Connolly Station Enhancement Options Study

National Transport Authority

Options Selection Report

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Project Manager:	Alex Bradley
Author:	Alex Bradley
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Jacobs Engineering Ireland Limited

Merrion House
Merrion Road
Dublin 4, D04 R2C5
Ireland
T +353 1 269 5666
F +353 1 269 5497
www.jacobs.com

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Executive Summary

This report describes the option selection process and supporting work completed which informed the outcome of an Option Appraisal Workshop held on 1st March 2019 by Jacobs from which an Emerging Preferred Option was developed from five short-listed options using multi-criteria analysis. The short-listed options were extracted from a long-list of over twenty feasible options that we had previously selected because of their potential to satisfy the requirements of the Connolly Station Enhancement Study brief.

To support the multi-criteria analysis our engineering leads presented the requirements, issues and constraints for their discipline with reference to the outline permanent way design layouts for each option. Train operational modelling and high-level comparative costing were also available for the five options.

The key features of the short-listed Options 3, 6B, 6D, 8B, and 8D can be summarised as:

Option 3 extends and realigns the existing platforms and includes a remodelling throat to reduce conflicts, it provides an improved Newcomen single line chord with a new canal drop-lock. The Enterprise Maintenance Shed needs to be removed.

Option 6B reconstructs all platforms, widened to suit passenger growth and all connected by a new footbridge and lifts. The Newcomen Chord is twin tracked and a new canal drop-lock is required along with a reconstructed North Strand Road bridge. The ticket gate-line is relocated in the train shed to the north to provide an enlarged concourse and retail area. The Enterprise Maintenance Shed is removed to enable the remodelled station throat to remove conflicting movements.

Option 6D is a variant of Option 6B. The main difference is the Newcomen Chord is only single tracked and there is no requirement to replace the North Strand Road bridge. However, the option does require the construction of a significant intervention at Glasnevin, which is outside the scope of this study but is briefly discussed below for completeness. This option will also require the construction of a new canal drop-lock.

Option 8B requires remodelling of the throat and an additional platform with associated replacement of an existing bridge deck on the western side of the station. The possibility of retaining the existing platforms and in particular Platforms 6 and 7 at their current width was examined but it was found that that the existing platforms are likely to require widening and lengthening to safely handle the potential number of passengers, services and access routes. Option 8B focused on the impact of these safety driven alterations rather than leaving the existing platforms untouched and this has had an impact across the entire northern throat. This results in necessary alterations to most of the station. Option 8B also requires a twin tracked Newcomen Chord with associated replacement of the North Strand Road bridge and new canal drop-lock. Third-party land is required for the new platform to the west of the station, including the adjacent car park and properties in Amiens Street and Preston Street.

Option 8D is a variant of Option 8B. The main difference is the Newcomen Chord is only single tracked and there is no requirement to replace the North Strand Road bridge. However, the option does require the construction of a significant intervention at Glasnevin, which is outside the scope of this study but is briefly discussed below for completeness. This option will also require the construction of a new canal drop-lock.

A service pattern whereby 16tphpd Maynooth and 12tphpd Phoenix Park Tunnel trains split equally so that 14tphpd go to both Connolly and Docklands stations might be possible should a major intervention take place at Glasnevin, while taking account of design requirements for MetroLink. Service levels are such that full grade separation is likely to be needed to achieve a reliable service. It is understood that Irish Rail's original proposal was developed on a smaller number of services operating through Glasnevin. Operational modelling is necessary to assess the performance impact of this intervention, but the capital cost is likely to be considerably higher than the installation of a dual-track along the Newcomen Chord, even with the reconstruction of the North Strand Road bridge.

The Multi-Criteria Analysis performed by the study team identified Option 6B as the Emerging Preferred Option. It is considered that although this Option will inevitably cause disruption to train operations during construction, the final scheme will provide the greatest operational flexibility achievable within the study area. The option

provides the better performance and passenger service outcomes for the ‘B’ options and delivers the maximum capacity and operational flexibility at Connolly Station to deal with changing demands in the future.

The results of this appraisal were presented to the National Transport Authority (NTA) and Iarnród Éireann (IÉ) on 6th March 2019.

Upon NTA acceptance of the appraisal findings, Jacobs will develop a Concept Design for the Preferred Option.

1. Introduction

1.1 Project Background

The National Transport Authority (NTA) along with Iarnród Éireann (IÉ) wishes to evaluate the options at Connolly Station to optimise its capacity to handle through-running or terminating trains from the four connecting radial routes served by the Northern Line, the Maynooth Line, Phoenix Park Tunnel Line and the Southeast Line. This is likely to involve platform changes and operational enhancements at the station together with changes to the approaching track layout and junctions.

Jacobs was awarded the Connolly Station Enhancement Options Study, which has the key objectives of:

- Identifying all options for enhancing capacity at Connolly Station to deliver the target capacities while taking the Connolly Master Plan into account;
- Minimising crossovers in the station and maintaining separation of the Northern Line from the western radial lines;
- Assessing various service patterns that maximise the capacity and flexibility of the station operations for each of the infrastructure layout options;
- Completing a sifting exercise to identify a shortlist of options, including those developed by IÉ prior to this scheme, that meet the project objectives;
- Producing outline designs for each of the shortlisted options, including the preparation of high-level cost estimates for each option and the identification of high level benefits; and
- Simulating train services to demonstrate that shortlisted outline designs and their service patterns can handle the specified target capacities.

The National Development Plan (2018 to 2027) has the aim of creating a full metropolitan area DART network for Dublin with all the lines linked and connected. Connolly Station sits at the heart of the Dublin railway system and the Connolly Station Enhancement Options Study is intended to increase capacity and operational flexibility.

NTA has set a station target capacity of 30 trains per hour per direction (tphpd) from the combined three radial routes: Northern Line (16 trains per hour per direction (tphpd)), Maynooth Line (16 tphpd) and the Phoenix Park Tunnel Line (12 tphpd) and with through running of 18 tphpd on the Southeast Line. The balance of 14tphpd is expected to be directed towards an expanded Docklands station.

The Connolly Station Enhancement Options Study shall take account of the following design requirements when developing options:

- The Schedule of Standards covering IÉ and Other Standards;
- Connolly Station designed to accommodate 8-car trainsets, including Diesel Multiple Unit (DMU) and DART Electric Multiple Units (EMUs) operating at 1500V DC. The design shall also accommodate the existing Belfast Enterprise service;
- Passive provision clearance for transition to 25KV AC electrification in the future;
- Station platforms to be minimum of 174m long for 8-car trainsets and 215m for Belfast Enterprise;
- Maximum track gradient at platform of 0.2%;
- Signalling design capacity for the station and radial routes on all lines of 20 trains per hour per direction;
- Turnback capacity per platform to be taken as 6 trains per hour for 1 driver or 9 trains per hour with 2 drivers utilising a ‘stepping-up of drivers’ operating procedure;
- Extent of Connolly Station enhancements to take cognisance of the wider Connolly Masterplan development;

- The relevant Study Area for this brief shall extend around Connolly Station and all track layout bounded by Loop Line Bridge on south and up to and including Newcomen, North Strand and East Wall Junctions in north.

1.2 Study Area

The diagram below indicates the study area to which this scheme is confined, and it is noted that Glasnevin Junction is outside the geographical boundary of the study.

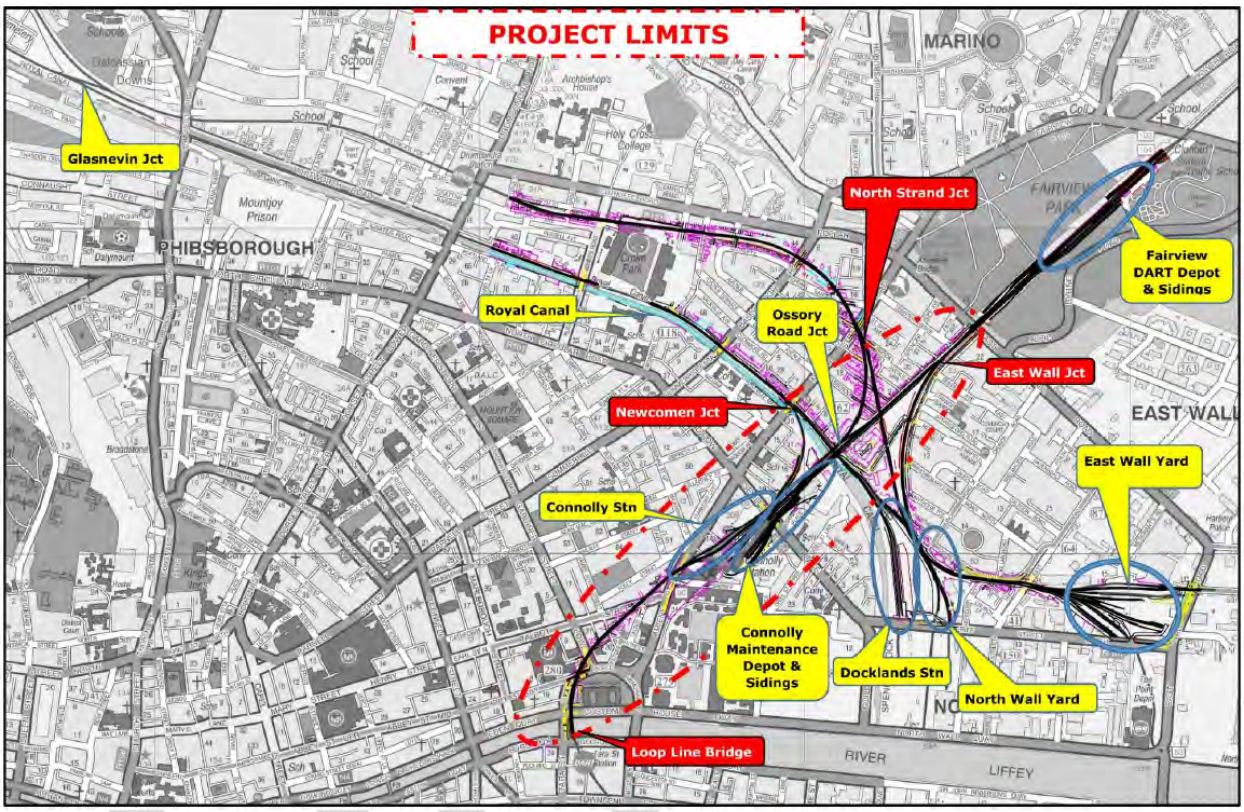


Image 1-1 Study Area for the Connolly Station Enhancement Options Study

1.3 Identification and Appraisal of Feasible Options

In November 2018, the Jacobs project team, led by the operations discipline lead, were tasked with identifying potential enhancement options to be developed for initial appraisal. This activity resulted in a list of 13No. options to be assessed. Each of these options was reviewed and appraised by the Project Discipline Leads prior to an Option Appraisal Workshop held on 13th December 2018.

A further 6No. options were identified during the workshop, which were added to the initial list to make 19No.for assessment.

The Option Appraisal Workshop was successful in further developing and assessing the 19No. identified options. A total of 5No. were removed from the list because they did not satisfy the project objectives, leaving a long list of 14No. options that had the potential of achieving the 30tphpd target. An additional 3No. options were added to this list after discussion at a Client Steering meeting on 18th December 2018 making a total of 17No. options forming the "Long List" that has since been assessed as part of the appraisal process. For detailed findings of this process including descriptions of the initial 'Long List' of options, reference should be made to the Options Appraisal Report, reference 32110100-GEN-RP-002.

The long list of options was assessed by workshop delegates from the disciplines of project management, train operations, permanent way, civil/structural, cost consulting, and environment. Acknowledging the project brief requirements, including the train service and station capacity, capital cost, constructability, and environmental impact, it was agreed to take a shortlist of 5No. options on to more detailed assessment.

The long list of options is listed below for information:

Table 1-1: Long List of Options

Option	Title	Description
1.	Do Nothing	Leave the station layout as it currently exists with no changes to platform arrangements, no changes to any operational approaches and a station throat layout with no changes to operational flexibility or routing.
2.	Alternative Approach to Platforming	Operational 'split' of the station to re-route trains between their respective points of origin and destination within the existing station layout with no changes to platforms or station throat.
3.	Platforms Unchanged with Remodelled Station Throat	Operational 'split' of the station and re-routing of trains between their respective points of origin and destination within the existing station layout. Minor modifications to terminal platform lengths and no changes to through-platform layout but with changes to station throat and routing.
3A.	Option 3, with dual-tracking of Newcomen Line	Operational 'split' of the station and re-routing of trains between their respective points of origin and destination within the existing station layout. Minor modifications to terminal platforms and no changes to platform layout but with changes to station throat and routing and a double track around the Newcomen Chord line.
4.	Remodelled Platform with Throat Retained	Operational 'split' of the station and re-routing of trains between their respective points of origin and destination. Reduction in the number of terminal platforms to 3 No and re-construction of through platforms eastwards to allow construction of a new Platform 7 with very minor changes to platform tracks and no change to station throat.
5.	Elevated Approach from West Lines	Operational 'split' of the station and re-routing of trains by diversion of the GSW lines over a dedicated twin track flyover (elevated) from North Strand Road Junction to serve an increased number of terminal platforms, shared in part by northern approaching services. Modifications to the station but only re-numbering of the through platforms to include a Platform 8 and a double track around the Newcomen Chord line.
6.	Remodelled Platforms and Station Throat – Platforms 6 and 7 Terminate	Operational 'split' of the station and a reduced number of terminating platforms in the train shed. Retention of only 2 No through tracks and re-construction of all platforms with a new terminal Platform 7 and the severing of Platform 6 track to also become a terminal platform. Total re-modelling of the station throat and introduction of a double track around the Newcomen Chord line.
6A.	Remodelled Platforms and Station Throat – Platforms 6 and 7 through line	Operational 'split' of the station and a reduced number of terminating platforms in the train shed. Creation of 4 No through tracks and re-construction of all platforms with a new Platform 7. Total re-modelling of the station throat and introduction of a double track around the Newcomen Chord line.
6B.	Remodelled Platforms and Station Throat in Combination with Additional Crossings	Operational 'split' of the station and a reduced number of terminating platforms in the train shed. Creation of 4 No through tracks and re-construction of all platforms with a new Platform 7. Total re-modelling of the station throat to include new scissor crossovers between Platforms 4&5, 6&7 and introduction of a double track around the Newcomen Chord line.

Option	Title	Description
6C.	Option 6 with scissors at end of platform	Operational 'split' of the station and a reduced number of terminating platforms in the train shed. Retention of 3 No through platform tracks and re-construction of all platforms with a new terminal Platform 7. Total re-modelling of the station throat to include new scissors crossovers between Platforms 4&5, 6&7, and introduction of a double track around the Newcomen Chord line.
6D.	Option 6b without dual-tracking of Newcomen	Operational 'split' of the station and a reduced number of terminating platforms in the train shed. Creation of 4 No through tracks and re-construction of all platforms with a new Platform 7. Total re-modelling of the station throat to include new scissor crossovers between Platforms 4&5, 6&7.
7.	Option 6b with variant on Crossings	Operational 'split' of the station and a reduced number of terminating platforms in the train shed. Creation of 4 No through platforms and re-construction of all platforms with a new Platform 7. Total re-modelling of the station throat to include new scissors crossovers between Platforms 4&5 and 6&7 but with reduced operational flexibility to service the double track Newcomen Chord lines by the positioning the 6&7 scissor crossover further northwards.
8	Modified Existing Layout with New Platform 8 and Revised Throat	Operational 'split' of the station with minor modifications to terminal platform lengths in the train shed. Retention of 3No through platforms and construction of a new terminal Platform 8. Total remodelling of the station throat utilising some double slip junctions for operational crossover flexibility and retention of single track Newcomen Chord line.
8A.	Option 8 with dual-tracking of Newcomen Line	Operational 'split' of the station with minor modifications to terminal platform lengths in the train shed. Retention of 3No through platforms and construction of a new terminal Platform 8. Total remodelling of the station throat utilising some double slip junctions for operational crossover flexibility and introduction of a double track around the Newcomen Chord line.
8B.	Combination of elements of 6a (Throat) and 8a (Platforms)	Operational 'split' of the station with the introduction of additional new platform 8 on west side as a terminus platform served by a double track on the Newcomen Chord line with double slip junctions into the Suburban Lines. A total re-modelling of the station throat and retention of existing platform arrangements and through tracks with only minor modifications to terminal track platforms.
8C.	Option 8B with Platform 8 Through Line	Operational 'split' of the station with the introduction of additional new through Platform 8 on west side served by a double track on the Newcomen Chord line. A total re-modelling of the station throat with total crossover flexibility and retention of existing platform arrangements and through tracks with only minor modifications to terminal track platforms.
8D.	Option 8B without dual-tracking of Newcomen	Operational 'split' of the station with the introduction of additional new Platform 8 on west side as a terminus platform. A total re-modelling of the station throat and retention of existing platform arrangements and through tracks with only minor modifications to terminal track platforms.
9.	Under Arches from Newcomen line	Operational 'split' of the station with the introduction of additional new Platform 8 & 9 island platform with scissor crossover, constructed beneath the existing train shed on a dedicated new connection from Newcomen Junction – replacing the Newcomen Chord Lines Remainder of existing station unaltered.
10.	Double-decking of the Loop Line	Operational 'split' of the station with the introduction of additional new double track overhead structure and grade separated high-level lines constructed over the top of the existing Suburban Lines and station throat from a location north of Ossory Rd Junction through new high level Platforms 9 & 10 over the existing Platforms 7 & 8, and southwards towards Tara Street station. Remainder of existing station unaltered.

Option	Title	Description
11.	Dual-tracking of Newcomen line only	Operational 'split' of the station and introduction of a double track over the Newcomen Chord lines only. No platform changes or alterations to existing station throat apart from new chord connection into suburban lines.
12.	Connect Container Depot lines to Terminal Platforms using Grade Separated Approach	Operational 'split' of the station with the introduction of a new double track connection into the low level North Wall Container Depot lines (east of the northern lines overbridge) and new double track chord connection climbing to station level over non-railway land, over the Docklands station lines and Royal Canal into the terminal tracks within the train shed. Station throat area of terminal tracks remodelled utilising single slip junctions to improve operational flexibility. Remainder of existing station unaltered.
13.	Platform 4 and 5 Suburban Island Platform	This layout creates a new island platform within the existing footprint of the station. It would enable the segregation of South-West and North Line through services to the Loop Line.

The Shortlisted Options were as follows:

- Option 3: Platforms Unchanged with Remodelled Station Throat
- Option 6B: Remodelled Platforms and Station Throat in Combination with Additional Crossings
- Option 6D: Option 6B, without dual-tracking of Newcomen
- Option 8B: Combination of elements of 6A (Throat) and 8A (Platforms)
- Option 8D: Option 8B, without dual-tracking of Newcomen

These options have now been developed further by the operational, engineering, environmental and cost consulting disciplines. The outputs and appraisal from each discipline is outlined within this report.

A further option has been briefly considered in Section 15 - Glasnevin in the event that Glasnevin Junction is remodelled so that Maynooth and Phoenix Park Tunnel services can access both Connolly Station and Docklands.

2. Methodology for Option Selection

2.1 Objective

The five shortlisted options, as listed in Section 1.3, were appraised using a Multi-Criteria Analysis (MCA) to establish an Emerging Preferred Option (EPR). The appraisal was carried out based on the criteria identified in the Common Appraisal Framework for Transport Projects and Programmes (DTTAS, 2016), as described in Jacobs' document entitled: Multi-Criteria Analysis – Methodology, dated 24 January 2019 (Ref: 32110100-GEN-RP-001).

A workshop was attended by the Jacobs' engineering team on 1st March 2019, chaired by the Jacobs Project Manager. Prior to the workshop outline designs were developed for each of the five shortlisted options. This included the preparation of cost estimates and the identification of high-level benefits. Train service simulation modelling was carried out to demonstrate that the shortlisted options and associated service patterns could provide the target capacities specified in the project brief. For further details refer to Section 3 below.

2.2 Criteria for Multi Criteria Analysis

The Common Appraisal Framework (CAF) recommends that the following topics are considered in a qualitative appraisal of options:

- Economy (including non-quantifiable economic impacts);
- Safety;
- Physical Activity;
- Environment;
- Accessibility and Social Inclusion; and
- Integration.

2.2.1 Aspects of Environmental Criterion

Under the environmental criterion the options had the potential to differ in terms of land use, water quality, landscape and visual, archaeological/ architectural heritage and biodiversity impacts.

However, they did not differ significantly at this stage in terms of socio-economic, air and climate including adaptation to climatic factors and human health/population, as all options ultimately support an increase in rail traffic through Connolly Station. Potential impacts on radiation, stray current and agronomy are not anticipated. These environmental sub-criteria were therefore not considered at this stage of the assessment.

The production of waste, impacts on soils/geology and impacts of vibration were not considered, however these impacts will be considered during the Concept Design of the Emerging Preferred Option, to be undertaken following the MCA appraisal process.

2.2.2 Criteria Not Included within Appraisal

The criterion of Physical Activity is considered neutral in the context of this appraisal as all rail infrastructure options use the same transport mode and will deliver similar health benefits for users.

Accessibility and social inclusion were not assessed as the study area is within a relatively small geographical area, and the operational similarities of the options under consideration would likely result in the options being neutral.

2.3 Option Appraisal

2.3.1 Stage 1 Appraisal

The long list of options was assessed by delegates from the disciplines of project management, train operations, permanent way, civil/structural, cost consulting, and environment at the workshop and in the days that followed.

A pass / fail criteria method of appraisal was used to undertake the Stage 1 assessment.

Acknowledging the project brief requirements, including the train service and station capacity, capital cost, constructability, and environmental impact, it was agreed to take a shortlist of 5No. options on to more detailed assessment.

2.3.2 Criteria for Stage 2 Appraisal

The criteria for the MCA appraisal are detailed in Table 2-1 as shown below:

Table 2-1 MCA Stage 2 Appraisal Criteria

Criteria	Sub-criteria	Description	Metric
Economy	Capital Cost	Estimates to be prepared and assessed in line with NTA guidelines	Comparison of options with regards to comparative capital cost
	Efficiency and Effectiveness	Maximise the value for money	Comparative analysis of options in relation to station capacity
	Construction and Maintenance Impacts	Minimise the potential disruption to rail and other transport users	Comparative assessment of potential impacts of delays to station and other transport network users arising from staging of works
Environment	Ecology and water resources (impacts on habitats/species and surface/groundwater arising from landtake)	Avoid and mitigate adverse effects on biodiversity arising from proposed scheme, and minimise impacts on water resources arising from implementation of proposed scheme	Qualitative appraisal of potential effects of proposed option on internationally and nationally important designated sites and associated flora and fauna, and existing surface water bodies and aquifers
	Built environment, land use and visual	Avoid and minimise impact on land take requirements	Comparative qualitative assessment of land use requirements for each option
	Archaeological architectural and cultural heritage	Avoid and minimise impact on the archaeological, architectural and cultural heritage environment	Qualitative appraisal of potential impacts of proposed options on legally protected sites
Integration	Integration	Maximise the integration of all connecting lines through and terminating at Connolly Station	Comparison of each option in relation to conflict reduction and connectivity
	Flexibility	Ensure option complies with City and Regional transport, economic and planning policies and strategies	Qualitative appraisal of compliance with appropriate policies
	Geographical Integration (Connolly Masterplan)	Maximise the integration of all operational and infrastructure implications with the proposed Connolly Masterplan	Qualitative appraisal of each option in relation to flexibility of design, specifically relating to proposed developments
Safety	Operational Safety	Reduction associated maintenance risk within the scheme area	Comparison of each option in relation to appraisal of asset maintenance requirements

2.4 MCA Scoring System

A comparative appraisal was undertaken using a five-point scale, ranging from significant advantages over other options to significant disadvantages over other options. This five-point scale is colour coded as presented in Table 2-2, shown below.

Table 2-2 Options Appraisal Colour Coding System

Score / Colour	Description
	Significant advantages over other options
	Some advantages over other options
	Comparable to other options
	Some disadvantages over other options
	Significant disadvantages over other options

2.4.1 Scoring Process

Each of the sub-criteria listed in Table 2-2 was considered in turn. A Discipline Lead was chosen for each of the sub-criteria to lead discussion and comparison of options, based on the development of the designs undertaken by the relevant Discipline Lead.

The results of each sub-criteria appraisal were challenged by the project team, and consensus was reached on each before moving onto the next sub-criteria.

The results of the appraisal are outlined in Sections 10 – 13 of this report.

2.5 Non-Scored Options

Following further development of the outline designs it was determined that two of the options did not meet the criteria as set out in the project brief.

- **Option 3** – the single suitable terminating platform means that a maximum of 26 tphpd (with 4 terminating) can be delivered in this Option. Furthermore, the minimal works undertaken to the platforms, and no extra provision for passenger movements, mean that this Option is not capable of achieving the required capacity.
- **Option 8B** - operational modelling of this Option was completed as part of this scheme. However, the modelling was undertaken with the assumption that a scissors crossover or similar arrangement could be provided at the end of Platforms 7 and 8. Subsequently it was confirmed that due to the curvature of the Newcomen Chord it would not be possible to install a scissors crossover at this location. Following confirmation of this it was decided that this Option would not be scored against the other options.

3. Outline Design Development

Prior to the workshop on the 1st March 2019, Jacobs developed outline permanent way and civils design drawings for each of the five shortlisted options. The input from each discipline and relevant appraisal sub-criteria is described below.

3.1.1 Permanent Way

Permanent way drawings were developed for each of the five shortlisted options and can be found in Appendix A of this report. The permanent way designs were developed in conjunction with other key disciplines, specifically the operations and civil engineering disciplines.

These drawings were provided to the engineering team to allow other key disciplines to develop their outline designs, and to facilitate comparative appraisal of each option during the workshop on 1st March 2019.

The permanent way designs were used to compare each option with regards to *operational safety*, specifically relating to the appraisal of asset maintenance requirements for each option.

3.1.2 Civil and Structural Engineering

Platform layout drawings were developed for each of the five shortlisted options, taking into account the findings of the pedestrian flow analysis. Furthermore, outline design drawings were developed for the construction of the drop-lock which will be required to allow for increased service over the Newcomen Chord. These drawings can be found in Appendix B of this report.

These drawings were provided to the engineering team to allow other key disciplines to develop their outline designs, and to facilitate comparative appraisal of each option during the workshop on 1st March 2019.

The outline civil engineering designs were used to compare each option against the *construction and maintenance impacts* and *geographical integration* sub criteria associated with **economy**.

Each option requires the construction of a drop-lock at the Newcomen Chord location. This drop-lock will allow navigation of the canal without the need to interfere with railway operations. Its form will be similar to that recently installed at Dalmuir, West Dunbartonshire, Scotland. This will allow the existing railway lifting bridge to be replaced with a fixed bridge. The required size and location of the drop-lock differs between option ‘B’ and ‘D’ variants as the ‘B’ variants require dual-tracking of the chord.

3.1.3 Train Operations

A summary was produced outlining the operational modelling undertaken on Options 6B, 6D, 8B and 8D for the remodelling of Connolly Station. This summary can be found in Section 9 of this report. Within the overall summary each option is scored from 1 (poor) to 5 (good) against four key operational areas:

1. Accommodate Specification
2. Passenger Outcomes
3. Performance
4. Future proofing

The operational modelling analysis was used to compare each option with regards to the following sub-criteria:

- *Efficiency and effectiveness*: the effectiveness of each option with regards to (1) accommodating the specification and (2) passenger outcomes was used to appraise each option with regards to *efficiency and effectiveness*.

- *Integration*: each option was ranked with regards to (3) performance.

- *Flexibility*: each option was ranked with regards to (4) future proofing.

3.1.4 Pedestrian Flow and Fire Safety

A Passenger Demand Assessment report was produced by the Jacobs' passenger flow team in order to complete a full comparative appraisal of each option. This report can be found in Appendix C of this report.

The passenger demand assessment was used to compare each option with regards to the *efficiency & effectiveness* sub criteria associated with **economy**.

The implications of station design were also reviewed with regards to fire safety. This review formed part of this overall appraisal.

3.1.5 Cost Consulting

Capital cost estimates have been produced for each option in accordance with the project brief. A breakdown of this cost build-up can be found in Appendix D of this report.

These estimates were used to assign a comparable rating for each option.

3.1.6 Environmental and Heritage

An Environmental Assessment of Options Report was written by Jacobs' environmental team in order to complete a full comparative appraisal of each option. This report can be found in Appendix E of this report.

This report was used to compare each option with regards to all **environment** main criteria.

3.1.7 Overhead Line Electrification (OLE)

Overhead Line Electrification drawings were developed for each of the five options and can be found in Appendix XX. These designs were developed in conjunction with other key disciplines, specifically the permanent way discipline.

These drawings were used to verify the feasibility of each option and feed into the overall costing for each option.

3.1.8 Telecommunications / Signalling / Electrical and Plant

The telecommunications / signalling / electrical and plant disciplines reviewed the outline designs for each option and provided commentary with regards to their feasibility.

4. Option 3 (Do-Minimum)

4.1 Overview

Option 3 is the 'Do Minimum' option requiring the lowest level of infrastructure changes. The proposals require the following interventions to be made to the rail infrastructure;

- The station throat to be remodelled to reduce conflicts and improve movements to provide a timetable allowing an increase in tphpd using the station to be increased towards the project target of 30 tphpd (this Option cannot achieve this target).
- Minor revision to the alignment and length of the north end of all platforms to accommodate the revised throat layout is required, platform widths and lengths will be improved.
- Installation of an improved Newcomen single line chord with new canal drop-lock and replacement single line rail bridge over the canal as well as a replacement cycle route bridge to allow revenue services to be timetabled on the chord.

There is no requirement to purchase land outside the railway boundary within this Option.

4.2 Track Works

This Option requires the replacement of the core of the north end track at Connolly Station which includes the east side approaches to the bay platforms and a completely new bay platform arrangement on new track centres. The number of bay platforms is retained at 4 and through tracks can be accommodated on very similar alignments to the existing arrangement and tracks tied-in approximately half way along the platform, well in advance of the south end of the station and junctions over Amiens Street.

Geographically, all new track work installation and changes are undertaken without affect to Ossory Road and Suburban Junctions. This Option preserves the void between the viaduct structures which contains the car repair centre.

The Newcomen Junction line remains as a single line and a revised positioning of the Newcomen cord connecting turnout provides for the drop-lock without the need to demolish the North Strand Road bridge but the new cycle bridge that is proposed to be connected to this bridge will require replacement.

4.3 Civil and Structural Works

This Option will not require any third-party land take and require the least infrastructure works, these can be summarised as;

- Platform 1-2 lengthened and realigned.
- Platform 3 lengthened and realigned.
- A very slight slue of the north end of Platform 5.
- A very slight slue of the north end of Platform 6.
- A significant slue of the north end of Platform 7.
- No structural works are required to the arches.
- The existing concourse and platform accesses are unaffected.
- The existing platform canopies are unaffected.
- The existing OLE masts in the station are unaffected but those in the station northern approaches will need to be reconstructed.
- Drop-lock installed at Newcomen Junction.
- New steel single line rail bridge installed to Newcomen Junction.

- New cycle bridge over canal at Newcomen Junction to be replaced.
- Demolition of the Enterprise Maintenance Shed.

4.4 Appraisal

Following further inter-disciplinary reviews with all members of the project team, it was determined that the Do Minimum option was not a feasible option as it does not provide the capacity required by the project brief. This Option was therefore ruled out prior to the Short List Option Appraisal Workshop and has not been scored as part of the overall appraisal.

5. Option 6B – Remodelled Platforms and Station Throat in Combination with Additional Crossings

5.1 Overview

Option 6B requires a significant level of infrastructure works, particularly within the station area. The proposals require the following interventions to be made to the rail infrastructure;

- The station throat is to be remodelled to reduce conflicts and improve movements to provide a timetable allowing an increase in tphpd using the station to be increased to achieve the project target of 30 tphpd
- Demolition of the Enterprise Maintenance Shed to accommodate the revised throat.
- Reconstruction of all platforms to provide the minimum width required to achieve the target passenger capacity, while accommodating the proposed track layout. This includes platform seven being relocated from the east to the west side of road seven, the current island Platform 6/7 to be rebuilt to take roads 5 & 6 and the terminating Platform 4 being relocated outside the train shed and being remodelled as new through line.
- Closure and infill of the existing subway serving Platforms 6 & 7.
- Provision of a new footbridge with lifts and stairs serving Platforms 3/4, 5/6 & 7.
- Relocation of the ticket gate-line to the north within the train shed to provide an enlarged concourse and retail area.
- Installation of an improved Newcomen twin line chord with new canal drop-lock and reconstructed twin line rail bridge over the canal as well as a replacement cycle route bridge to allow revenue services to be timetabled on the chord.
- The North Strand Road bridge over the railway and canal will need to be replaced to facilitate the dual-track Newcomen Chord.

This Option does not require the purchase of land outside the railway boundary.

This Option will cause significant disruption to transport infrastructure during construction as the station platforms are all remodelled and the North Strand Road bridge will require replacement. However, the final scheme is believed to offer the greatest operational capacity and flexibility and the initial Jacobs constructability review found that Connolly Station could remain operational using two through tracks open at all times, with the exception of a limited number of possessions for replacing key turnouts and signalling commissioning.

5.2 Track Works

This Option comprises a large amount of track alteration and installation with re-aligned through platforms and a new arrangement of bay platforms. The number of bay platforms is reduced from 4 down to 3 and the introduction of a new Platform 7 on the western edge of the railway structure introduces an additional through line connecting into a revised junction arrangement over Amiens Street. Tracks immediately to the north are effectively straightened out to accommodate back to back running double junction between the Dundalk and Suburban lines and a double junction from the Dundalk lines to serve the bay platform approaches. Additionally, there is a new scissors crossover within the Dundalk lines which can be positioned to avoid clash with the existing Suburban Junction.

Geographically, all new track work installation and changes are undertaken without affecting Ossory Road and Suburban Junctions. This Option preserves the void between the viaduct structures which contains the car repair centre.

The Newcomen Junction Chord becomes a twin track line and a drop-lock is provided.

5.3 Civil and Structural Works

This Option will not require any third-party land take but will require the most infrastructure works, these can be summarised as;

- All platforms require to be reconstructed.
- The corridor between arches requires to be bridged to allow for rail loading
- The Enterprise Maintenance Shed requires demolition.
- The redundant existing platform wells in the concourse are to be infilled and paved.
- The existing underpass to Platform 5-6 is to be infilled and a new footbridge structure connecting Platforms 3 to 7 to replace it.
- The existing Platform 5, 6 & 7 canopies require to be reconstructed.
- The existing OLE masts require to be fully reconstructed.
- No land purchase is required.
- Drop-lock to be installed at Newcomen Junction.
- New steel double line rail bridge installed to Newcomen junction.
- New cycle bridge over canal at Newcomen Junction to be replaced.
- North Strand Road bridge to be replaced.

5.4 North Strand Road Bridge

The replacement of the North Strand Road bridge is a significant requirement of this Option. North Strand Road is a major arterial road into and out of Dublin city centre and this intervention will cause delays during the construction period.

The Jacobs design team have undertaken high-level considerations of this and have identified methods by which this interruption can be minimised. Existing archive information and records will be sought at the next stage of the project to determine construction type of the bridge which will have implications for any time savings that can be made.

5.5 Reconstruction of Platforms within Station

The reconstruction of the platforms within the station is a significant intervention but will allow the flexibility required for this scheme. The construction has been considered by the Jacobs project team at a high-level and have concluded that two through lines can remain operational at all times, with the exception of a limited number of possessions for replacing key turnouts and signalling commissioning.

Furthermore, in order to minimise disruption to the network a phased approach would be required which would see the platforms reconfigured in two stages. This would require temporary alignments of the permanent way. This will be considered in detail at the next stage of design.

5.6 Enterprise Maintenance Shed

At the next stage of design, all endeavours will be made to attempt to refrain from impacting on the Enterprise Maintenance Shed. However, to prepare for the event that retaining the maintenance shed is not achievable Jacobs have undertaken high-level considerations of potential depot relocations.

6. Option 6D – As Option 6B but without dual-tracking of Newcomen

6.1 Overview

Option 6D is a variant of Option 6B and is identical for the core of the station and approach works. The exception is the Newcomen Junction line which in this Option, is a single line.

The revised alignment of the Newcomen Chord connecting turnout provides for the drop-lock and the elimination of the need for demolition of the North Strand Road bridge.

The differences between this Option and Option 6B are summarised below;

- Newcomen Junction realigned single track.
- New steel single line rail bridge installed to Newcomen Junction.
- Existing North Strand Road bridge is retained.

This Option reduces the impact on transport links during construction by not requiring the reconstruction of the North Strand bridge However, this Option can only achieve the 30 tphpd target if there is an intervention at Glasnevin to provide an improved junction.

7. Option 8B – Combination of Elements of 6a (at Throat) and 8a (at Platforms)

7.1 Overview

Option 8B requires infrastructure works, both within the station and new structures outside the existing railway boundary. The proposals will require the purchase and demolition of third-party property. The proposals require the following interventions to be made to the rail infrastructure;

- The station throat to be remodelled to reduce conflicts and improve movements to provide a timetable allowing an increase in tphpd using the station to be increased towards the project target of 30 tphpd. (this Option cannot achieve this target).
- An additional platform (Platform 8) will be constructed to the Western side of the station, this platform will extend out over third-party land. This will require the purchase of the third-party land, comprising of the adjacent car park, No. 102-106 Amiens Street, part of Preston Street and No.4 Preston Street.
- All existing platforms will require revision to their alignment and length at the north end to accommodate the revised throat layout. The lengths of Platforms 3, 4/5 & 6/7 will be increased, Platform 1/2 will be shortened.
- An existing bridge deck to the Western side of the station (part of the face of the station retaining wall) will require replacement with a new retaining wall and infill to allow the proposed Platform 8 to be constructed.
- This Option requires the modification of the void between the viaduct structures which contains the car repair centre.
- Provision of a new footbridge with lifts and stairs serving Platforms 1/2, 3, 4/5, 6/7 & 8. The existing subway serving Platform 6/7 will be retained.
- Installation of an improved Newcomen twin track chord with new canal drop-lock and reconstructed twin track rail bridge over the canal as well as a replacement cycle route bridge to allow revenue services to be timetabled on the chord.
- The North Strand Road bridge over the railway and canal will need to be replaced to facilitate the installation of the drop-lock.

This Option will cause disruption to transport infrastructure during construction as the North Strand Road bridge will require replacement. There will also be disruption to train operations at Connolly Station to facilitate the required improvements to the platforms. If this option were to be taken forward to concept design the Jacobs project team would develop methods of minimising the effects of this.

The Enterprise Maintenance Shed and sidings are not affected by this Option

7.2 Track Works

This Option requires the replacement of all the north end track at Connolly Station with some minor changes to the east side bay platforms and service roads. The train shed and bay platforms are unaffected and the alignments remain in their current position for Platforms 1 to 4.

The through tracks can be accommodated on very similar alignments to the existing arrangement and tracks tied-in approximately half way along the platform length, well in advance of the south end of the station and junctions over Amiens Street.

Geographically, all new track work installation and changes are undertaken without affect to Ossory Road and Suburban Junctions. This Option requires the modification of the void between the viaduct structures which contains the car repair centre.

In order to provide the target capacity as required by the project brief, a scissors crossover would be required at the north end of Platforms 7 and 8. Due to the curvature of the Newcomen Chord it was not possible to provide this crossover without realignment of the tracks, leading to further land purchase and demolition.

7.3 Civil and Structural Works

This Option will require significant works to be completed outside the current station land boundary, the proposed works are summarised below;

- Platform 1-2 shortened and realigned redundant track trough to be infilled and paved.
- Platform 3 lengthened and realigned.
- Platform 4-5 lengthened and realigned.
- Platform 6-7 lengthened and realigned.
- Platform 8 constructed overhanging the edge of the existing arches. Blockwork/concrete piers will support concrete beams to form the platform.
- Platform 8 line constructed overhanging the edge of the existing metallic underbridge. Bridge to be removed and infilled, with a new retaining wall constructed.
- Emergency access stairs to be provided from both ends of Platform 8 to street level.
- The corridor between arches requires to be bridged to allow rail loading.
- The Enterprise Maintenance Shed is retained.
- The existing concourse and platform accesses are unaffected.
- A new footbridge structure spanning all platforms is required.
- The existing Platform 5 canopy requires reconstruction.
- The existing Platform 6-7 canopy requires reconstruction at the north end.
- The existing OLE masts throughout the station and approaches will require to be fully reconstructed.
- Land purchase is required along the western fringe of the station, comprising of the adjacent car park, No. 102-106 Amiens Street, part of Preston Street and No.4 Preston Street.
- The open area between arches requires to be bridged. A ventilation system will likely need to be installed as part of these works
- Drop Lock installed at Newcomen Junction.
- New steel double line rail bridge installed to Newcomen junction.
- New cycle bridge over canal at Newcomen Junction to be replaced.
- North Strand Road bridge to be replaced.

7.4 Platform Widening within Station

During the development of this design it was determined that the target number of trains per hours will require a greater capacity to the existing platforms, as well as the construction of Platform 8. The Passenger Demand Assessment Report (included in Appendix C) concludes that the existing station layout is unlikely to cope with long term (foreseeable) peak passenger flows with growth derived from the NTA Dublin Regional Model for 2040. Platform congestion and ramp access congestion is forecast.

The island Platform 6 and 7 in particular would require a significant increase in width and length to accommodate the proposed train and passenger numbers. The Passenger Demand Assessment Report also indicates that the footbridge is a requirement of this design as it provides the necessary connection and capacity between platforms. The footbridge and the required width of the stairs impacted on the final design width of Platform 6 and 7.

The assessment undertaken by the Jacobs Passenger Flow team states that this Option matches the passenger forecast 2040 flows, with the designs as shown in the drawings provided. For example, the required width of island Platform 6 and 7 is 9.8m, and the design size of the platform is currently 10m.

8. Option 8D – Option 8B, without dual-tracking of Newcomen

8.1 Overview

Option 8D is a variant of Option 8B and is identical for the core of the station and approach works. The exception is the Newcomen Junction line which in this Option, is a single line.

The revised alignment of the Newcomen Chord connecting turnout provides for the drop-lock and the elimination of the need for demolition of the North Strand Road bridge.

The differences between this Option and Option 8B are summarised below;

- Newcomen junction realigned single track.
- New steel single line rail bridge installed to Newcomen junction.
- Existing North Strand Road bridge is retained.

This Option reduces the impact on transport links during construction by not requiring the reconstruction of the North Strand Road Bridge.

The 30 tphpd target can only be achieved with this Option if there is an intervention at Glasnevin to provide an improved junction.

9. Operational Modelling

9.1 Overview

This section summarises the operational modelling undertaken on Options 6B, 6D, 8B and 8D for the remodelling of Connolly Station. The objective is to determine which option delivers the target 30 tphpd into Connolly with the best possible performance and passenger outcomes.

9.2 Train Service Summary

The specified train service comprises 44 trains per hour per direction (tphpd) running in and out of central Dublin from the Phoenix Park, Maynooth and Northern Lines. 30 tphpd run to Connolly Station, with the balance running to Docklands station. Of these 30 tphpd, 18 tphpd run across Connolly Station towards Pearse, Grand Canal Dock or Bray.

- **Northern Line**: 16 tphpd are specified on this route (including a 1 tphpd 'Enterprise' service). All of these services must run to Connolly Station as no connection between the Northern Line and Docklands has been assumed. A significant number of Northern Line services currently run across Connolly towards Bray in today's timetable
- **Phoenix Park Line**: 12 tphpd are specified on this route; this route has the option to run to either Connolly or Docklands. There is an existing flow from the Phoenix Park line to Pearse and towards Bray. Therefore, it is assumed that it would be beneficial for this service linkage to continue in the future.
- **Maynooth services**: 16 tphpd are specified on this route; this route can run to either Connolly or Docklands. There are only a few existing services that run across Connolly Station on this route.

As the Northern Line can only run to Connolly, the remaining 14 tphpd (to make 30 tphpd) total must come from the Phoenix Park and/or Maynooth lines. The simplest solution in terms of timetabling and providing a choice of destinations for passengers is for half of the service on each route (8 tphpd Maynooth and 6 tphpd Phoenix Park) to operate to Connolly and the remainder to Docklands. In theory, this provides a clockface, alternating destination service on both lines.

A maximum of 15 out of the 18 tphpd running across Connolly towards Bray can come from the Northern Line (with the Enterprise service terminating). The remainder must run through from either Phoenix Park or Maynooth. When considering which route to run trains across Connolly Station from, the following points are taken into account:

- It would be beneficial to provide more than 3 tphpd from either route in order to provide a consistent, useable clockface service; the proportion of Northern line services running through can therefore be reduced
- It is operationally simpler (and likely to deliver significantly more robust performance) to have the additional services operate solely from one route (rather than a mix of both Phoenix Park and Maynooth lines)
- It would be operationally simpler and provide a better timetable for all of the services from the chosen route to run towards Bray (rather than a proportion terminating at Connolly)

In this study, the services chosen to run through are the Phoenix Park trains. This is because:

- There is an existing linkage on this route today
- It is easier for Maynooth services (compared with Phoenix Park trains) to terminate at Connolly Station without impact on other service groups
- An 18 tphpd timetable towards Bray could notionally be based on a repeating 3/3/4-minute service interval (i.e. departures at xx.00, xx.03, xx.06, xx.10 etc.). This would be easier to integrate with half (6 tphpd) of Phoenix Park line services running to Connolly operating on a 10-minute interval than 8 tphpd from Maynooth on a 7.5-minute interval
- It is easier to integrate 12 tphpd Northern Line with 6 tphpd Phoenix Park line rather than 10 tphpd Northern Line with 8 tphpd Maynooth line

Therefore, the service specification has been implemented as follows:

Table 9-1: Service Specification Required

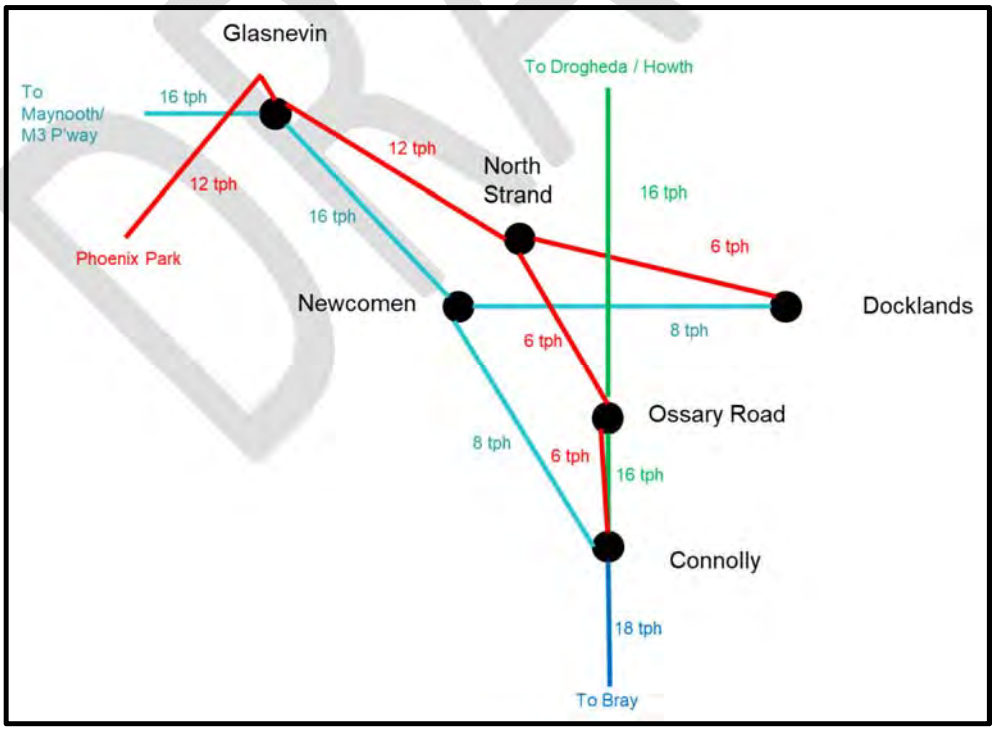
Service	Total tphpd	To Docklands	To Connolly	Of which, running through Connolly
Northern Line	16	0	16	12
Maynooth	16	8	8	0
Phoenix Park	12	6	6	6
TOTAL	**44**	**14**	**30**	**18**

9.3 'B' Routeing Options (Option 6B and 8B)

N.B. This analysis assumes a scissor crossover or similar arrangement is provided in Option 8B at the end of Platforms 7 and 8. Without this crossover, it is likely this option is not feasible

Options 6B and 8B have the Newcomen Chord double-tracked leading into two separate platforms at Connolly. This fits well with the train service described previously, as all Maynooth trains are routed via Newcomen Junction with half proceeding to Docklands and half to Connolly via the Newcomen Chord. This provides complete segregation between the Maynooth and Phoenix Park routes, which will provide a significant performance benefit as delay will not be transferred between routes. It also allows each route's timetable to be optimized to provide the best possible journey times and service spacing, as integration with the other route is not required.

Figure 9-1: Operational Layout of 'B' Options



8 tphpd from Maynooth therefore terminate in the two platforms at the west side of the station (4 trains per hour in each platform). This is possible with robust turnrounds (typically around 10 minutes) for each service.

The Phoenix Park trains cross the layout at the parallel ladder at the end of the central platforms. The timetable has been planned around parallel moves across this junction to provide maximum robustness.

The remaining Northern Line services terminate in the bay platforms; three platforms are more than sufficient for this, even providing a dedicated platform for the Enterprise service.

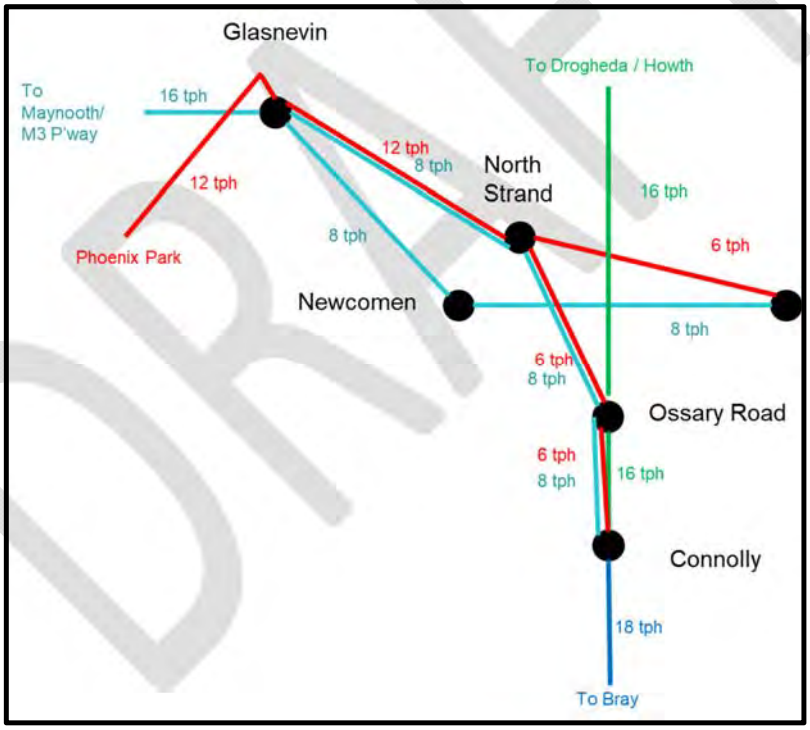
Overall, these options therefore accommodate all of the 30 tphpd requirement and provide a good passenger output and are likely to give the best performance possible.

9.4 'D' Routeing Options (Option 6D and 8D)

In Options 6D and 8D, Newcomen Chord is not doubled but an intervention is assumed at Glasnevin Junction. It is assumed that this intervention will allow the integration of the Maynooth and Phoenix Park routes at Glasnevin as required.

In these Options, the Maynooth – Docklands services can continue to operate via Newcomen Junction, but the Maynooth – Connolly services must merge with the Phoenix Park line services at Glasnevin Junction. This places 20 tphpd between Glasnevin Junction and North Strand Junction, where the service splits between 6 tphpd to Docklands and 14 tphpd to Connolly.

Figure 9-2: Potential Operational Layout of 'D' Options



This number of services can be accommodated, but significant constraints are imposed:

- The even intervals on each route cannot be maintained, as a 5-minute interval from Phoenix Park does not fit well with a 7.5-minute interval from Maynooth.
- With 20 tphpd operating over North Strand Junction, the junction must be planned to operate using parallel moves to/from Docklands and Connolly. This therefore involves aligning both directions which imposes an additional timetable constraint.

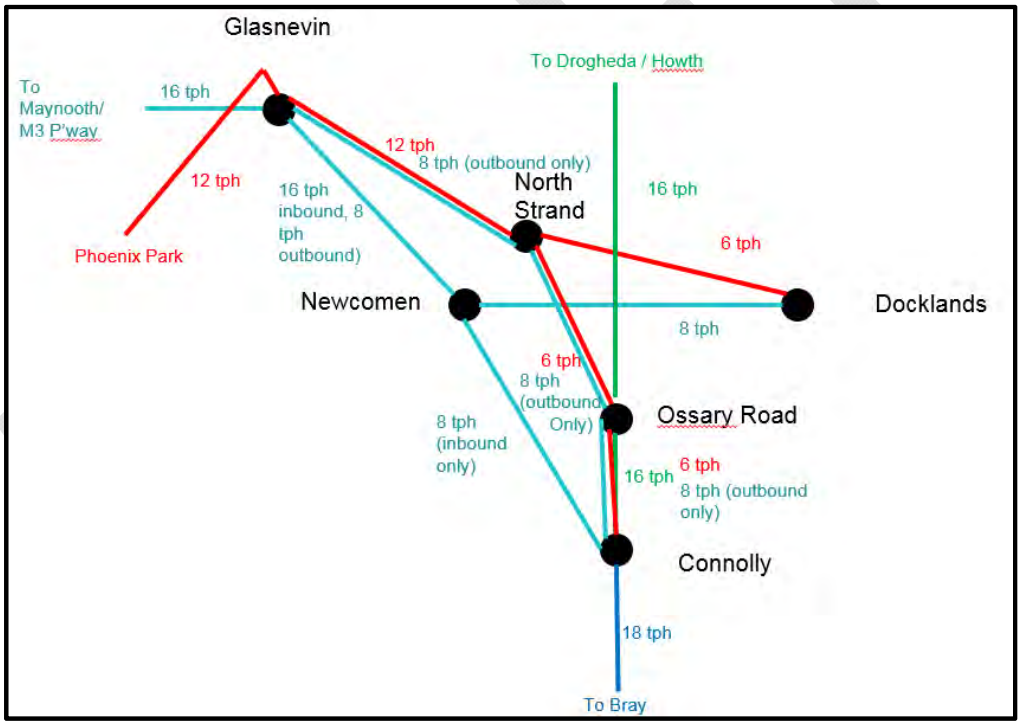
- The Phoenix Park line services are fixed by the timings at Connolly to integrate with the Northern line. Therefore, the Maynooth line services are adjusted to fit

The impact of this is that the intervals on each route are lost (for example, a train every 7.5 minutes on the Maynooth line into Connolly can become a 4/11-minute service interval). Pathing time is added in some trains to get them to present at key locations on time, meaning junction times are extended compared to the minimum possible.

The line between Glasnevin Junction and North Strand Junction (and North Strand Junction itself) is likely to be operating at near-maximum capacity, even if a signalling enhancement is also provided. This, combined with the inter-mixing of different service groups and potential knock-on impact to Northern Line and Bray services, means that a significant performance impact is likely to be seen compared to the 'B' Options.

Therefore the 'D' options are designed to route inbound services from Maynooth via Newcomen Junction and outbound services via North Strand Junction. This means that, 20 tph is required between North Strand Junction and Glasnevin Junction in only one direction, and the number of conflicting moves at North Strand Junction is reduced. Although this eases the timetable issues and performance risks slightly, it will require reconstruction of the Newcomen Chord whilst providing little of the benefit of the equivalent 'B' Option. This is shown in the operational diagram below:

Figure 9-3: Operational Layout of 'D' Options



9.5 Option 6 and 8 Comparison

This section of the report compares Options 6B and 6D with Options 8B and 8D, as the significant differentiator between the 'B' and 'D' variants is the construction of the Newcomen Chord, i.e. dual-track in the 'B' variants and single-track in the 'D' variants.

In terms of the ability to operate the train service specified and as implemented here, Options 6 and 8 are functionally identical. They are differentiated only on a few points, as described below.

The benefits of Option 6 are:

- Significantly more flexibility if Maynooth services are to operate across Connolly Station. The additional through platforms allow these trains to operate in either 'B' or 'D' scenarios and provides full routeing flexibility. This is likely to occur should Northern Line services be diverted away from Connolly Station in the future.

- Ability to divide station in two parts for maintenance purposes and keep operating a through service.

- Flexibility to route around any issues occurring at Connolly Station itself. Operating 18 tphpd or more through a busy station with only two operational through platforms is a challenge similar to Crossrail or Thameslink.

The benefit of Option 8 is:

- An additional terminating bay platform on the west side of the station. This may provide limited additional flexibility to terminate more trains from the Northern line, but as described previously this is a less likely scenario.

Therefore, Option 6 provides more future-proofing than Option 8 as more trains can use the platforms at the station providing maximum flexibility.

The Option 6 routeing flexibility is also likely to be beneficial in terms of maintenance and recovery from more significant delays.

For example, in a scenario where a train fails in one of the through platforms:

- In Option 6, one of the three other through platforms is used for Bray services, allowing the target of 18 tphpd to/from Bray to still operate. The Maynooth service to Connolly is thinned from 8tph to 4 tph or diverted to Docklands.

- In Option 8, only one of the two other through platform is available for westbound through services. Given the increased platform reoccupations when alternating direction through a single platform, the Bray service must be thinned to 7 – 8 tphpd. Services from the Northern Line or Phoenix Park can terminate at Connolly Station, but services from Bray must be held elsewhere on the route, or turned back, until the full service restarts (which will be operationally challenging due to lack of suitable holding locations).

In essence, with Option 8 there is one fewer through platform that would be available under degraded working caused by failures either at Connolly or elsewhere on the network. There is capability to terminate some services (including those from the Northern Line) in the lower numbered bay platforms in times of disruption, but some services may need to be terminated elsewhere in the station. Option 6 offers full flexibility to work around any such operational requirements, but Option 8 is more restricted due to the reduction in through platforms. Therefore, in some perturbed scenarios there may be a requirement to intervene and reduce the service further in Option 8 compared to Option 6.

9.6 Overall Summary of Operations

The four options considered have been ranked from 1 (poor) to 5 (good) for four key operational areas:

Accommodate Specification: defined by the capacity of an option to accommodate the required timetable as specified in the project brief.

Passenger Outcomes: defined as the performance of an option with regards to movement of passengers across the network, and interconnectivity with routes within the system and other transport networks.

Performance: scored using the operational modelling undertaken using Railsys by evaluating the performance of each option with regards to consistency of service, potential of perturbation, and risk of delay.

Future Proofing: defined as the suitability of an option to integrate with proposed future schemes and developments, for example, DART Underground.

Table 9-2: Operational Scoring of Options

Criteria	Option 6B	Option 6D	Option 8B	Option 8D
Accommodate Specification	5	4	5	4
Passenger Outcomes	5	2	5	2
Performance	5	1	3	1
Future Proofing	5	5	3	3
Total	**20**	**12**	**16**	**10**

Option 6B is scored best, as it provides the better performance and passenger service outcomes of the 'B' Options combined with the maximum flexibility at Connolly Station and suitability for the future. Furthermore, this Option is not dependent on a scheme being built at Glasnevin Junction. Option 8B is scored marginally worse due to the restriction on future flexibility and impact under perturbation.

9.7 Option 3

Option 3 has not been considered in detail here as it does not deliver the specified service outputs. The single Newcomen Chord means that the disbenefits of the 'D' Options also apply to this Option, and the single suitable terminating platform (for services from the west), means that a maximum of 26 tph (with 4 terminating) could be delivered. However, this Option could be an intermediate step between today and either of the Option 6 or Option 8 designs.

10. Economy

10.1 Capital Cost

Indicative comparative costs were prepared for five options in relation to the adaptation of Connolly station and the associated rail infrastructure out to Newcomen Junction. The indicative costs were prepared from outline design information provided by the Jacobs design team, augmented where necessary by assumptions as to differentiator costs between the options. The cost estimates prepared are intended only to provide a comparison of the likely costs associated with each option. Due to the limited amount of design information available, the total costs stated are indicative of the likely total cost only.

The report included in Appendix D is intended to provide details of the indicative costs used at the workshop to identify the Emerging Preferred Option.

A summary of the Costs associated with each option, subject to the contents of the CDAL (Cost Data Assumptions List) and Exclusions listed elsewhere in this report, are as follows:

Table 10-1: Connolly Station Options Cost Summaries

Connolly Station Detailed Options - Cost Summary (€ M's)	
	Cost
Option 3	**€135.00**
Option 6b	**€198.00**
Option 6d	**€187.00**
Option 8b	**€198.00**
Option 8d	**€184.00**

Where possible, the major elements of construction have been quantified. These quantities have been costed at rates derived from projects of a similar nature and where these have not been available, from pricing books or using the estimator's judgement.

An allowance of 30% has been applied to all cost estimates in relation to preliminaries costs. Without an outline construction programme, it has not been possible to differentiate between the options for this cost element. However, discussions during design team conference calls indicated that where one programme may take longer in comparison to another, the effects of each would be neutralised against each other as a comparison. Consequently, the same percentage has been used for all options. It is not considered likely that any fluctuation in this percentage allowance would differentiate between the options.

The overall costs were used to appraise each option against the sub-criteria of Capital Cost. The results of the appraisal are as follows:

Sub-Criteria	Description	Metric	6B	6D	8D
Capital Cost	Estimates to be prepared and assessed in line with NTA guidelines	Comparison of options with regards to comparative capital cost			

As the capital cost difference between options is not considered to be significant, Options 6D and 8D are considered as “comparable to other options” while Option 6B is considered to have “some disadvantages over other options”.

10.2 Efficiency and Effectiveness

Operational modelling was used to compare each of the options, and a summary is provided in Section 9. The key operational areas of “Accommodate Specification” and “Passenger Outcomes” were used to appraise each option against the sub-criteria of Efficiency and Effectiveness.

Furthermore, a Passenger Demand Assessment report was produced by the Jacobs’ passenger flow team in order to complete a full comparative appraisal of each option. This report can be found in Appendix C of this report.

The results of the appraisal are as follows:

Sub-Criteria	Description	Metric	6B	6D	8D
Efficiency and Effectiveness	Maximise the value for money	Comparative analysis of options in relation to station capacity			

Option 6B scores higher than Options 6D and 8D for the reasons set out in the operational modelling analysis.

With regards to pedestrian flow, it is accepted that at current design maturity the passenger flow capability of Option 8B is superior to Options 6B and 6D. However it is considered that, if taken forward to Concept Design Stage, amendments can be made to the Option 6B design which make the passenger flow capability as good as Option 8B.

10.3 Construction and Maintenance Impacts

A qualitative comparison of the construction and maintenance impacts was undertaken, to appraise each option with regards to impact on the station and on transport network users. The permanent way and civil engineering drawings were used to outline the key items with regards to construction requirements for each option.

Key differentiators between options have been discussed in previous sections of this report and these were used as part of the comparative appraisal. The results of the appraisal are as follows:

Sub-Criteria	Description	Metric	6B	6D	8D
Construction and Maintenance Impacts	Minimise the potential disruption to rail and other transport users	Comparative assessment of potential impacts of delays to station and other transport network users arising from staging of works			

There were several key considerations when determining these scores.

Option 6B requires significant work within Connolly Station, as well as the dual-tracking of the Newcomen Chord. Furthermore, the North Strand Road bridge must be reconstructed in order to provide room for the dual-tracked chord.

11. Environment

A report titled Environmental Assessment of Potential Options has been prepared and is included as Appendix E. The following sections summarise the potential impacts associated with ecology & water resources, the built environment, land use & visual, and cultural heritage.

11.1 Ecology and Water Resources

11.1.1 Ecology

All of the options propose works to the Royal Canal. Given the canal's status as a proposed Natural Heritage Area (pNHA) and the records of protected flora and fauna associated with the canal it is recommended that aquatic ecology surveys be undertaken as the Emerging Preferred Option is progressed through the design phases, to identify any specific aquatic constraints. In the comparison for the three options, it is considered that the options present similar potential impacts to aquatic ecology. Similarly, at this stage it is considered that all three options present similar impacts in relation the potential to encounter invasive species, particularly Japanese Knotweed (*Fallopia japonica*).

During a site walkover a number of properties with the potential to support roosting bats were recorded, including houses on Preston Street and Seville Place, 102-106 Amiens Street and Irish Rail offices. In addition, bridges within the Study Area are also considered to have potential to support roosting bats while the underground vaults/arches may have the potential to support hibernating bats.

Option 6D is considered to have some advantages as there are fewer potential impacts associated when compared to the other two Options.

Option 6B is considered to have disadvantages when compared to Option 6D as the double tracking of the Newcomen Chord will require the demolition and reconstruction of the North Strand Road bridge. The linear nature of the canal means that the bridge has bat roost potential. Further surveys and assessments will be required if this Option is progressed.

Option 8B is considered to have significant disadvantages of the three Options as it will require the demolition of all or part of 102-106 Amiens Street, No.4 Preston Street and disturbance to properties adjacent to Preston Street. These properties were all identified as having bat roost potential during an initial site walkover, and further surveys of these buildings are recommended in advance of any construction or demolition works.

11.1.2 Water Quality

Option 6B comprises a large amount of infrastructure works to construct. From a water quality perspective, the activities with the greatest potential for water impacts would include the development of the twin tracking of the Newcomen Junction Line which involves construction on the banks of the canal and over it, the demolition and reconstruction of the North Strand Road bridge which spans the canal and the development of a drop lock in the Royal Canal. The twin tracking of the Newcomen Junction Line associated with this option will require a much larger drop lock construction than the single-track options and necessitates the demolition and reconstruction of the North Stand Road bridge. The level of construction works required in, over and around the Royal Canal means that Option 6B presents the most potential for negative water quality impacts between the options.

Option 6D and Option 8D will involve an upgrade of the single-track on the Newcomen Junction Line and the development of a drop lock. The upgrade to the single track does not require the demolition and reconstruction of the North Strand Road bridge and the drop lock required will be smaller than that associated with Option 6B. The potential water quality impacts of Options 6D and 8D are anticipated to be similar at this stage.

Sub-Criteria	Description	Metric	6B	6D	8D
Ecology and water resources	Avoid and mitigate adverse effects on biodiversity arising from proposed scheme	Qualitative appraisal of potential effects of proposed option			

11.2 Built Environment, Land Use and Visual

It is anticipated at this stage that all three options will have a significant short-term visual impact at the station and in the surrounding areas. However, it is also acknowledged that Dublin City is constantly evolving and the presence of construction including cranes and hoarded off sites are common place.

Option 6B will require the demolition and reconstruction of the North Strand Road bridge. At this stage a detailed design for the reconstruction has not been prepared but it is anticipated that the detailed design will take into consideration the historic nature of the Royal Canal and the existing bridge design and will develop a design which is appropriate to the area. Option 6B will include the introduction of a passenger footbridge from Platforms 3 to 7. This will alter the existing view of the station from the north. Again, it is anticipated that the design of the footbridge will take into account the visual impact. Option 6B does not require any third-party land take.

As with Option 6B, Option 6D is anticipated to result in a local visual impact associated with the realignment of platforms and the introduction of the footbridge from Platforms 3 to 7. Option 6D does not require any third-party land take.

Option 8D presents the greatest potential for negative landscape and visual impacts. 102-106 Amiens Street may require demolition as part of the option, or at least part of the building to the rear. If the building is demolished in it's entirely this will have an impact on the existing landscape of Amiens Street. The building is on the National Inventory of Architectural Heritage as a property with features of architectural, artistic, historical and social interest. If only part of the building is demolished (the rear closest to the existing Platform 7) consideration will need to be given to how the rear of the building is reconstructed – the oculus (round window) to the rear of the building is noted in descriptions of the buildings and has formed part of the existing landscape of the station as the buildings rear wall borders the existing station footprint. Option 8D also includes for the introduction of a large footbridge, spanning from Platform 1 to the Proposed Platform 8. It is considered that Option 8D presents the most significant potential for negative impacts in terms of the built environment, land use and visual and therefore it has been identified as being the least preferred among the three Options.

Sub-Criteria	Description	Metric	6B	6D	8D
Built environment, land use and visual	Avoid and minimise impact on land take requirements	Comparative qualitative assessment of land use requirements for each option			

11.3 Cultural Heritage

There are more than 40 other Protected Structures in the vicinity of Connolly Station including houses and other premises along Amiens Street, Preston Street, Seville Place, Talbot Street and North Strand Road. These include 102–106 Amiens Street (former postal sorting office, RPS Ref. No. 126), 100 Seville Place (RPS Ref. No. 7496; reputedly used as a safe house by Michael Collins during the War of Independence), 4 Preston Street (RPS Ref. No. 6850), the lock-keeper's cottage at the 1st Lock, Royal Canal (RPS Ref. No. 5824) and Newcomen Bridge/North Strand Road bridge (RPS Ref. No. 911), North Strand, which is a granite canal bridge built c.1790 to carry North Strand Road over the Royal Canal. The canal was built in the late eighteenth century to provide freight and passenger transport between Dublin and the River Shannon. George's Dock, to the south of Connolly Station, was built in 1821 to the designs of John Rennie, and is also a Protected Structure (RPS Ref. No. 3173) comprising limestone ashlar dock walls with granite copings, granite and cast-iron bollards, steps, lock gates,

cast-iron mooring rings, ladders and winches. All nineteenth-century portions of main railway station complex are a Protected Structure (RPS Ref. No. 130, NIAH 50011009 – Regional significance) listed in the current Record of Protected Structures (RPS) for Dublin City (Volume 3 of the 2016–2022 Dublin City Development Plan).

All three Options will involve reconstruction of the roof canopies and would result in potential impacts on the arches below the station, both of which are a component part of the Connolly Station Protected Structure (RPS Ref. No. 130).

Option 8D would involve the greatest levels of impact to Cultural Heritage, including the potential demolition of part or all of the former postal sorting office at 102–106 Amiens Street (Protected Structure) and demolition of No. 4 Preston Street (Protected Structure), while the footbridge would require removal of the turntable and would also potentially impact on the water tower. Option 8D has been identified as being the least preferred among the three Options from the perspective of Cultural Heritage.

Option 6B and Option 6D would also have a potential impact on the turntable as result of the proposed footbridge. In addition, Option 6B would require demolition and reconstruction of Newcomen Bridge/North Strand Road Bridge (Protected Structure) and demolition of stone-built sections of the Royal Canal at the proposed drop lock and is assessed as not preferable from the perspective of Cultural Heritage.

Sub-Criteria	Description	Metric	6B	6D	8D
Archaeological architectural and cultural heritage	Avoid and minimise impact on the archaeological, architectural and cultural heritage environment	Qualitative appraisal of potential impacts of proposed options on legally protected sites			

12. Integration

12.1 Integration

Operational modelling was used to compare each of the options, and a summary is provided in Section 9.

The key operational areas of “Performance” was used to appraise each option against the sub-criteria of Integration. The results of the appraisal are as follows:

Sub-Criteria	Description	Metric	6B	6D	8D
Integration	Maximise the integration of all connecting lines through and terminating at Connolly Station	Comparison of each option in relation to conflict reduction and connectivity			

12.2 Flexibility

Operational modelling was used to compare each of the options, and a summary is provided in Section 9.

The key operational areas of “Future Proofing” was used to appraise each option against the sub-criteria of flexibility. The results of the appraisal are as follows:

Sub-Criteria	Description	Metric	6B	6D	8D
Flexibility	Ensure option complies with City and Regional transport, economic and planning policies and strategies	Qualitative appraisal of compliance with appropriate policies			

12.3 Geographical Integration (Connolly Masterplan)

Civil engineering drawings were used to assess the impacts of each option on the Connolly MasterPlan. The outline designs for the Connolly MasterPlan were provided by Iarnród Éireann.

During development of the outline designs it was determined that none of the options had any impact on the requirements of the Connolly MasterPlan, and therefore each option was scored identically. The results have been included in this report in order to record that this was taken into consideration:

Sub-Criteria	Description	Metric	6B	6D	8D
Geographical Integration (Connolly Masterplan)	Maximise the integration of all operational and infrastructure implications with the proposed Connolly Masterplan	Qualitative appraisal of each option in relation to flexibility of design, specifically relating to proposed developments			

13. Safety

All designs have been developed to ensure maximum safety of train operations and network users. However the Common Appraisal Framework does include Safety as one of the main criteria to include in the optioneering process. Therefore each option was assessed with regards to operational safety, specifically with regards to the associated maintenance risk of each option.

The Jacobs permanent way team undertook a review of each design to determine which option required the most switches and crossings to be installed. A comparison was made, with the premise being that the more switches and crossings in place the more maintenance would be required. This is an example of considering safety in design at the very early stages.

The results of the appraisal are as follows:

Sub-Criteria	Description	Metric	6B	6D	8D
Operational Safety	Reduction associated maintenance risk within the scheme area	Comparison of each option in relation to appraisal of asset maintenance requirements			

Each of the options are considered equal with regards to operational safety as all options have been designed with safety at the forefront of considerations.

14. Overall Scoring

The overall scores are shown in the table below:

Table 14-1 Summary of Scoring

Criteria	Sub-Criteria	Description	Metric	6B	6D	8D
Economy	Capital Cost	Estimates to be prepared and assessed in line with NTA guidelines	Comparison of options with regards to comparative capital cost			
	Efficiency and Effectiveness	Maximise the value for money	Comparative analysis of options in relation to station capacity			
	Construction and Maintenance Impacts	Minimise the potential disruption to rail and other transport users	Comparative assessment of potential impacts of delays to station and other transport network users arising from staging of works			
Environment	Ecology and water resources	Avoid and mitigate adverse effects on biodiversity arising from proposed scheme	Qualitative appraisal of potential effects of proposed option			
	Built environment, land use and visual	Avoid and minimise impact on land take requirements	Comparative qualitative assessment of land use requirements for each option			
	Cultural heritage	Avoid and minimise impact on the archaeological, architectural and cultural heritage environment	Qualitative appraisal of potential impacts of proposed options on legally protected sites			
Integration	Integration	Maximise the integration of all connecting lines through and terminating at Connolly Station	Comparison of each option in relation to conflict reduction and connectivity			
	Flexibility	Ensure option complies with City and Regional transport, economic and planning policies and strategies	Qualitative appraisal of compliance with appropriate policies			
	Geographical Integration (Connolly Masterplan)	Maximise the integration of all operational and infrastructure implications with the proposed Connolly Masterplan	Qualitative appraisal of each option in relation to flexibility of design, specifically relating to proposed developments			
Safety	Operational Safety	Reduction associated maintenance risk within the scheme area	Comparison of each option in relation to appraisal of asset maintenance requirements			

15. Glasnevin

The project brief indicates that it may be beneficial to “look at combining the Western trains onto the existing North Strand line – but any required development at Glasnevin is outside the scope of this study”.

Train operations at Connolly Station, specifically regarding direction of movement to/from the west of Dublin, would be impacted significantly if an intervention at Glasnevin were to be introduced. The precise details of any intervention at Glasnevin are outside this study brief. However, for a robust appraisal of all options affecting Connolly Station, we have included a high-level assessment.

Jacobs are advised by IÉ that they are considering a rail infrastructure scheme at Glasnevin Junction that enables an equal split of trains going to Connolly and Docklands Stations. This service pattern is illustrated in the operational diagram shown in Figure 15-1 below:

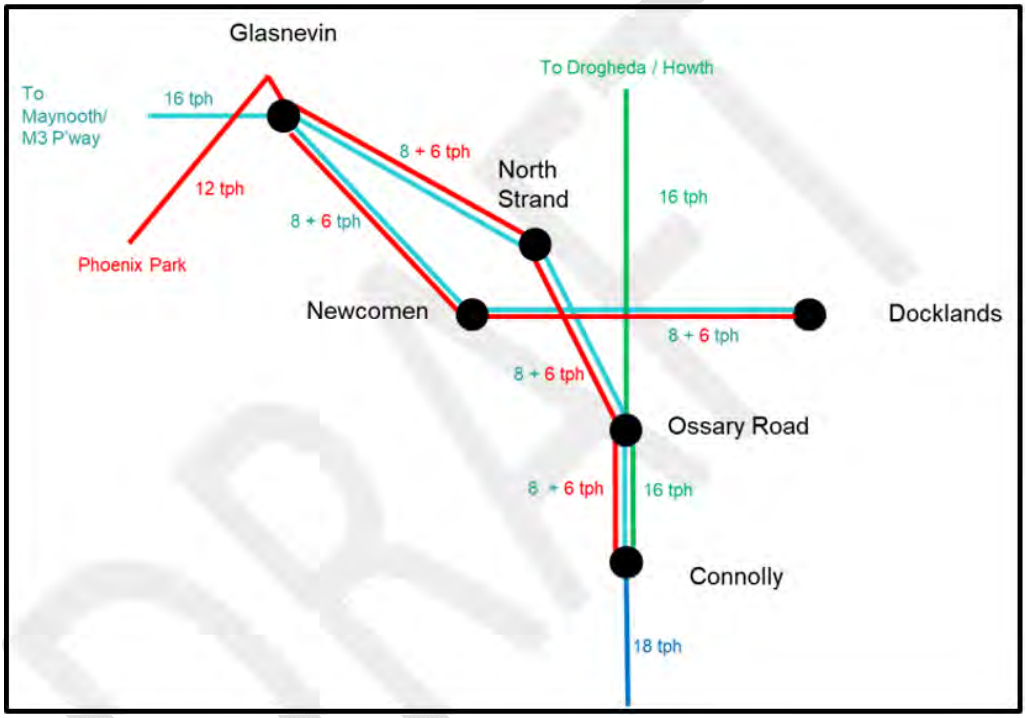


Figure 15-1 - Operational Layout including Intervention at Glasnevin

The above diagram illustrates a method for routeing trains that requires the complete remodelling of Glasnevin Junction to enable the crossover of services in each direction between the MGWR and GSWR lines. This is currently only possible in one direction from the MGWR to the GWSR as can be seen form the “Quail Map” copied below in Figure 15-2 below.

A further consideration is the heavy rail work necessary to align with the proposals being developed for the proposed MetroLink station at Glasnevin.

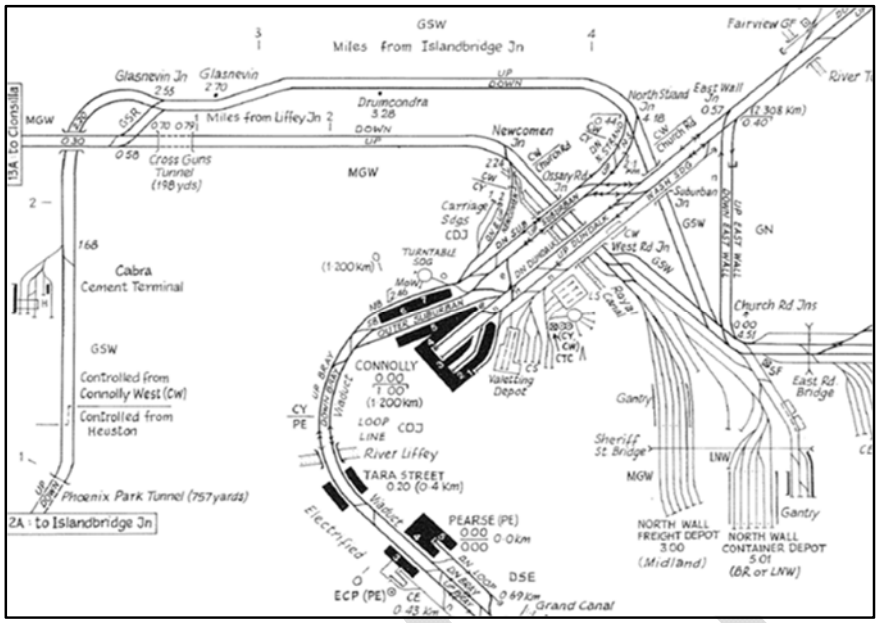


Figure 15-2 – Track Layout at Connolly Station and Glasnevin Junction

Should it be possible in the future to route trains as shown it would address some of the capacity constraints described for the Glasnevin Junction routeings for Options 3, 6D and 8D, namely:

- All services to Docklands would be routed via Newcomen Junction (from both Phoenix Park and the Maynooth line)
- All services to Connolly would be routed via North Strand Junction (from both Phoenix Park and the Maynooth line)

This reduces the service levels between Glasnevin Junction and Connolly Station to 14 tphpd, and eliminates the conflicting junction moves at North Strand Junction. This is an improvement over the previously described option of routeing trains via North Strand Junction but, compared to Option 6B and the use of Newcomen Chord, the following should be considered:

- Integrating trains from both lines at Glasnevin Junction (as opposed to keeping them segregated as in Option 6B) means that service intervals are likely to be more uneven because the service spacing on both lines (16tphpd to Maynooth and 12 tphpd to Phoenix Park) are not equal.
- There are a higher number of trains between Ossory Road Junction and Connolly Station than proposed in Option 6B; integrating a proportion of these trains with the Northern Line service is likely to be more difficult and lead to a higher performance risk. This is because there must be an available path on the Suburban Lines that aligns with a crossing move into the through platforms at Connolly Station, which is more difficult to achieve when the traffic on the Suburban lines has increased.
- Services from both Phoenix Park and Maynooth can serve Drumcondra, unlike in Option 6B. However, Drumcondra can only be served by trains to Connolly, not Docklands
- The infrastructure that must be provided at Glasnevin Junction is significant. Ideally, full grade separation would be provided due to the service levels involved (28 tph in each direction, half of which are swapping lines). Should only an upgraded flat junction or partially grade separated junction be provided, the required timetable is likely to be constructed around all moves being parallel moves which, as well as imposing additional timetable constraints, is likely to significantly increase performance risk when trains are running out of course.

Therefore, we conclude that while the separation of service flows at Glasnevin Junction is likely to accommodate the required 30 tph service level at Connolly Station, this would provide a less optimal passenger timetable (in terms of service intervals on each individual line) and with a higher performance risk than Option 6B.

Operational modelling could be performed to determine the scale of the performance impact of this intervention.

The remainder of the commentary comparing Option 6 and Option 8 still applies to this method of routeing trains.

As any scheme at Glasnevin is outside the scope of this report the capital cost of a grade-separated or other junction at Glasnevin has not been considered. However, following a high-level review of the requirements of any scheme of this nature, the capital cost is likely to be considerably higher than the installation of a dual-track along the Newcomen Chord, even with the reconstruction of the North Strand Road bridge.

16. Conclusion

Following the appraisal the results were aggregated to determine which option achieved the highest score in each main criteria. The overall are shown in Table 16-1 below:

Table 16-1: Aggregate of Scores from MCA Appraisal

	6B	6D	8D
Economy			
Environment			
Integration			
Safety			

Option 6B scores highest in terms of flexibility and provides the greatest capacity at Connolly Station. The capital cost and construction impacts of Option 6B is concluded to be marginally higher than the other options, but this is offset against the benefits.

Options 6B and 6D score similarly with regards to impacts on the environment, with the significant difference being the demolition and reconstruction of the North Strand Road Bridge. The differentiating factor with regards to Option 8D is principally that, environmentally, it will have the biggest visual impact and requires the greatest land purchase.

With regards to Integration Option 8D offers the least flexibility from an operational viewpoint.

Each option has been designed with safety at the forefront of considerations and therefore each option scores neutral on a comparative basis.