



Constructability Report - Green Line Closure

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Executive Summary

This report has been prepared by London Bridge Associates Ltd (LBA), working in support of Jacobs Idom JV (Jacobs/Idom), to inform the scope of the works that would be required to the LUAS Green Line as part of the MetroLink upgrade to Sandyford.

The works are based on the current conceptual MetroLink scheme and describe and summarise the order of magnitude of temporary closures of the existing Green Line that will be required to enable planned MetroLink operations between Charlemont and Sandyford. Indicative construction programmes are presented comparing the upgrade of the Green Line both in conjunction with the current proposed MetroLink works from Estuary to Charlemont and undertaken as a separate later phased upgrade to metro operation.

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**METROLINK
CONSTRUCTABILITY REPORT – GREEN LINE CLOSURE**

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CONSTRUCTABILITY REPORT – GREEN LINE CLOSURE

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1 INTRODUCTION

1.1 The Project – Swords to Sandyford

The MetroLink project is the proposed development of a north-south urban railway service that is intended to run between Swords and Sandyford, connecting key destinations including Dublin Airport and the City Centre along the 26km route.

A large proportion of the proposed route will be underground, including where it passes under Dublin Airport and the City Centre. To the south, the underground section will rise to the surface at a portal between the Ranelagh and Beechwood stations on the existing Luas Green Line. South of the portal it is intended, as part of the overall project, to upgrade the existing Luas Green Line infrastructure to MetroLink format as far as Sandyford. The proposed MetroLink service will run at a substantially higher frequency than that of the existing Luas Green Line. Railway operations on the integrated section will need to be fully segregated from all other modes of transport and any other unrelated activities.

For the full route, the scheme is proposed to include a total of 25 stations (including 15 new stations), 3,000 additional Park and Ride spaces, and a journey time of approximately 50 minutes from Swords to Sandyford.

1.2 The Green Line Works

To connect to the Green Line corridor, MetroLink would come to the surface south of a new underground station at Charlemont, and then run overground along the upgraded existing Luas Green Line alignment as far south as Sandyford station.

It is planned that, along this overground section, the existing Luas Green Line infrastructure will be upgraded to the MetroLink format with higher platform levels and overhead power line catenary levels compatible with both overground and tunnel operations.

Platform lengths will also be increased to accommodate the planned MetroLink trains which at 64m length will be longer and have higher floors than the 55m long Luas Green Line trains.

These differences in configuration mean that MetroLink trains will be unable to operate a passenger service on the existing Luas Green Line railway infrastructure and, vice versa, existing Luas Green Line trains will be unable to run a service using the new MetroLink track and platforms.

It is inevitable, therefore, that the underground tie in and upgrade of the Luas Green Line to MetroLink operation will require one or more closures of the existing Green Line. This report describes and summarises the likely duration of such closures.

1.3 This Report

This Report is based on the current conceptual MetroLink scheme. It describes and summarises the order of magnitude of temporary closures of the existing Green Line that will be required to enable planned MetroLink operations between Charlemont and Sandyford.

1.4 Sources of Information

Information for this Report has been drawn from the following:

- The project drawings and documents supplied

- An extensive Question and Answer schedule, trying to identify or understand key elements of the scope
- Information passed during meetings with Jacobs / IDOM (both in person and by Skype)
- A full day site visit to many of the proposed station locations, including all stations along the existing Green Line between Charlemont and Sandyford.

1.5 Context of this Report

This report was prepared in March / April 2019 to specifically describe and summarise the order of magnitude works durations and service interruption impacts of modifying a section of the existing Luas Green Line to enable the planned MetroLink service. It is based on planning work carried out in the summer and autumn of 2018.

At that time, the MetroLink scheme proposals were at an early stage of concept development. It was, therefore, necessary to make a number of assumptions, with key ones relevant to the Green Line noted in this report.

2 GREEN LINE WORKS

2.1 Scope of the Works

To connect to the Green Line corridor, MetroLink would come to the surface to the south of a new underground station at Charlemont, and then join to the existing Luas Green Line, running on the existing tracks as far south as Sandyford Station. The tie-in to the Green Line corridor would include a new tunnel portal at the end of the bored tunnel section south of Ranelagh, followed by a cut and cover length to Beechwood.

The proposed Green Line upgrade section runs from the Tunnel Boring Machine (TBM) reception portal between Ranelagh and Beechwood stations to the proposed southern MetroLink terminus at Sandyford, and includes the following:

- TBM portal construction south of Ranelagh, and ramp to the surface south of Beechwood
- A new MetroLink station sub surface station at Beechwood
- A new overground Luas Green Line southern terminus station at Beechwood
- The upgrade of the existing Green Line from Beechwood to Sandyford, including:
 - Lengthening platforms to 65m long
 - Raising platforms to suit the new, higher floor trains
 - Upgrading of the overhead power system
 - Installation of new signalling for automatic, driverless trains and platform screen doors
- A new elevated station at Stillorgan to remove the at grade St Raphaela's Road crossing
- Removal of all other at grade crossings, requiring:
 - A new access road to the Milltown sub-station

- Closing access gates at Milltown Station to the neighbouring college
- Pedestrian and cycle bridges and / or under-passes at and occasionally between stations, for crossing the tracks. These to be fitted with lifts
- New fencing to prevent unauthorised access to the track
- Minor modifications to the existing Sandyford Depot to provide overnight stabling for 7 new MetroLink trains

As the planned MetroLink and existing Green Line have differing key dimensions a train from one is not designed to operate on the other's track. The proposed upgrade of a section of the Green Line to MetroLink configuration, therefore, requires one or more temporary closures of portions of the existing Green Line.

2.2 Nature and Timing of the Works

To determine the likely duration of the proposed temporary closures, it is first necessary to examine the nature of the works that are required to the Green Line. These can then be split into a number of categories as follows:

- Works that can be carried out without a closure of the Green Line
- Works that can be carried out during overnight or weekend closures
- Works that can be carried out during a short closure period of up to 4 weeks
- Works that require extended closure

2.2.1 Works that can be carried out without a closure of the Green Line

The crossing of St Raphaela's Road at Stillorgan must be changed from an at grade crossing (tracks and road at the same level with controlled gates) to an elevated crossing (with MetroLink either crossing over or under the road). Without this, the change to a Metro service would require closure of the road.

To construct an elevated crossing at the same location as the existing would require a closure of the Green Line of many months. However, a new structure to carry MetroLink trains over St Raphaela's Road could be built adjacent to the existing without any service closures (other than a temporary closure or relocation of Stillorgan Station). The service could then be switched on to the new alignment during a short duration closure.

2.2.2 Works that can be carried out during overnight or weekend closures

The increase in train length will require longer platforms. It would not be safe to construct these during normal Green Line operation, but they could be constructed during normal or extended overnight closures, with weekend closures used either occasionally (for the more complex sections of this work), or more frequently (to improve efficiency and reduce overnight noise).

The change from the low floor Luas trains to high level MetroLink trains will require the existing platforms to be raised. The platform cannot be used by a Luas Green Line train after the start of this work and cannot be used by a MetroLink service until this work is complete.

In some locations, however, it may be possible to construct an interim 'temporary' station (suitable for the existing Luas Green Line trains) either north or south of the existing station. The existing platform structures could then be raised and lengthened for MetroLink, with installation of the screen doors taking place later during systemwide upgrade. All of these works could probably be carried out using overnight and weekend closures. A short duration closure would then be required to change the overhead power lines (which must be lowered) to switch the service from Luas Green Line to MetroLink.

Similarly, it may be possible to install the new signalling system during overnight and weekend closures, placing it alongside the existing signalling system. 'Black boxes' could then be installed in one or more Green Line trains to test the new system without actually using any MetroLink trains. This would minimise the period required for testing, commissioning and trial running.

2.2.3 Works that can be carried out during short closures of up to 4 weeks

Crossing the tracks (either by vehicles or pedestrians) will not be permitted on MetroLink, due to the automated trains proposed and the requirement for a segregated line. Therefore, new pedestrian over-bridges or underpasses are required at a number of stations and at various locations between stations. It is considered probable that the walls for these underpasses could be formed from bored piles placed from the track level during weekend closures.

A short duration closure would then be required for works as follows:

- Remove the overhead power lines and track
- Dig out between the walls
- Cast concrete base and roof slabs
- Backfill over
- Replace the track and overhead power lines

2.2.4 Works that require extended closures

There are three significant activities that do not fit into any of the above categories and require extended Luas Green Line closures. These are as follows:

- The works for the new tunnel portal between Ranelagh and Beechwood.
- Construction of a new surface Luas Green Line southern terminus station at Beechwood.
- The upgrade of the existing Luas Green Line from Beechwood to Sandyford to MetroLink operation.

More detailed consideration of these works and closures follows in the sections below.

3 WORKS REQUIRING EXTENDED CLOSURES

3.1 Tunnel Portal

The new MetroLink is planned to be in tunnel from a new station at Northwood (just south of the M50) to a new tunnel portal between Ranelagh and Beechwood. It is proposed that this portal be situated under the current Green Line alignment to avoid significant impact to adjacent properties.

A section of cut and cover and retained cut would then run from this portal to a new sub-surface MetroLink Beechwood station south of Dunville Avenue, from where the alignment would rise to meet the existing alignment between Beechwood and Cowper. The existing Green Line tracks from Ranelagh would then be laid back over the new works from Ranelagh station to a new Luas Beechwood southern terminus station immediately north of Dunville Avenue. See Figures 3.1 to 3.4 below.

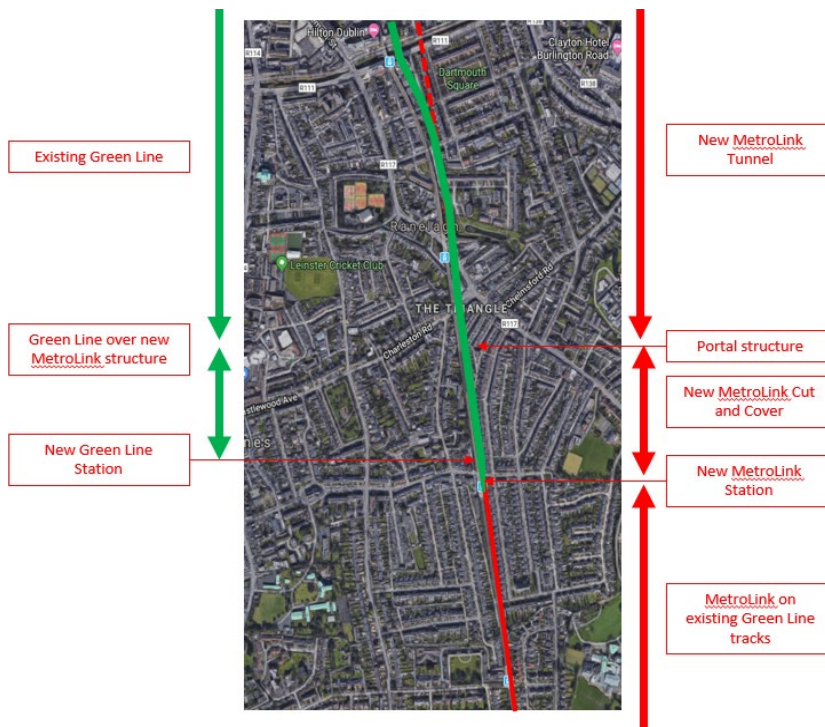


Figure 3.1: Planned MetroLink and Green Line alignments



Figure 3.2 Beechwood Portal and MetroLink Tie In (plan below ground)

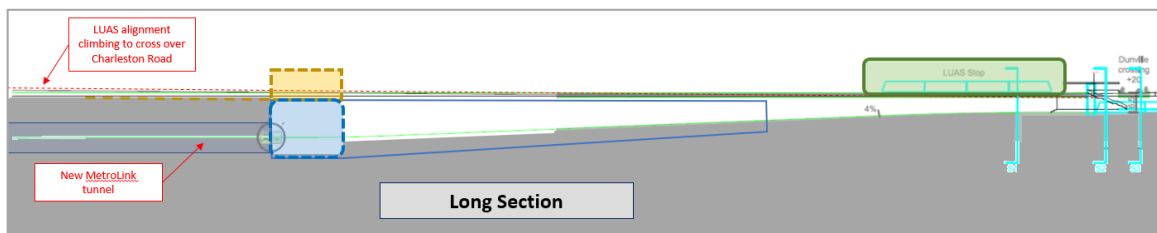


Figure 3.3 Beechwood Portal and MetroLink Tie In (section)

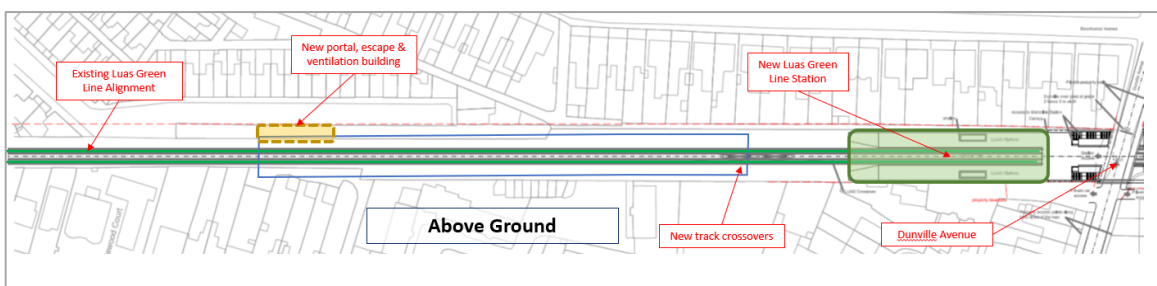


Figure 3.4 Beechwood Green Line Terminus Station (plan)

3.2 Portal Location

The location of the portal is constrained by the following:

- The objective of maintaining surface ground movement due to tunnelling at acceptable levels on the approaches to the portal without extensive ground treatment. This requires the portal to be in the region of 20m deep, equivalent to one tunnel diameter of ground cover above the tunnel.
- The need for sufficient space to the side of the Green Line tracks for the necessary ventilation and escape building.
- The required alignment constraints (both horizontal and vertical) must be satisfied.

The preferential portal location to meet these constraints is within land adjacent to Elmwood Avenue Upper. See Figure 3.2 above.

3.3 Portal Construction

Works are required to construct the portal in order to receive the TBM as follows:

- Dismantle and remove the overhead lines and track in this area
- Excavate to ground level (the Green Line is currently above ground level in this area as the alignment climbs to pass over Charleston Road)
- Install bored piles for the new structure

- Excavate between the piles and install temporary steel props to support the walls
- Cast a concrete base slab
- Cast in-situ reinforced concrete walls and slabs working from bottom upwards, removing the temporary props as the new slabs are cast

The TBM is then able to excavate into the portal and it must then be dismantled and removed.

3.4 New Green Line Station at Beechwood

After the completion of TBM removal, works can take place as follows:

- Complete the construction of the reinforced concrete portal structure
- Cast the concrete roof slab and the offset structure for ventilation and escape
- Backfill over and to the side of the cut and cover box structure, back to the current Green Line level
- At this point the track and overhead power lines for the Green Line can be placed back over the new structures as far as a new Luas station north of Dunville Avenue
- The track and overhead power lines can also be paced, joining the New MetroLink to the existing Green Line

3.5 Upgrading the Green Line to MetroLink

3.5.1 Upgrade to MetroLink configuration

The upgrade of the existing Green Line between Beechwood and Sandyford to MetroLink configuration will require a temporary closure of the line to conduct works as follows:

- The existing overhead lines and hangers are dismantled, additional poles erected where required, new hangers installed, and the new power lines installed
- Testing, commissioning and trial running takes place
- All other works not previously completed take place

3.5.2 Independent Operation

It is not proposed that the upgraded section between Beechwood and Sandyford is to be operated in MetroLink configuration on an interim basis, independent to the rest of the Metro service. This would otherwise require an additional control room and stabling facilities at Sandyford. The provision of these would entail substantial duplication of the proposed permanent facility at Dardistown. In any case; it may not be possible to install the additional facilities whilst maintaining the Luas Green Line services.

Therefore, the tie in infrastructure at Beechwood must be completed in order to enable through running to the Dardistown rail depot.

4 NECESSARY GREEN LINE EXTENDED CLOSURES

4.1 Works requiring extended closures

Extended closures of the Green Line will be required for works as follows:

- For the MetroLink portal construction works, the Green Line will need to be closed between the current Beechwood station (south of Dunville Avenue) and Ranelagh station
- To construct the new MetroLink station at Beechwood (which is below ground), this closure will need to be extended to Cowper station
- Upgrade of the Luas Green line to MetroLink configuration will require closure between Beechwood and Sandyford stations

4.2 Overall programme of proposed works

An overall programme showing the likely sequence and order of magnitude durations for the proposed works is shown in Figure 4.1 below.

This is a strategic level programme based on conceptual designs for the MetroLink tie in at Beechwood and a new Luas Green Line southern terminus station, also at Beechwood.

The sequence and to an extent the prospective duration of these works is determined, in part, by the spatial constraints of working, predominantly within the narrow existing corridor of the Green Line.

The duration of systemwide works for the upgrade of the Green Line to MetroLink configuration is based on similar works already undertaken on Luas projects and elsewhere.

As stated in Section 3.5 above, these works require an extended closure and it is not proposed that, once completed, this section would be operated at any time independently of MetroLink as a whole. It is proposed, therefore, that the works are conducted in parallel with the equivalent MetroLink systemwide works.

The programme has been developed to arrive at a robust order of magnitude estimate of the likely durations of interruptions to Green Line service and is based on currently available information. Taken as a whole, the total period over which extended closures will be required is approaching four years.

This period is subject to review and amendment as the scheme is refined. However, without strategic changes to the scheme and as an order of magnitude estimate, it is unlikely to be reduced by more than one year.

The major civil engineering works proposed in the Beechwood area would not, taken alone, require the Green Line to be closed along the full length from Ranelagh to Sandyford. In order to minimise overall interruption of service, these works could be staged within a local zone, or blockade, breaking the service locally and affecting two or three stations.

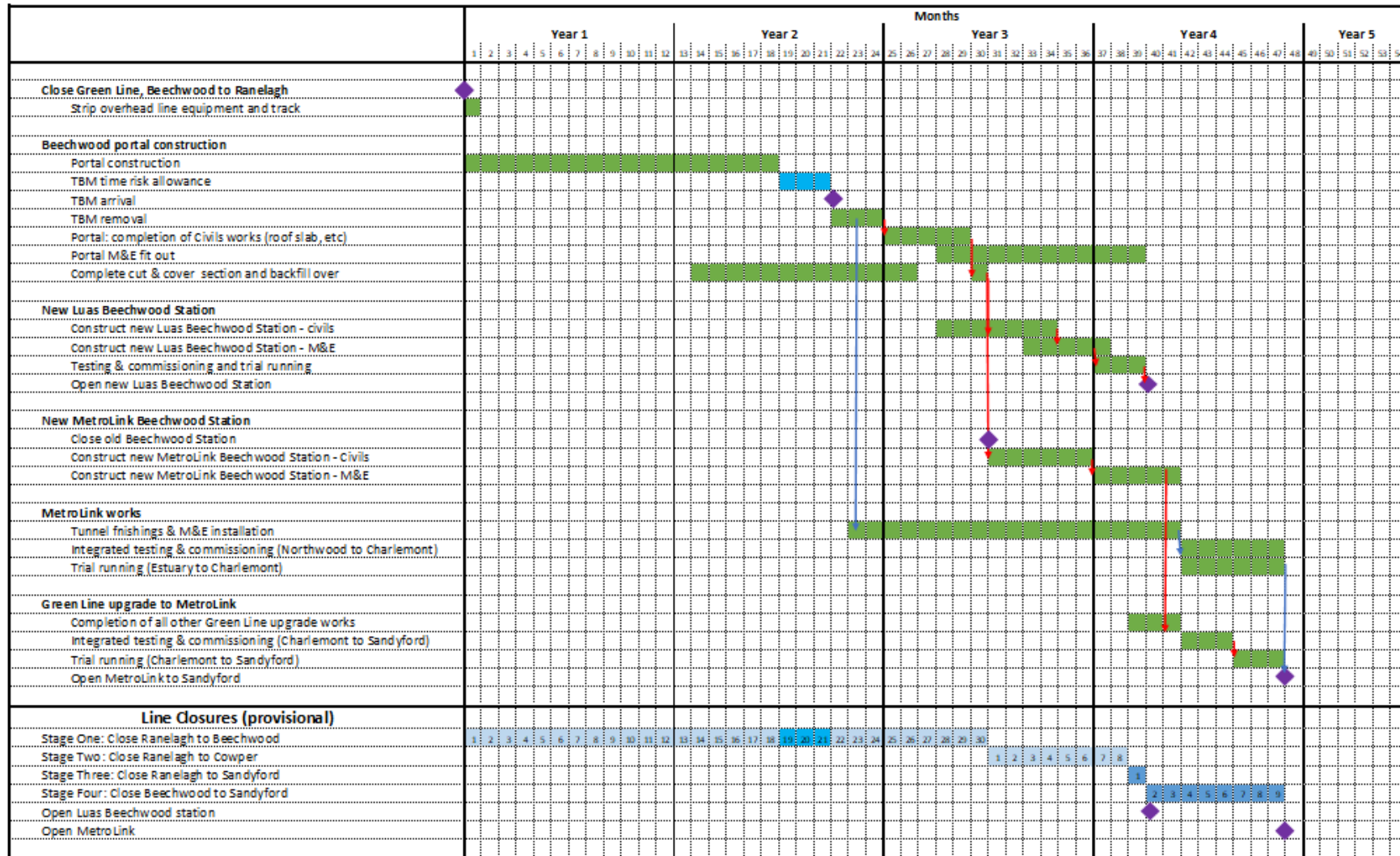


Figure 4.1: Green Line Order of Magnitude Closure Programme

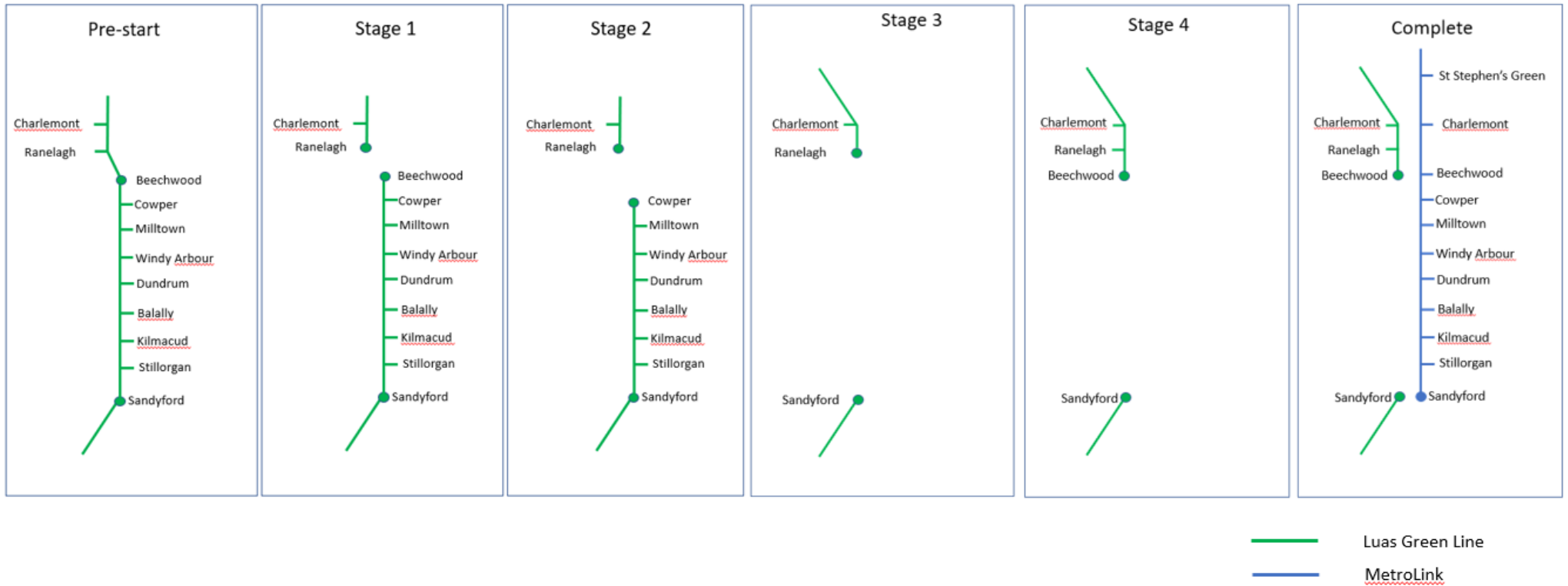


Figure 4.2: Green Line indicative phasing

4.3 Staging of Green Line Closures

4.3.1 Staging Plan

A staging plan for local closures with the objective of minimising the length of necessary service blockades is shown in Figure 4.2 above.

4.3.2 Stage 1 Closure: Beechwood to Ranelagh

The Green Line works in this stage would consist of the Beechwood portal works only.

The Luas Green Line could continue to function south of Beechwood and north of Ranelagh.

Based on the current concept scheme, a period of around 18 months is assessed as being required to construct the portal and prepare for the TBM arrival. A time risk allowance of 3 months is included in the programme to protect the overall MetroLink critical path against local delays.

The Green Line must remain closed whilst the TBM is removed, the portal works are completed and backfilled over, and the new Luas Beechwood station constructed, fitted out and commissioned.

Assumptions:

- That no major works are required elsewhere to split the Green Line into two operational sections (e.g. an additional Control Room, additional service, train storage depot, etc...)
- That the signalling and control systems can be simply split into two independent systems
- The interface between passengers and construction traffic at Dunville Avenue (where HGVs to the portal will drive on to the current track alignment) can be managed safely
- HGVs for the TBM removal can reverse down Elmwood Avenue Upper
- There is sufficient space for a crane or lifting gantry to lift the TBM sections
- HGV access is sufficient to support the programme

4.3.3 Stage 2 Closure: Cowper to Ranelagh

The existing Beechwood station must be closed to allow for the following:

- The diversion of the sewer and other services in Dunville Avenue^(*)
- Piling across Dunville Avenue and the formation of the new road deck (and MetroLink roof slab)^(*)
- Demolition of the existing station and café, site clearance and piling for the retaining walls for the new station
- Excavation of the new station, installing props and tie backs as required
- Casting of the new base slab, platforms and wall lining
- Continuing with the retaining wall and excavation towards Cowper, until the new alignment rises to meet the existing

- Construction of plant rooms, staircases, platform covers and platform screen doors
- M&E installations and standalone testing and commissioning

(*) These items may be completed before the start of this phase

The programme at Figure 4.1 above indicates a stage duration of around 9 months.

4.3.4 Stage 2A Closure: Cowper to Beechwood

The physical extent and, potentially therefore, the impact of service interruption would be reduced if completion of the new Luas Green Line Beechwood station could be brought forward. This would limit or remove the need for a blockade spanning Cowper to Ranelagh.

At the current state of scheme development, this remains an opportunity to be explored as the design progresses.

4.3.5 Stage 3 Closure: Sandyford to Ranelagh

As stated in Section 4.2 above, it is proposed that the Green Line upgrade works detailed in Section 3.5.1 above will be conducted in parallel with the equivalent Metrolink systemwide works. It is estimated that these Green Line works will take approximately 9 months and require a complete closure of the existing Green Line north of Sandyford. It is currently estimated that this closure period will overlap for a short duration (around 1 month) with the closure detailed in 4.3.3 above, therefore, requiring a complete closure between Sandyford and Ranelagh.

4.3.6 Stage 4 Closure: Sandyford to Beechwood

On completion and opening of the new Green Line southern terminus station at Beechwood, the Stage 3 closure will be reduced in extent to run from Sandyford to Beechwood.

5 STRATEGIC ALTERNATIVES

5.1 General

As stated in Section 4.2 above; taken as a whole, the total period over which extended closures will be required is approaching four years (47 months). Without strategic changes to the scheme and as an order of magnitude estimate, this duration is unlikely to be reduced by more than one year.

Two potential strategic alternatives to the current concept scheme have been identified which may substantially reduce the overall period of required Green Line closure. These are:

- Change from an on-line to an off-line portal
- Long term phasing of the MetroLink opening

5.2 An off-line portal

The extended Green Line closure between Ranelagh and Beechwood described in the sections above is necessary largely due to the portal being directly below line the alignment of the current Green Line. This necessitates the Green Line being closed for all of the portal works.

If the portal is moved 'off-line', then the Green Line does not necessarily require closure for the full duration of the portal works. A closure is still required to connect the new and existing alignments with potentially a significant reduction in duration depending on the precise location.

However, a preliminary examination of possible sites has revealed no clear and obvious locations in which an off-line portal could be placed without significant environmental impact.

5.3 Phasing of MetroLink

If the MetroLink opening were to be phased, opening first from Estuary to Charlemont and a second phase to Sandyford opening some years later, then the following sequence may be possible:

Phase 1:

- No works to the existing Green Line for the new build MetroLink
- Construct the new tunnel as far as the future Beechwood Portal and leave the TBM in the ground. This will require the stripping out of the TBM internals and cleaning of the remainder
- Make provision for a temporary turn-back of the Metro at Charlemont
- Complete new build track, M&E installation, testing & commissioning, and trial running
- Open MetroLink Phase One (from Estuary to Charlemont)

Phase 2:

- Local staged closure of the Green Line, initially between Ranelagh and Beechwood, and then from Ranelagh to Cowper
- Excavate the portal and complete the other works described in section 3 above to connect the MetroLink onto the existing Green Line tracks south of Beechwood, including:
 - New tunnel portal structure, with ventilation and escape functions, adjacent to Elmwood Avenue Upper
 - New cut and cover section from this portal to Dunville Avenue
 - Relay the tracks over this structure to connect the Green Line at Ranelagh with a new Luas station north of Dunville Avenue
 - New MetroLink Beechwood station in the position of the current Beechwood station but below ground
 - The retained cut section required south of Beechwood to bring the new alignment up to surface
- Extended stage closure of Green Line, initially between Ranelagh and Sandyford, and then from Beechwood to Sandyford
- The existing overhead lines and hangers are dismantled, additional poles erected where required, new hangers installed, and the new power lines installed
- Testing, commissioning and trial running takes place

- All other works not previously completed take place
- Open MetroLink Phase Two (extending to Sandyford)

An approximate indicative programme for Phase 2 is shown as Figure 5.1 below. Note this is shown to illustrate the potential time savings of the phased opening and is based on similar planning to that described previously.

As can be seen, this significantly reduces the required Green Line closure from that described for an unphased sequence. The time saving comes from:

- The works will not be dependent on the arrival of the TBM
- The TBM is removed during the excavation of the portal and other works can carry on in parallel (assuming HGV and crane access is sufficient).
- The TBM would be partially dismantled during Phase 1 (all internals stripped out and the remainder cleaned from the inside). Hence fewer tasks are needed to dismantle and remove the TBM in Phase 2
- The critical path for the programme follows the Beechwood activities and not the line wide completion of the tunnel trackwork and M&E
- Testing, commissioning and trial running are expected to be simpler and, therefore, take less time for Phase 2 than for the whole alignment

The indicative programmes of figures 4.1 and 5.1 indicate a saving in the required closure of around 14 months.

Assumptions: (Note: These are the same as for the single-phase construction phase programme. See section 4.3.2):

- HGVs for the TBM removal can reverse down Elmwood Avenue Upper
- There is sufficient space for a crane or lifting gantry to lift the TBM sections
- HGV access is sufficient to support the programme

