JACOBS IDOM

MetroLink

Provisions for Control of TBM Launch and Reception at Station Boxes

P01

2024/02/29

MetroLink

Project No:	32108600
Document Title:	Provisions for Control of TBM Launch and Reception at Station Boxes
Document No.:	N/A
Revision:	P01
Date:	2024/02/29
Client Name:	Transport Infrastructure Ireland
Client No:	
Project Manager:	Paul Brown
Author:	Maurice Gallagher
File Name:	Provisions for Control of TBM Launch and Reception of Station Boxes.docx

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

Document history and status

Revision	Date	Description	Author	Checker	Reviewer	Approver
01	29/02/24	For Information	MG	JK	JK	MOC

Contents

1. Introduction and Background

This paper has been produced to provide the Inspector with further details on the risk-based approach the MetroLink Project has undertaken in relation to 'tunnel breakouts', i.e. tunnel boring machine (TBM) reception and launch, further to a query raised during the Oral Hearing on 22 February 2024.

These matters have been appropriately assessed and are included as part of the EIAR. Consistent with the EIAR, the Project has adopted a conservative approach.

With respect to tunnel breakouts, particularly in terms of controlling ground movement, as well as verifying that ground movements are in accordance with specified volume losses, the worst-case scenario assessed as part of the EIAR is described within this document.

2. Risk Assessment / Mitigation

The main risk associated with tunnel breakouts is the creation of groundwater flow and ground instability with the effects being unforeseen ground movement. The main cause of this risk is the TBM experiencing a loss in face pressure.

The EIAR has assessed the provision of a 20m x 20m x 15m ground treated zone adjacent to each station box at both the reception and launch side of the station box. (EIAR, Chapter 19, para *19.6.2.1.1*, set out further below).

For reception, the length of the treated zone is sufficient to allow the tunnel rings to be grouted into the treated ground in advance of the TBM head reaching (and subsequently breaking through the diaphragm wall) and into the tunnel seal / pressure relief chamber. This provision is to provide a safe junction and effectively mitigate water and ground ingress and thereby controlling ground movement.

For TBM launch, similar provisions are allowed so that effective face pressure control can be maintained to mitigate impact of the built environment.

It should be noted that the design is to be bespoke to each station and considers the actual ground and water conditions at that location.

Additionally, there are spatial limits on each site, the working areas, and any works undertaken from the surface would need to be undertaken from within the site boundary areas. The space available varies on each site. An assessment of the working area is shown in Appendix A.

The treated zone can be achieved by:

a) vertical or inclined drilling and grouting from ground level, or

b) horizontal or inclined drilling and grouting from within the excavated station box, or

c) a combination of a) and b).

Where space is limited inclined / horizontal drilling is required. No additional impacts results from the required methodology at the specific location.

Instrumentation and monitoring will be installed to both monitor the ground movement, any adjacent structures and assist the control of the TBM passage through the launch or reception.

Instrumentation will bespoke to each location and include:

- Monitoring of the station wall vertically through which the TBM will pass, and additional monitoring on the exposed wall face, if the box has been excavated.
- Transverse ground movement studs at the transition from the native material to the ground treatment
- Transverse ground movement studs above the grouted block
- Monitoring the ground water levels outside the ground treatment and where applicable inside the box.
- Confirmation that the monitoring on any adjacent structures which is appropriate for the type of movement predicted has been installed and baselined prior to the TBM passage, further details in Appendix A.
- All movements will have associated trigger / action plans to ensure that suitable controls are implemented to manage impacts.

The building damage assessment approach has combined the tunnel and box settlement predictions which will conservatively account for the movement predictions and do not assume any benefits from the alterations caused by the ground treatment.

3. Environmental Assessment

With respect to tunnel breakouts, particularly in terms of keeping ground movement to a minimum, as well as verifying ground movements are in accordance with specified volume losses, the worst-case scenario assessed as part of the EIAR is described within this document.

It should be noted that the TBM may transit through a station in advance of station excavation reaching tunnel level. In such cases, although the need for the ground treatment is considered less, similar provisions have been included to allow for programme flexibility (station box or tunnel delay) and to have consent to provide external ground treatment to provide an effective tunnel / diaphragm wall temporary connection prior to station excavation to tunnel level.

The EIAR includes for the grouted block at all stations to maintain flexibility in case of fluctuations in the tunnel schedule. This is a conservative approach that safeguards the overall programme and allows for effective mitigation on the surrounding built environment. The environmental impacts assessed are therefore robust.

Tunnel breakout ground treatment is covered under the EIAR as follows:

a) The EIAR refers to the potential need to pre-treat the ground outside the box to safely receive and relaunch the TBMs. It is referenced in Chapter 19 Hydrogeology and specifically in para *19.6.2.1.1 Tunnel Eyes*. This clause states:

> *Typically, the grouting (if required) would form a zone approximately 20m x 20m centred on tunnel axis for a distance of 15m back from the D-wall to safeguard TBM entry / exit. Grouting will typically be undertaken from surface (vertical drilling) or subsurface (horizontal drilling) or a combination of both.*

b) Any ground treatment (as with any activity) will be undertaken in line with the noise and vibration limits set by the RO as granted.

c) The width of the proposed ground treatment is within the limits of deviation.

4. Conclusions

This paper demonstrates that the Project has:

- Appropriately assessed the risk associated with tunnel breakouts.
- Undertaken an appropriate EIAR that, by assessing the most extensive intervention required at each location, provides flexibility for the D&B Contractor to implement the necessary ground support and monitoring measures as each station requires.
- Made allowance for provisions to ensure that ground movements do not exceed those assessed in EIAR Appendix 5.17.

Appendix A. Tunnel Breakouts Ground Treatment Zones

Station	Break-in/out	External Ground treatment included in EIAR	Available worksite space[1]	Limited worksite space[2]	Predominant Ground Conditions	Comment
Dublin Airport	North	✓	✓		Limestone	Monitoring studs in the ground
	South	✓		✓	Limestone	Working space varies outside the southern wall but deemed sufficient to allow top-down ground treatment. Some inclined or horizontal drilling required. Monitoring studs will be installed on the roads outside the hoarding boundary.
Northwood	North	✓	✓		Boulder Clay	Monitoring studs in the ground
	South	✓	✓		Boulder Clay	Monitoring studs in the ground
Ballymun	North	✓	✓		Alluvial Deposits / Limestone	Monitoring studs in the ground
	South	✓	✓		Alluvial Deposits / Limestone	Monitoring studs in the ground
Collins Ave.	North	✓		✓	Alluvial Deposits / Limestone	Collins Avenue north side complicated due to traffic management arrangements. Inclined drilling required to cover area utilised for TM.

[1] Available working space refers to the 20m x 15m zone referenced in the EIAR
[2] Limited Working Space is any site that has less than above

Station	Break-in/out	External Ground treatment included in EIAR	Available worksite space[1]	Limited worksite space[2]	Predominant Ground Conditions	Comment
						Monitoring studs in road surface and close residential properties
	South	✓	✓		Alluvial Deposits / Limestone	Monitoring studs in road surface
Griffiths Park	North	✓		✓	Limestone	As in the Limestone ground treatment may be limited but deemed sufficient space to allow top-down ground treatment if preferred. Monitoring studs in the ground
	South	✓		✓	Limestone	As in the Limestone ground treatment may be limited but deemed sufficient space to allow top-down ground treatment if preferred. Monitoring on the riverwall.
Glasnevin	North	✓		✓	Boulder Clay	Working space varies slightly outside the northern wall but deemed sufficient to allow top-down ground treatment. Some inclined or horizontal drilling required. Monitoring of the residential properties
	South	✓		✓	Boulder Clay/ Alluvial Deposits	Working space varies slightly outside the southern wall but deemed sufficient to allow top-down ground treatment. Some inclined or horizontal drilling required. Monitoring on the rail, rail structures, the canal walls and canal gates

Station	Break-in/out	External Ground treatment included in EIAR	Available worksite space[1]	Limited worksite space[2]	Predominant Ground Conditions	Comment
Mater	North	✓		✓	Boulder Clay/ Alluvial Deposits	Working space varies slightly outside the northern wall due to TM requirements but deemed sufficient to allow some top-down ground treatment. Some inclined or horizontal drilling required. Monitoring on the Mater Hospital, residential properties and studs in the ground
	South	✓		✓	Boulder Clay / Alluvial Deposits	Working space is very limited outside the southern wall. Inclined or horizontal drilling required. Monitoring on St Joseph Church
O'Connell Street	North	✓		✓	Boulder Clay / Alluvial Deposits	Working space is somewhat limited outside the northern wall but deemed sufficient to allow some top-down ground treatment. Some inclined or horizontal drilling required. Monitoring of the adjacent buildings
	South	✓		✓	Limestone	Working space is somewhat limited outside the southern wall but deemed sufficient to allow some top-down ground treatment. This end of the box is in Limestone and hence the need for treatment is more limited. Some horizontal drilling required. Monitoring of the adjacent buildings

Station	Break-in/out	External Ground treatment included in EIAR	Available worksite space[1]	Limited worksite space[2]	Predominant Ground Conditions	Comment
Tara Street	North	✓		✓	Limestone	Working space is somewhat limited outside the northern wall. This end of the box is in Limestone and hence the need for treatment is limited. Some horizontal drilling required. Monitoring of the adjacent rail structures and track, monitoring studs in the road
	South	✓		✓	Limestone	Working space is varies hugely outside the southern wall. This end of the box is in Limestone and hence the need for treatment is limited. Some horizontal drilling more beneficial. Monitoring studs in the ground
St Stephens Green	North	✓	✓		Limestone	Monitoring studs in the ground and on buildings to the east
	South	✓	✓		Limestone	Monitoring studs in the ground
Charlemont	North	✓	✓		Limestone	Although working space is sufficient it may be compromised by need to maintain the laneway. However, the end of the station is in Limestone and the need for treatment is limited. Horizontal drilling may be more beneficial. Monitoring of canal tunnel sewer, river wall and studs along the road.
	South	✓		✓	Limestone	Working space outside the southern wall is constrained. However, the end of the station is in

Station	Break-in/out	External Ground treatment included in EIAR	Available worksite space[1]	Limited worksite space[2]	Predominant Ground Conditions	Comment
						Limestone and the need for treatment is limited. Horizontal drilling required. Monitoring studs in the ground, residential properties and LUAS tracks and structures.