authority (May 2018)</b>	<b>£</b>	<b>3,294</b>
Authority Reduction approved - July 2021	<b>-£</b>	<b>300</b>
<b>Current Authority</b>	<b>£</b>	<b>2,994</b>
<b>July 2021 - reported EFC</b>	<b>£</b>	<b>2,902</b>
<b>EFC Movements since July 2021</b>	<b>£(m)'s</b>	
Indexation (new rates applied)	£	40.5
Cost and Risk increases: Including resources	£	15.3
Cost reductions and efficiency opportunities realised	<b>-£</b>	<b>36.2</b>
Scope deferrals to Stage 2	<b>-£</b>	<b>20.9</b>
<b>Current Stage 1 - EFC</b>	<b>£</b>	<b>2,900.7</b>
<b>Variance from original Authority</b>	<b>-£</b>	<b>393</b>

- 5.2 Since July 2021, industry price increases have led to the introduction of updated inflation indices by TfL which has added £40.5m to the overall cost of the Stage 1 forecast.
- 5.3 Through further maturity of PLU system design and performance and applying a Value Engineering approach, some £20.9m of scope items have been identified for deferral to the Stage 2 programme where these are not necessary to support the introduction of new trains under Stage 1.
- 5.4 Through active management of risk and the realisation of cost reduction opportunities a further £36.2m saving has been achieved. Overall, the EFC for Stage 1 has been reduced by £1.3m since July 2021.

## **6 Benefits and Value**

- 6.1 As authorised in May 2018, the business case for Stage 1 implementation, relative to the “Do Minimum” base, had a Benefit-Cost Ratio (BCR) of 5.3:1. At the update in March 2020, the Stage 1 BCR had increased to 5.6:1 following reductions in the estimated final cost achieved to that point.

- 6.2 By July 2021, the Stage 1 business case had been further refreshed to reflect savings and efficiencies achieved in the EFC, in addition to a six month deferral in benefits and revenue generation resulting from the revised Stage 1 delivery schedule. The Stage 1 BCR was improved slightly, to 5.9:1 relative to the 'Do Nothing' case.
- 6.3 Currently, the Piccadilly line demand is around 60-70 per cent of 2019 levels and longer-term public transport demand and travel patterns across London remain uncertain.
- 6.4 Since July 2021, extensive work has been carried out by TfL to update public transport demand models to reflect latest projections of post-pandemic travel across the TfL network to 2041. Through scenario planning, a range of uncertainty has been defined to inform demand forecasting. Within this range, two demand scenarios have been developed by TfL to assess and understand the possible changes to the nature of travel, in terms of origin/destination patterns, trip lengths and trip timing:
- (a) **2041 Reference Case** - a "business as usual" forecast that represents London's growth and travel behaviour returning quickly to pre-pandemic levels.
  - (b) **2041 Hybrid Case** – a more conservative forecast which reflects the impact of longer-term changes to working patterns and travel behaviour, accelerated by the pandemic.
- 6.5 The Reference case assumes substantial shorter-term growth with Piccadilly Line boarders growing by up to 30 per cent on pre-pandemic levels by 2041. The Hybrid Case assumes a more gradual return of demand by 2041.
- 6.6 Using these projections of demand and the latest TfL Value of Time the PLU Business Case has been refreshed to update previous assessments of the customer benefits from the planned Piccadilly line train service enhancements.
- 6.7 With latest cost and benefits data, the higher 'Reference' demand scenario confirms the strong business case for the Stage 1 programme with an overall BCR of 6.96:1 and a Net Present Value (NPV) of £2,502m, which represents an increase from July 2021. Similarly, the currently unfunded Stage 2 scheme is shown to be financially positive.
- 6.8 For the lower 'Hybrid' demand scenario, the refreshed analysis shows a reduced BCR for the Stage 1 programme of 5.04:1 and a Net Present Value of £2,192m. These results confirm the continued robustness of the Stage 1 Piccadilly line upgrade business case.
- 6.9 Using the latest cost estimates and the currently deferred delivery schedule, the updated modelling also shows an overall BCR for the Stage 2 scheme of 11.16:1 based on 'Hybrid' levels of demand. This confirms the continued strong business case for the currently unfunded Piccadilly line signalling upgrade and service enhancements.

## **7 Assurance**

- 7.1 A Targeted Assurance Review has been undertaken for PLU, led by TfL Assurance as part of the continuous assurance process for this programme.
- 7.2 The review highlighted concerns over the current trend of the programme and ongoing failure to meet Tier 3 delivery milestones, compounded by specialist internal resource shortages.
- 7.3 If this trend continues the programme will not meet the target dates for the migration states, resulting in a critical position whereby the trains will be delivered ahead of the infrastructure being ready for train testing.
- 7.4 Key recommendations from the review include the need to consider the scenario of a delayed programme, and the contingency plans which could be put into place should the position be confirmed as unrecoverable.
- 7.5 As the programme is reporting schedule risk on key migration state milestones and resourcing issues are not being addressed in a timely manner, it is recommended that the governance model is reviewed to validate it remains fit for purpose and will support the programme through detailed design and delivery.
- 7.6 A management response has been prepared to address all the review recommendations.

### **List of appendices to this report:**

Appendix 1: New Siemens trains and PLU delivery progress.

A paper containing exempt supplemental information is included on Part 2 of the agenda.

### **List of Background Papers:**

Independent Investment Programme Advisory Group (IIPAG) Report and Management Response

TfL Project Assurance Report and Management Response

Contact Officer: Stuart Harvey, Chief Capital Officer  
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## Appendix 1: New Siemens trains and PLU delivery progress

Figure 1: Siemens 24Tube Stock: Train Exterior showing driving cab



Figure 2: Walkthrough Train interior showing digital information screens



Figure 3: Siemens 24 Tube Stock: First production vehicle bodyshell painted in TfL livery



## South Harrow Sidings Upgrade

Figure 4: Site construction work 2022 – final groundwork preparation prior to track laying



Figure 5: First 4 new stabling sidings brought into use, July 2022



## Innovation

Figure 6: Lightweight Fibre Reinforced Polyester platform 'hump' prototype



Figure 7: Modular, prefabricated Equipment Room installed at TUCA, Ilford



Figure 8: Prototype Cooling panel under test at Holborn station

