

Board

Date: 17 March 2016

**Item: New Tube for London programme: Piccadilly Line
Modernisation**

This paper will be considered in public

1 Summary

UIP2344		New Tube for London Programme		
Existing Financial Authority	Estimated Final Cost (EFC)	Existing Project Authority to 31 Mar 2016	Additional Authority Requested	Total Authority
£ 3,969.3m	£ 16,511.4m	£ 59.1m	£95m	£154.1m

Authority Approval:

To approve budgeted project authority to a total of £154.1m for the New Tube for London programme inclusive of £95m to commence the procurement of new rolling stock and signalling systems for the Piccadilly line modernisation, deliver enabling works and to continue design development for the Bakerloo, Central and Waterloo & City line upgrades by 31 March 2018.

Outputs and Schedule:

This request covers the initial preparatory works for the modernisation of the Piccadilly line and further development of the Bakerloo, Central and Waterloo & City line upgrades, as follows:

- Commencement of procurement for a new Signalling and Train Control system including preparation and issue of an Invitation to Tender (ITT);
- Completion of competitive tendering and supplier negotiations for new Piccadilly line trains;
- Commencement of designs and specifications for the procurement of infrastructure and railway systems upgrades on the Piccadilly line; and
- Commencement of HV power supply upgrades and signalling immunisation works.

These preparatory works will contribute towards the following strategic outputs:

- Delivery of line modernisation, asset renewals and capacity upgrades on the Piccadilly and Waterloo & City lines by 2026; and
- Subsequent modernisation of the Bakerloo line by 2028 and the Central line by 2033;

- 1.1. On 2 March 2016, the Finance and Policy Committee endorsed the recommendations in this paper.
- 1.2. A paper is included on Part 2 of the agenda which contains exempt supplementary information. The information is exempt by virtue of paragraph 3 of Schedule 12 A of the Local Government Act 1972 in that it contains information relating to the business affairs of TfL. Any discussion of that exempt information must take place after the press and public have been excluded from this meeting.

2 Recommendation

2.1 The Board is asked to:

- (a) note the paper and the supplementary paper included on part 2 of the agenda; and**
- (b) approve additional Project Authority of £95m, taking the Project Authority to a total of £154.1m.**

3 Background

The New Tube for London (NTfL) programme

- 3.1 The New Tube for London (NTfL) programme delivers part of the Mayor's Transport Strategy (MTS), by transforming key parts of London's transport infrastructure through the continuation of the LU line modernisation programme. Responding to current and forecast increases in passenger demand the NTfL programme will modernise four London Underground lines – the Piccadilly, Waterloo & City, Bakerloo and Central lines.
- 3.2 The NTfL programme will specifically contribute to the following goals in the MTS:-
 - (a) support economic development and population growth;
 - (b) enhance the quality of life for all Londoners;
 - (c) improve the safety and security of all Londoners;
 - (d) improve transport opportunities for all Londoners; and
 - (e) reduce transport's contribution to climate change and improve its resilience.
- 3.3 The NTfL programme aims to modernise the Piccadilly, Waterloo & City, Bakerloo and Central lines with the introduction of a new generation of high capacity, walk-through, air-cooled trains with modern signalling control systems and supporting infrastructure to allow high frequency automatic train operation on these lines.
- 3.4 The replacement of ageing assets on these lines will also enable a step change in customer service quality and the transformation of operating and maintenance models through the introduction of modern technology.
- 3.5 Following on from the modernisation of the Victoria, Jubilee, Northern and Sub-Surface lines, the NTfL programme will form the final phase of the LU line modernisation programme. The NTfL lines constitute a third of the Underground network, carrying around two million passengers per day to key locations across

London, including: The City, West End, Stratford, Kings Cross and Heathrow Airport. Underground demand is forecast to grow by over 25 per cent during the next 10 years which will increase the need for additional capacity on these lines.

- 3.6 Delivery will commence with modernisation of the strategically critical Piccadilly line, which will deliver a 60 per cent increase in peak period capacity.
- 3.7 The Programme is budgeted within the current TfL business plan. In response to the Comprehensive Spending Review, sufficient funding is anticipated to be prioritised through the business planning process to allow the core elements of this programme to proceed to enable delivery of critical asset renewal and capacity improvements.
- 3.8 In February 2014, the Board approved an increase of £36.2m in Project Authority, to a total of £59.1m including earlier feasibility phases, to undertake design and specification activities for the NTfL programme by 31 March 2016.
- 3.9 During this period, the NTfL programme has continued to develop the infrastructure scope and business requirements for the Piccadilly line modernisation. This has resulted in the generation of a detailed technical specification and contract documentation necessary for the NTfL Rolling Stock procurement competitive tendering process which commenced in January 2016 with the release of the Invitation to Negotiate (ITN).
- 3.10 Work has continued on the definition of the overall NTfL programme scope and requirements with infrastructure analysis and research conducted to further the development of the later Bakerloo, Central and Waterloo & City lines upgrade schemes.
- 3.11 Programme development is based around an integrated railway system design to ensure that all requirements and interfaces can be effectively specified and managed through delivery. The following key outcomes have been achieved during the current “Design and Specification” stage:

Piccadilly line Trains Procurement

- 3.12 The issue of a Pre-Qualification Questionnaire in March 2014 resulted in the shortlisting of five bidders in October 2014 for the procurement process for the design, build and maintenance technical support of the new Piccadilly line trains.
- 3.13 A comprehensive Technical Specification and associated procurement documentation for the new rolling stock has been completed to allow release of the Invitation to Negotiate (ITN) in January 2016. This has included the development of a comprehensive tender evaluation model for assessment of suppliers' bids.
- 3.14 This procurement includes whole life technical support by the manufacturer to ensure that high levels of reliability are sustained and options for the supply of rolling stock for the other NTfL lines, which are exercisable at TfL's sole discretion.

Railway Control/Signalling system

- 3.15 Railway control system development has focussed on establishing requirements and creating market appetite to allow a competitive procurement for a common

Signalling and Train Control system for all NTfL lines, commencing with the Piccadilly line, which comprise over 30 per cent of the LU network.

- 3.16 Concept solutions have been developed for the interoperable sections of the Piccadilly line where new signalling will need to allow for operation of District and Metropolitan line trains over common track sections in West London.

Infrastructure

- 3.17 *Depots* – feasibility investigations have focussed on maintenance facilities for the new trains at the existing depot locations. Outline plans for the location of key maintenance and stabling facilities within the depots have been produced to inform rolling stock bidders' train maintenance proposals.
- 3.18 *Track and civils* – track capability has been reviewed in order to understand the requirement for track alterations to meet post-upgrade capacity needs and to define an optimised set of changes to deliver beneficial improvements in run times.
- 3.19 *Power and cooling* – enhancements to the power supply system to support new train introduction, higher service levels, faster runtimes and higher rolling stock auxiliary loads (e.g. air-cooling) have been assessed and system optimisation opportunities (e.g. regenerative braking and 750 Volt supply) considered to understand requirements for power infrastructure reinforcements.
- 3.20 *Platform Train Interface (PTI)* – the programme has led LU's research and development to investigate technologies for managing safety and performance at the PTI, building on lessons learnt from the Four Lines Modernisation (4LM) programme and metro practice worldwide.

Operations & Maintenance (O&M)

- 3.21 The embedded O&M team has focussed on developing the vision of how an optimised, post upgrade railway would be operated and maintained. Development of detailed set of User Requirements for each Grade of Automation has commenced to inform the rolling stock Technical Specification. Supporting Operations Concepts documents are also under development to define the future operating environment and management approach to Piccadilly line Operations, Service Control and Depots & Fleet Maintenance.

Line sequence and strategy

- 3.22 The programme strategy has undergone extensive review to optimise delivery scope and line sequencing to maximise benefits within funding constraints. The main strategic developments since the paper to the Board in February 2014 have been:
- (a) that upgraded Piccadilly line services will initially be under manual operation with new trains (Grade of Automation or GoA1) with migration to Automatic Train Operation (GoA2)⁽¹⁾ to follow line re-signalling. The upgrade will

(1) Grade of Automation 2 is operation with a Train Operator as currently utilised on the Central, Jubilee, Northern and Victoria lines. GoA4 is driverless operation.

continue to provide the system capability for future conversion to fully automatic (GoA4) operation at a future date. This staged delivery is planned to prioritise funding and resources on the initial, most beneficial, asset renewal and capacity upgrade;

- (b) the Waterloo & City line modernisation has been brought forward to be delivered alongside the Piccadilly line, resolving an open item as reported to the Board in February 2014; and
- (c) the order of the Central and Bakerloo modernisations has been reversed. With commitment of additional investment on existing Central line assets to secure their continued safety and reliability, the Bakerloo line modernisation has been prioritised ahead of the Central line to accelerate the replacement of the oldest trains on the network which are operating on the Bakerloo line⁽²⁾. It is intended that the relative order of these two lines in the NTfL delivery sequence be kept under review, informed by emerging asset condition and available funding.

3.23 To enable the programme to continue beyond completion of the current stage in March 2016, further Project Authority is now requested to progress scope development, key system procurements and enabling works for the Piccadilly line modernisation to March 2018.

4 Proposal

4.1 Delivery will commence with the Piccadilly line modernisation, which provides the greatest opportunity to increase capacity and has a high priority for asset renewal. To enable achievement of delivery timescales, the next stage of the NTfL programme will secure the programme team resources to progress critical scope development, train system procurement and key infrastructure enabling works on the Piccadilly line.

4.2 Preparatory design work will also commence for the modernisation of the Waterloo & City line.

4.3 A base programme of work has been developed to progress the delivery of the NTfL programme to the point of award of the rolling stock contract in late 2017. These activities include the following key work packages:

Rolling Stock procurement

4.4 Following issue of the ITN, the programme will progress through the tendering and evaluation process in 2016/17 leading to supplier negotiations for the new Piccadilly line trains contract.

4.5 Tenders will be assessed for compliance with requirements and deliverability, with acceptable bids then being evaluated on the basis of whole life costs and benefits. This evaluation includes capital costs, operating/maintenance costs, passenger

(2) The additional investment recently committed to the existing Bakerloo line 1972 tube stock trains is required under any NTfL line-sequence. The refinement of any additional works required on these legacy trains is being planned in conjunction with NTfL delivery sequence plans.

benefits and the monetised cost of carbon emissions. Carbon costs result from the estimated energy usage of each bidder's train in operational service and include an estimate of energy usage by additional infrastructure cooling schemes required to mitigate heat generated in the tunnels by the new trains.

- 4.6 Five global train manufacturers have pre-qualified to compete in the tendering process for the NTfL rolling stock and the internal team will lead the tendering and evaluation process. Following the release of the ITN for the NTfL Rolling Stock procurement in January 2016, a tendering period will continue until July 2016 and will conclude with an award recommendation in October 2017. At the point of a contract award recommendation further Project and Procurement Authority will be sought.

Railway Control System procurement

- 4.7 Following publication of an OJEU notice in March 2016, the procurement process for a new signalling and train control system will commence with the pre-qualification of suppliers and the preparation of a contract specification to support the release of an ITT in October 2016.
- 4.8 Bidders' capabilities to provide a system that can meet the specified requirements will then be evaluated to identify two tenderers to be taken through into a design development process. This will allow two potential suppliers to demonstrate that their systems are capable of meeting the project requirements which will inform the selection of a winning supplier and product for NTfL application, initially on the Piccadilly line.
- 4.9 Survey and design works will be undertaken at all Piccadilly line locations (in four tranches) for the re-positioning of train stopping marks and chevrons for new rolling stock introduction. Modifications will also be progressed to the legacy signalling system on the Piccadilly line to ensure electro-magnetic compatibility with modern rolling stock traction systems.
- 4.10 Work will commence on the procurement of a single railway control system for all four NTfL lines to provide integrated control and monitoring of security systems, fire alarms, ventilation, customer information/CCTV, lifts and escalators and pumps. Design work will also be undertaken for upgrading of the OPO CCTV systems needed for safe PTI management in support of new train operation.

Infrastructure upgrade

- 4.11 *DC Traction Power* – initial scoping and requirements development will be undertaken for upgrades to the DC traction power systems required to support higher service levels on the Piccadilly line.
- 4.12 *Performance Modelling* – system performance modelling will be completed for the Piccadilly line including analysis of: HV power distribution, DC traction systems, air temperature, air velocity and the optimisation of energy efficiency mitigations. System modelling for Central, Bakerloo and W&C lines will also be commenced.
- 4.13 *HV Power* - following concept, detailed design and procurement stages contracts will be awarded for works at Manor House to relocate the telephone exchange to enable power sub-station upgrading. Implementation will commence on an initial

tranche of upgrade works to the HV power distribution system at three priority 22kVa sub-stations (at Mansell St, Cobourg St and Manor House) and frequency conversion works at another three substations to support signalling track circuit immunisation.

- 4.14 *Depots & Stabling* - concept designs will be completed for major upgrades at Cockfosters and Northfields depots to increase stabling capacity and provide modern maintenance facilities to support the new rolling stock. These concepts will then be developed into detailed designs in readiness for procurement.
- 4.15 *Cooling* - concept designs will be completed for priority station cooling schemes at Holborn and Knightsbridge as the initial stage of a wider programme of cooling system interventions at multiple locations on the Piccadilly line. These are aimed at mitigating the projected temperature rises resulting from the introduction of new trains, on-train air-cooling and higher service levels.
- 4.16 *Track* - modelling and business case assessment will be completed to finalise the track layout changes needed to support higher frequency services on the Piccadilly line. Further survey, design and enabling works will then be progressed.
- 4.17 *Platform-Train Interface* - further system development and detailed design will also be completed on 'safe PTI management' systems required for migration, Automatic (GoA2) and Fully Automatic (GoA4) operation. This will include systems benchmarking, supplier engagement and PTI system development (Platform Edge Doors, gap fillers and secondary detection).
- 4.18 *Signalling enabling* - following confirmation of preferred strategy and location, feasibility and design will commence on a new Operational Control Centre facility for the NTfL lines.

Waterloo & City line

- 4.19 Engineering design development will be undertaken to refine the initial feasibility design of the infrastructure and system changes needed on the Waterloo & City line to support new train operation and maintenance and higher levels of automation. This will include designs for track and depot remodelling required at Waterloo and assessment of the closure blockade duration needed to deliver higher service frequencies and new train maintenance capability.

Bakerloo and Central lines

- 4.20 Engineering design development will be undertaken to update and refine earlier feasibility studies to reflect current assumptions and requirements and develop the maturity of the programme scope and schedule.

Programme Management

- 4.21 The above programme deliverables will be enabled through the resourcing of a programme management team which will provide essential project controls, estimating, assurance, safety management and reporting functions.

4.22 The existing programme management team capability will be augmented by the engagement of an external Programme Partner to provide expertise to establish the structures, processes and organisation necessary for downstream delivery of a complex infrastructure programme.

Programme Engineering and Systems Integration

4.23 A dedicated Engineering and Systems Integration team will be deployed to support the design development and delivery stages and to develop and manage the processes necessary to ensure an integrated railway system solution.

4.24 On completion of this next stage in early 2018, a further submission will be made requesting Project authority to implement the Piccadilly line modernisation. This submission will occur at the point of the award of the Piccadilly line trains supply contract in late 2017, and will also request Procurement Authority for this contract.

4.25 Operational impacts during the next programme stage will be minimised and any survey and investigation works requiring access to the operational railway will be conducted during Engineering Hours.

4.26 No major closures or operational changes are required during this stage. An Access planning workstream will be undertaken during the next stage to assess the level of intrusive access or closures needed during Piccadilly line implementation.

4.27 Any Equality impacts will be considered as part of programme implementation.

5 Benefits and Value

5.1 NTfL will deliver substantial benefits to London through:

(a) a step-change increase in peak capacity on each of the four lines (36 per cent on average), which are at capacity on the busiest sections, to cater for the forecast expansion of London's population and supporting its continued economic growth:

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|---------------------------|------------------|
| (i) Piccadilly line | 60 per cent; |
| (ii) Bakerloo line | 25 per cent; |
| (iii) Central line | 25 per cent; and |
| (iv) Waterloo & City line | 35 per cent. |

(b) faster and more reliable journeys; and

(c) improved journey quality, with improved accessibility, air cooling (for the first time on the LU deep tube network) and enhanced customer information.

5.2 In addition, the programme will deliver the essential asset renewals required to continue to operate safe and reliable services on these lines.

5.3 The capability to operate in fully automatic modes will be designed into the system, although when the first new trains enter service on the Piccadilly line they will have an operator on board.

- 5.4 Significant contributions will be made to three of the four Rail & Underground Priorities:
- (a) increase capacity from the current network;
 - (b) improve customer service; and
 - (c) improve reliability and safety.
- 5.5 There is no “Do nothing” option for this project as significant investment in the existing life-expired assets would be required to sustain services on these lines in all cases. Consequently the business case is assessed against a “Do Minimum” option for sustaining safe and reliable services on these lines, which includes deferred renewal of trains, signalling and supporting systems.
- 5.6 The main focus of the next stage of programme development is on the Piccadilly line modernisation. The overall benefit cost ratio for this line upgrade was updated in autumn 2015, and is 4.0 to 1, which falls into the Department for Transport category of very high value for money.
- 5.7 Further development is underway to refine the business cases for the other lines, which will be delivered sequentially after the Piccadilly line.
- 5.8 The results of the Piccadilly line business case analysis are shown below:

Net Present Values, £k	<i>Incremental to Do Minimum</i>
Discounted NPV CAPEX	-934,637
Other CAPEX	n/a
Other costs	n/a
OPEX (+ or -)	-17,754
Third Party	n/a
Revenue	411,376
Other Income	n/a
Net Financial Effect	-541,015
Payback Period	n/a
Passenger Benefits	2,185,615
Impacts during Implementation	Included in overall benefits
Total Benefit, £k	2,185,615
Benefit : Cost Ratio	4.0 to 1

6 Programme Delivery arrangements

- 6.1 The NTfL programme delivery model is based around an internal LU integrated client team comprising delivery management, engineering and programme controls functions operating in conjunction with embedded Operations & Maintenance and Sponsor teams.
- 6.2 A suite of requirement documents is being finalised to define the business requirements for the Piccadilly line modernisation. This includes the Sponsor’s Programme Requirements (SPR) and supporting reference data which will form a controlled baseline for programme delivery during the next stage.

- 6.3 A programme partner (CH2M/PWC) has been appointed to support the development of the programme as it progresses into the delivery phase. The Programme Partner's role is to strengthen the capability of the NTfL delivery organisation to operate effectively in a complex programme management environment through the provision of external skills, knowledge and expertise gained on other large UK infrastructure programmes (e.g. HS2, 2012 Olympic Games).
- 6.4 A programme delivery partner will be appointed in early 2017 to provide ongoing support and expertise for the delivery stage.
- 6.5 As the Prime Systems Integrator (PSI), the NTfL programme team will be responsible for the application of a Systems Engineering approach to the definition and management of technical, operational and programme integration issues for the NTfL programme. This will ensure the business requirements and benefits are fully realised and a Systems Integration Team has been formed to manage the processes necessary to achieve an integrated solution.
- 6.6 Within the PSI framework, in-house LU expertise (e.g. Power and Cooling) will be engaged where appropriate to support the programme's engineering and delivery functions. Major NTfL supply contracts will be sourced through competitive procurement.
- 6.7 Maintenance of the new NTfL rolling stock will be sourced 'in-house' by LU staff with whole-life technical support by the train manufacturer under a Fleet Support Agreement. This model will ensure that the rolling stock supplier is incentivised and fully committed to the sustained achievement of the high levels of reliability required.
- 6.8 The NTfL programme has key interfaces and interdependencies with other R&U investments, in particular the modernisation of the District, Metropolitan, Circle and Hammersmith & City lines (4LM programme) which is upgrading signalling on key sections of infrastructure shared with the Piccadilly line.
- 6.9 The Piccadilly line Interim Control Upgrade project (PICU) also provides a key enabling project for the migration to the new NTfL Piccadilly line signalling system through the creation of an interim control system and modern control facility to replace the existing Earl's Court Control Room. At Holborn, the planned station modernisation project will provide congestion and crowding relief necessary for the introduction of higher train service levels.
- 6.10 Other downstream dependencies exist with asset renewals investments, significantly the Track replacement programme, where line upgrade service improvements and new train performance are dependent on the achievement of modern track quality standards throughout the Piccadilly line.
- 6.11 Key milestones identified for the next stage of the NTfL programme are as listed below:

Milestone	Target Date
Piccadilly line HV Power Infrastructure Specification	20 May 2016
Signalling RCS procurement: Issue of the Invitation to Tender	31 October 2016
Programme level maturity level 3: Targeted actions achieved and verified.	31 March 2017
Piccadilly line trains procurement: Award Recommendation	31 October 2017

7 Financial Implications

- 7.1 The programme currently has Project Authority of £59.1m for completion of the design and specification phase by 31 March 2016. Of this sum, a total of £9.3m is forecast to remain unspent at 31 March 2016.
- 7.2 The estimated cost of the work covered in this paper is £104.3m. Taking into account the £9.3m unspent, this will require an increase in authority of £95m to an overall total of £154.1m.
- 7.3 The current budget (at Q3 2014/15) to 2023/24 is £3,969.3m, including prior years. The plan years include a substantial proportion of the Piccadilly line modernisation, and continued development and initial delivery stages of the other three lines. The delivery of the NTfL programme will span many years beyond the current Plan, with approximately 25 per cent of spend in the plan period. This proposal, as part of the overall NTfL Programme, has existing Financial Authority in the Business Plan.
- 7.4 The full estimated final cost (EFC) of the modernisation of all four lines is £16,511.4m outturn.
- 7.5 The funding strategy for the programme builds on the earlier approach of progressive maturity linked to staged programme authority requests. The proposed authority to 31 March 2018 will enable major cost elements of the programme (principally Rolling Stock and Signalling & Train Control supply) to be more accurately assessed through competitive tendering and supplier engagement. On completion of this stage, in late 2017, further authority will be sought for implementation of the Piccadilly line modernisation programme with higher confidence and reduced estimating risk.
- 7.6 A key area of focus in this next phase of the project is to identify efficiencies, challenge scope assumptions and refine cost estimates such that the overall programme EFC is mature, robust and comparable with relevant benchmarks prior to seeking full authority for the Piccadilly line modernisation in late 2017.
- 7.7 Whole life Operating and Maintenance costs have been modelled for inclusion in the NTfL Business Case. These will be refined during the next stage and informed by suppliers' responses to the Rolling Stock and Signalling procurements.
- 7.8 The estimated changes in OPEX have been developed with discipline experts, based on assessment of key cost drivers, recent experience on other upgrades and benchmarked maintenance rates from other lines and metro systems. These reflect the expected operating model and level of service together with high level maintenance requirements.

8 External Assurance reviews

- 8.1 The programme has been subject to ongoing external assurance reviews during the current phase with an annual Integrated Assurance Review at NTfL Programme level now well established. This has been supplemented by Rolling Stock specific reviews during the procurement development process to ensure the robustness of the programme and readiness to enter the procurement stage.
- 8.2 The Annual Programme Integrated Assurance Review (IAR) was conducted in November 2015 culminating in a review with external experts Jacobs, the Independent Investment Programme Advisory Group (IIPAG) and TfL Assurance on 8 December 2015. This review identified 11 general recommendations to be addressed by the programme.
- 8.3 The IAR recommendations were directed at the overall need for an integrated programme baseline at the commencement of the delivery stage, including clarity of objectives and requirements, a business change plan to support the transformation enabled by NTfL and finalised operating and maintenance concepts.

9 Views of the Finance and Policy Committee

- 9.1 On 2 March 2016, the Finance and Policy Committee considered a similar paper. The Committee requested that future papers include reference to carbon costs as part of the tender evaluation. Additional information has been provided in paragraph 4.5 of this paper.
- 9.2 The Committee raised no other issues for the attention of the Board and endorsed the recommendations in this paper.

List of appendices to this paper:

Exempt supplementary information is included in a paper on Part 2 of the agenda.

Background papers:

None.

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