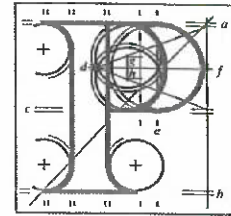


Our Case Number: ABP-314724-22

Your Reference: Wynn's Hotel



**An
Bord
Pleanála**

John Spain Associates
39 Fitzwilliam Place
Dublin 2
D02 ND61

Date:

Re: Railway (Metrolink - Estuary to Charlemont via Dublin Airport) Order [2022]
Metrolink. Estuary through Swords, Dublin Airport, Ballymun, Glasnevin and City Centre to
Charlemont, Co. Dublin

Dear Sir / Madam,

An Bord Pleanála has received your recent submission and oral hearing request (including your fee of €100) in relation to the above-mentioned proposed Railway Order and will take it into consideration in its determination of the matter.

The Board will revert to you in due course with regard to the matter.

Please be advised, there is no fee for an affected landowner, listed on the schedule, to make an observation on this case. Further note, there is also no fee required to request an oral hearing, therefore, a cheque refund of €100 is enclosed.

The Board has absolute discretion to hold an oral hearing in respect of any application before it, in accordance with section 218 of the Planning and Development Act 2000, as amended. Accordingly, the Board will inform you on this matter in due course.

Please be advised that copies of all submissions/observations received in relation to the application will be made available for public inspection at the offices of the relevant County Council(s) and at the offices of An Bord Pleanála when they have been processed by the Board.

More detailed information in relation to strategic infrastructure development can be viewed on the Board's website: www.pleanala.ie.

If you have any queries in the meantime, please contact the undersigned. Please quote the above mentioned An Bord Pleanála reference number in any correspondence or telephone contact with the Board.

Teil
Glaó Áitiúil
Facs
Láithreán Gréasáin
Ríomhphost

Tel (01) 858 8100
LoCall 1800 275 175
Fax (01) 872 2684
Website www.pleanala.ie
Email bord@pleanala.ie

64 Sráid Maoilbhríde
Baile Átha Cliath 1
D01 V902

64 Marlborough Street
Dublin 1
D01 V902

Yours faithfully,



Niamh Thornton
Executive Officer
Direct Line: 01-8737247

Tel
Glao Áitiúil
Facs
Láithreán Gréasáin
Ríomhphost

Tel
LoCall
Fax
Website
Email

(01) 858 8100
1800 275 175
(01) 872 2684
www.pleanala.ie
bord@pleanala.ie

64 Sráid Maoilbhríde
Baile Átha Cliath 1
D01 V902

64 Marlborough Street
Dublin 1
D01 V902

The Secretary
An Bord Pleanála,
64 Marlborough Street,
Dublin 1

AN BORD PLEANÁLA
LDG- 060444-23
ABP- _____
13 JAN 2023
Fee: € 400 Type: cheque
Time: 16.40 By: hand

Date: 13/01/2023
Our Ref: DF 22111

Dear Sir or Madam,

**RE: SUBMISSION ON THE METROLINK ON BEHALF OF WYNN'S HOTEL, 35-39
ABBEY STREET LOWER, DUBLIN 1, D01 C9F8**

ABP Ref. NA29N.314724

**Description - MetroLink Railway Order – Estuary through Swords, Dublin
Airport, Ballymun, Glasnevin and City Centre to Charlemont, Co. Dublin**

**Submission on behalf of: Wynn's Hotel, 35-39 Abbey Street Lower, Dublin 1,
D01 C9F8**

Introduction

Our client, Wynn's Hotel, welcomes the opportunity to make a submission on the Railway Order for the MetroLink line. Our client has a number of observations and concerns in relation to the Railway Order. As further detailed in the enclosed Memorandum by PUNCH Consulting Engineers dated the 12th January 2023, our client requires further information and reassurance in regard to a number of technical queries to fully understand the potential impact on Wynn's Hotel.

In particular these concerns relate to the potential impact on the structural integrity of the building and potential negative impacts on the building and its occupants during the construction and operational phase. Our client also wishes to request that an Oral Hearing is held in respect of the Railway Order application so that the points raised within this submission can be further clarified and addressed at the hearing for the benefit of all parties.

Our client has the benefit of an extant permission for additional floors (DCC Reg. Ref. 3131/28; ABP-303179-18) which our client intends to implement, we seek confirmation that the Railway Order will not prejudice this permission.

The following is enclosed with this submission:

- Fee of €50.00 in respect of this submission and a further fee of €50.00 in respect of the Oral Hearing request.
- Appendix 1: Extant Permission DCC. Reg. Ref. 3131/18.

Managing Director: John P. Spain BBS MRUP MRICS ASCS MRTPI MIPi

Executive Directors: Paul Turley BA MRUP Dip Environmental & Planning Law MIPi Rory Kunz BA (MOD) MScERM MAT&CP Dip EIA Mgmt. MIPi

Stephen Blair BA (Mod) MRUP MIPi MRTPI Blaine Cregan B Eng BSc MSc

Senior Associate Directors: Luke Wymer BA MRUP Dip Plg & Env Law Dip PM Prof Cert Env Mgmt MIPi

Meadhbh Nolan BA MRUP MRTPI Kate Kerrigan BA MSc MRTPI

Associate Director: Ian Livingstone MA (Hons) Town & Regional Planning, MSc Spatial Regeneration. MRTPI

John Spain Associates Ltd. trading as John Spain Associates. Directors: J. Spain, S. Spain.

Registered in Ireland No. 396306. Registered Office: 39, Fitzwilliam Place, Dublin 2 D02 ND61. VAT No. IE 6416306U

Appendix 2: Engineering Commentary prepared by PUNCH Consulting Engineers.

Site Location

Wynn's Hotel is located at Lower Abbey Street and comprises a 6-storey building located within Dublin City.



Figure 1: Site Location with approximately boundary outlined in red (Source: Google)

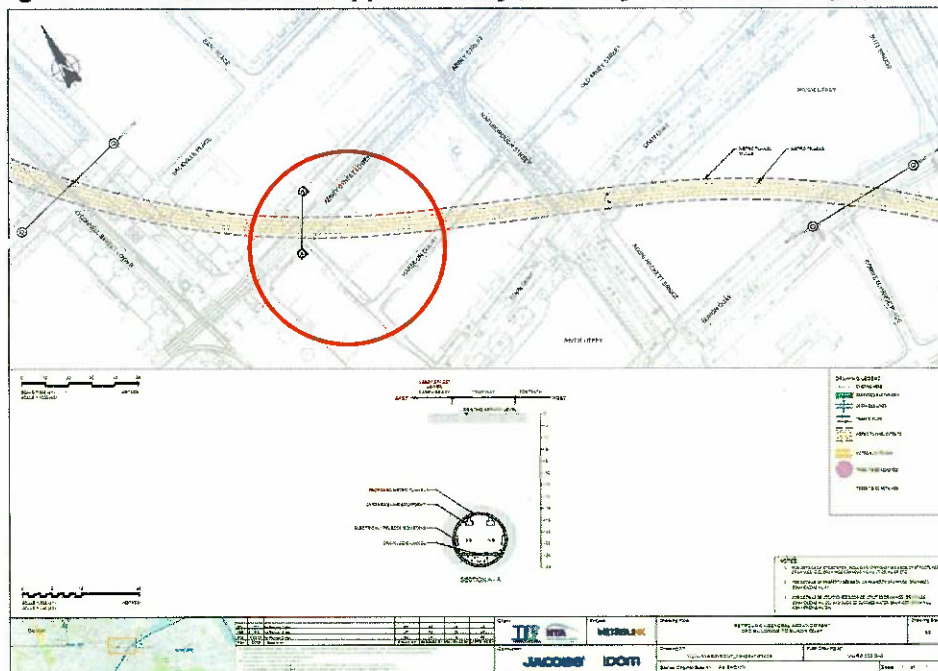


Figure 2: Alignment of the MetroLink directly under the subject site (Source: metrolink.ie) ref: ML1-JAI-ARD-ROUT_XX-DR-Y-03089

The Metrolink line is proposed to run beneath Abbey Street and directly under Wynn's Hotel. It is acknowledged by the applicant & TII that the construction of the proposed Metrolink will have an impact on the subject site. However, our client has serious concerns in relation to the identified noise and associated disruption contained within the Railway Order documentation and the significant difficulties this would cause for the hotel operation and to the hotel structure itself. Wynns Hotel is a Protected Structure in the Dublin City Development Plan 2022-2028.

Our client has the benefit of an extant permission for additional two storey extension (please see Appendix 1 DCC Reg. Ref. 3131/18) which our client proposes to implement, we seek confirmation from the applicant, TII that the Railway Order will not prejudice the ability of our client to carry out this permission.

The information and documentation submitted with the application is considered insufficient and inadequate to enable a proper assessment of the likely impacts to be carried out. Our client therefore requests a list of further information, data and analysis as set out by Punch Consulting Engineers to enable a proper assessment to be undertaken. It is respectfully submitted that such additional assessment be undertaken prior to the Board making any decision on the Railway Order application.

Engineering Considerations

A Memorandum has been prepared by PUNCH Consulting Engineers to accompany this submission, and is included in Appendix 2. The memo states:

- "iii) TWHD primary concern is the effect the proposed works will have on the business operations of its company. The hotel is in existence over 170 years and its operations cannot be negatively impacted by the proposed Metrolink works. We would request immediate engagement with TII on allay these concerns.*
- "iv) There are serious concerns based on information received that the building will be damaged by the proposed Metrolink works. The building is a protected structure and its structural integrity cannot be compromised by any works. We would request immediate engagement with TII on allay these concerns."*

Concluding Comments


Our client welcomes the opportunity to make a submission on the Metrolink Railway Order and the sustainable transport benefits which would be delivered. The proposed MetroLink alignment is running directly through our client's property and our client's concern relates to the impact the proposed MetroLink project will have on the operation of Wynn's hotel, and on the structure of the hotel itself, which is a Protected Structure in the current Dublin City Development Plan 2022-2028. Our client acknowledges that a scheme of this scale will result in impacts, however, these should be mitigated to the full extent possible and should be carefully managed to minimise the effects on our client's hotel.

Our client reserves the right to elaborate further on these issues as necessary should the Board decide to hold an oral hearing or require any clarification and would welcome any responses from the applicant.

We trust this submission will be taken into consideration in assessing the proposals.

The assessment of compensation would not be limited to the content of this submission.

Yours sincerely,



John Spain Associates

APPENDIX 1: EXTANT PERMISSION DCC. REG. REF. 3131/18; ABP-303179-18

ABP issued decision to grant permission on 07 May 2019 for the following development, as set out in the statutory notices:

PROTECTED STRUCTURE: Permission for development of a two-storey roof extension at a 623 sq.m site. The proposed development will comprise the following: The removal of the existing lift overrun structure and lift motor room, water tanks, service plant, 5 no. non-original roof lights and 4 no. disused chimneys to the rear at roof level to facilitate the provision of a 2 no. storey extension at sixth and seventh floor levels, with 776 sq.m floor area with terrace areas of 92 sq.m. The proposed works will also include the raising of 5 no. chimneys by 450mm, general fire safety upgrades and the replacement of an external steel fire escape and open walkways to the rear serving first to fifth floor levels. The proposed extension comprises a part cantilevered structure with metal cladding on top of the existing 6 no. storeys over basement Protected Structure, bringing the total height to 27.9m above ground (excluding lift overrun), increasing the total gross internal floor area by 831 sq.m. bringing the total gross floor area to 4,049 sq.m. The proposal consists of the addition of 27 no. ensuite bedrooms, terraces at sixth and seventh floor levels, a covered walkway across an existing lightwell at sixth and seventh floors to provide safe access doors from bedrooms within the pitched roof enclosure. The proposed roof structure will also incorporate perforated metal panels to provide natural ventilation to the new consolidated and concealed plant areas at roof level. The proposed fire safety works comprise fire protection upgrades to the existing internal staircase including new glazed fire screens at second to fifth floor levels, the provision of an enclosed firefighting stairs with metal cladding from first floor to seventh floor levels and new external covered walkways at first to fifth floor levels replacing the existing external steel fire escape stairs and open walkways. The proposed scheme also includes a new ventilated lobby to a new fire-fighting lift within the existing lift shaft servicing basement to seventh floor levels, the reconfiguration of the east elevation window at each of the first to fifth floor levels facing Harcourt Court, the relocation of the existing fire exit from the dining room at ground floor, the provision of a new emergency escape stairs from basement to ground floor with a new exit door to the rear courtyard with associated minor alterations to the existing external wall. The proposed development also includes sundry minor internal partition alterations to facilitate the new firefighting lobby, a new bespoke platform lift to the main entrance and all ancillary site development works.

APPENDIX 2: ENGINEERING COMMENTARY PREPARED BY PUNCH CONSULTING ENGINEERS

Memorandum

Project Title	Project Metrolink – Wynn's Hotel Dublin	From	Robert Coughlan, PUNCH Consulting Engineers
Project No	222266	To	An Bord Pleanála
Subject	Technical Submission to Railway (Metrolink–Estuary to Charlemont via Dublin Airport) Order 2022 at – Wynn's Hotel Dublin, 35-39 Abbey Street Lower, North City, Dublin 1, D01 C9F8	Cc	
Date	12-01-2023		

1.0 Introduction

PUNCH Consulting Engineers (PUNCH) have been appointed by Wynn's Hotel Dublin (WHD) to produce a Technical Submission to An Bord Pleanála in response to the Railway (Metrolink–Estuary to Charlemont via Dublin Airport) Order 2022 at Wynn's Hotel Dublin, 35-39 Abbey Street Lower, North City, Dublin 1, D01 C9F8.

The National Roads Authority, operating as Transport Infrastructure Ireland) (TII), applied for a Railway Order to An Bord Pleanála on the 30th September 2022. This order was for a Railway Metrolink–Estuary to Charlemont via Dublin Airport. On the 20th September 2022, as an owner of land at The Wynn's Hotel Dublin, our client was served with an Information Pack relating to the Railway Order application. The submission is based on information received in that Information Pack and information on <https://www.metrolinkro.ie/>.

It is essential that each of the points raised in this submission are addressed in full by TII. It is noted that the comments in this submission will expand following further engagement with TII. The hotel is over 170 years old and is a Protected Structure (NIAH 50010276) and is an iconic hotel in Dublin City Centre. It is vital to WHD that the building remains fully operational during the works and in its operational phase and cannot accept any interruption or damage to its business.

The hotel was badly affected during construction works of the Luas Red Line in the early 2,000's and cannot suffer similar issues with the proposed Metrolink. Lack of clear communication when works would

be undertaken by TII during construction of the Luas Red Line led to significant disruption for the hotel. Also the hotel did not have a specific point of contact in TII or with the Main Contractor during these works which further added to the disruption.

The hotel requests early engagement with TII on the items raised in this submission and request that An Bord Pleanála condition same in any grant of the Railway Order.

WHD suffered substantial financial losses during construction works of the Luas Red Line and request details from TII for proposed compensation procedures. WHD noted there were no procedures in place during construction of the Luas Red Line to compensate businesses for losses and cannot accept the same with the proposed Metrolink.

We wish to confirm our client requests an Oral Hearing is held in respect of the Railway Order application and again the justification for this is outlined further in this submission.

2.0 Technical Observations

The following is a preliminary list of technical queries which we require to be fully assessed and resolved to our client's satisfaction prior to the proposed Oral Hearing. We request ABP condition in any grant of the Railway Order early engagement from TII with WHD to work through this technical list.

a. What is the Tunnel detail design procurement approach i.e. client design or contractor design?

In responding to this item, we ask that TII to consider the following along with any other items they consider relevant:

- i) A detailed design programme for the tunnel under Wynns Hotel Dublin is required?
- ii) If the tunnel design is by the main contractor, TII to confirm how soon after the grant of the Railway Order a Main Contractor be appointed
- iii) TII to confirm estimated construction programme from when WHD are likely to experience noise and vibration from the proposed Construction Works
- iv) TII to confirm what information WHD will receive prior to the Oral Hearing

- v) Assuming the detailed design is by the Main Contractor, TII to confirm the extent to which the Main Contractor will be required to engage with WHD during the detailed design process? WHD would request a sole point of contact from the main contractor for the full duration of works.

- b. Confirmation that a full copy of the detail design and construction package will be issued by TII in relation to Wynn's Hotel Dublin.**

In responding to this item, we ask that TII to consider the following along with any other items they consider relevant:

- i) We expect to see a full copy of the detailed design and construction package which allows for an independent assessment to be carried out by WHD as they wish. We request confirmation of timelines from TII for this but note this needs to allow sufficient time for our client to fully review the proposals.
- ii) It is vital for WHD that the building is not damaged during these works and the extent of building damage suggested by TII in the railway order is not acceptable.
- iii) The efficient running of the business operations in the hotel is of paramount importance to WHD. Whilst some disruption in terms of noise and vibration is likely, these levels cannot be such that they affect the company's daily operations. We would request that TII provide detailed reassurances on these matters.

- c. Confirmation by TII of the Identity of the Civil and Structural Design Firm for the Metrolink tunnel beneath Wynn's Hotel Dublin?**

- d. Confirmation of the Identity of the Geotechnical Design Firm for the Metrolink tunnel beneath Wynn's Hotel Dublin?**

- e. Confirmation of the Technical Design Checking Process for the Metrolink tunnel beneath Wynn's Hotel Dublin**

In responding to this item , we ask that TII to consider the following along with any other items they consider relevant:

- i) Category 3 independent checking is expected as a minimum checking process. We ask TII to confirm checking process and we request An Bord Pleanála to condition same in any grant of the Railway Order

- f. **Details and frequency of proposed condition surveys for Wynn's Hotel Dublin by TII, both in advance of and during the construction works as well as during the tunnel operational phase.**

In responding to this item , we ask that TII to consider the following along with any other items they consider relevant:

- i) In the Damage Assessment Report of Building document on <https://www.metrolinkro.ie/>, it places WHD (B-241) in Damage Category B (Refer to Appendix A) . This cannot be accepted by WHD and will likely negatively impact the building's basement, frame and facades which in turn affects the operations of the business.
 - ii) Visual condition surveys of the building are expected prior to and during construction works. There must be photographic condition surveys carried out by professional independent parties procured by TII/Main Contractor to ensure any potential damage to the building is accurately recorded.
 - iii) It is expected that the condition surveys continue post construction and through the tunnel operational stages and request frequency of these surveys to be confirmed by TII.
 - iv) We request this information from TII as soon as possible to ensure the integrity of the building is maintained during all phases of the works.
 - v) We request TII to confirm when guidelines regarding the process for remediation will be released, should remediation be required. It is our understanding these guidelines are under development by TII based on information from <https://www.metrolinkro.ie/> . We reiterate that damage to the building cannot be accepted but we need to understand the guidelines nonetheless.
-
- g. **Vertical settlement of the existing structure at The Wynns Hotel Dublin from the proposed works.**

In responding to this item , we ask that TII to consider the following along with any other items they consider relevant:

- i) The predicted settlement is a concern from available information on <https://www.metrolinkro.ie/>. The settlement contours on Figure 20.16, sheet 26 of 30 (Refer to Appendix B), suggest settlement of 40-45mm in the calculated settlement trough. We request details from TII on how they established this deflection data. The building is a Protected Structure and over 170 years and TII must recognise this.
 - ii) There appears to be no evidence of undertakings on <https://www.metrolinkro.ie/> to confirm the quality of the rock at the tunnel level beneath WHD. We request that geophysical surveys are carried out by TII on the rock at tunnel level from the existing basement. 2d Resistivity and Seismic Refraction surveys are suggested to determine the rock mass characteristics.
 - iii) It appears that the tunnel will be formed in limestone rock with gravel and made ground layers above the rock. If a dense rock with little fractures is encountered during this testing, this is favourable in terms of boring. If the rock is heavily fractured together with the crown of the tunnel close to the gravel layers, this increases risk of settlement. We ask TII to comment on the rock/soil characteristics below the hotel.
- h. Noise Impacts under the existing structure at Wynn's Hotel Dublin from the proposed works.**

In responding to this item , we ask that TII to consider the following along with any other items they consider relevant:

- i) There is a concern in relation to the identified noise and associated disruption contained within <https://www.metrolinkro.ie/>. A "Very High Adverse (significant)" residual impact is identified in the documentation. This is not acceptable to WHD and will be detrimental to our client's daily business operations . TII should assess this further and mitigate this impact.
- ii) Whilst this impact is noted as being "short term", there is no clarity or estimate provided beyond this in relation to the duration of these works and associated negative impacts. We request TII to confirm duration of the proposed works and associated impacts on our client's building.

- iii) Table 14.3: Groundborne Noise from Underground Sources - Threshold of Significant Effects on Non-Residential Buildings (Refer to Appendix C) states a threshold of 45dB for commercial buildings. The calculated noise levels from works under the hotel are 50dB and in excess in the threshold.
- iv) There is a concern with the noise levels during the operational phase of the Metrolink. TII to confirm these levels directly under the building. Disruption to the hotel due to noise cannot be accepted by WHD.
- v) In the event the hotel experience noise disturbance during the construction phase which results in WHD incurring losses. We will require confirmation from Metrolink or the contractor that WHD will be reimbursed
- i. TII to confirm that the tunnel can be constructed in the proposed position/depth considering the depth of the existing rock and gravels and formation level of the single basement level at Wynn's Hotel Dublin?
- j. TII to confirm that the permissible vertical deviation for the tunnel as outlined in Section 6(d)ii of the Draft Railway Order of 5m upwards has been fully considered on the proposed tunnel under the hotel?

In responding to this item , we ask that TII to consider the following along with any other items they consider relevant:
 - i) It appears that the tunnel will be formed in limestone rock with gravel and made ground layers above the rock based on information in <https://www.metrolinkro.ie/>
 - ii) Should the tunnel deviate 5m upwards, it will likely formed in the gravels. Tunnelling in gravel strata increases the risk of greater settlements in the building when compared to tunnelling in rock. Tunnelling in the gravels likely results in greater damage to the building. We ask TII to comment on the proposed tunnel level on relation to the rock and gravel strata.
- k. TII to confirm the calculated loads used in the tunnel design from the existing building at Wynn's Hotel Dublin?
- l. The hotel structure has been designed for a number of additional floors and the client intends to extend the height of the building in the future accordingly. Planning

Permission for these works was obtained in 2018, Planning Reference 3131/18. TII to confirm that the loadings for the additional floors will be included in design of the tunnel.

- m. TII will need to provide full details of the constraints the tunnel will impose on the future development potential/value of the site. This will need to set out the engagement process which the client/site owner will need to undertake for the preparation of any future planning applications.

In responding to this item , we ask that TII to consider the following along with any other items they consider relevant:

- i) As outlined above Planning Permission has been granted for additional floors, Planning Reference 3131/18. We note our client's intention to proceed with these works.
- ii) TII to confirm if the Luas located outside the front of the building impacts on the design of the tunnel at this location?

- n. **Written confirmation from TII of any anticipated negative impacts on the hotel building and its occupants at Wynn's Hotel Dublin during the construction phase?**

In responding to this item , we ask that TII to consider the following along with any other items they consider relevant:

- i) PUNCH request TII to issue details and timelines of any negative impacts for WHD on the normal execution of their business operations during construction phase of the works.

- o. **Written confirmation from TII of any anticipated negative impacts on the building and its occupants at Wynn's Hotel Dublin during the operational phase?**

In responding to this item , we ask that TII to consider the following along with any other items they consider relevant:

- i) PUNCH request TII to issue details and timelines of any negative impacts for WHD on the normal execution of their business operations during the operational phase of the works.

- p. Confirmation that that the structural integrity of the building at Wynn's Hotel Dublin will not be affected in any way by the proposed works during the construction and operational phase.

In responding to this item , we ask that TII to consider the following along with any other items they consider relevant:

- i) In the Damage Assessment Report of Building document on <https://www.metrolinkro.ie/>, it places the Wynn's Hotel Dublin (B-241) in Damage Category B . We note that the building is a protected structure and because of this, a Phase 3 assessment will be undertaken. This Phase 3 assessment, as we understand it, will be a detailed assessment of the Ground Movement Response for the hotel specifically. We request timelines of when this will be carried out by TII and specific details of the process?
- ii) WHD will not accept building damage and the integrity of the building cannot be compromised in any way. The superstructure and facades cannot be damaged. Should remediation be required to the superstructure, the work practices and daily operations of the company will be hugely affected.

3.0 Conclusions

- i) The project is of both Local and National significance and accordingly warrants an Oral Hearing. Accordingly, our client wishes to request that an Oral Hearing is held in respect of the Railway Order application, so that the points raised within this submission can be further clarified and addressed in detail at the hearing for the benefit of all parties.
- ii) We wish to develop and resolve each of the observations made in this submission in advance of any future Oral Hearing and request immediate engagement with TII accordingly. We request that ABP condition same in any grant of the Railway Order.
- iii) WHD primary concern is the effect the proposed works will have on the business operations of its company. The hotel has operated successfully for over 170 years and its operations cannot be negatively impacted by the proposed Metrolink works, either in the construction

or the operational phase. We would request immediate engagement with TII to allay these concerns.

- iv) There are serious concerns based on information received that the building will be damaged by the proposed Metrolink works. The building is a protected structure and its structural integrity cannot be compromised by any works. We would request immediate engagement with TII to allay these concerns.

Yours sincerely



Robert Coughlan

BE CEng MIEI MStructE

Technical Director

PUNCH Consulting Engineers

Appendix A -Extract of Damage Assessment Report of Building and Other Assets

Appendix D. Subsidence Damage Assessment Methodology for Buildings due to Tunnelling and Other Associated works

1. Introduction

1.1 The construction of Dublin MetroLink tunnels, station boxes, shafts, retained cutting will all lead to ground movements near the ground surface. The amount of ground movements will depend on several factors including

- the depth and volume of the works below ground;
- the ground conditions;
- the method of construction;
- the presence and nature of buildings;
- and the type of foundations.

1.2 The magnitude of the ground movement will vary across the footprint of the buildings resulting in differential ground movement which has the potential to damage buildings and other infrastructure, including utilities. If damage were to occur, it could range from small internal cracks in plaster to effects on the structural integrity of the building, although in most cases there is no discernible effect on the structure itself. Depending on the level of risk either

- no action will be required (i.e. the building fall outside of the 1mm contour);
- buildings will be monitored during construction;
- or special protective measures will be implemented to protect the buildings.

2. Settlement Impact Assessments

2.1 The industry standard three-phased approach is proposed to assess the buildings that may be affected by the structural excavations carried out by the Contractor which is similar to the process adopted for other major tunnelling projects including Crossrail in London or HS2 in the UK.

PHASE 1

2.2 The Phase 1 assessment is based on “green-field” site conditions. This means that the interaction of the building and its foundations on the shape of settlement profile is ignored.

2.3 For bored tunnels, the settlement predictions for “green-field” site conditions are based on empirical methods described by O'Reilly and New (1982) using parameters for ground loss determined from case histories considering the method of tunnelling and ground conditions. For the Phase 1 assessment, the volume loss for the tunnels within the superficial material and rock strata will be taken as 1.5% and 0.75%

respectively. The tunnel is considered in rock when there is at least half-a-tunnel diameter rock cover above the tunnel crown, otherwise tunnel is assumed to be in superficial material.

2.4 For excavations comprising shafts, station boxes and retained cuttings, a conservative methodology for predicting settlements has been developed based on case history data presented in CIRIA 760.

2.5 Where the predicted settlement from bored tunnels and from other excavations referred above is less than 10mm and the predicted ground slope is less than 1/500, those buildings are not subject to further assessment. Those for which predicted settlement is 10mm or more, or for which predicted ground slope is 1/500 or more, are subject to a Phase 2 assessment.

2.6 However, despite the above screening process, any buildings within the 1mm contour will be subject to a Phase 2 assessment if:

(a) it is on shallow foundations and is within a distance from a retained cutting, shaft or box equal to the excavated depth of superficial deposits or 50% of the total excavation depth, whichever is the greater. In this context, superficial deposits are taken to be soils above the rockhead level;

(b) it has a foundation level deeper than 4m, or (in the case of a bored tunnel) greater than 20% of the depth to tunnel axis;

(c) it is a Protected/Prominent Buildings; or

(d) any 'sensitive' buildings that might need further assessment to determine whether any protective works required.

PHASE 2

2.7 In Phase 2, the settlement calculated for "green-field" conditions are imposed on buildings, i.e. it is assumed that buildings behave completely flexible ignoring the building stiffness. In addition, the deformation due to horizontal ground movement is considered (analysed using for example CIRIA 760 for diaphragm wall installation to determine the 'green-field' horizontal deformation and closed form solutions for the tunnel induced lateral movement). This is still a conservative assumption as in reality the buildings will modify the settlement effects thus reducing the potential for damage.

2.8 The potential for damage in this Phase 2 assessment is classified using the procedure described by Burland (1995) and Mair et al (1996). Each building is categorised into one of six damaged categories by reference to maximum tensile strain as described in column 2 of Table 1. This classification assumes a simple brick masonry construction, whereas other forms of construction, such as framed buildings, are more robust.

2.9 This assessment is only sufficiently informative for buildings with relatively shallow foundations.

2.10 Buildings assessed to be in Damage Category 0, 1 or 2 after the Phase 2 assessment are not subject to further assessment. All buildings which are placed in Damage Category 3 or above in the Phase 2 assessment are subject to a Phase 3 assessment.

2.11 However, despite the above classification of the Damage Category level, all buildings will be subject to a Phase 3 assessment if:

(a) it is on shallow foundations and is within a distance from a retained cutting, shaft or box equal to the excavated depth of superficial deposits or 50% of the total excavation depth, whichever is the greater. In this context, superficial deposits are taken to be soils above the rockhead level;

(b) it has a foundation level deeper than 4m, or (in the case of a bored tunnel) greater than 20% of the depth to tunnel axis;

(c) it is a Protected Structure; or

(d) any 'sensitive' buildings that might need further assessment to determine whether any protective works required.

PHASE 3

2.12 In Phase 3 of the assessment procedure, each building is considered individually in contrast to the first 2 phases where the area of interest is analysed generically.

2.13 The Phase 3 assessment consists of several sub-steps (referred to as "Iterations"), each refining the building and tunnel model to a higher degree. In this phase, both the magnitude of strain developing in the building and the validity of the standard risk categories (which are originally based on masonry structures) are reappraised. In the first iteration, a similar model that was used for the Phase 2 assessment will be adopted. The model is then successively refined in the subsequent iterations. If required, the tunnel-excavation-ground-building interaction is modelled using Finite Element / Finite Difference techniques with appropriate level of sophistication to verify whether a reduction in the category of damage to an acceptable level is feasible.

2.14 A structural survey will be undertaken to determine the structural form and condition of the building where necessary for the assessment. In every case where a building is subject to a Phase 3 assessment, a desktop structural appraisal by a qualified structural engineer will be carried out for the purpose of confirming the likely structural behaviour and determining whether a detailed structural survey would be required.

2.15 As a result of the Phase 3 assessment, the risk category of the building is reassessed, the requirement for any protective works is established for implementation. Appropriate instrumentation and monitoring strategy will also be developed. These details will be included in the building damage assessment report.

3. References

Burland, J.B., Broms, B.B., & de Mello, V.F.B. (1977). Behaviour of foundations and structures. Pages 495-546 of: Proc. 9th Int. Conf. Soil Mech. and Found. Eng., vol. 2.

Burland, J.B. (1995). Invited Special Lecture: Assessment of risk of damage to buildings due to tunnelling and excavation. 1st Int. Conf. on Earthquake Geotechnical Engineering, Tokyo, Vol 3; 1189-1201.

O'Reilly, M.P. and New, B.M. (1982). Settlements above tunnels in the United Kingdom – their magnitude and prediction. Tunnelling '82. Ed Jones, M.J. pp 173-181. London, IMM.

Rankin, W.J. (1988). Ground movements resulting from urban tunnelling: predictions and effects. Pages 79-92 of: Engineering geology of underground movements. The Geological Society, London.

Mair, R.J., Taylor, R.N. and Burland, J.B. (1996). Prediction of ground movements and assessment of risk of building damage due to bored tunnelling. In: Proc. Of the Int. Symp. On Geotech. Aspects of Underground Construction in Soft Ground, 713-718, Balkema, Rotterdam.

Mair, R.J. (2001). Theme Lecture, Research on tunnelling-induced ground movements and their effects on buildings – Lessons from the Jubilee Line Extension. Proceedings of the international conference held at Imperial College, London, UK, on 17–18 July 2001

TABLE 1

Building Damage Classification ¹				
1 Risk Category	2 Max Tensile Strain %	3 Description of Degree of Damage	4 Description of Typical Damage and Likely Form of Repair for Typical Masonry buildings	5 Approx ² Crack Width (mm)
0	0.05 or less	Negligible	Hairline cracks.	
1	More than 0.05 and not exceeding 0.075	Very Slight	Fine cracks easily treated during normal redecorations. Perhaps isolated slight fracture in building. Cracks in exterior brickwork visible upon close inspection.	0.1 to 1
2	More than 0.075 and not exceeding 0.15	Slight	Cracks may require cutting out and patching. Recurrent cracks can be masked by suitable linings. Repointing and possibly replacement of a small amount of exterior brickwork may be required. Doors and windows sticking. Utility services may be interrupted. Weather tightness often impaired.	1 to 5
3	More than 0.15 and not exceeding 0.3	Moderate	Cracks may require cutting out and patching. Recurrent cracks can be masked by suitable linings. Repointing and possibly replacement of a small amount of exterior brickwork may be required. Doors and windows sticking. Utility services may be interrupted. Weather tightness often impaired.	5 to 15 or a number of cracks greater than 3
4	More than 0.3	Severe	Extensive repair involving removal and replacement of sections of walls, especially over doors and windows required. Windows and door frames distorted. Floor slopes noticeably. Walls lean or bulge noticeably, some loss of bearing in beams. Utility services disrupted.	15 to 25 but also depends on number of cracks
5		Very Severe	Major repair required involving partial or complete reconstruction. Beams lose bearing, walls lean badly and require shoring. Windows broken by distortion. Danger of instability.	Usually greater than 25 but depends on number of cracks

Notes

The table is based on the work of Burland et al (1977) and includes typical maximum tensile strains for the various damage categories (column 2) used in phase 2 settlement analysis.

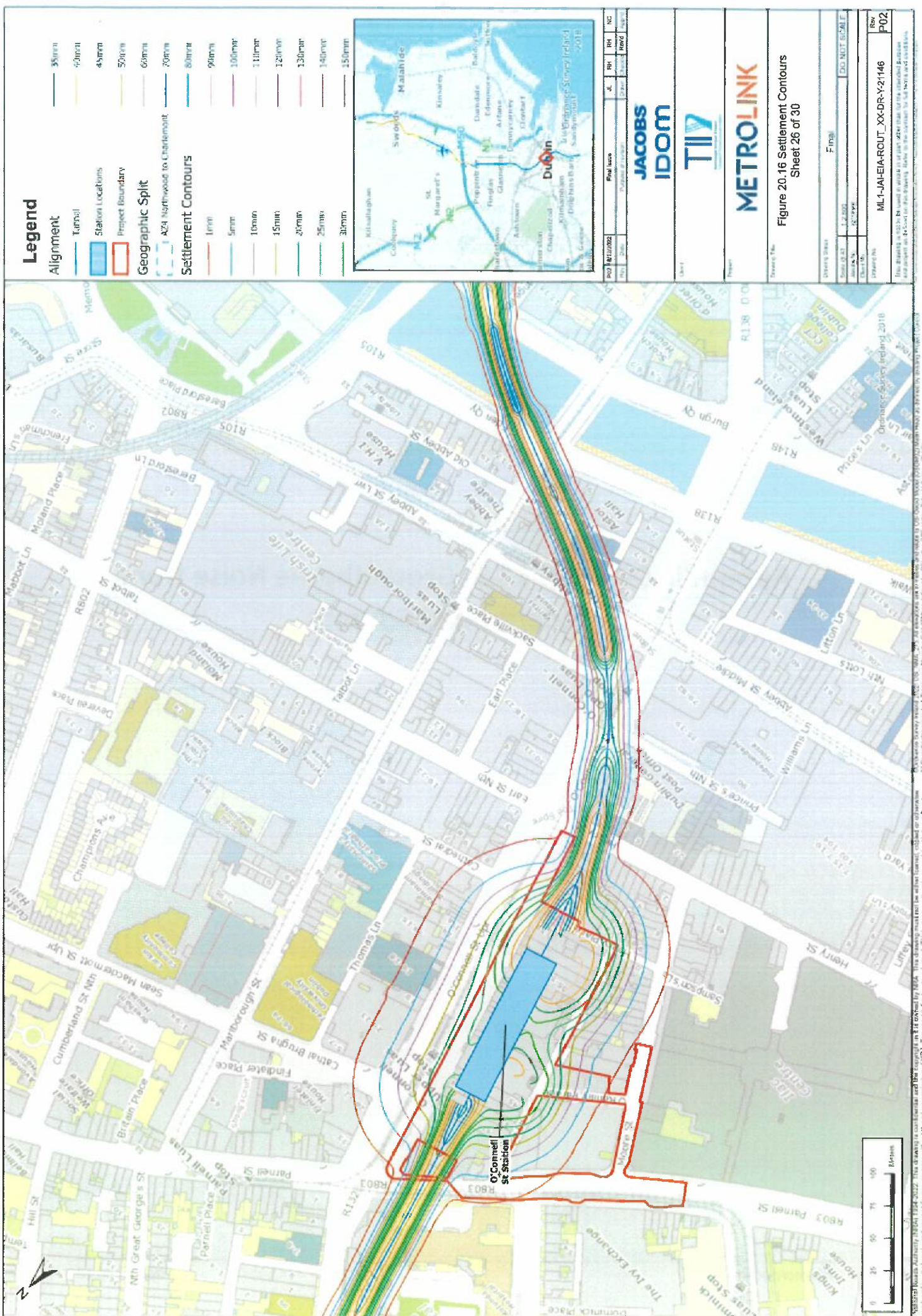
Crack width is only one aspect of damage and should not be used on its own as a direct measure of it.

Ref	Chainage	Description	Height (m)	Number of Floors	Length (m)	Depth of basement (m)	Initial Phase 2a Assessment Damage Category	Refined Phase 2a Assessment Damage Category	RPS, NIAH, RMP or other heritage (Y/N/unknown)	Continue to next assessment phase? (Y/N)	Comments
			21.0	6	4.3	-3.0	2 (Slight)	2 (Slight)	Y	Y	Special building
B-242	19760	Residential	10.5	3	10.1	0.0	N/A	N/A	N	N	Outside 1mm contour
B-243	14840	Unknown	7.9	3	12.4	0.0	N/A	N/A	Y	N	Outside 1mm contour
B-244	14100	Lloyd Institute Trinity	7.0	2	11.0	0.0	2 (Slight)	1 (Very Slight)	N	N	Damage category 2 or below

BUILDING CODE	BUILDING DESCRIPTION			BUILDING LOCATION			BUILDING INFORMATION			
	NAME	CONSIDERATION	CATEGORY	Chainage	Dmin (m)	Dmax (m)	Height (m)	N° Floors	Length (m)	Depth (m)
B-238	Arthur Cox Building	0	0	18+980	0.00	17.81	40.0	7	17.81	-8.10
B-239	Residential	Residential	0	13+120	10.51	15.50	8.7	2	4.99	0.00
B-240	Presbytery, Corballis Road North, Dublin Airport, Swords Co. Dublin	Presbytery	Church	7+060	42.92	61.12	7.0	2	18.20	0.00
B-242	Residential	Hotel	0	17+020	0.00	4.26	21.0	6	4.26	-3.00
		0	0	19+760	51.95	61.79	10.5	3	10.08	0.00
B-243	Unknown	0	0	14+840	121.02	133.44	7.9	3	12.42	0.00
B-244	Residential	Residential	0	14+100	0.00	11.03	7.0	2	11.03	0.00
ST-1	Airport Road	Road	Road	8+320	0.00	115.66	0.0	0	115.66	0.00
ST-2	Ballymun's Road Gas Station	Petrol Station	Petrol Station	12+860	26.55	49.28	0.0	0	62.96	0.00
ST-3	Mobli's Road Bridge	Bridge	Single Span	13+900	17.66	37.03	0.0	0	21.75	0.00
ST-4	Railway	Railway	Railway	14+880	0.00	116.51	0.0	0	116.51	0.00
ST-5	Near Cross Guns Quay (nearly B-202) / Floodgates	Watergate	Watergate	14+840	0.00	41.06	0.0	0	41.06	0.00
ST-6	O'Connell Street cross	Main Street	Road	16+900	0.00	57.64	0.0	0	57.64	0.00
ST-7	Bridge between O'Connell Street and Butt Bridge	Bridge	Multiple Span	17+120	9.11	67.72	0.0	0	48.05	0.00
ST-8	Bridge over Poothberg Street corner with Lucke Street	Bridge	Single Span	17+380	22.81	42.47	0.0	0	36.33	0.00
ST-9	Bridge over Townsend Street	Bridge	Single Span	17+500	23.05	31.94	0.0	0	21.13	0.00
ST-10	Bridge over Shaw Street	Bridge	Single Span	17+580	25.39	41.19	0.0	0	38.89	0.00
ST-11	Bridge over Dartmouth Road	Bridge	Single Span	19+420	7.68	21.74	0.0	0	17.42	0.00
ST-12	Bridge over Northbrook Road	Bridge	Single Span	19+520	9.42	21.13	0.0	0	15.15	0.00
ST-13	Bridge over Ranelagh Road	Bridge	Single Span	19+780	24.89	39.94	0.0	0	53.47	0.00
ST-14	Bridge over Cullenswood Road	Bridge	Single Span	19+943	2.69	14.67	0.0	0	15.83	0.00
ST-15	Embankment carrying LUAS, masonry faced circa 4.5m in height, interspersed with ST-11 to ST-14	Embankment	Embankment	19+350 – 19+750	0	35	5	0	400	0

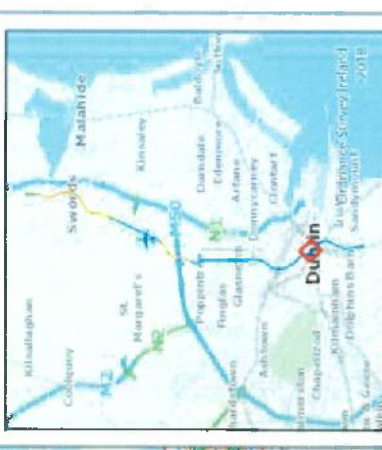
Specific Building	Parameter	Critical Segment	Start [m]	End [m]	Curvature	Max Slope	Max Settlement [mm]	Max Tensile Strain [%]	Min Radius of Curvature (Hogging) [m]	Min Radius of Curvature (Sagging) [m]	Damage Category
B-190	Min Radius of Curvature (Hogging)	-	-	-	-	-	-	-	-	-	-
	Min Radius of Curvature (Sagging)	1	0	14.316	Sagging	0.0031489	37.672	0.068756	-	1404.8	1 (Very Slight)
	Max Slope	1	0	11.302	Sagging	0.0032467	37.697	0.059156	-	1313.6	1 (Very Slight)
	Max Settlement	1	0	11.302	Sagging	0.0032467	37.697	0.059156	-	1313.6	1 (Very Slight)
	Max Tensile Strain	2	11.302	28.239	Hogging	0.0032466	22.859	0.074335	2958.8	-	1 (Very Slight)
	Min Radius of Curvature (Hogging)	2	11.302	28.239	Hogging	0.0032466	22.859	0.074335	2958.8	-	1 (Very Slight)
B-179	Min Radius of Curvature (Sagging)	1	0	11.302	Sagging	0.0032467	37.697	0.059156	-	1313.6	1 (Very Slight)
	Max Slope	1	0	3.3418	Sagging	0.0041987	26.007	0.054914	-	2194.6	1 (Very Slight)
	Max Settlement	2	3.3418	15.739	Sagging	0.0041987	42.882	0.097797	-	895.29	2 (Slight)
	Max Tensile Strain	2	3.3418	15.739	Sagging	0.0041987	42.882	0.097797	-	895.29	2 (Slight)
	Min Radius of Curvature (Hogging)	3	15.739	28.623	Hogging	0.0041863	26.046	0.0922	2025.1	-	2 (Slight)
	Min Radius of Curvature (Sagging)	2	3.3418	15.739	Sagging	0.0041987	42.882	0.097797	-	895.29	2 (Slight)
B-172	Max Slope	1	11.563	26.325	Hogging	0.004604	27.298	0.097389	1767.6	-	2 (Slight)
	Max Settlement	2	26.325	38.232	Sagging	0.004604	45.093	0.10247	-	786.68	2 (Slight)
	Max Tensile Strain	2	26.325	38.232	Sagging	0.004604	45.093	0.10247	-	786.68	2 (Slight)
	Min Radius of Curvature (Hogging)	1	11.563	26.325	Hogging	0.004604	27.298	0.097389	1767.6	-	2 (Slight)
	Min Radius of Curvature (Sagging)	2	26.325	38.232	Sagging	0.004604	45.093	0.10247	-	786.68	2 (Slight)
	Max Slope	1	11.711	26.37	Hogging	0.0043104	26.103	0.095496	1919.3	-	2 (Slight)
B-174	Max Settlement	2	26.37	34.444	Sagging	0.0043104	43.149	0.063597	-	864.64	1 (Very Slight)
	Max Tensile Strain	1	11.711	26.37	Hogging	0.0043104	26.103	0.095496	1919.3	-	2 (Slight)
	Min Radius of Curvature (Hogging)	1	11.711	26.37	Hogging	0.0043104	26.103	0.095496	1919.3	-	2 (Slight)
	Min Radius of Curvature (Sagging)	2	26.37	34.444	Sagging	0.0043104	43.149	0.063597	-	864.64	1 (Very Slight)
	Max Slope	1	0	10.71	Sagging	0.0032863	38.272	0.046568	-	1376.4	0 (Negligible)
	Max Settlement	1	0	10.71	Sagging	0.0032863	38.272	0.046568	-	1376.4	0 (Negligible)
B-175	Max Tensile Strain	2	10.71	20.686	Hogging	0.0032863	22.861	0.080436	2869.4	-	2 (Slight)
	Min Radius of Curvature (Hogging)	2	10.71	20.686	Hogging	0.0032863	22.861	0.080436	2869.4	-	2 (Slight)
	Min Radius of Curvature (Sagging)	1	0	10.71	Sagging	0.0032863	38.272	0.046568	-	1376.4	0 (Negligible)
	Max Slope	1	0	11.191	Hogging	0.0046549	27.175	0.10346	1705.6	-	2 (Slight)
	Max Settlement	2	11.191	18.456	Sagging	0.0046549	45.062	0.062084	-	784.52	1 (Very Slight)
	Max Tensile Strain	1	0	11.191	Hogging	0.0046549	27.175	0.10346	1705.6	-	2 (Slight)
B-59	Min Radius of Curvature (Hogging)	1	0	11.191	Hogging	0.0046549	27.175	0.10346	1705.6	-	2 (Slight)
	Min Radius of Curvature (Sagging)	2	11.191	18.456	Sagging	0.0046549	45.062	0.062084	-	784.52	1 (Very Slight)
	Max Slope	1	0	12.732	Hogging	0.0044683	20.489	0.094141	1617.3	-	2 (Slight)
	Max Settlement	1	0	12.732	Hogging	0.0044683	20.489	0.094141	1617.3	-	2 (Slight)
	Max Tensile Strain	1	0	12.732	Hogging	0.0044683	20.489	0.094141	1617.3	-	2 (Slight)
	Min Radius of Curvature (Hogging)	1	0	12.732	Hogging	0.0044683	20.489	0.094141	1617.3	-	2 (Slight)
B-57	Min Radius of Curvature (Sagging)	-	-	-	-	-	-	-	-	-	-
	Max Slope	1	0	2.9424	Sagging	0.0017042	15.857	0.014401	-	111.15	0 (Negligible)
	Max Settlement	2	2.9424	20.948	Sagging	0.0017042	25.997	0.030985	-	324.14	0 (Negligible)

**Appendix B- Volume 4, Chapter 20- Fig 20.16, sheet 29
of 30**



Legend

- Alignment**
- Tunnel
 - Station Locations
 - Project Boundary
- Geographic Split**
- A24 Northwood to Charlemont
- Settlement Contours**
- 1mm
 - 5mm
 - 10mm
 - 15mm
 - 25mm
 - 25mm
 - 30mm
 - 35mm
 - 40mm
 - 45mm
 - 50mm
 - 60mm
 - 70mm
 - 80mm
 - 90mm
 - 100mm
 - 110mm
 - 120mm
 - 130mm
 - 140mm
 - 150mm



Proj Ref: 2022	Proj Name: Dublin	Proj Date: 2022	Proj Ref: 2022	Proj Name: Dublin	Proj Date: 2022
----------------	-------------------	-----------------	----------------	-------------------	-----------------

JACOBS
IDOM

TII

METROLINK

Figure 20.16 Settlement Contours
Sheet 26 of 30

Drawing Sheet	Final	DO NOT SCALE
Scale: 1:1000	1:1000	1:1000
Scale: 1:500	1:500	1:500
Scale: 1:250	1:250	1:250

Rev: P02
ML-1-JALEIA-ROUT_XC-DR-Y21146

Vertical Road Authority (VRA) 1994-2022. This drawing is confidential and the copyright in it is owned by VRA. This drawing must not be used without the prior written permission of VRA. Transport Infrastructure Ireland (TII) is an operational name of the National Roads Authority.

Appendix C - Table 14.3: Groundborne Noise from Underground Sources

above is of interest generally in the low frequency range up to 80Hz, and groundborne noise is of interest in a higher frequency range of about 20Hz-500Hz.

Impacts from blasting are discussed in terms of groundborne noise, vibration and also air overpressure. Air overpressure is a short duration rise in pressure above atmospheric pressure followed by a brief dip below which is heard as sound, but may also cause secondary effects by rattling structures such as windows. It is normal practice to measure it in terms of its un-weighted maximum value, expressed in decibels, although because it has predominantly low frequency content, and is not weighted for the low sensitivity of the human ear to low frequencies, the values of air overpressure expressed in decibels are much higher numbers than normally seen in noise assessments.

14.2 Methodology

14.2.1 Appraisal Method for the Assessment of Impacts

14.2.1.1 Groundborne Noise

Groundborne noise from the construction and operation of the proposed Project has the potential to have an adverse effect on sensitive receptors. The main sources of groundborne noise and vibration from the Construction Phase that have the potential for adverse effects would be mechanical excavation, blasting and tunnel boring. The main sources of groundborne noise and vibration during operation would be from rolling stock movement within the tunnels.

The significance of groundborne noise levels arising from underground activity has been determined from the criteria defined in Table 14.2 for residential dwellings. Impact has been considered significant if groundborne noise levels exceed 40 dB $L_{Amax,S}$. This excludes the passage of the TBM, which is short term and transitory and is accordingly assessed with higher thresholds as described below.

Table 14.2: Groundborne Noise from Underground Sources - Threshold of Significant Effects on Residential Building Occupants

Impact Magnitude	Groundborne Noise Level dB ($L_{Amax,S}$) (measured near the centre of any dwelling room on the ground floor)		Significance of Effect
	Activity except TBM	TBM advancement	
Low	35-39	40-44	Not significant
Medium	40-44	44-49	Significant effect
High	45-49	50-54	
Very High	>49	>54	

Note 1: TBM passage is short term and transitory and has been assessed using thresholds 5dB higher as explained below.

In the case of buildings known to be used as reference libraries, lecture theatres, auditoria, theatres, hospitals, churches, schools and similar buildings, the use of which is particularly sensitive to noise or vibration, significant impacts have been deemed to occur if the levels in the Table 14.3 below are exceeded during the periods of their use.

Table 14.3: Groundborne Noise from Underground Sources - Threshold of Significant Effects on Non-Residential Buildings

Building	Level/ Measure (Activity except TBM)	Level/ Measure (TBM advancement)	Commentary
Theatres	25 dB $L_{Amax,S}$	30 dB $L_{Amax,S}$	<i>Human Response:</i> Noticeable to all and disturbing to some during quiet performances.

Building	Level/ Measure (Activity except TBM)	Level/ Measure (TBM advancement)	Commentary
Large Auditoria/Concert Halls	25 dB $L_{Amax,S}$	30 dB $L_{Amax,S}$	<i>Human Response:</i> Noticeable to all and disturbing to some during quiet performances.
Studios	30 dB $L_{Amax,S}$	30 dB $L_{Amax,S}$	<i>Equipment:</i> Noticeable in recordings.
Churches	35 dB $L_{Amax,S}$	40 dB $L_{Amax,S}$	<i>Human Response:</i> Noticeable to all and disturbing to some
Courts, lecture theatres	35 dB $L_{Amax,S}$	40 dB $L_{Amax,S}$	<i>Human Response:</i> Noticeable to all and disturbing to some
Small Auditoria/halls	35 dB $L_{Amax,S}$	40 dB $L_{Amax,S}$	<i>Human Response:</i> Noticeable to all and disturbing to some
Schools Colleges	40 dB $L_{Amax,S}$	45 dB $L_{Amax,S}$	<i>Human Response:</i> Noticeable to all and disturbing to some.
Hospitals, laboratories	40 dB $L_{Amax,S}$	45 dB $L_{Amax,S}$	<i>Human Response:</i> Noticeable to all and disturbing to some.
Libraries	40 dB $L_{Amax,S}$	45 dB $L_{Amax,S}$	<i>Human Response:</i> Noticeable to all and disturbing to some.
Offices	40 dB $L_{Amax,S}$	45 dB $L_{Amax,S}$	<i>Human Response:</i> Noticeable to all and disturbing to some.
Commercial Buildings	45 dB $L_{Amax,S}$	50 dB $L_{Amax,S}$	<i>Human Response:</i> Noticeable to all and disturbing to some.

Note 1: Commercial buildings are defined as buildings used for commercial purposes (e.g. shops, restaurants, manufacturing facilities, which may include small back room offices)

The impact of groundborne noise from the TBM will be transient in nature, as it would progress continuously, at a variable rate depending on conditions at a particular location. It would therefore be within range of any particular location for a very limited duration. Based on experience of the driving of the Dublin Port Tunnel and other major tunnelling projects the implementation of a consultation and public relations programme in advance of the works will allow for a higher threshold of acceptability than is the case for the permanent operating railway. As a result a threshold is proposed for groundborne noise from the passage of a TBM 5dB $L_{Amax,S}$ greater than the thresholds for other sources in Table 14.2 and Table 14.3 is proposed for groundborne noise from the passage of a TBM.

14.2.1.2 Vibration

Groundborne vibration from the construction and operation of the proposed Project has the potential to have an adverse effect on nearby sensitive receptors. The main vibration sources from the Construction Phase that have the potential for annoyance would be blasting, TBM advancement, mechanical excavation, secant piling and diaphragm walling (D-wall). During operation rolling stock movement are a potential source of groundborne vibration.

This assessment of the potential effects from vibration have been based on absolute levels and not a change in level. These are broken down into those relating to building damage, annoyance to people and interference with the use of sensitive laboratory equipment. The level of magnitude between human perceptions and building damage are large, and each has separate assessment criteria.

14.2.1.2.1 Vibration from Blasting

For assessment of vibration from blasting, the metric conventionally used is peak particle velocity (PPV). The Environmental Protection Agency in the 2006 "Guidance Note for Noise in Relation to Scheduled Activities, 2nd Edition" recommends that, to avoid any risk of damage to properties in the vicinity, the vibration levels from blasting should not exceed a peak particle velocity of 12 mm/s as measured at a receiving location when blasting occurs once per week or less. However, when the frequency of

therefore be within range of any particular location for a limited duration. With the implementation of a consultation and public relations programme a higher threshold of acceptability can be achieved than is the case for the permanent operating railway, and a threshold of $1\text{ms}^{-1.75}$ VDV_{day} and $0.5\text{ms}^{-1.75}$ VDV_{night} are proposed for dwellings for the passage of the TBM where exceedance of these thresholds is considered to be significant. For the same reason increases are also proposed for the hospital and education category for the passage of the TBM to thresholds of $0.4\text{ms}^{-1.75}$ VDV_{day} and $0.2\text{ms}^{-1.75}$ VDV_{night}.

14.2.1.2.4 Vibration from Operation

The significance of vibration levels affecting building occupants arising from the operation of the proposed Project has been determined from the criteria defined in Table 14.9, based on the guidance in BS 6472-1:2008.

Table 14.9: Vibration During Operation - Threshold of Significant Effects on building occupants

Impact Magnitude	In the Absence of Appreciable Existing Levels of Vibration		Appreciable Existing Levels of Vibration ⁽¹⁾	Effect according to BS 6472	Significant?
	VDV $\text{ms}^{-1.75}$ Daytime (07:00-23:00)	VDV $\text{ms}^{-1.75}$ Night-time (23:00-07:00)	% Increase in VDV ⁽²⁾		
None	≤ 0.2	< 0.1	< 25	Adverse comment not expected	Not significant
Negligible	$> 0.2 - 0.4$	$> 0.1 - 0.2$	25 – 40%	Low probability of adverse comment	
Low	$> 0.4 - 0.8$	$> 0.2 - 0.4$	$> 40 - 100\%$	Adverse comment possible	
Medium	$> 0.8 - 1.6$	$> 0.4 - 0.8$	$> 100 - 185\%$	Adverse comment probable	Significant
High	> 1.6	> 0.8	$> 185\%$	Adverse comment very likely	

⁽¹⁾ Highest impact category used, daytime or night-time.

⁽²⁾ Where there is an appreciable existing level of vibration and daytime and night-time vibration dose values (VDVs) exceed $0.22\text{ms}^{-1.75}$ and $0.13\text{ms}^{-1.75}$.

The potential for significant effect upon structures has been deemed to occur if the threshold levels given in Table 14.8 were predicted to be exceeded.

14.2.1.2.5 Vibration from Maintenance – Operational Phase

Maintenance of the railway during the operational phase may consist of track-component replacement, signalling and other lineside-equipment maintenance, and rail maintenance including rail grinding (the use of a grinding machine to maintain the rail surface). The need for rail grinding is system-specific, and unforeseeable in its extent and frequency. Some systems need little grinding if there is low propensity for rail corrugation to grow. Others may need it every few weeks. Noise or vibration from rail grinding is normally so infrequent that it is not a significant effect (although it usually takes place at night). Grinding will be managed and mitigated with consultation and good communication with the occupiers of nearby properties.

Rail grinding of underground track is highly beneficial from the point of view of keeping ongoing groundborne noise levels down. When the grinding takes place, there are no effects on the majority of receptors. If grinding were to take place directly beneath laboratories containing sensitive equipment, it would generate measurable vibration. Mitigation includes making sure it is not planned on a night when a critical operation is in progress in a laboratory.

Address (Section AZ4)	Construction - TBM				Construction - Mechanical Excavation				Blasting		Operation			
	L _{ASma} x dB(A)	VC	VDV day	VD V nig ht	L _{ASma} x dB(A)	V C	VD V day	VD V nig ht	Ppv	AO p dB	L _{ASm} ax dB(A)	VC	VDV day	VDV night
26/27 EDEN QUAY DUBLIN 1	40	>VC- A	0.155	0.1 3	16	VC- A	0	0			18	>VC- A	0.002	0.001
29 ABBEY STREET LOWER DUBLIN 1	47	>VC- A	0.231	0.1 95							29	>VC- A	0.005	0.003
110 MARLBOROUGH STREET DUBLIN 1	49	>VC- A	0.251	0.2 11							33	>VC- A	0.007	0.004
26 ABBEY STREET LOWER DUBLIN 1	45	>VC- A	0.208	0.1 75							27	>VC- A	0.004	0.002
25 EDEN QUAY DUBLIN 1	41	>VC- A	0.162	0.1 36	16	VC- A	0	0			21	>VC- A	0.002	0.001
19 EDEN QUAY DUBLIN 1	46	>VC- A	0.213	0.1 79							33	>VC- A	0.007	0.004
15-17 EDEN QUAY DUBLIN 1	46	>VC- A	0.213	0.1 79							33	>VC- A	0.007	0.004
111 MARLBOROUGH STREET DUBLIN 1	49	>VC- A	0.263	0.2 21							34	>VC- A	0.009	0.005
28 EDEN QUAY DUBLIN 1	39	>VC- A	0.144	0.1 21	16	VC- A	0	0			15	>VC- A	0.001	0.001
10/11 O'CONNELL STREET LOWER DUBLIN 1	49	>VC- A	0.257	0.2 16							34	>VC- A	0.008	0.005
35-39 O'CONNELL STREET LOWER DUBLIN 1	47	>VC- A	0.227	0.1 91	16	VC- A	0	0			31	>VC- A	0.006	0.003
30 ABBEY STREET LOWER DUBLIN 1	50	>VC- A	0.272	0.2 29							36	>VC- A	0.009	0.005
24 EDEN QUAY DUBLIN 1	42	>VC- A	0.169	0.1 42							22	>VC- A	0.003	0.002
9 O'CONNELL STREET LOWER DUBLIN 1	47	>VC- A	0.235	0.1 97							31	>VC- A	0.006	0.004
8 O'CONNELL STREET LOWER DUBLIN 1	47	>VC- A	0.224	0.1 89							29	>VC- A	0.005	0.003
32 ABBEY STREET LOWER DUBLIN 1	50	>VC- A	0.279	0.2 34							36	>VC- A	0.01	0.006
31 [REDACTED]	50	>VC- A	0.273	0.2 3							35	>VC- A	0.009	0.005
21 EDEN QUAY DUBLIN 1	44	>VC- A	0.194	0.1 63							29	>VC- A	0.005	0.003