INFORMATION IN THIS CHAPTER HAS BEEN REVISED. PLEASE REFER TO COVER

Appendix E: Project Level Quantified Risk Assessment Summary

This appendix is a summary assessment of the project risk register and the quantified risk assessment developed and undertaken by TII's engineering designer Jacobs/Idom.

MetroLink will be a transformative project for Dublin and Ireland. Delivering this project will be a significant undertaking and managing project risks effectively will be essential to success.

To this end, the project team has created a live risk register for MetroLink. Currently the register has identified 345 identified risk events related to the pre-procurement, procurement, design and construction stages of MetroLink, and associated uncertainties and assumptions. These risks have been identified and assessed for their potential impact to the project budget and schedule, using metro development experience from other jurisdiction, other Irish project experience and the experiences of the project team and technical advisors.

Risk management is a continuous activity for the MetroLink project team, and the risk assessment must continue to be refined, enhanced and updated as the project progresses. Specifically, at the time of submission of the preliminary business case, detailed risk identification and analysis for the operations and maintenance period is required. This required assessment will be influenced strongly by the finalisation of the contracting and procurement strategy. For example, the current anticipated procurement strategy, subject to detailed value for money analysis, is to include a PPP Service Delivery Partner. Accordingly, the risk assessment will need to consider how the PPP responsibility may influence and impact the risks of the operations and maintenance period.

Furthermore, the risk assessment presented herein has not fully considered the current contracting and procurement strategy as presented in Chapter 6, with risks related to the splitting of scope across contracts, or the inclusion of the PPP Service Delivery Partner, having yet to be considered in detail. This work and analysis will form a critical part of the detailed value for money analysis that will be necessary to confirm and finalise the contract and procurement strategy.

For now, the risk assessment includes several additional risks that have not been integrated into the full risk register but are captured in the cost uplift.

Risk register function

The risk register has two primary functions. The first is it allows for the quantification of the specific risk event allowance. This allowance is currently estimated to be €1.67 billion which is based upon a set of Monte Carlo simulations that further break down into cost impacts (€0.57 billion) and delay impacts (€1.1 billion).

The second function of a risk register is to facilitate effective risk management, monitoring and mitigation. By identifying and understanding their likelihood and potential impacts, TII can deploy resources, and risk management strategies to better manage and mitigate the specific risk events insofar as may be possible.

What is critical to appreciate is that the risk register, and therefore the associated manageable allowance, is not static. It is in a continuous review and update cycle. As the project progresses, certain risks will expire (as the risk event will have passed for example or no longer be relevant). In other instances, new risks may be identified, perhaps by a bidder during the tender process, or due to a new technical standard or world event, or generally new information. This may occur through the procurement, design, or construction stages.

Accordingly, the approach to risk management as an active and ongoing function is critical to overall programme budget management and effective execution of contracting strategy. Furthermore, it has a significant and direct link to achieving overall value for money goals.

Risk assessment process

A robust approach including qualitative and quantitative analysis has been implemented to assess project risks. This risk assessment process includes:

1. Qualitative assessment: Qualitative risk assessments are used to calculate a risk score which enables the project to determine the significance of specific known risks. The determination of risk significance feeds into risk quantification when assumptions around the probabilities and cost / delay impacts of specific risk events are developed.
2. Quantification through a Quantitative Risk Assessment ("QRA") consisting of two elements:
   a. Quantitative schedule risk analysis ("QSRA") to analyse the impact of known risk events and uncertainties to the project duration and completion date.
   b. Quantitative cost risk analysis ("QCRA") including consideration of prolongation (cost impacts caused by schedule delays identified in the QSRA).

   Both the QSRA and QCRA utilised a three-point estimate of schedule / cost impact (low, medium, high) for a probable risk event. Monte Carlo simulation was then utilised to generate a risk schedule distribution (for the QSRA) and risk cost distribution (for the QCRA). This approach relied on the use of probabilistic assumptions. Where mitigation strategies which have been implemented to reduce the cost / delay impact and / or probability of the risk occurring, this is considered.
3. Review and refinement: Risk information (such as risk registers, risk reports and subsequent risk analysis) are reviewed on an on-going basis, as the project proceeds through its lifecycle. The aim of these efforts is to recognise project progress, and to facilitate risk-based decision making using the most up to date and accurate information and methods available.

Summary of Delivery Risks

Over 345 risks relating to the delivery of MetroLink have been identified and have been grouped in 12 categories, as set out in Table E - 1 below.

Category	% of total	# specific risks	Risk category summary
Design, Construction and Contractual	42.0%	195	Design risks mainly contemplate changes in requirements during the design, construction and operations stages resulting in a change to the scope; design integration risks such as overlaps, omissions, misalignments; and requirements for redesign due to legal challenges / stakeholder (DCC, FCC, sports clubs, etc.) requirements. Construction risks include: the scheduling / sequencing of construction tasks and their interdependencies (one of key risks), rates of progression (with the TBM), construction / engineering challenges during the construction (e.g. water inflows, alignment of tunnels); and ground conditions not being as anticipated. One of the most significant construction risks is that advance and enabling works cannot commence until a railway order is made. Contractual risks relating to contractual arrangements and the inability of contractors to deliver. Key contract related risks include oversights in contractual terms (due to the complexity of the project) creating unforeseen integration clashes and delays; the risk of a principal contractor going out of business or underperforming; and risk of delays due to failure to accept stations and railway system assets.
Procurement	22.4%	19	Procurement related risks contemplate risks such as: delays in awarding contracts due to delays in obtaining Government approval; risks that bids will be rejected as they don't provide value for money; risks of challenges by unsuccessful bidders; and risk that the railway order application does not take place as planned in Q2 2022.
Environment	11.1%	42	Environment risks mainly relate to the issues and potential challenges to carrying out the required Environmental Impact Assessment Report and related activities, e.g. basement impact assessments. Other environment risks relate to achieving planning, finding agreement with key stakeholders and issues relating to the acceptance of the proposed blasting approach by an Bord Pleanála.
Traffic Management	7.0%	13	Traffic management risks are mostly concerned with: the risk that programme extensions or overruns may require a change to existing traffic management plans; potential stakeholder objections to specific traffic junctions causing delay to approval of the railway order; and the risk that train or bus routes change during the design and construction stages.
Stakeholder Consultation	5.6%	17	Risks which relate to stakeholder consultation consider: the risk that works restrictions are introduced into the programme to facilitate special events taking place in Dublin; the risk of protests causing delay to the construction programme; risk that objections are raised or extreme restrictions are placed on tunnelling activities; and risk of not reaching agreement with key stakeholders (e.g. DCC, FCC and DAA).
Heritage	3.7%	9	Heritage related risks are mostly concerned with the listed building status of properties in the vicinity of the MetroLink; potentially damaging monuments during the construction; and obtaining the required approvals and permissions to commence construction.
Programme	2.9%	4	Programme risks cover risks such as the risk that programme timelines are excessive, underestimation / overestimation of key timelines such as the time to receive planning approval from An Bord Pleanála (12 months); and the risk that testing could take longer than currently assumed.
Property	3.0%	10	This risks considers all property and land related risks, namely: the risk of not identifying / underestimating the cost of acquiring / renting the lands required to complete MetroLink; the lack of detailed design which makes identifying all lands impacted by MetroLink difficult; and the risk that lands required are not available when works are scheduled to take place.
Utility	1.2%	14	Utility risks include: the risk that utilities works and approvals take longer than anticipated; the risk that MetroLink preliminary design may become incompatible with other strategic transport projects undertaken by NTA, Local Authorities, Irish Rail; and the risk that storm design requirements provided to manage flooding solution may not be accepted by FCC and DCC.
Resources	0.5%	9	This risk relates to the resourcing of the project. The lack of / scarcity of / tight availability of required specialised skills / resources in areas such as system integration; project delivery and civil works (due to a tight market for very specialised skills) poses a risk for the project as it could lead to delays in decision making and project delivery. Furthermore, with all projects of this nature, there is the risk that resources will seek new projects when the MetroLink approaches its conclusion.

Legal	0.3%	9	Legal risks include risks relating to the appointment of the independent safety assessor; risk of fraud and cybersecurity breaches; the impact of Brexit on the supply of labour for the project; and changes in regulatory standards.
Archaeology	0.2%	4	This risk primarily relates to the risk of finding archaeologically significant finds during the works that may be provided national monument status.
	100.0%	345	

Table E - 1: Summary of Delivery Risks. Source: MetroLink Risk Register

The above table provides some insights to the type of risks which may impact on the MetroLink final cost. Managing these risks is a key focus of the MetroLink project team, and comprehensive mitigation strategies are being developed and to be put in place to limit their cost impact.

Risk event and delay costs

While specific risks will have a cost impact to rectify, manage, alleviate etc., they also can trigger a delay cost. Whether or not a particular risk event could trigger a delay cost is a function of more than just the risk event itself. When the risk occurs, if other risks have occurred already, or if the risk event is the result of cumulative impacts of other risks, will all play a part in determining the scale and impact of a risk event potentially generating delay costs.

Accordingly, the risk simulation modelling for delay costs is more complex than the Monte Carlo Simulation for specific risk event cost impacts – being driven by all risks at the same time occurring at different points in the construction programme. Such complexity is overcome by developing a logically linked and integrity error-free schedule, along with activity duration ranges attributable to risk and uncertainty impacts, and their likelihood of occurrence. Through a randomisation and iterative simulation (based on Monte Carlo methods), the level of confidence in completing the project in line with the deterministic schedule with uncertainty and risk events considered can be determined.

The current analysis has assessed the potential for risk event-related delay costs in the range of €1.1 billion.

To assist in appropriate risk management and mitigation activity, various project activities have been identified as having critical impacts on the project schedule and therefore have the greatest potential to generate delay costs. Risk events that impact these tasks must be managed effectively to reduce the delay cost risk implications on the project budget.

Table E – 2 sets out the top 10 activities that have the most potential to drive the MetroLink schedule based on their duration sensitivity. Duration sensitivity of a task / activity is a measure of the correlation between its duration and the duration of the project as a whole.

Activity	Duration Sensitivity (%)
1. Launch Shaft / Northwood Station	84%
2. Deliver, Assemble and Commission TBM	84%
3. Dublin Airport Station: Drill to temporary prop level 1 (11,934m^3 @ 75m^3 / day)	26%
4. Dublin Airport Station: Drill underside of 2nd prop (4,774m^3 @ 75m^3 / day)	26%
5. Dublin Airport Station: Drill underside of concourse slab (4,774m^3)	25%
6. Dublin Airport Station: Drill (Excavate) to tunnel axis in 10m sections	23%
7. Integrated Test & Commissioning - Signalling, Power, Comms, System Wide	20%
8. Dublin Airport Station: Drill (Excavate) sump (527m^3 @75m^3 / day)	20%
9. Carry Out Dynamic Testing / Trial Runs - Phase 2 South	19%
10. Collins Avenue Station: Drill (Excavate) LHS & RHS of tunnel 527m^3	16%

Table E – 2: Top 10 drivers of MetroLink Schedule.

These top 10 drivers of the schedule can be grouped further as:

- the assembly and commissioning of the tunnel boring machine, which logically is highly

correlated with the launch of the Northwood shaft (commencement of the Southern tunnel);
- tunnel boring at Dublin Airport Station; and
- testing and commission of Line-wide systems.

Risk exposure windows

As noted earlier, the risk assessment is not static. At certain times, the project will encounter less or more risks. Currently, the risk register includes a large proportion of risks related to procurement for example.

Broadly speaking, over 50% of the exposure is expected to be carried between now and the end of year four of construction. The remaining 50% exposure is associated with the subsequent years of the construction, testing and commissioning programme.

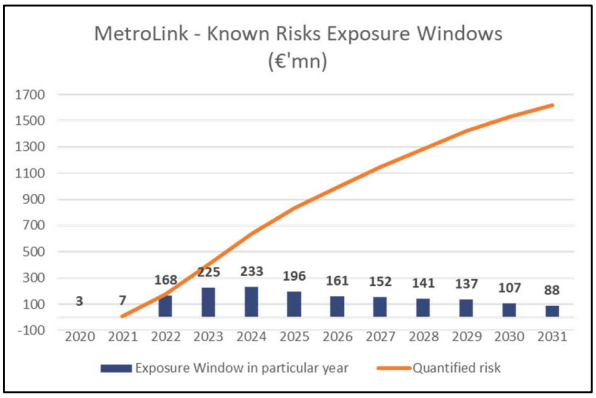

Figure E - 3: Risk exposure windows.

Figure E - 3 Explained: The blue bars represent the exposure windows associated with identified risk events, uncertainties and the main quantifiable assumptions for each year of MetroLink delivery and the orange bar represents the total cumulative known / quantified risks.