architectus™ Conrad Gargett

Heritage Impact Statement

Proposed invert lowering works at the Geelong Railway Tunnel

Railway Tunnel, Geelong-Colac Line, between Ryrie and Little Myers Streets, Geelong, City of Greater Geelong, Victoria

State heritage place (Victoria)

VHR: H1106

PREPARED FOR V/LINE
APRIL 2024 – REVISION F

Architectus Conrad Gargett acknowledges the rich histories and profound connections Aboriginal and Torres Strait Islander peoples have to Country. We are committed to ensuring their knowledge, voices and values are embedded in our practice.

Front cover: View of down-end portal of Geelong Railway Tunnel
Source: ACG 2023

Contents

Documentation control

REVISION	DESCRIPTION	ISSUE DATE	PREPARED BY	REVIEWED BY
A	HIS – Draft	5 Dec 2023	SM	BL
B	HIS – Draft	15 Dec 2023	SM	BL
C	HIS – HV Permit Application	18 Dec 2023	SM	BL
D	HIS – HV Permit Application Amend	11 Jan 2024	BL	SM
E	HIS – Client Review	27 Mar 2024	SM	BL
F	HIS – HV Permit Application Amend	04 Apr 2024	SM	BL

1.0 Project Overview

1.1 Introduction

This heritage impact statement (HIS) has been commissioned by the V/Line to set out the impacts of the proposed construction works and to accompany a Heritage Permit Application for the *Railway Tunnel* in Greater City of Geelong. The Tunnel Rehabilitation project involves lowering the invert of the existing rail tunnel and the associated track to rehabilitate the tunnel and rectify existing defects and settlement within the tunnel invert which requires ongoing maintenance attention. In addition, the project aims to improve the clearance within the tunnel to future proof for larger trains and allow for freight cars carrying high-cube containers to utilise the line, making the line more attractive and efficient for freight operations. The invert lowering also makes allowance for a future waterproof lining to be installed (which will be delivered by others) within the tunnel.

This heritage impact statement (HIS) has been commissioned by the V/Line to set out the impacts of the proposed construction works and to accompany a Heritage Permit Application for the *Railway Tunnel* in Greater City of Geelong. The Tunnel Rehabilitation project involves

The subject site is listed on the Victorian Heritage Register (VHR: H1106) and this report is prepared to support a Heritage Permit Application under the *Victorian Heritage Act 2017* and seeks approval from Heritage Victoria (HV) which works under the Department of Energy Environment and Climate Action (DEECA).

The proposed development involves construction works and therefore, V/line arranged Pre-lodgement meetings with HV on 26 May and 5 Sep 2023 that also provided support for a heritage permit application pathway for the proposed works. The proposed construction activities on this tunnel rehabilitation project are covered in this HIS.

The proposed development aims to provide confidence, continuity and efficiency to rail services operating on the Geelong to Warrnambool line. The impacts of the proposed development on the heritage values of the place are mitigated and managed with the advice from heritage and engineering experts.

The existing rail infrastructure consists of a single broad-gauge track running between Geelong Station and South Geelong Station on the Warrnambool line. The track is maintained to a Class 2 standard, with varying speed restrictions in certain sections, especially within the tunnel due to the ongoing issues with the existing invert. The tracks are not electrified and serve diesel V'Locity passenger and locomotive-hauled passenger and freight trains. The existing drainage network requires frequent maintenance due to sediment accumulation and poor runoff control. The tunnel itself has historical drainage issues, resulting in mudspots leading to poor track geometry.

FIGURE 1: VIEW OF UP-END PORTAL OF GEELONG RAILWAY TUNNEL (**SOURCE**: ACG 2023)

1.2 Methodology

Site visits were made by ACG heritage team (David Gole) also attended by V/line team. ACG Heritage have been involved in regular feedback sessions with the V/line team on heritage issues.

This HIS has reviewed the proposed works at final design (FD) stage on the heritage place and the impacts on the heritage values requiring assessment in accordance with pre-lodgement guideline/advice from Heritage Victoria (HV), assessment against sections 101(2) and 101(3) of the *Heritage Act 2017* and in response to the VHR criteria of significance. This HIS has been prepared in accordance with the principles of the *Burra Charter, 2013*.

1.3 Program of Works

The project works is being staged to suit track occupation timetable with the following program current as on 16 February 2024 with the program subject to change to operational requirements.

Occupation	Timeframe	Proposed Works/Sequence	Comment
January - March	January - March	Commence service relocation in tunnel New signal trunking installed (seq 1) - permit granted.	Heritage permit application P39206 has been granted by HV in Jan 2024
June - August	June - August	Old signal trunking to be removed (seq 1) - permit granted	
Enabling Occupation WPD – Geelong to Warrnambool	June/August 2024	**Sequence 2:** Down-end portal retaining works. **Sequence 3 (Early works):** - Rock bolting inside tunnel - Refuge strengthening works **Sequence 4:** Up-end portal retaining works. **Sequence 5:** Test section of invert lowering works.	This updated HIS covers these works and will become part of amendments to an existing Heritage Permit Application (P39170)
Main Occupation	2025-2027	**Sequence 5:** main lowering works	Updated HIS covers the phase of main lowering works in clay/sand sections of the tunnel and will become part of amendments to an existing Heritage Permit Application (P39170) IFC drawing will be submitted to HV when complete, as a HV condition of the Permit Application.

1.4 Approvals

This HIS seeks to have the proposed works approved in sequence order (if required) to enable works to be undertaken within the prescribed track occupation timeframes and to mitigate construction delays.

1.5 Planning information

The subject site is entered on the Victorian Heritage Register, called *'Railway Tunnel'* (VHR: H1106); and all elements are subject to the provisions of the *Victorian Heritage Act 2017* (see Figure 2 and Figure 3). Development is regulated to avoid or minimise the loss of cultural heritage significance. Assessment of proposed works is required as it involves building works on the heritage place. The significance of heritage place is listed on the State Heritage Register and a discussion of key heritage values are listed in this report.

The subject site is also included on the local heritage register (HO144) of Greater Geelong, however the development on site is regulated by the provisions of the *Victorian Heritage Act 2017* as the place is listed on the Victorian Heritage Register (VHR).

This application is made on behalf of V/line and is development by the State.

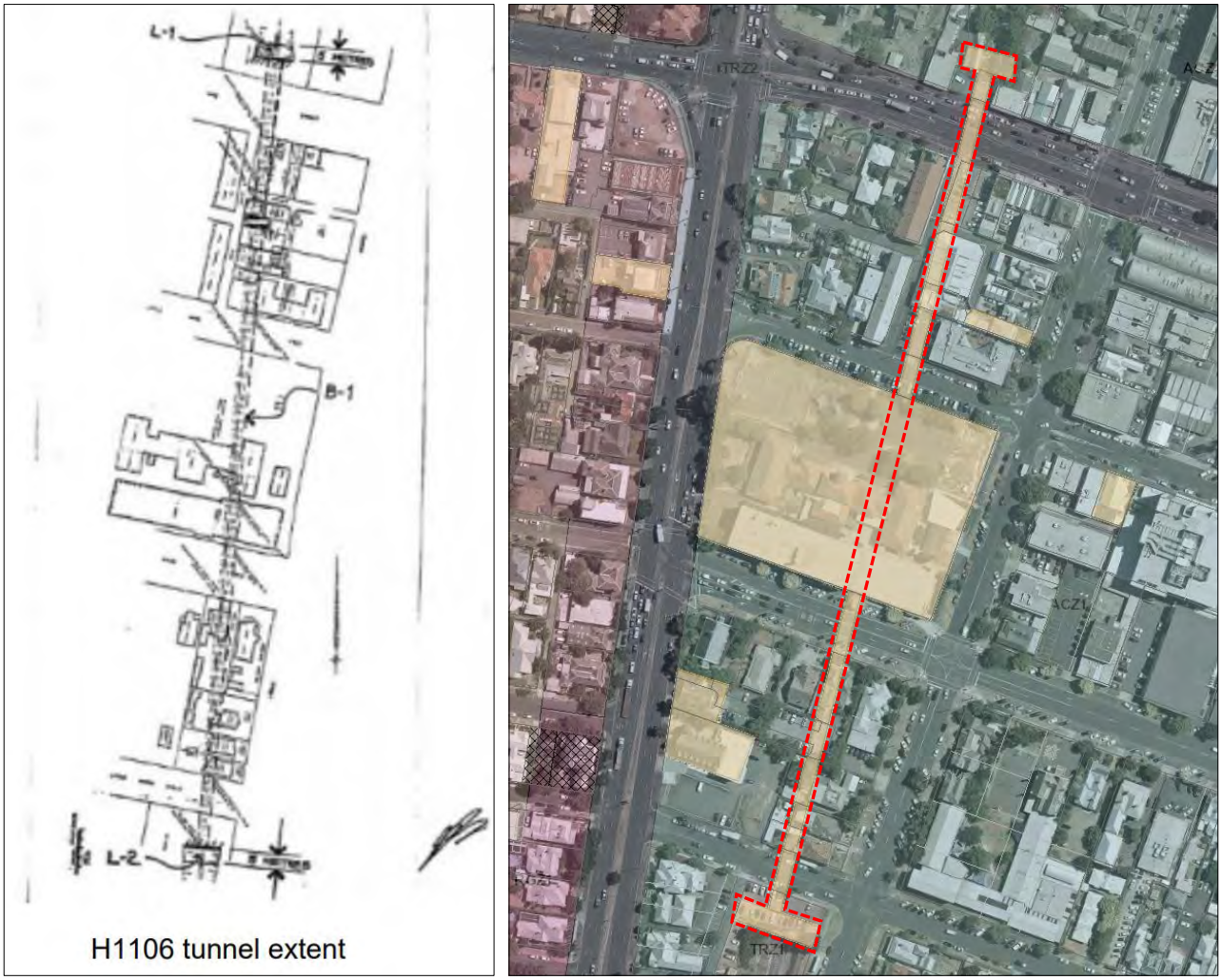


FIGURE 2 (LHS): MAP SHOWING THE TUNNEL FEATURES (TUNNEL – B1, PORTALS AND 5M AREA INFRONT OF NORTH AND SOUTH PORTALS – L1 AND L2) INCLUDED IN THE STATE EXTENT OF HERITAGE REGISTRATION. (**SOURCE**: VH)
FIGURE 3 (RHS): AERIAL PHOTO SHOWING EXTENT OF RAILWAY TUNNEL – DASHED RED OUTLINE. (**SOURCE**: VICPLAN)

PS map ref	Heritage place	External paint controls apply?	Internal alteration controls apply?	Tree controls apply?	Solar energy system controls apply?	Outbuildings or fences not exempt under Clause 43.01-4	Included on the Victorian Heritage Register under the Heritage Act 2017?	Prohibited uses permitted?	Aboriginal heritage place?
HO144	Railway Tunnel (Geelong-Colac Line) Ryrie Street & Little Myers Street (between), Geelong	-	-	-	-	-	Yes Ref No.H1106	No	No

FIGURE 4: TABLE SHOWING RAILWAY TUNNEL INCLUDED IN LOCAL HERITAGE REGISTER (HO144) OF GREATER GEELONG. (**SOURCE**: VICPLAN)

2.0 Understanding the heritage place

2.1 Brief history and description

The following history of *Railway Tunnel* is taken from the VHR entry:

> *History*
> *The railway tunnel in Geelong was built between 1874 and 1875 by Overend and Robb, along the Geelong-Colac line. It is 426m long and constructed of bluestone and brick laid in the classic horseshoe shape.*

FIGURE 5: CIRCA 1930 PHOTOS SHOWING A2 845 EXITS THE GEELONG TUNNEL ON AN UP PORT FAIRY PASS. (**SOURCE**: VICTORIANRAILWAYS.NET)

FIGURE 6: UNDATED PHOTOS TAKEN FROM THE PLATFORM AT GEELONG LOOKING SOUTH TOWARDS THE TUNNEL. THE SIGNALBOX ON THE RIGHT WAS GEELONG B BOX (**SOURCE**: VICTORIANRAILWAYS.NET)

2.2 Statement of significance

The following criteria of significance for *Railway Tunnel* are taken from the VHR entry:

> *The railway tunnel in Geelong was built between 1874 and 1875 by Overend and Robb, along the Geelong-Colac line. It is 426m long and constructed of bluestone and brick laid in the classic horseshoe shape.*
>
> *The Railway Tunnel, Geelong is of architectural and historic value to Victoria.*
>
> *The tunnel is of architectural importance as a unique example of an early railway tunnel constructed in an urban environment in the 19th century that was also the longest in the state of Victoria, until the construction of the Melbourne underground loop. The structure demonstrates an historical association with the important expansion of the rail network in the 1870s that connected the Western District with the main lines.*
>
> *The railway tunnel in Geelong is a representative example of construction technology in accordance with 19th century railway engineering guidelines.*

Cultural Heritage Significance	
Criterion A Importance to the course, or pattern, of Victoria's cultural history	
Criterion B Possession of uncommon, rare or endangered aspects of Victoria's cultural history.	
Criterion C Potential to yield information that will contribute to an understanding of Victoria's cultural history	
Criterion D Importance in demonstrating the principal characteristics of a class of cultural places and objects.	
Criterion E Importance in exhibiting particular aesthetic characteristics.	
Criterion F Importance in demonstrating a high degree of creative or technical achievement at a particular period.	
Criterion G Strong or special association with a particular present-day community or cultural group for social, cultural or spiritual reasons.	
Criterion H Special association with the life or works of a person, or group of persons, of importance in Victoria's history.	

2.3 Schedule of significant elements

The following schedule of significant elements of *Railway Tunnel* is extracted from the VHR entry.

Significant elements
– *Portals* – *Tunnel linings in whole length of tunnel* – *5m area in front of both portals*

2.4 Condition and integrity

Existing tunnel is functional with restricted speed limit. Externally the portals on up and down ends of the tunnel remain largely intact, well maintained and is easily recognisable as the original 1875 design (see Figure 7 and Figure 9). Internally the tunnel is lined with bricks and shotcrete and appears largely intact with evidence of poor drainage (see Figure 13 and Figure 16) Observations during site visit indicate that periodic maintenance works have been implemented in the tunnel. Overall the tunnel and relevant railway track lacks current compliance requirements. Some major observations are listed below:

- Original brickwork invert deteriorating and reaching end of life
- Poor drainage resulting in mudspots.
- Water ingress is identified in multiple locations in the brick lining, with significant water ingress in multiple locations.
- Inadequate kinematic envelope for freight.
- Increasing maintenance costs
- The first 125 m of tunnel is in very poor condition. The tunnel is now in a situation where closure could occur at any moment and remedial works are urgently required.
- There is no sign of movement of the tunnel lining impacting the integrity of the tunnel structure.
- Tunnel brick lining in acceptable condition, with occasional missing bricks, typically in the crown
- 1995 shotcrete in good condition with localised historic cracks. There is no sign of movement of the tunnel lining impacting the integrity of the tunnel structure. Weep holes evident allowing water seepage.
- Existing services installations in the tunnel and at portal approaches are in poor condition.

The tunnel is generally in a fair condition however, building fabric and rail infrastructure within the tunnel are aged and require refurbishment/upgrade to meet V/Line's future intent with the tunnel as detailed in V/Line's Concept Design.

2.5 Photographic Survey

FIGURE 7: VIEW OF UP-END PORTAL OF GEELONG RAILWAY TUNNEL. (**SOURCE**: ACG)

FIGURE 8: VIEWS OF LHS AND RHS APPROACHES AND THEIR INTERFACE WITH THE UP-END PORTAL. (**SOURCE**: ACG)

FIGURE 9: VIEW OF APPROACHES AND PORTAL AT DOWN-END SIDE. (**SOURCE**: ACG)

FIGURE 10: VIEWS SHOWING INTERFACE OF APPROACHES WITH DOWN-END PORTAL. (**SOURCE**: ACG)

FIGURE 11 (LHS): VIEW OF DAMAGED BRICKS ON DOWN-END PORTAL. (**SOURCE**: ACG)
FIGURE 12 (RHS): VIEW OF UP-END PORTAL SHOWING DEGRADED MORTAR AND GRAFFITI. (**SOURCE**: ACG)

FIGURE 13: INTERNAL VIEW OF TUNNEL SHOWING CONDITION OF BRICK LINING, TRACK AND SERVICES – LOOKING SOUTH. (**SOURCE**: ACG)

FIGURE 14: INTERNAL VIEW OF TUNNEL SHOWING CONDITION OF RELATIVELY RECENT SHOTCRETE – LOOKING SOUTH. (**SOURCE**: ACG)
NOTE: TUNNEL STRUCTURAL DESIGN REPORT MENTIONED THIS SHOTCRETE ON WALLS AND PUMPING GROUT BEHIND LINING TO FILL VOIDS WAS DONE IN 1995.

FIGURE 15: INTERNAL VIEW OF TUNNEL SHOWING CONDITION OF BRICK LINING, TRACK AND SERVICES – LOOKING SOUTH. (**SOURCE**: ACG)
NOTE: TUNNEL STRUCTURAL DESIGN REPORT MENTIONED THIS SHOTCRETE ON WALLS AND PUMPING GROUT BEHIND LINING TO FILL VOIDS WAS DONE IN 1995.

FIGURE 16: INTERNAL VIEWS SHOWING CONDITION OF REFUGES. (**SOURCE**: ACG)

3.0 The proposal

3.1 Scope of invert lowering works

3.1.1 Generally

The scope of the proposed works includes:

- DEMOLITION AND ADDITIONAL HOLES
    - Brick Invert: All brick invert to be removed (see Figure 17 and Figure 18);
    - Breather holes: 30-40mm diameter breather / inspection holes above rock bolting
    - Additional holes to facilitate construction works: To facilitate construction works within the tunnel, additional holes to be drilled into the brickwork of the tunnel for installation of lights, power, fans signage etc.
- DRAINAGE:
    - New drainage system will be integrated within the new concrete invert. This drainage system will divert water away from the tunnel.

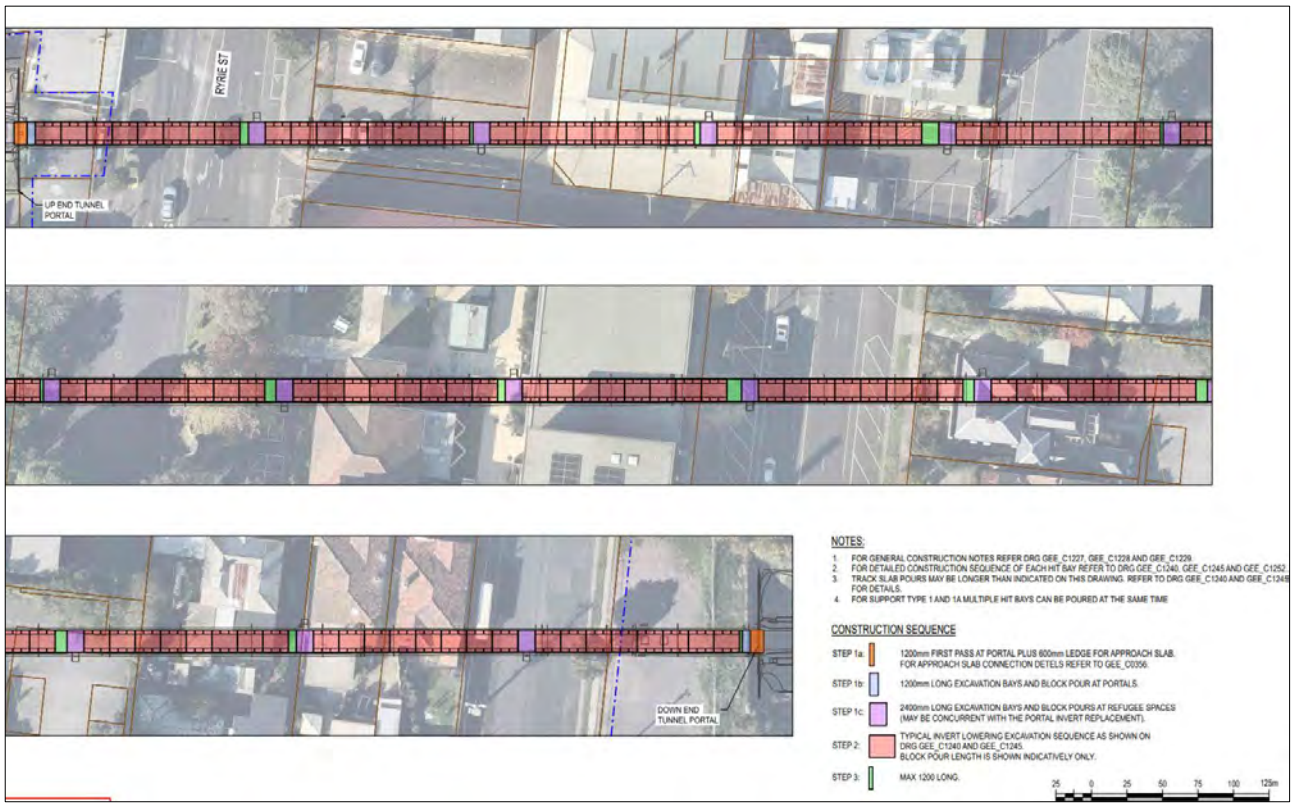


FIGURE 17: PLAN SHOWING CONSTRUCTION SEQUENCE. (**SOURCE**: AURECON/VLINE)

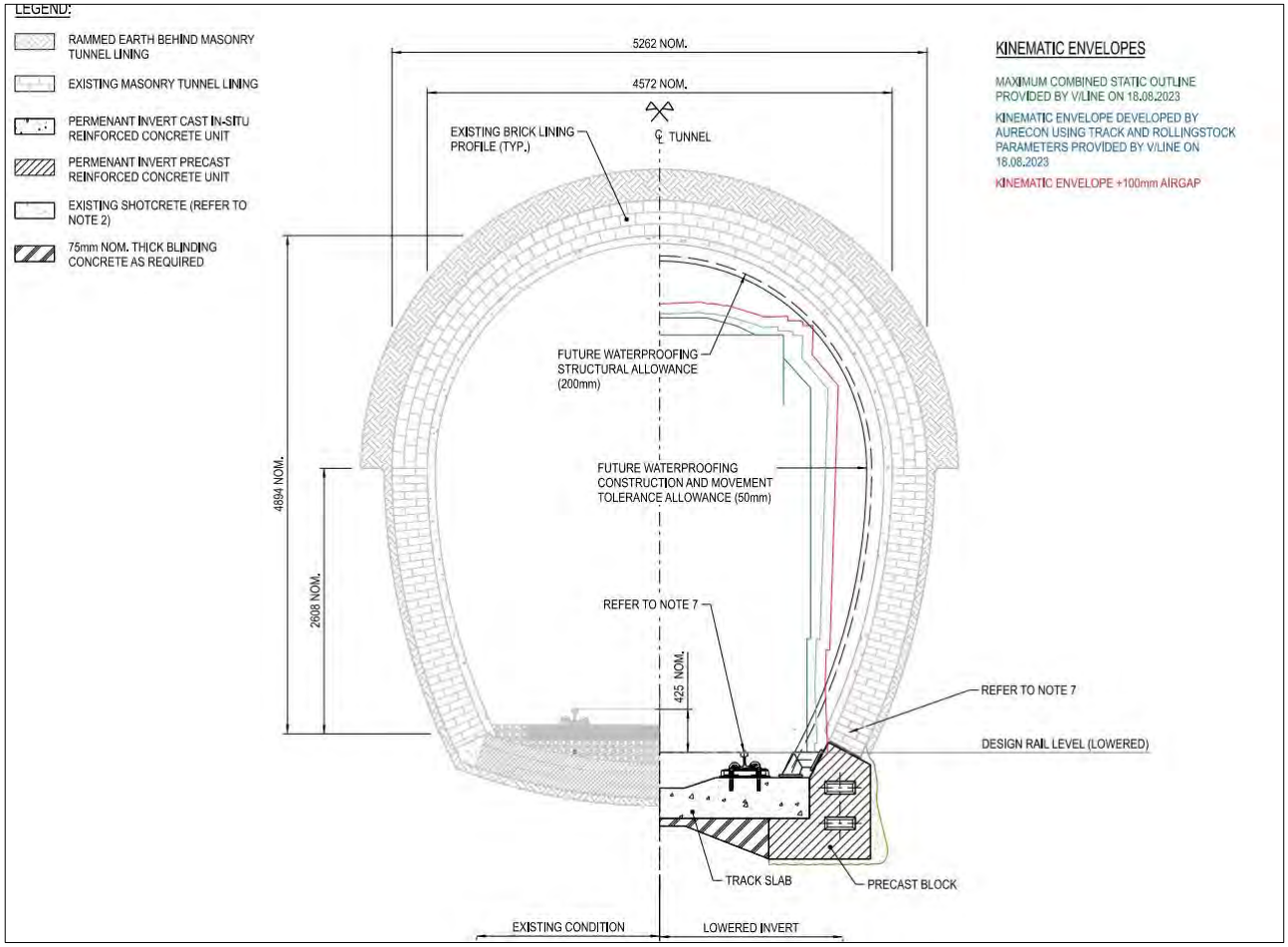


FIGURE 18: TYPICAL CROSS SECTION SHOWING EXISTING PROFILE (LHS) AND PROPOSED MINIMUM INTERNAL PROFILE REQUIREMENTS (RHS). (**SOURCE**: AURECON/VLINE)

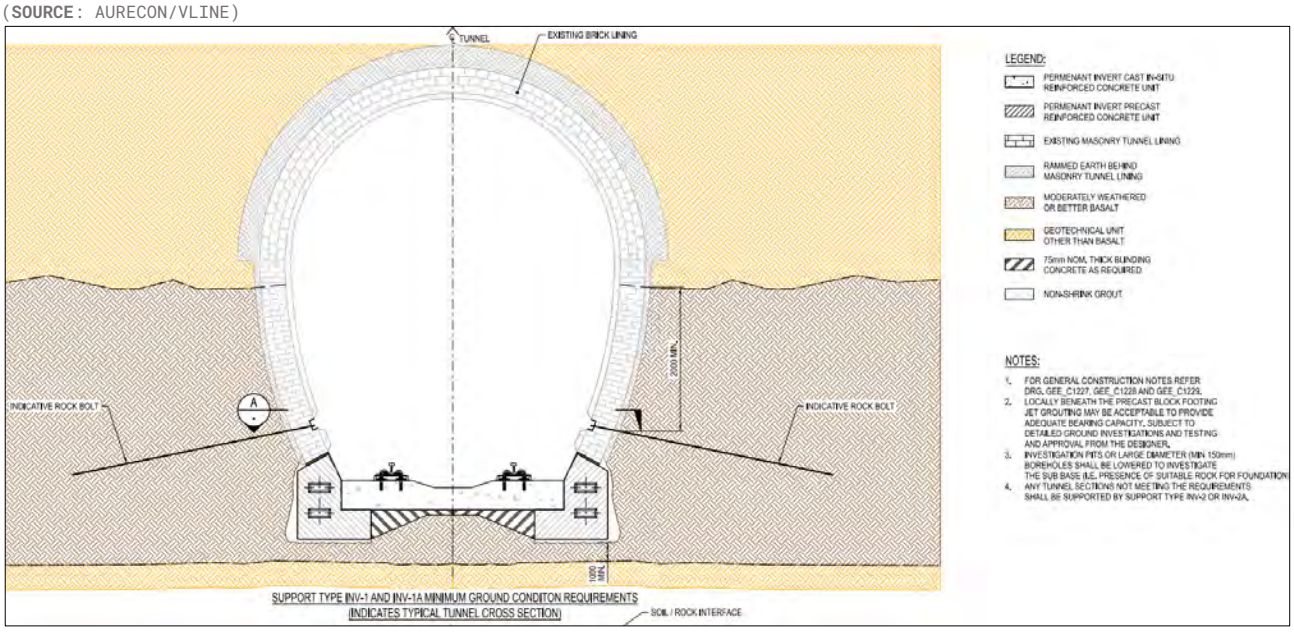


FIGURE 19: TYPICAL CROSS SECTION THROUGH TUNNEL LINING. (**SOURCE**: AURECON/VLINE)
NOTE FOR PFC INSTALLATION AND ROCK BOLT SUPPORT TO TUNNEL LINING REFER **SECTION 3.1.4.**

3.1.2 Sequence 1 - Service Relocation

Note: Heritage permit application (P39206) to cover service relocation works has been approved by HV in Jan 2024

3.1.3 Sequence 2 – Down end portal retaining works

- Existing brick retaining walls near portal and interface of approached with the portal retained (see Figure 9 and Figure 26);
- Install sheet piles adjacent to existing brick portal (see Figure 20);
- Where required remove shotcrete and regrade slopes;
- Install soil nails and apply geotextile with seeded topsoil (see Figure 21 and Figure 25);
- Excavate to nominated levels in front of sheet pile retaining (see Figure 21 and Figure 22);
- Install new trackbed, drainage and ballast at new lower level (see Figure 23 - Figure 25).

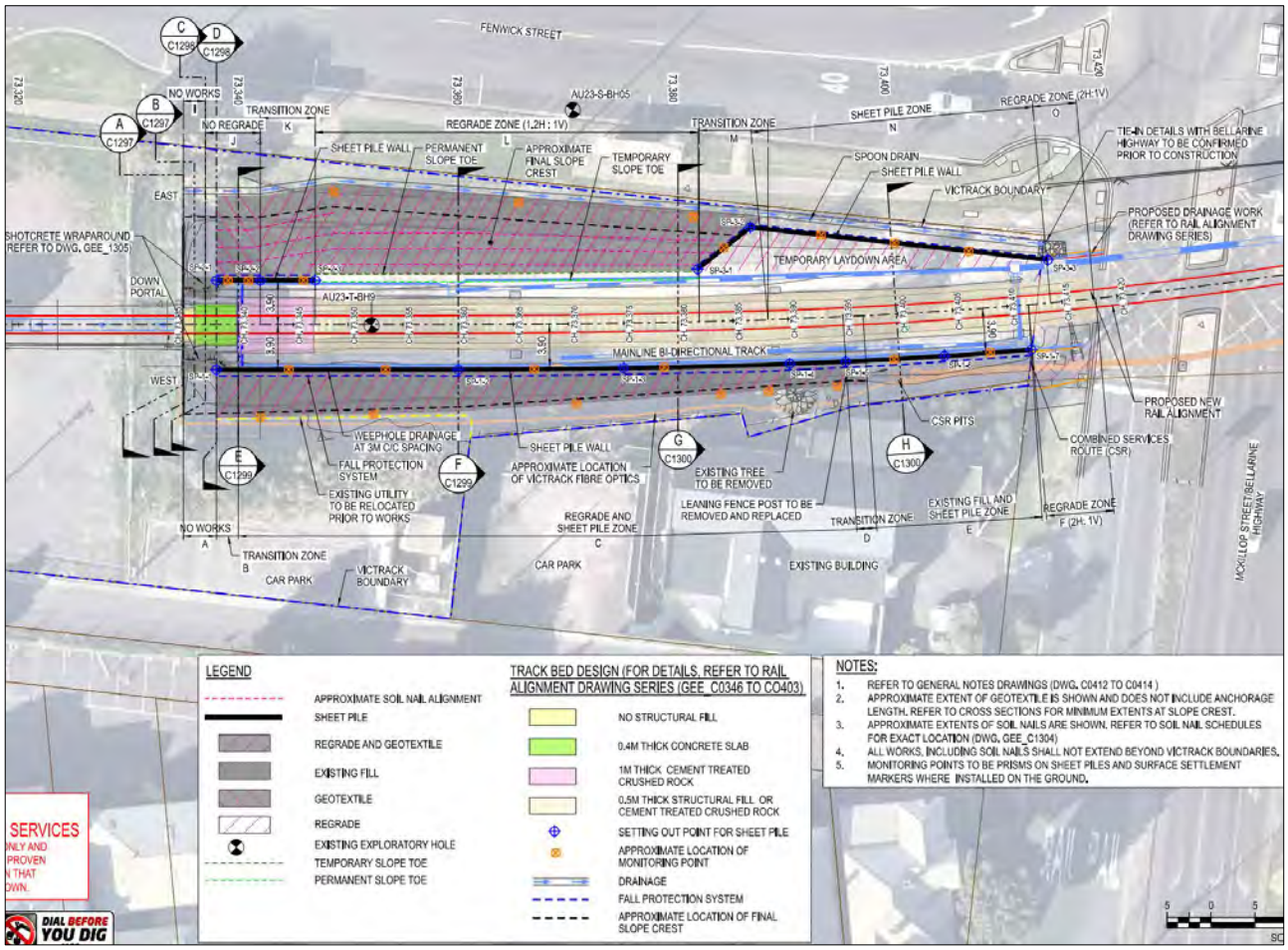


FIGURE 20: PLAN SHOWING RETAINING WORKS AT DOWN END PORTAL. (SOURCE: AURECON/VLINE)

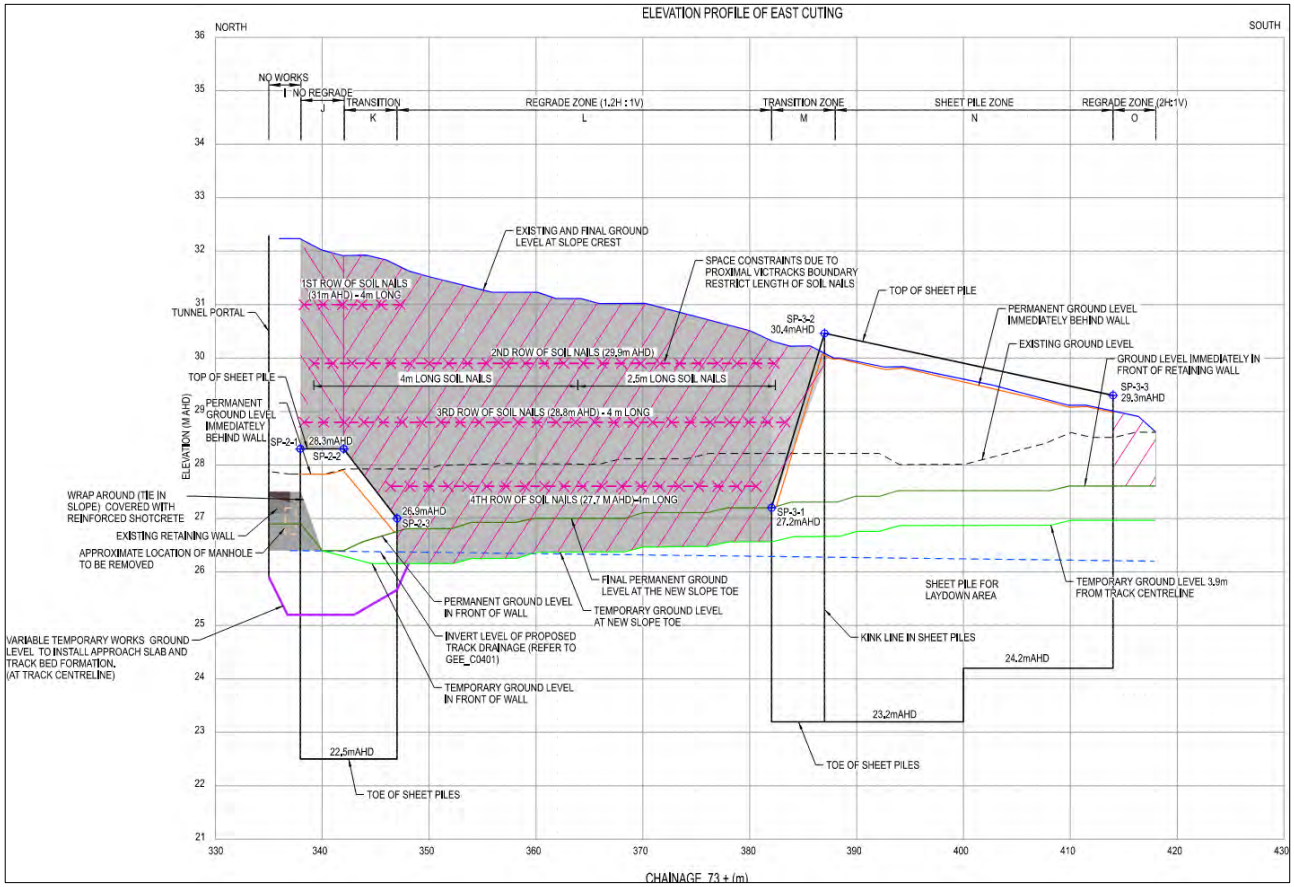


FIGURE 21: ELEVATION SHOWING RETAINING WORKS ON EAST APPROACH AT DOWN END PORTAL. (SOURCE: AURECON/VLINE)

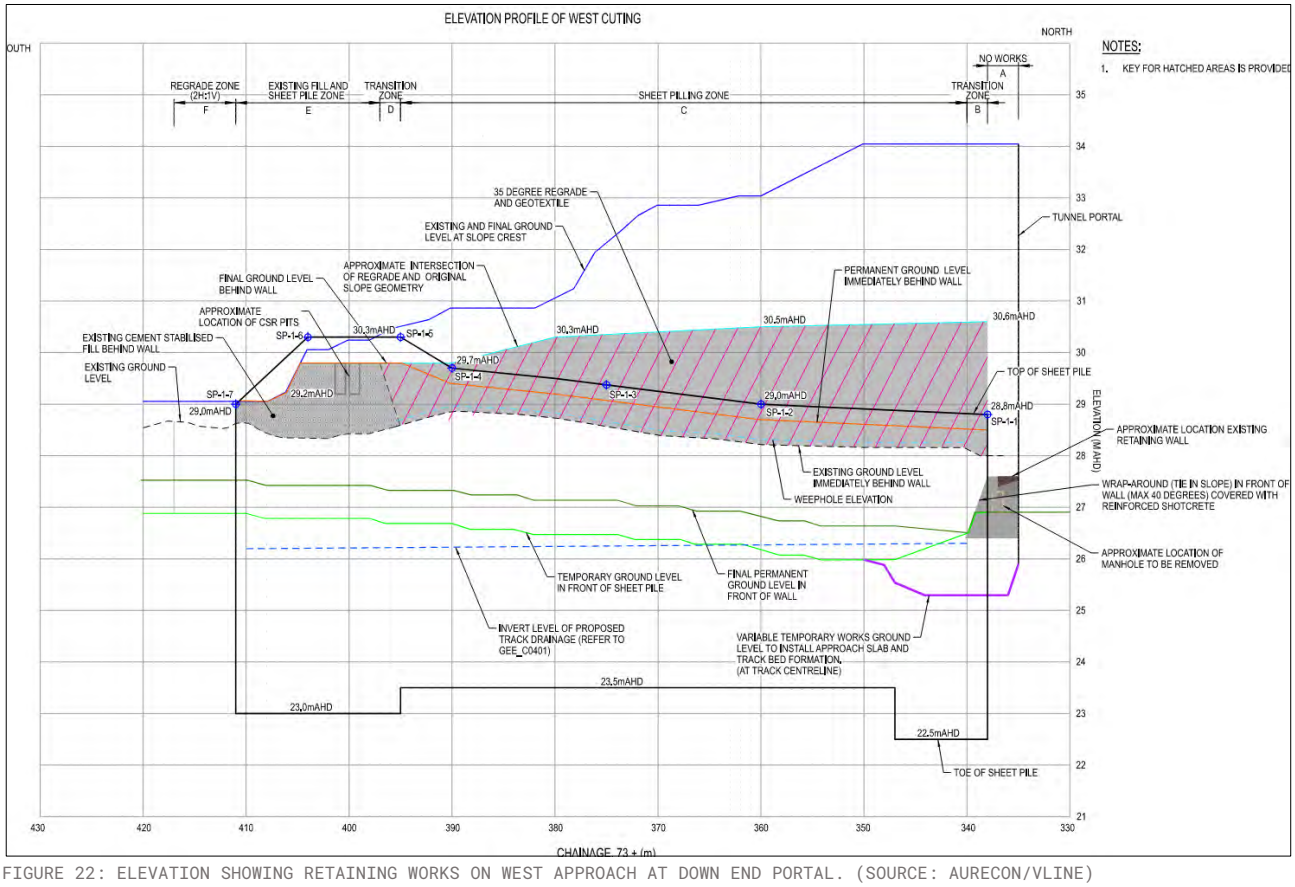


FIGURE 22: ELEVATION SHOWING RETAINING WORKS ON WEST APPROACH AT DOWN END PORTAL. (SOURCE: AURECON/VLINE)

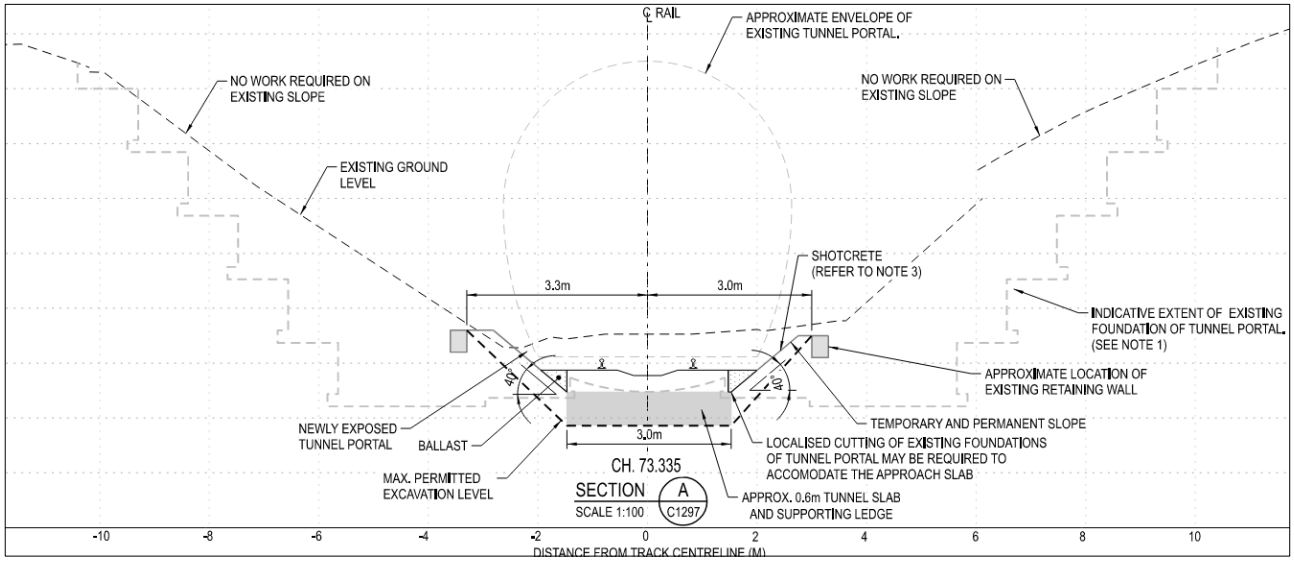


FIGURE 23: TYPICAL SECTION AT CH. 73.335 SHOWING RETAINING WORKS AT DOWN-END PORTAL (SOURCE: AURECON/VLINE)

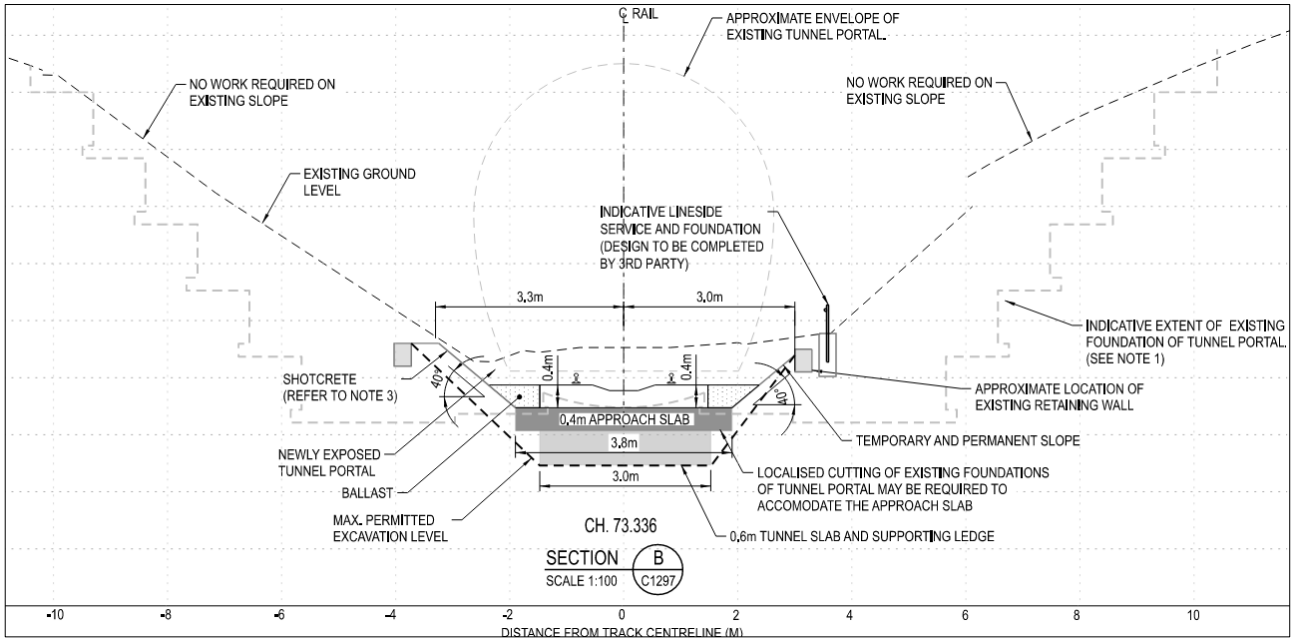


FIGURE 24: TYPICAL SECTION AT CH. 73.336 SHOWING RETAINING WORKS AT DOWN-END PORTAL (SOURCE: AURECON/VLINE)

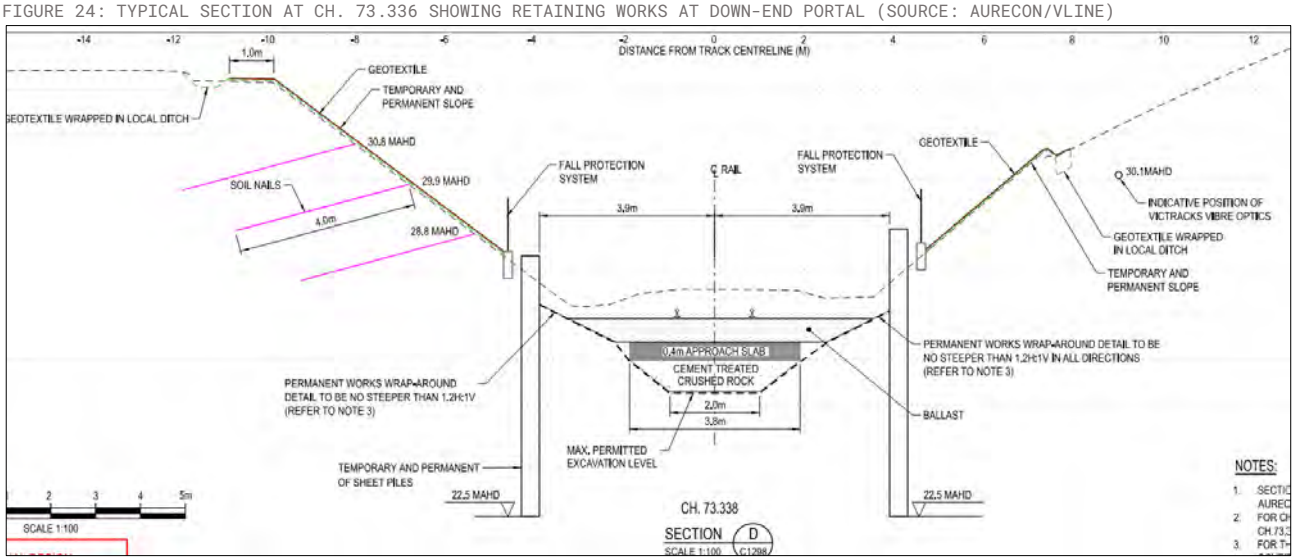


FIGURE 25: TYPICAL SECTION AT CH. 73.338 SHOWING RETAINING WORKS AT DOWN-END PORTAL (SOURCE: AURECON/VLINE)

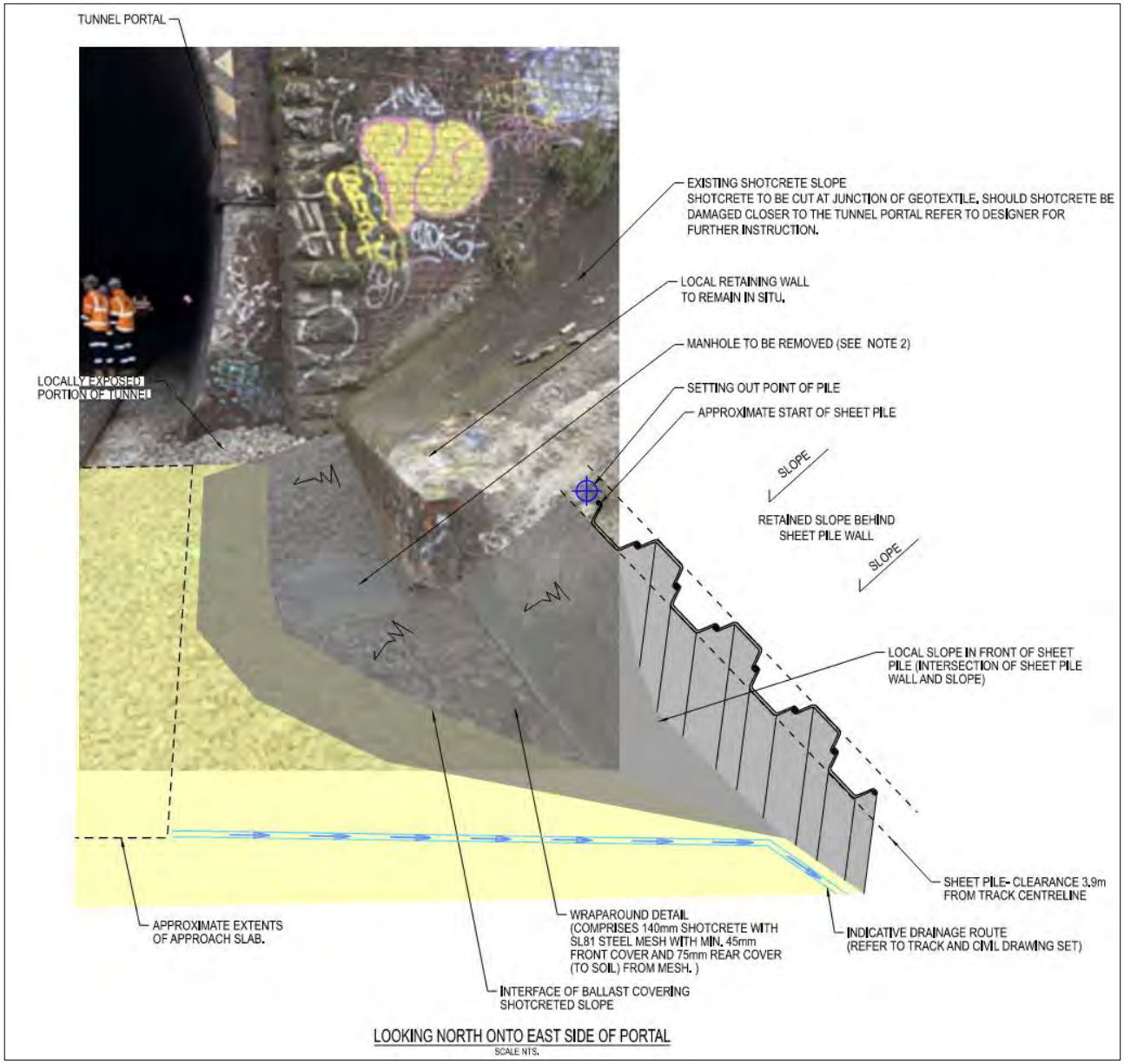


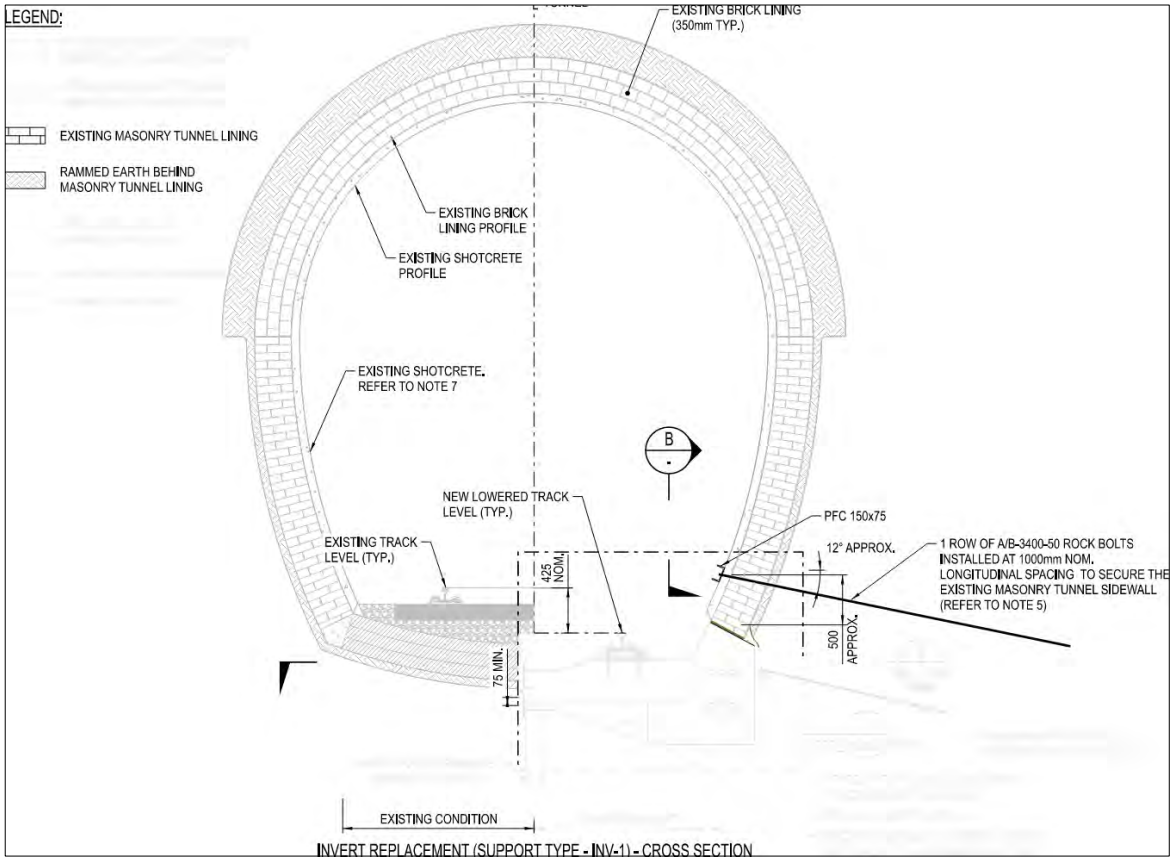
FIGURE 26: PHOTO OVERLAY SHOWING RETAINING WORKS AT TUNNEL PORTAL INTERFACE, DOWN-END PORTAL (SOURCE: AURECON/VLINE)

FIGURE 27: EXISTING VIEW OF DOWN END PORTAL (**SOURCE**: ACG)

FIGURE 28: 3D VISUALISATION SHOWING THE DOWN-END PORTAL AFTER COMPLETION OF RETAINING WORKS (**SOURCE:** ACG IMAGE)

3.1.4 Sequence 3 - PFC and rock bolt installation

- Install rock bolts through existing brickwork and PFC (150x75) on the inner face of the brickwork (see Figure 29);
- 1 row of a/b-3400-50 rock bolt installed at 1000mm nom. longitudinal spacing to secure the existing masonry tunnel sidewall.
- After invert lowering construction is complete, the PFC is removed and replaced with large galvanised washer.
- Drainage: 20mm to 50mm diameter weep holes shall be drilled through the existing concrete / brick masonry within the tunnel lining (see Figure 30).
- horizontal drainage pipes are to be installed into moorabool viaduct sands. Horizontal pipes to be installed from portal face, longitudinal to lowered invert level (see Figure 30).



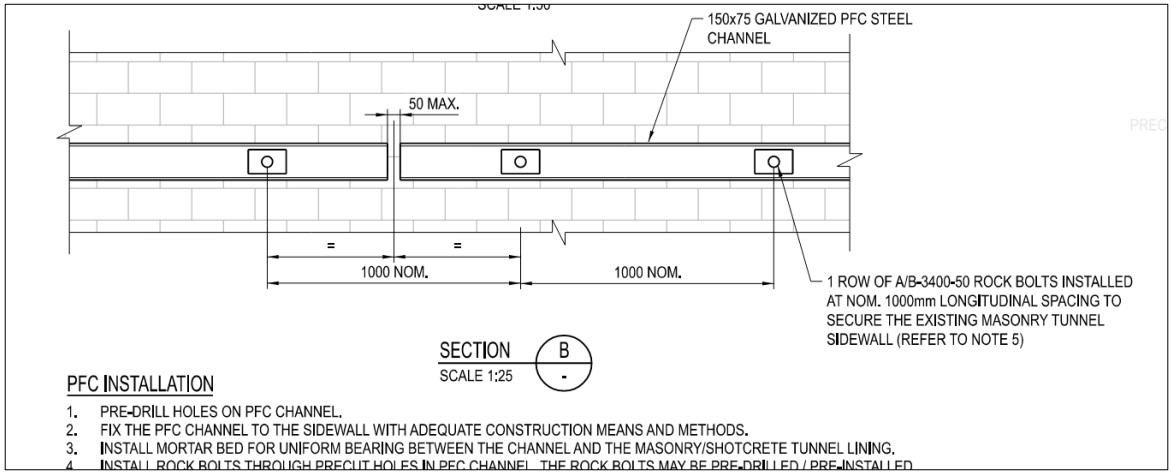


FIGURE 29: TYPE INV-1 CROSS SECTION OF TUNNEL (TOP) AND ELEVATION (BOTTOM) DEAILS SHOWING PFC INSTALLATION AND ROCK BOLT SUPPORT TO TUNNEL LINING. **(SOURCE: AURECON/VLINE)**

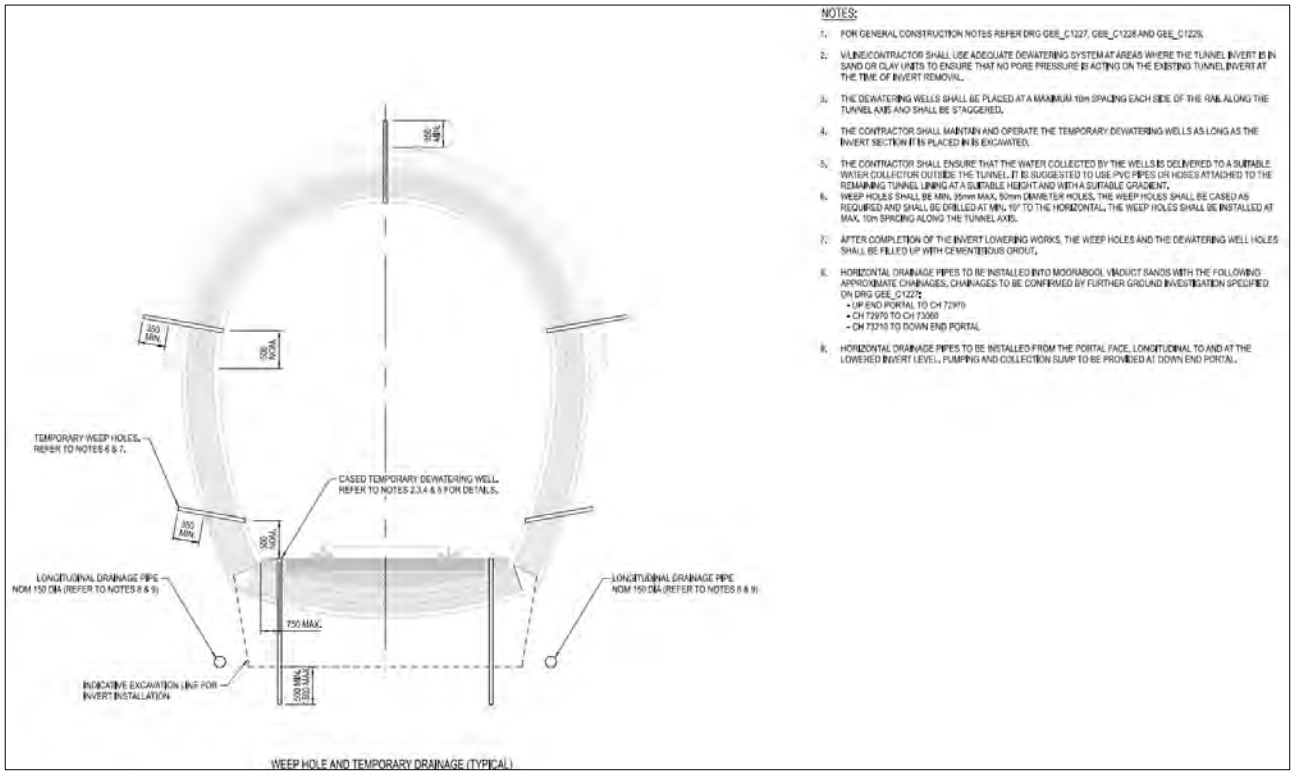


FIGURE 30: TYPICAL CROSS SECTION OF TUNNEL SHOWING WEEP HOLES AND TEMPORARY DRAINAGE SUPPORTING INVERT LOWERING WORKS. (SOURCE: AURECON/VLINE)

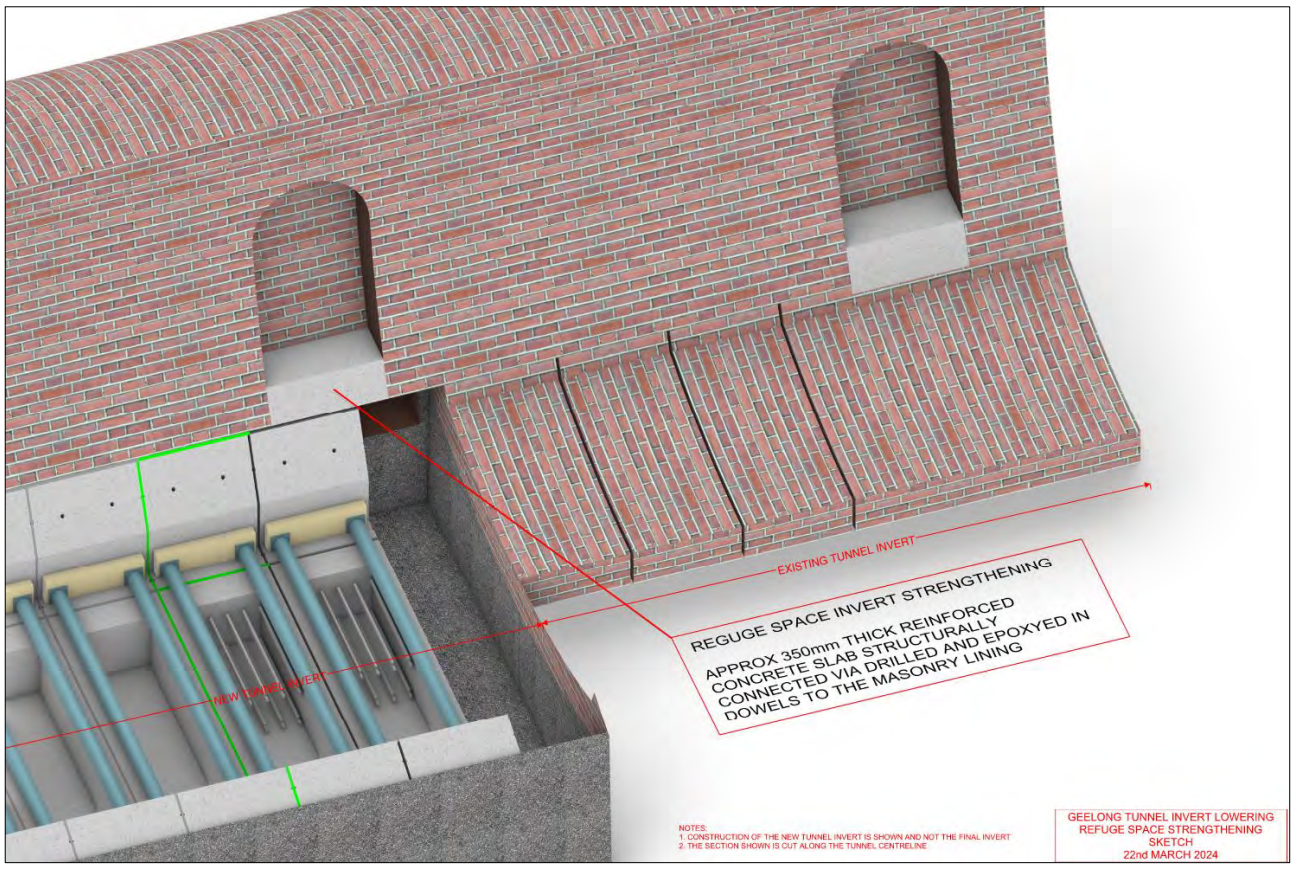


FIGURE 31: 3D SKETCH SHOWING THE REGUGE STRENGTHENING WORKS. (SOURCE: AURECON/VLINE)

3.1.5 Sequence 4 - Up end portal retaining works

- Install new retaining wall (bored piles 750mm dia) on both sides of approaches adjacent to existing brick portal. Piles spacing is 2000mm on east and 1500 mm typical on west sides (see Figure 32);
- New bored pile retaining walls will be spaced about 1800mm clear from portal face (see Figure 32 - Figure 34);
- New bored pile with 150mm shotcrete infill retaining walls will be spaced about 1800mm clear from portal face; (see Figure 33 - Figure 36);
- Where required remove shotcrete and regrade slopes;
- Install Install soil nails and apply 150mm reinforced shotcrete across sloped area where cracked or damaged(see Figure 35 and Figure 36);
- Excavate to nominated levels in front of pile retaining;
- Install new trackbed, drainage and ballast at new lower level.

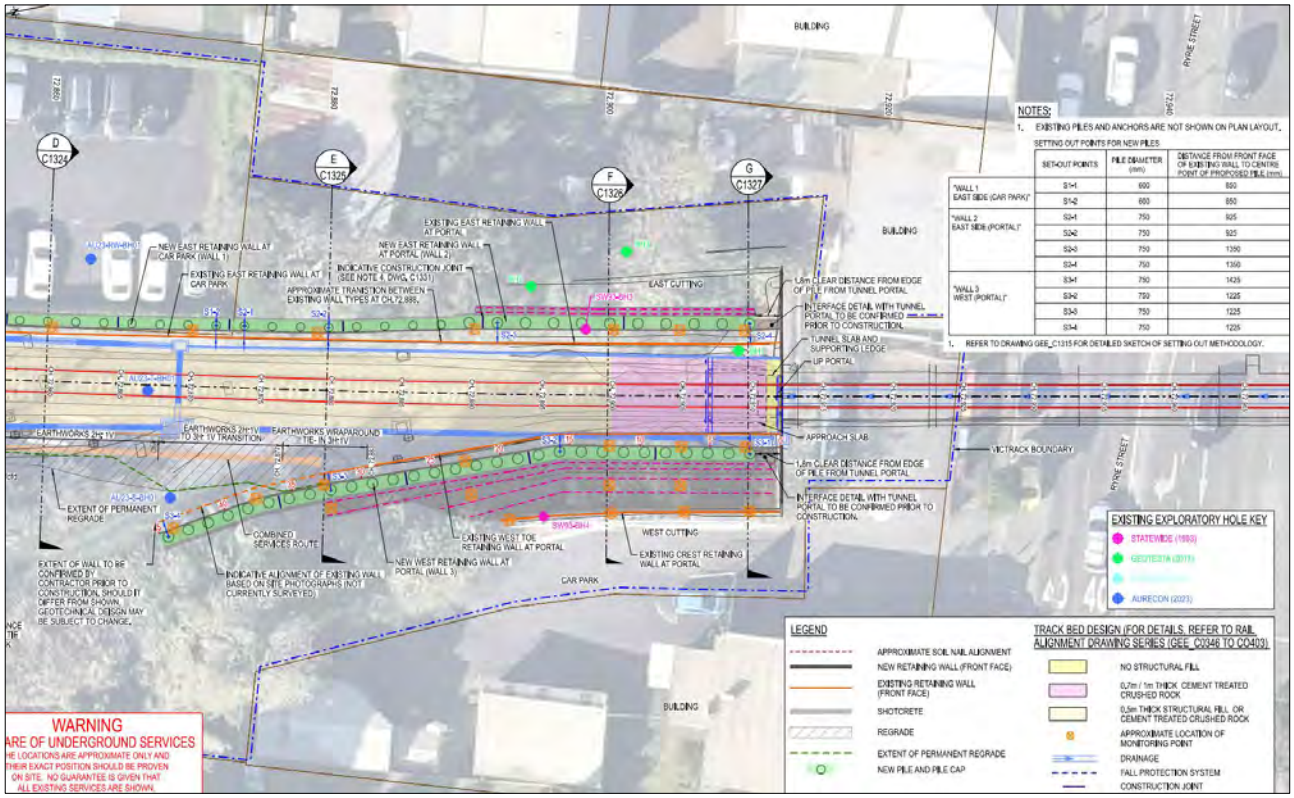


FIGURE 32: PLAN SHOWING RETAINING WORKS AT UP-END PORTAL. (SOURCE: AURECON/VLINE)

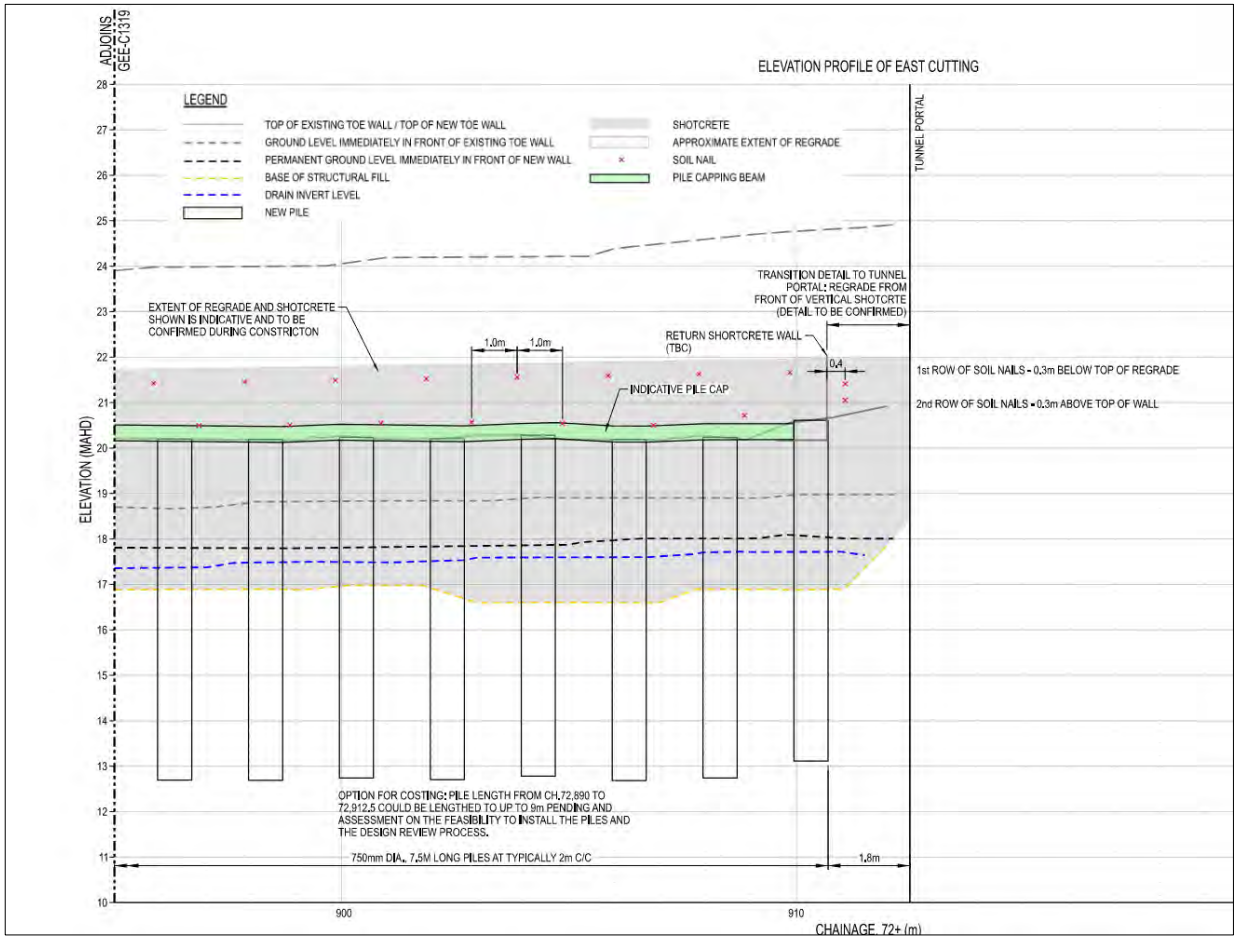


FIGURE 33: ELEVATION SHOWING RETAINING WORKS ON EAST APPROACH AT DOWN END PORTAL. (SOURCE: AURECON/VLINE)

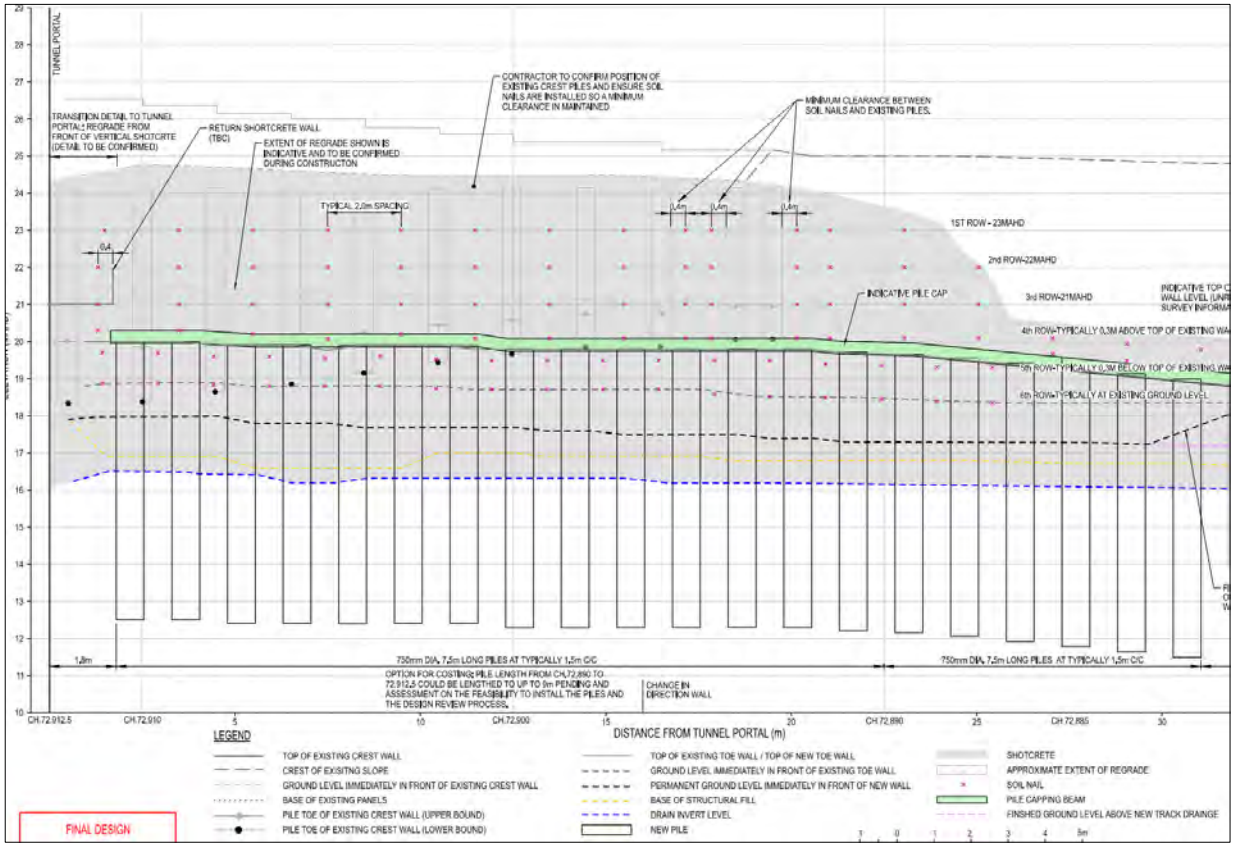


FIGURE 34: ELEVATION SHOWING RETAINING WORKS ON WEST APPROACH AT DOWN END PORTAL. (SOURCE: AURECON/VLINE)

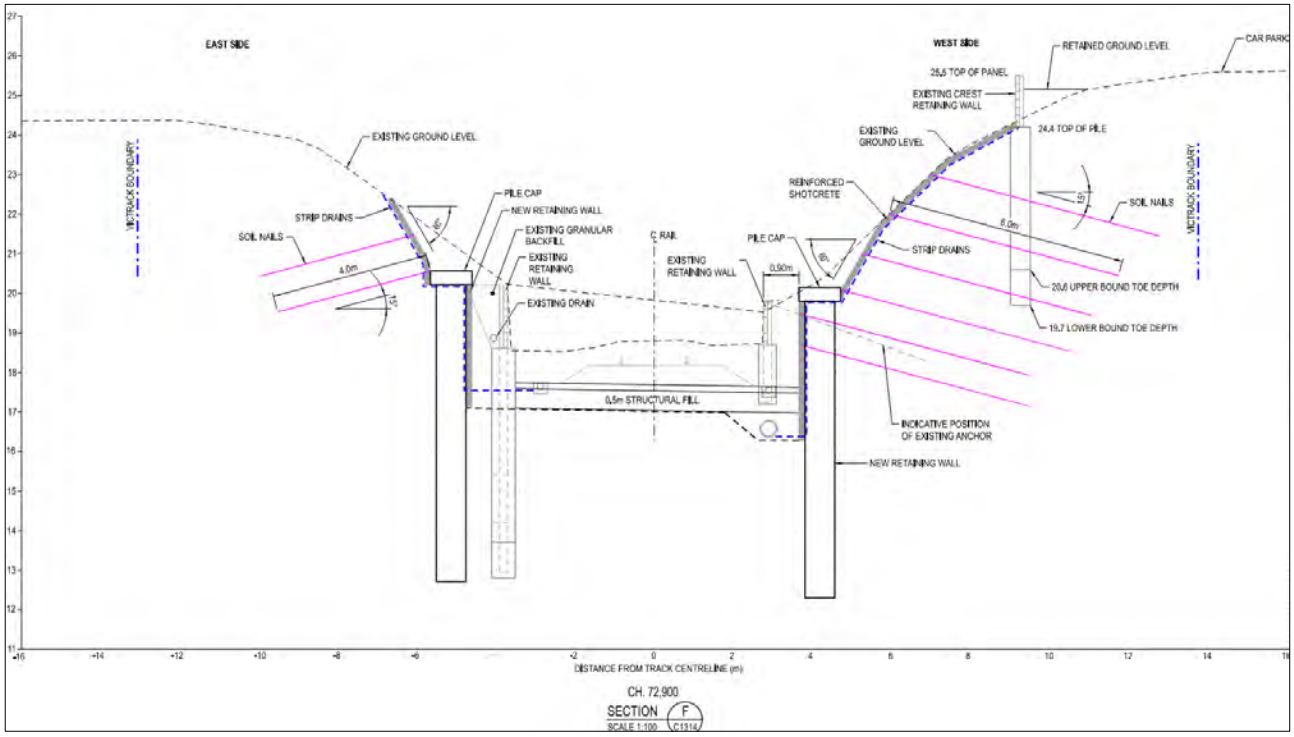


FIGURE 35: TYPICAL SECTION AT CH. 72.900 SHOWING RETAINING WORKS ON APPROCHES AT UP-END PORTAL (SOURCE: AURECON/VLINE)

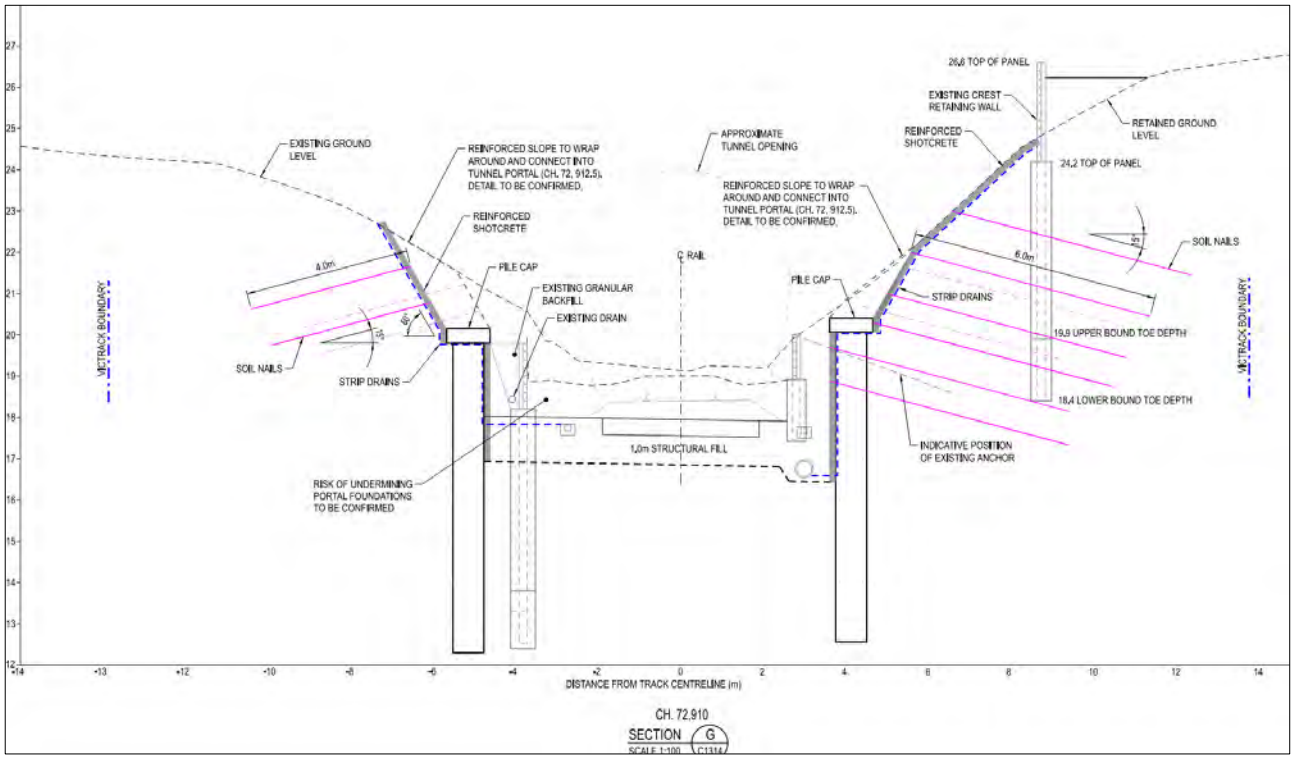


FIGURE 36: TYPICAL SECTION AT CH. 72.910 SHOWING RETAINING WORKS ON APPROCHES AT UP-END PORTAL (SOURCE: AURECON/VLINE)

FIGURE 37: EXISTING UP END PORTAL (**SOURCE:** ACG IMAGE)

FIGURE 38: 3D VISUALISATION SHOWING THE UP-END PORTAL AFTER COMPLETION OF RETAINING WORKS

3.1.6 Sequence 5 – Main Invert lowering works

Following table will summarises the sequence of steps to be followed to install invert replacement type INV-1 in volcanics/rock area and type INV-2 in clay and sand areas of the tunnel. (see Figure 39):

Invert replacement type INV-1 in volcanics area	Invert replacement type INV-2 in clay and sand areas
Step 1 - Test invert lowering works (INV-1) in volcanic/rock areas of the tunnel Step 2 - opening up of invert and sidewalls and installation of sidewall precast units at max. 3600mm length (see Figure 40). Note: The sidewall shall be fully supported by the precast reinforced concrete lining units on both sides before opening up the adjacent sidewall section. Grout strength shall be minimum 12mpa. Step 3 - once all grout has attained the required strength (12 mpa) excavate adjacent sidewall hit 'bite' by repeating step 2; Step 4 - install the permanent invert cast in situ reinforced concrete (see Figure 41); Step 5 - following completion of the invert replacement and the cast in situ concrete reaching 12mpa. remove the PFC sections, install a large washer on rock bolt heads. Note on Tunnel lining contingency and temporary support: The contingency measures may be required at areas where the existing invert is in place or the invert is excavated out or the new invert partially or fully installed (see Section 0 below)	Step 1 - Test invert lowering works (INV-2) in clay and sandy areas of the tunnel. Step 2 - install the permanent invert (see Figure 43 and Figure 44): Brief summary of the Sequential construction methodology to install invert (clay): o Excavation of max.1600 mm to allow for installation of a single 900mm wide precast base segments which consists of (2 x sidewall kerb units + 1 x central 'bathtub' precast units). o Precast kerb sidewall units installed underneath both walls. Levelled accordingly. o Temporary props (acro or similar) installed between precast kerb sidewall units to allow safe worker entry. Temporary support is installed as required to temporarily stabilise the ground not supported by the sidewall units. o Levelling of ground underneath the 'bathtub' levelled. Compaction and levelling, method to be confirmed. o Temporary props (Acrow or similar) removed. o "Bathtub" is lifted into place and secured on both sides with precast steel elements. o Temporary props (acro or similar) re-installed to allow safe worker entry. o "Bathtub" secured on both sides to the sidewall units with the reinforcement bars using cast in couplers and threaded ended reinforcement bars. o Concurrent activities: ▪ Excavation of max. 1600 mm width for next 900mm wide precast segments. Excavation for next section can commence prior to the installation of the grout at the previous precast segment reaching required strength. If a void is present behind and/or beneath the segments it is to be adequately filled using fast set concrete / pea gravel or other suitable methods to ensure the ground is as much as it is possible is supported. ▪ Grouting of previous units to take place concurrently with excavation of next section. Grouting required between precast segments and underneath and behind precast kerb units. It is assumed that the cutting and excavation will take approx. 3 hours needed for the grout to reach 30-40 MPa. (final grouting TBC) ▪ In the case the 2nd excavation is complete and 2nd units are installed prior to the grouting reaching required strength for

Invert replacement type INV-1 in volcanics area	Invert replacement type INV-2 in clay and sand areas
	the 1st units, can the 3rd excavation begin? As a minimum the grout providing structural connection between the masonry lining and the precast sidewall units and the grout between the sidewall and middle precast unit has to gain sufficient strength and the voids needs to be adequately filled. o This process can be repeated until 8 segments are installed 0.9m x 8 =7.2 m total. o The bathtubs are then filled with concrete, curing and working time to be confirmed. o Excavation for the 9th segment can commence without having to wait for the cast-in situ concrete to cure. Brief summary of the Sequential construction methodology (sand): o The same process used for clay is to be used (see above). This can be repeated until 6 segments are installed 0.9m x 6 =5.4 m total. o The bathtubs are then filled with concrete, curing and working time to be confirmed. o Excavation for the 7th segment can commence without having to wait for the cast-insitu concrete to cure. Note on Tunnel lining contingency and temporary support: The contingency measures may be required at areas where the existing invert is in place or the invert is excavated out or the new invert partially or fully installed (see Section 0 below)

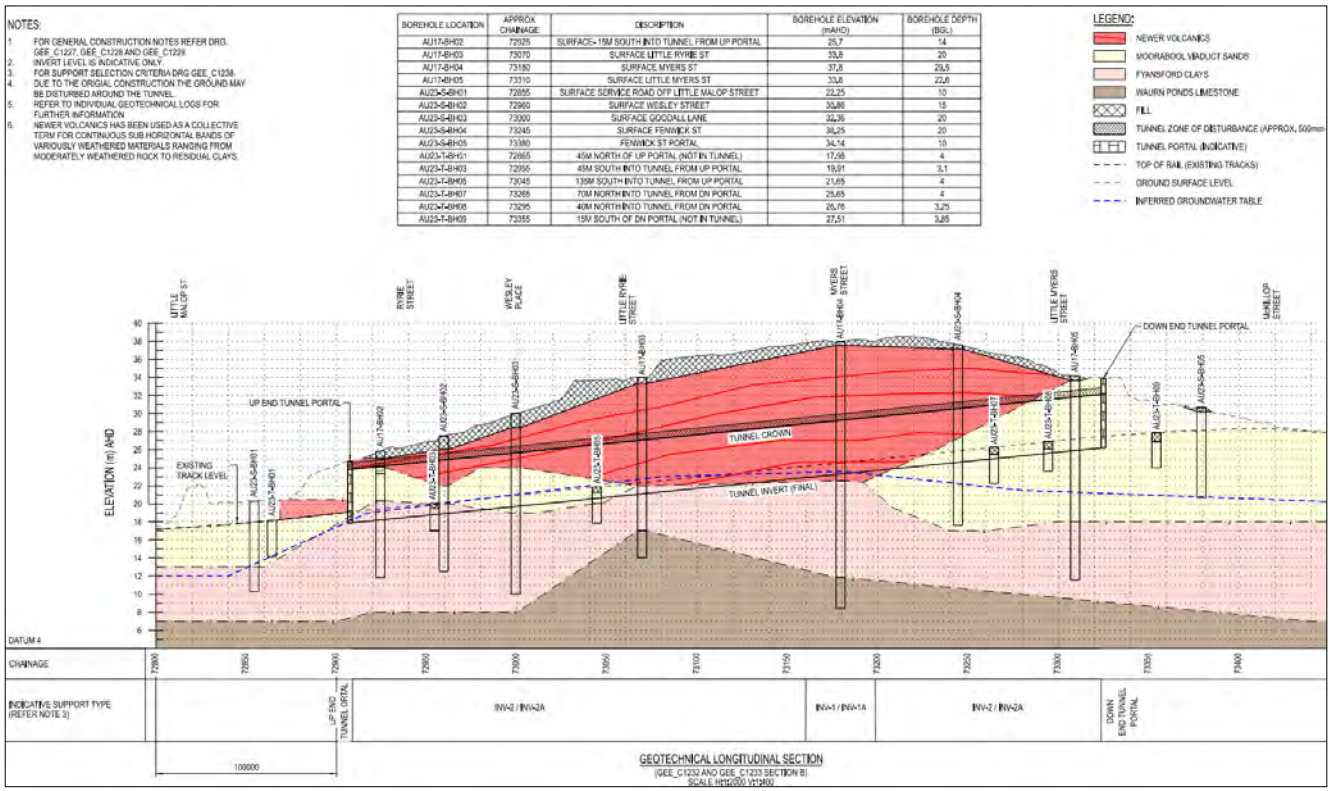


FIGURE 39: LOGITUDINAL SECTION OF THE TUNNEL SHOWING THE SUPPORT TYPE INV-1 IN VOLCANICS AREA AND SUPPORT TYPE INV-2 IN CLAY AND SAND AREAS. **(SOURCE: AURECON/VLINE)**

INVERT REPLACEMENT TYPE INV-1 IN VOLCANICS AREA

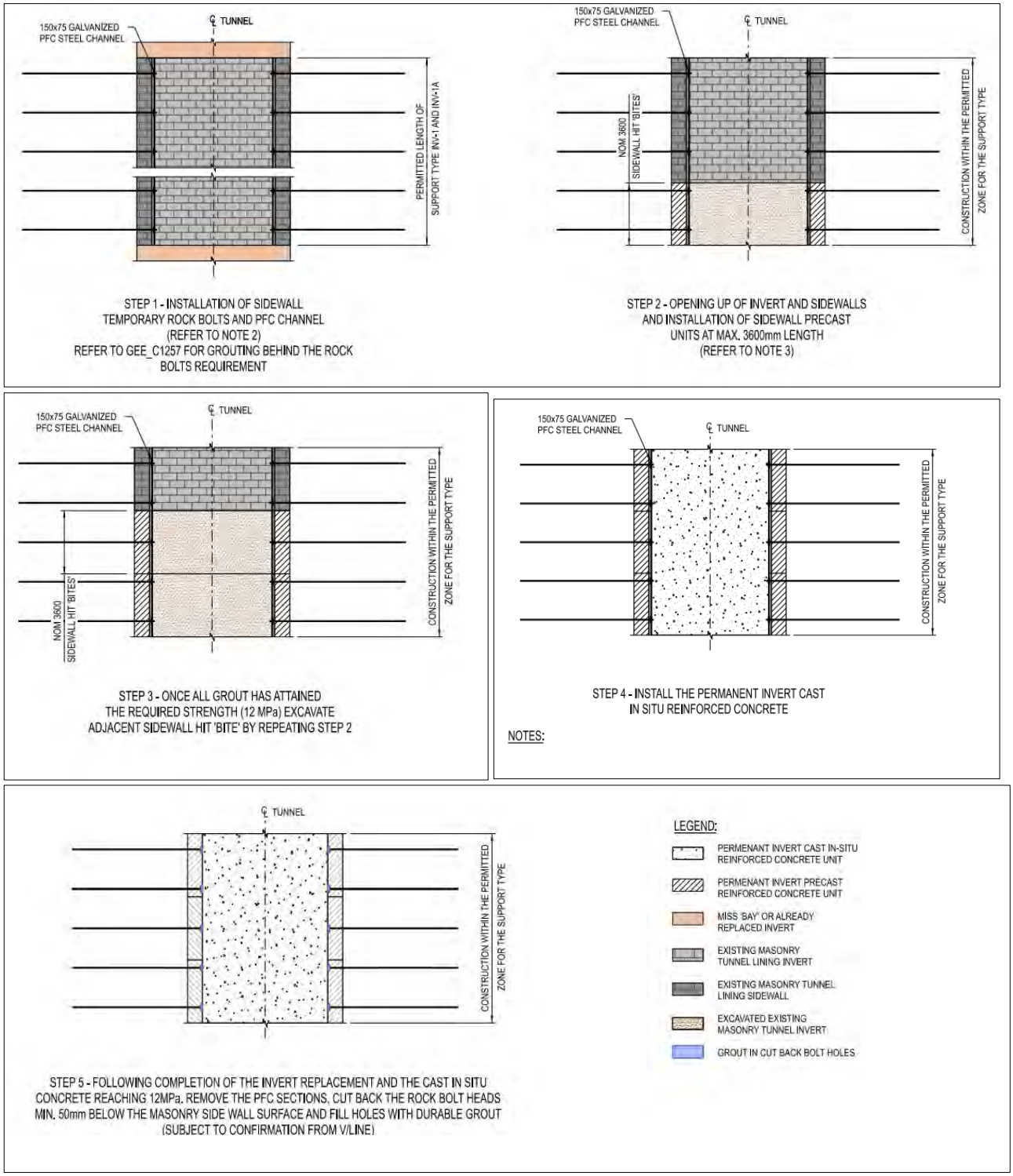


FIGURE 40: DRAWING SHOWING INVERT LOWERING WORKS STEPS IN SUPPORT TYPE INV-1 IN ROCK (VOLVANIC) AREA OF THE TUNNEL. (**SOURCE**: AURECON/VLINE)

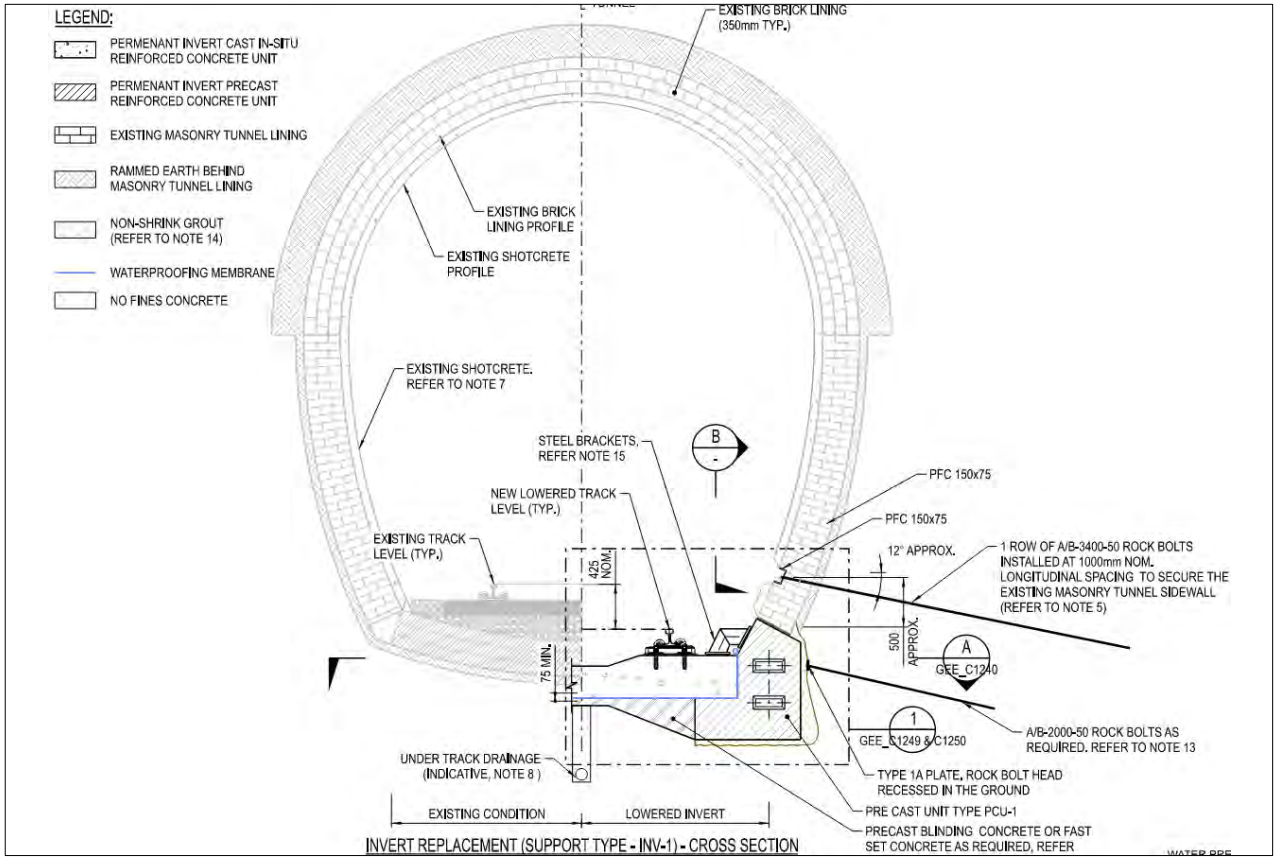


FIGURE 41: TYPICAL CROSS SECTION OF TUNNEL SHOWING INVERT REPLACEMENT TYPE INV-1 IN VOLCANICS AREA. (SOURCE: AURECON/VLINE)
NOTE FOR PFC INSTALLATION AND ROCK BOLT SUPPORT TO TUNNEL LINING REFER **SECTION 3.1.4**.

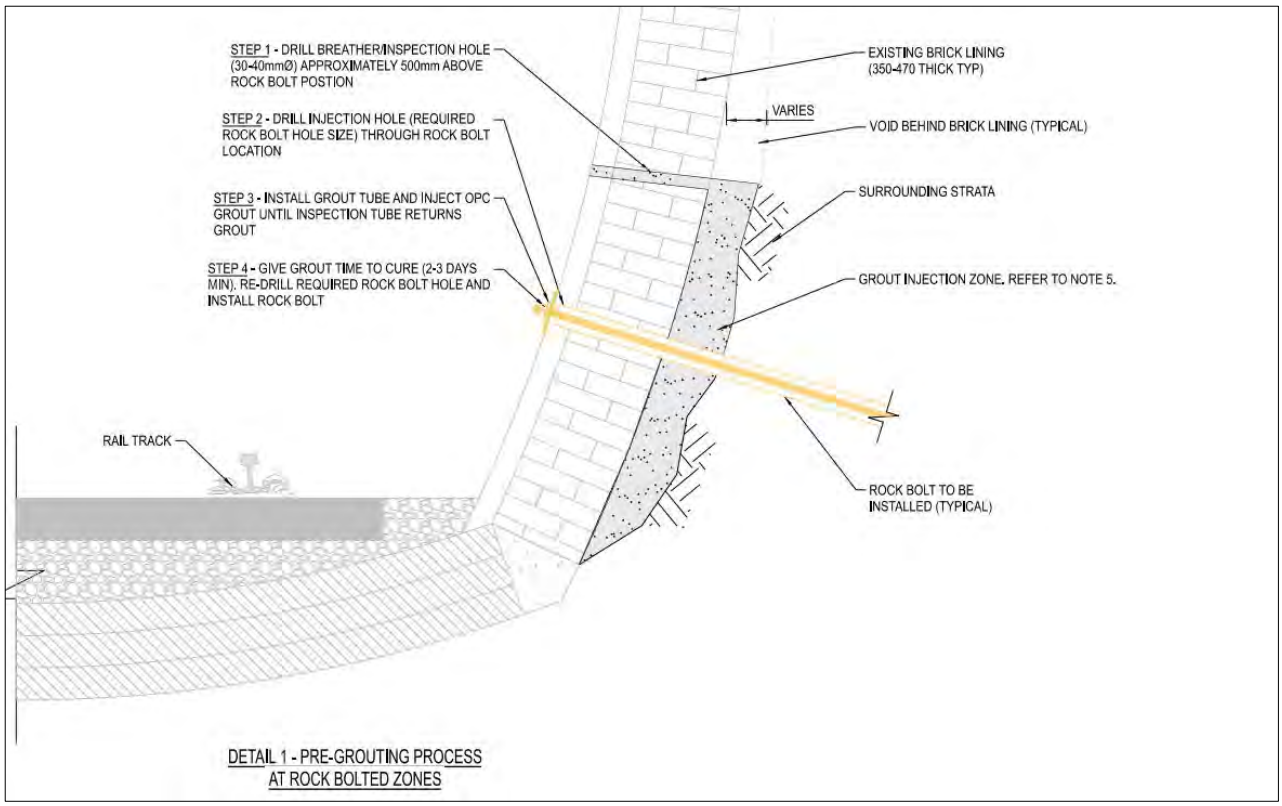


FIGURE 42: TYPICAL SECTION SHOWING PRE-GROUTING PROCESS AT ROCK BOLTED ZONE. (**SOURCE**: AURECON/VLINE)

INVERT REPLACEMENT TYPE INV-2 IN CLAY AND SAND AREAS

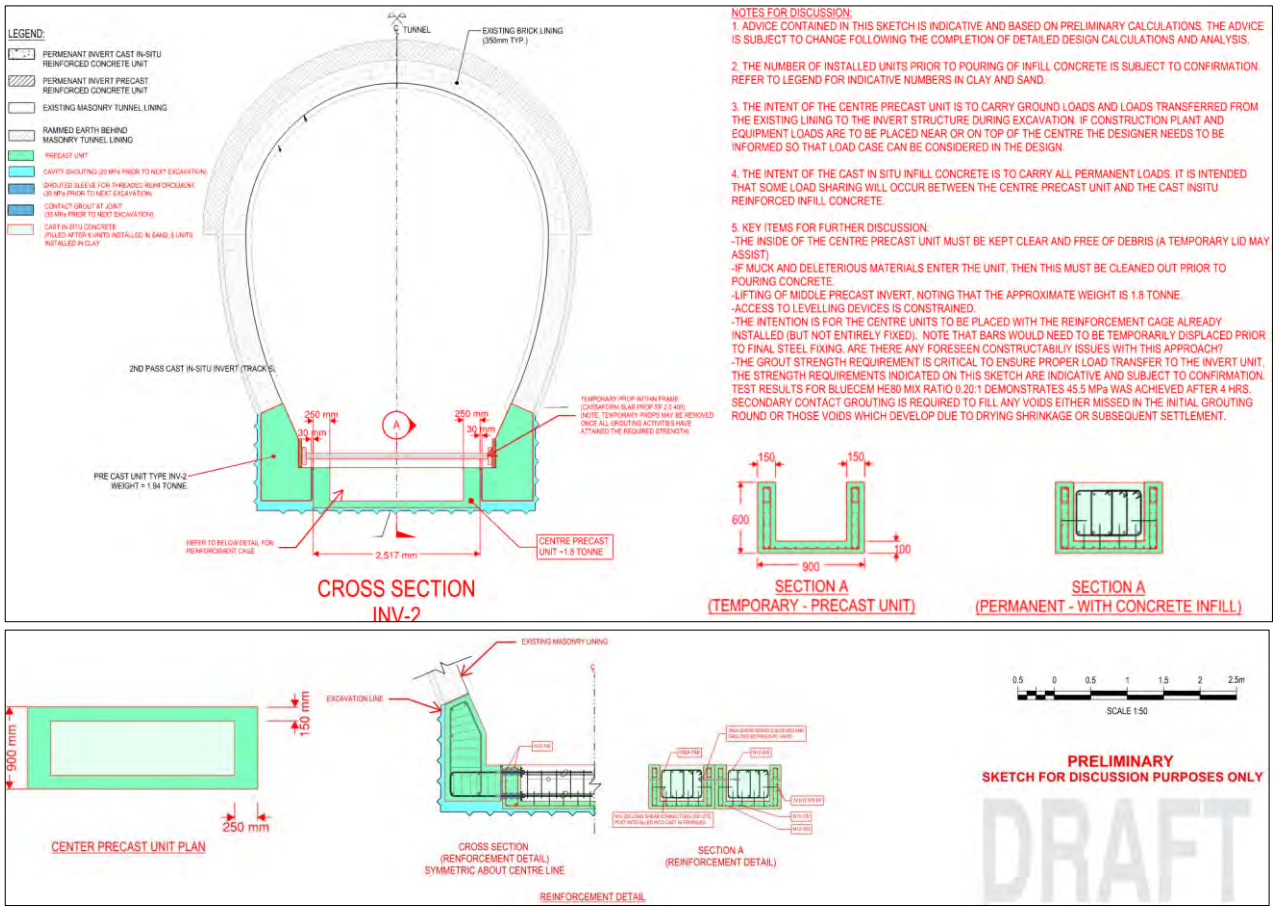


FIGURE 43: SECTION OF THE TUNNEL AND DETAILS SHOWING THE CENTRAL AND SIDE WALL PRE-CAST UNITS AS SUPPORT TYPE INV-2 IN CLAY AND SAND AREAS OF THE TUNNEL. (**SOURCE**: AURECON/VLINE)

3D VISUALISATIONS SHOWING THE CONSTRUCTION METHODOLOGY TO INSTALL CENTRAL (BATHTUB) AND SIDE WALL PRE-CAST UNITS AS SUPPORT TYPE INV-2 IN CLAY AND SAND AREAS OF THE TUNNEL

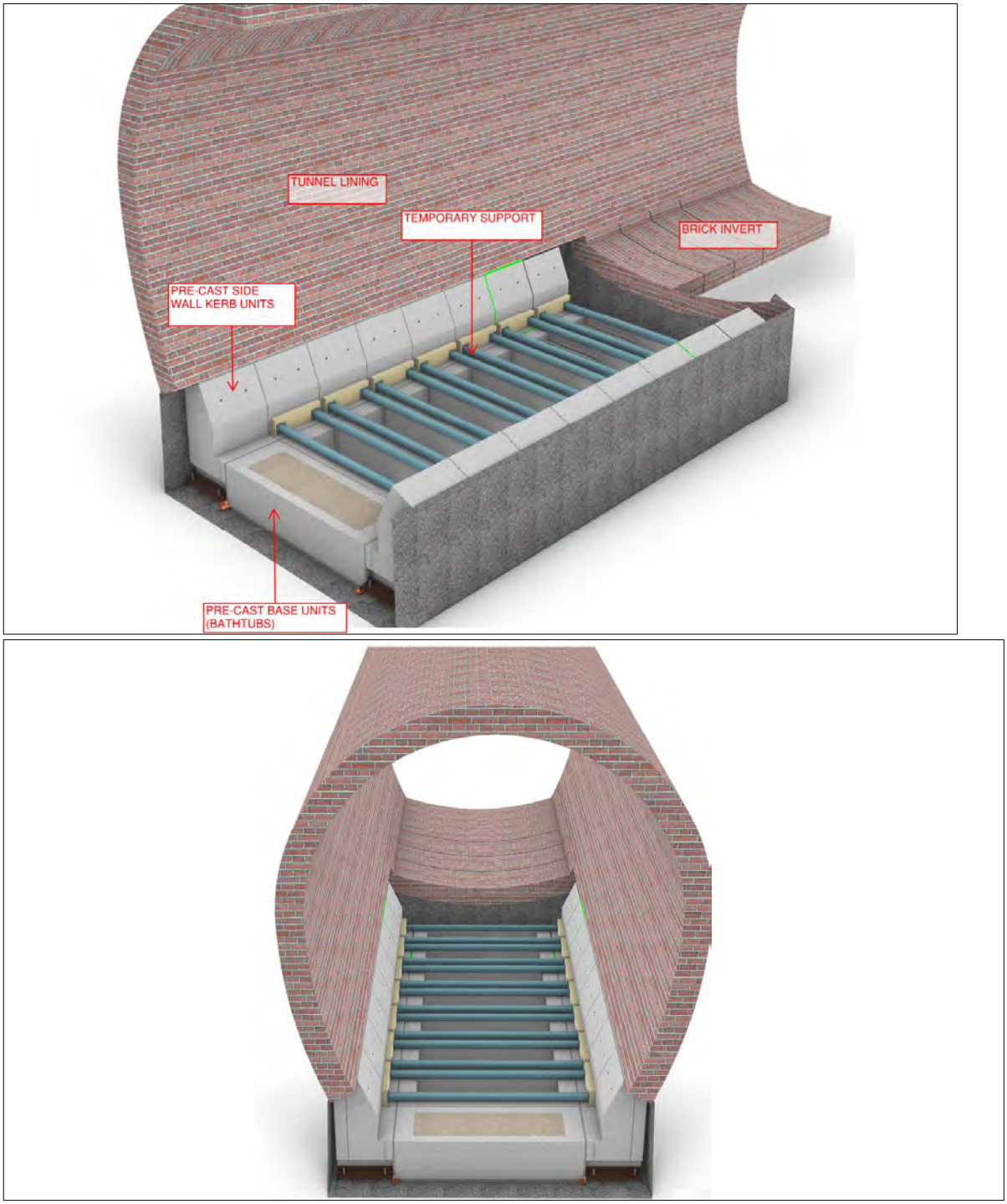


FIGURE 44: 3D VIEWS SHOWING THE TEMPORARY SUPPORT SYSTEM AND INSTALLATION OF PRE-CAST CENTRAL AND SIDEWALL BASE UNITS AS SUPPORT TYPE INV-2 IN CLAY AND SAND AREAS OF THE TUNNEL. (**SOURCE**: AURECON/VLINE)

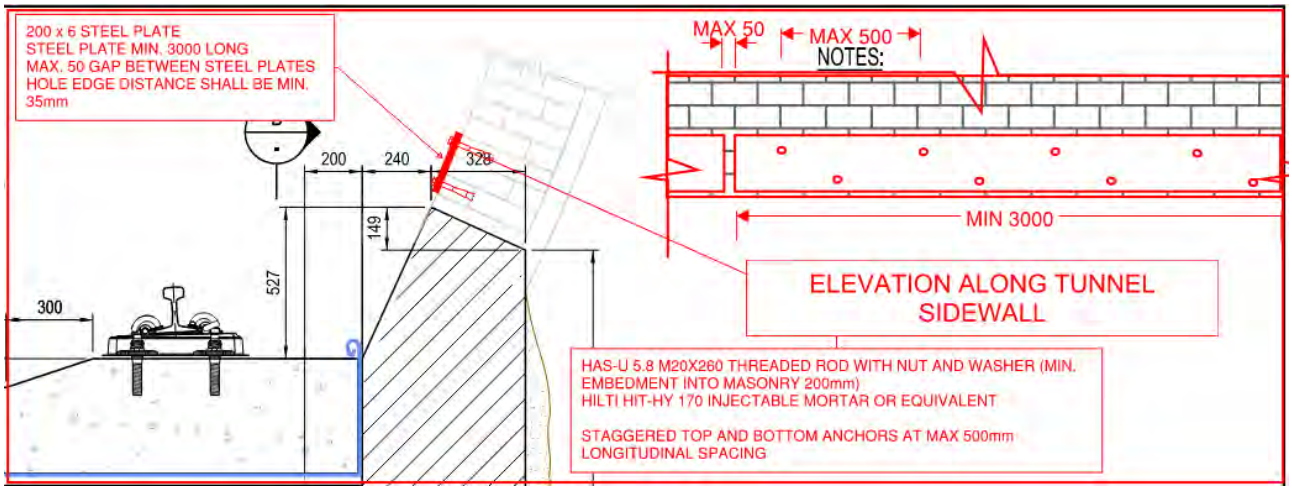


FIGURE 45: MASONRY WALL EDGE TEMPORARY SUPPORT - STEEL RIBBON TO MAINTAIN STRUCTURAL INTEGRITY OF THE MASONRY (**SOURCE**: AURECON/VLINE)

Refuge strengthening works

The approx. 2050mm high, 900mm wide and 700mm deep refuge spaces are located at approximately 30m spacing on alternating sides of the Geelong tunnel. The invert level of the refuge spaces is approximately at the level of the existing top of the rail (see Figure 16). It is anticipated that currently a couple of course of bricks are providing the structural connection between the invert of the refuge spaces and the tunnel masonry lining. As the proposed invert lowering works are required for structural reasons to establish the connection between the existing masonry lining and the new precast concrete elements approximately 100mm below the refuge spaces invert level the Designer proposes to strengthen the refuge spaces with reinforced concrete structurally connected to the masonry tunnel lining as shown in Figure 31 below. The invert strengthening is proposed for all the refuge spaces to:

(i) ensure the integrity of the masonry lining is maintained during construction and in the long term;

(ii) guarantee the load transfer between the sidewall precast elements and the masonry tunnel lining during construction and in the long term;

(iii) and mitigate the risk of refuge space invert disintegration during opening up the invert adjacent to and the associated construction health and safety aspects

The refuge space invert strengthening, would be made of durable bar reinforced cast in -situ concrete, would be installed in advance of the invert lowering and would remain in the tunnel in the long term as structural members.

3.1.7 Repair works to masonry

- All original tunnel wall lining are to be retained and protected during construction;
- Damaged masonry sections of portals and internal lining to be repaired (see Figure 46).
- All degraded/softened mortar at the portals and within the tunnel to be repointed on like-for-like basis (see Figure 12).
- Undertake graffiti removal using non abrasive method to avoid damaging face of the brickwork

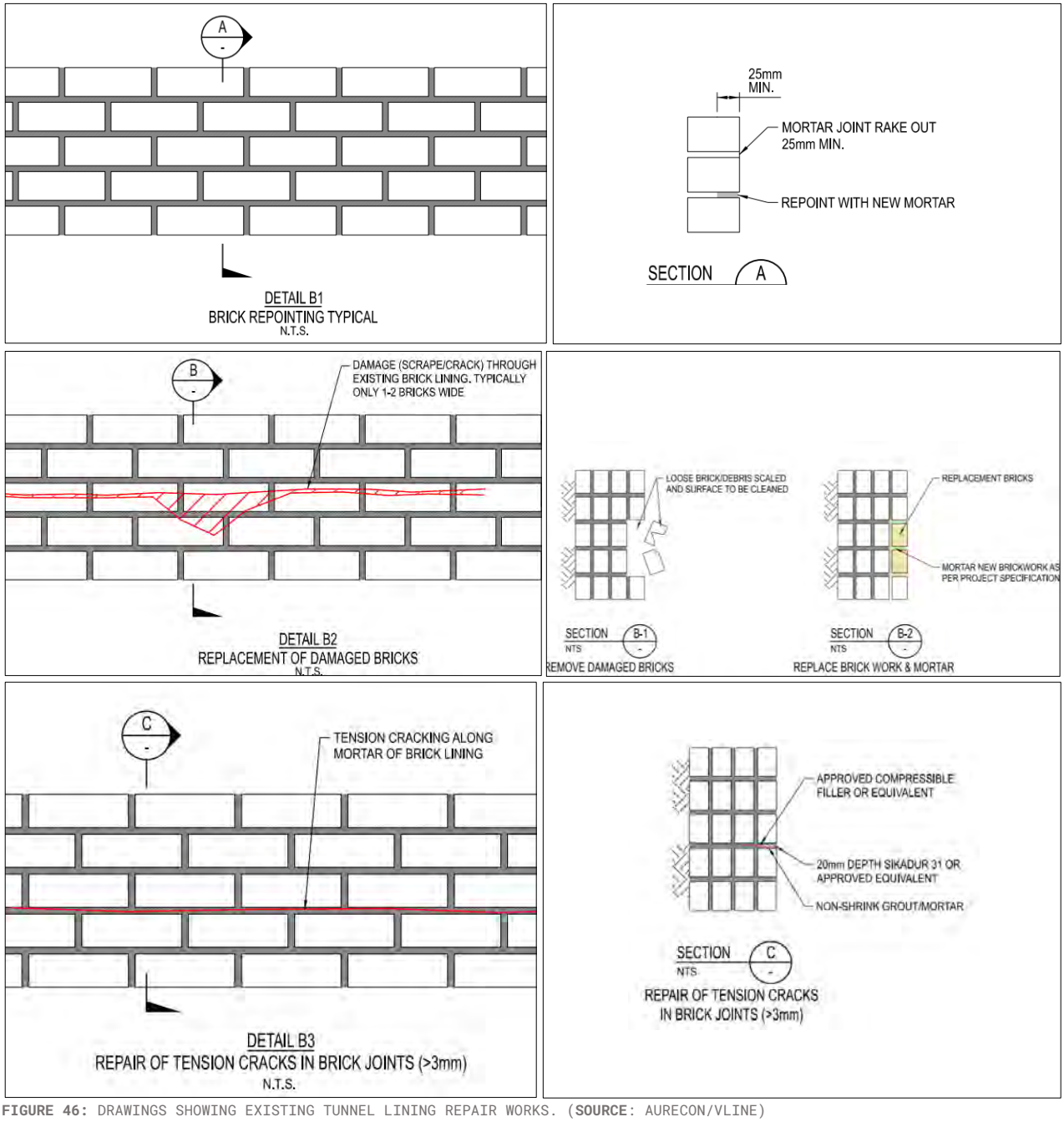


FIGURE 46: DRAWINGS SHOWING EXISTING TUNNEL LINING REPAIR WORKS. (**SOURCE**: AURECON/VLINE)

3.2 Drawings assessed

The following drawings on tunnel and portal works were assessed in preparation of this report. While some extracts are included in the report the full design package should be referred to in Appendix 0.

	Drawing number	Drawing description	Date and issue
SEQUENCE 2			
1	GEE_C1286	GEOTECHNICAL DESIGN - COVER SHEET AND DRAWING INDEX	20/03/24 – C
2	GEE_C1287	GEOTECHNICAL DESIGN - GENERAL NOTES - SHEET 1	20/03/24 – C
3	GEE_C1288	GEOTECHNICAL DESIGN - GENERAL NOTES - SHEET 2	20/03/24 – C
4	GEE_C1289	GEOTECHNICAL DESIGN - GENERAL NOTES - SHEET 3	20/03/24 – C
5	GEE_C1293	GEOTECHNICAL DESIGN - GENERAL ARRANGEMENT PLAN DRAWING	20/03/24 – C
6	GEE_C1295	GEOTECHNICAL DESIGN - ELEVATION PROFILE OF EAST CUT	20/03/24 – C
7	GEE_C1296	GEOTECHNICAL DESIGN - ELEVATION PROFILE OF WEST CUT	20/03/24 – C
8	GEE_C1297	GEOTECHNICAL DESIGN - TYPICAL SECTIONS - SHEET 1	20/03/24 – C
9	GEE_C1298	GEOTECHNICAL DESIGN - TYPICAL SECTIONS - SHEET 2	20/03/24 – C
10	GEE_C1299	GEOTECHNICAL DESIGN - TYPICAL SECTIONS - SHEET 3	20/03/24 – C
11	GEE_C1300	GEOTECHNICAL DESIGN - TYPICAL SECTIONS - SHEET 4	20/03/24 – C
12	GEE_C1301	GEOTECHNICAL DESIGN - SHEET PILE DETAILS	20/03/24 – C
13	GEE_C1302	GEOTECHNICAL DESIGN - SOIL NAIL AND FACING DETAILS	20/03/24 – C
14	GEE_C1304	GEOTECHNICAL DESIGN - SOIL NAIL SCHEDULE	20/03/24 – C
15	GEE_C1305	GEOTECHNICAL DESIGN - TUNNEL PORTAL INTERFACE	20/03/24 – C
16	GEE_C1306	GEOTECHNICAL DESIGN - MISCELLANEOUS DETAILS	20/03/24 – C
SEQUENCE 3			
17	GEE_C1226	COVER SHEET, DRAWING INDEX & GA	26/03/24 - D
18	GEE_C1227	GENERAL NOTES - SHEET 1	26/03/24 - D
19	GEE_C1228	GENERAL NOTES - SHEET 2	26/03/24 - D
20	GEE_C1229	GENERAL NOTES - SHEET 3	26/03/24 - C
21	GEE_C1230	TYPICAL ROCK BOLT DETAILS	26/03/24 - D
22	GEE_C1237	GEOTECHNICAL LONG SECTION	26/03/24 - D
23	GEE_C1239	TEMPORARY SUPPORT TYPE INV-1 - SHEET 1	26/03/24 - D
24	GEE_C1256	EXISTING LINING DEFECT REPAIRS	26/03/24 - D
25	GEE_C1257	MASONRY TUNNEL PRE-GROUTING	26/03/24 - D
26	GEE_C1259	TUNNEL TEMPORARY DRAINAGE AND WEEP HOLES	26/03/24 - D
27	GEE_C1261	TUNNEL INSTRUMENT MONITORING - SHEET 1	26/03/24 - D
28	GEE_C1262	TUNNEL INSTRUMENT MONITORING - SHEET 2	26/03/24 - D
29	GEE_C1264	TUNNEL MONITORING AND TRIGGER LEVELS	26/03/24 - D
SEQUENCE 4			
31	GEE_C1307	COVER SHEET AND DRAWING INDEX	15/03/24 - A
32	GEE_C1308	GENERAL NOTES – SHEET 1	15/03/24 - A
33	GEE_C1309	GENERAL NOTES – SHEET 2	15/03/24 - A
34	GEE_C1310	GENERAL NOTES – SHEET 3	15/03/24 - A
35	GEE_C1313	GENERAL ARRANGEMENT PLAN – SHEET 1	15/03/24 - A
36	GEE_C1314	GENERAL ARRANGEMENT PLAN – SHEET 2	15/03/24 - A
37	GEE_C1315	SET OUT INFORMATION	15/03/24 - A
38	GEE_C1317	ELEVATION – EAST – SHEET 1	15/03/24 - A
39	GEE_C1318	ELEVATION – EAST – SHEET 2	15/03/24 - A
40	GEE_C1319	ELEVATION – EAST – SHEET 3	15/03/24 - A
41	GEE_C1320	ELEVATION – EAST – SHEET 4	15/03/24 - A
42	GEE_C1321	ELEVATION – WEST – SHEET 1	15/03/24 - A
43	GEE_C1322	ELEVATION – EAST – SHEET 2	15/03/24 - A
44	GEE_C1323	TYPICAL SECTIONS – SHEET 1	15/03/24 - A
45	GEE_C1324	TYPICAL SECTIONS – SHEET 2	15/03/24 - A
46	GEE_C1325	TYPICAL SECTIONS – SHEET 3	15/03/24 - A

	Drawing number	Drawing description	Date and issue
47	GEE_C1326	TYPICAL SECTIONS – SHEET 4	15/03/24 - A
48	GEE_C1327	TYPICAL SECTIONS – SHEET 5	15/03/24 - A
49	GEE_C1329	BOARD PILES AND SHOTCRETE DETAILS – SHEET 1	15/03/24 - A
50	GEE_C1330	BOARD PILES AND SHOTCRETE DETAILS – SHEET 2	15/03/24 - A
51	GEE_C1331	PILE CAPPING BEAM – SHEET 1	15/03/24 - A
52	GEE_C1331	PILE CAPPING BEAM – SHEET 2	15/03/24 - A
53	GEE_C1332	SOIL NAIL ABD FACING DETAILS – SHEET 1	15/03/24 - A
54	GEE_C1333	SOIL NAIL ABD FACING DETAILS – SHEET 2	15/03/24 - A
55	GEE_C1335	CONSTRUCTION SEQUENCE	15/03/24 - A
SEQUENCE 5			
56		INV-2 TYPE: PRELIMINARY SKETCH FOR DISCUSSION PURPOSES ONLY	21/03/24 - A
57		INV-2 TYPE: 3D SHOWING PRE-CASTINVERT BLOCKS AND WALL UNITS	21/03/24 - A
58	GEE_C1239	INV-1 TYPE: TEMPORARY SUPPORT TYPE INV-1 - SHEET 1	03/11/23 - B
59	GEE_C1240	INV-1 TYPE: TEMPORARY SUPPORT TYPE INV-1 - SHEET 2	03/11/23 - B

4.0 Heritage Impact Mitigation Strategies

4.1 Generally

To comply with heritage requirements the proposed development seeks to minimise impacts on the heritage place, while meeting the V/line's design brief for the construction of the new tunnel invert at a lower level. In line with V/line design brief, the proposed tunnel invert lowering works will facilitate the following aspects of the V/line design brief:

- The lowering of the invert should see the tunnel remain operational for 50 years
- New integrated drainage system to divert water away from the tunnel
- Keeping the tunnel in service with a reduction in ongoing maintenance of track and invert
- Improvement to the kinematic envelope
- Restoring the legacy speed limit of 65km/h for all trains (passenger and freight) by removing the current PSR

The high heritage values and cultural heritage significance of Geelong Railway Tunnel are acknowledged. Proposed invert lowering works are guided by the pre-lodgment advice from HV and the cultural heritage significance identified in the VHR entry.

The proposed construction works involve replacing brick invert with new concrete invert and improved drainage that has been carefully considered within the context of the existing significant features. The proposed construction works will result in removing the original brick invert and some impacts on the brick lining where the rock bolting has been proposed to strengthen the brick lining during the removal of existing brick invert. The impacts will be managed and mitigated appropriately to reduce impacts on the cultural heritage values of the heritage place. These impacts are mitigated through the following key aspects of the conservation and engineering design response:

- Best practice heritage process: guided by the Architectus Conrad Gargett (ACG) heritage team and advice from HV in a pre-lodgement meeting best practice heritage process has been followed.
- Use of specialist advice: Under the guidance of heritage architects from ACG, specialists with relevant heritage experience will be sourced at the early stages to investigate and advice on geotechnical, propping tunnel lining, rock bolting and repair works (see engineering reports in appendix)
- Condition inspection/assessment of masonry: a condition assessment of the masonry in the tunnel lining is required prior to construction works.
- Geotechnical investigations: To further the understanding of the ground conditions along the tunnel and associated portals, a geotechnical investigation has been undertaken by Aurecon. The investigation comprised borehole drilling completed from the current ground surface and from within the tunnel.
- Propping tunnel lining during proposed construction works: See Section 4.4 below.
- Rock bolting the tunnel lining: See section 4.3.6 above.
- Phasing out proposed works: see section 3.0 on work sequences.
- Construction Monitoring: Impacts on building fabric (tunnel and other properties above tunnel) from construction activities will be appropriately monitored through instrument installed on portals and inside tunnel (see section 4.3 below).

These considerations ensure proposed invert lowering work will result in minimal detrimental impact on the cultural heritage significance of the heritage place, while meeting the design brief for an upgraded tunnel.

4.2 Strategies to minimise and mitigate adverse impacts

The potential detrimental impacts on the cultural heritage significance of the Geelong Railway Tunnel that may result from the proposed works, and strategies to ensure any detrimental impact is minimal are identified below.

Potential Impact	Mitigation Measures
Damage to brick lining to install rock bolts	The primary role of temporary rock bolts is to strengthen the brick lining and provide horizontal support to the masonry tunnel sidewalls during the construction phase. To enhance the support provided by the rock bolts, PFC (Parallel Flange Channel) channels are installed, which provide additional support to the brick masonry wall along the channel. Bricks will be cored through to install the rock bolts cause some damage to existing fabric of the tunnel however, impacts are to be localised to a small section of original tunnel lining and minor in scale (see Figure 29). The impacts are to be managed by photographically recording the existing condition before any works for archival purposes. Any damages to significant building fabric during the installation of rock bolting will be repaired on like-for-like basis.
Removal of brick invert	Step 1 - installation of sidewall temporary rock bolts and PFC channel (refer PFC and Rock bolt installation above) after grouting behind the rock bolts (see Figure 42); Step 2 - opening up of invert and sidewalls and installation of sidewall and invert units in: – clay/sand area (see Sequence 5 in Section 3.1.6) – rock (volcanic) area (see Sequence 5 in Section 3.1.6). Note: The sidewall shall be fully supported by the precast reinforced concrete lining units on both sides before opening up the adjacent sidewall section. Grout strength shall be minimum 12mpa. Step 3 - once all grout has attained the required strength excavate adjacent sidewall hit 'bite' by repeating step 2; Step 4 - following completion of the invert replacement and the cast in situ concrete reaching 12mpa. remove the PFC sections, install a large washer on rock bolt heads.
Deformation in tunnel lining and portals	See Construction Monitoring in Section 4.3 below.

Potential Impact	Mitigation Measures
Tunnel lining contingency and temporary support during construction	Contingency measures are in place to respond to red trigger exceedance during construction monitoring. These measures may be required at areas where the existing invert is in place or the invert is excavated out or the new invert partially or fully installed (see Section 0 below).
Brick and mortar repairs	- Condition inspection was conducted (August 2023) on the tunnel to identify areas requiring repair or rectification works. Before any works commence within the tunnel, it is necessary to undertake a detailed condition survey. This is required to map the areas in need of repair prior to commencement of invert lowering works and to provide comparative documented basis for the future repairs after the invert lowering works will have been completed. - the portal and in tunnel masonry surfaces shall be thoroughly and carefully cleaned as required to help the visual inspection with water pressure washing (100-150 psi) prior to commencement of the brickwork repointing of the invert replacement works. Care shall be taken to avoid loosening of the existing mortar by the water pressure washing.
Portal retaining works	In order to minimise impacts of the proposed retaining works on the significant brick/stone portals following measures are proposed: - Existing interface of approaches with the portal retained. - Brick retaining wall on down-end portal retained and strengthened with wraparound shotcrete to address excavations. - New bored pile retaining walls on up-end portal will be 1800mm cleared from the face of portal.

4.3 Construction Principles

Key construction principles below:

1. The location of the monitoring prisms on the facade will be managed by V/Line / Contractor and the locations will be defined in consultation with the owners and with Heritage Victoria where applicable.
2. The construction works will be carried out in a way that it causes minimum disturbance to the ground as this is seen to be essential to ensure no additional load is introduced onto the masonry tunnel lining. This will be achieved by following during construction the observational approach which means that:
    a) the tunnel invert will be lowered down in short sections.
    b) at a time the required minimum length of tunnel invert will be opened up.
    c) the new tunnel support providing support for the ground behind it as well will be installed immediately.
    d) the displacements of the tunnel lining will be measured.

e) the opened up invert ground conditions including presence of groundwater will be mapped by the site geologist.

f) Permit to excavate process will be held daily where the following will be evaluated:

- displacements of tunnel lining.
- quality and completeness of recently constructed sections.
- ground stability.
- presence of groundwater.
- health and safety aspects and safe work conditions (e.g. man entry zone re-evaluation.

g) The Permit to excavate process based on the evaluation of the above data may require the implementation of any of the below mitigation measures:

- install additional localised dewatering to enhance the stand up time of the granular layers.
- install temporary face support (e.g.: conventional timber lagging, trench shoring system).
- install grout, cast in situ concrete close to the face to increase the 'rigidity' of the support at the excavation face.
- shorten the excavation length to the minimum required to install the precast segments.
- install crushed rock or conventional shoring to mitigate the sidewall movements in the event of encountering unstable ground.

h) The Permit to excavate process based on the evaluation of the above data may require the implementation of any of the below contingency tunnel support measures:

- install horizontal struts to support the tunnel lining.
- install steel plates fixed to the masonry lining above the cut line to guarantee the integrity of the masonry lining.

3. By implementing the above construction principles, the tunnel construction will target to achieve a close to zero displacement induced by the tunnelling. However as an additional safety tool the construction team will baseline and measure the displacements of the surface buildings; and
4. Should there be any sign of ground loss or significant settlement of the tunnel during construction at any given section of the tunnel, the tunnel construction team will immediately increase the frequency of the surface building monitoring from once per week to daily at the zone of influence.
5. The tunnel will be constructed with an 8 Tonne excavator, the exiting tunnel lining will be saw cut where possible to minimise the vibration impact and approximately 2/3 of the tunnel invert will be excavated using the bucket of the excavator in sand and clay. The remaining portion of the tunnel is in the Newer Volcanics unit and where required will be excavated using a rock breaker attachment. This section of the tunnel is at the middle of the tunnel under the largest ground cover, and it is expected that the cover from the surface to the invert will be min. 10m.
6. Based on the experience of a double track railway tunnel upgrade project in the Blue Mountains it is anticipated that the vibration caused by the rolling stock is greater than the construction plant induced vibration.

Overall, the invert lowering of the Geelong tunnel has been developed together with V/Line and specialist contractors to ensure the key safety aspects and considerations can all be meet by the Project and that for all credible construction scenarios timely, effective and efficient response can be given and consequently the remedial risk of creating significant impact to third parties is minimised as much as it is reasonably practicable.

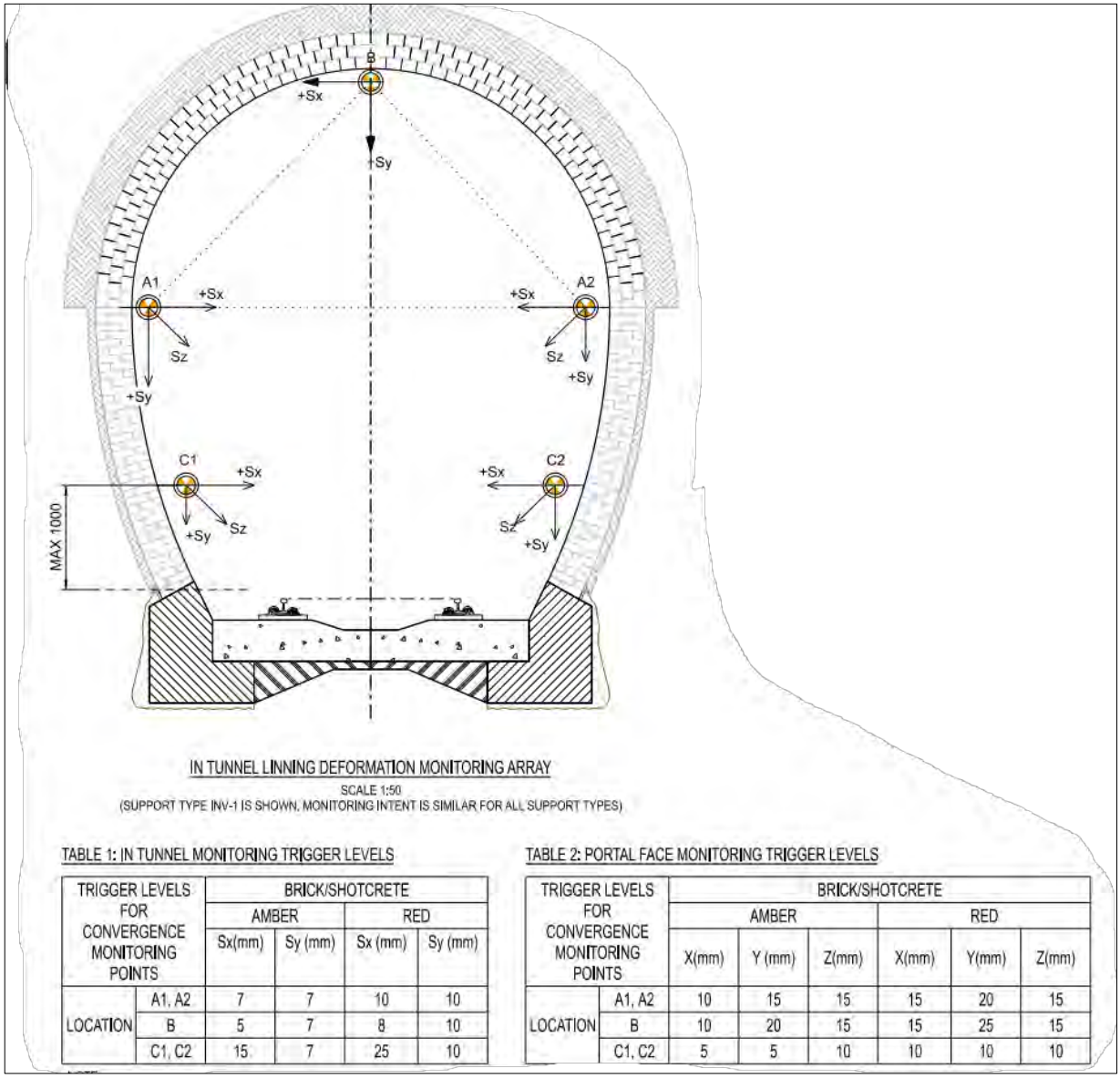
4.3.1 Construction Monitoring

4.3.2 Tunnel condition surveys

An initial condition survey for the portals and tunnel prior to the commencement of works has been undertaken by Aurecon to record the current condition of the tunnel and portals. This record will allow an understanding of any changes to the tunnel fabric that may occur throughout the invert lowering works in the tunnel due to vibration and other construction issues. The survey included a series of photographs and observations covering 5m length of tunnel lining, elements and details on conditions and both portals at up and down ends of the tunnel.

4.3.3 Tunnel lining deformation and tunnel portal face monitoring

Aurecon have provided a procedure to monitor tunnel lining deformation and tunnel portal face monitoring during the project (see Figure 47 and Figure 48). This procedure includes a number of strategies that will be implemented, and the frequency and monitoring review levels. These strategies will provide critical information to ensure the support systems are performing in accordance with the design predictions and allow the interpretation of recorded site data relevant to Tunnel during construction. Various instrumentation will be installed during the project to measure horizontal displacements, vertical settlement and tilt changes. Baseline readings should be established prior to excavation commencing by three readings of each monitoring devices spread over at least one week and no more than two weeks. Detailed engineering analysis and assessment will be performed to determine any associated impact on tunnel lining and portals due to movement during construction. Where shotcrete is present it shall be retained and monitored for cracking and movement.



IN TUNNEL LINNING DEFORMATION MONITORING ARRAY

SCALE 1:50

(SUPPORT TYPE INV-1 IS SHOWN, MONITORING INTENT IS SIMILAR FOR ALL SUPPORT TYPES)

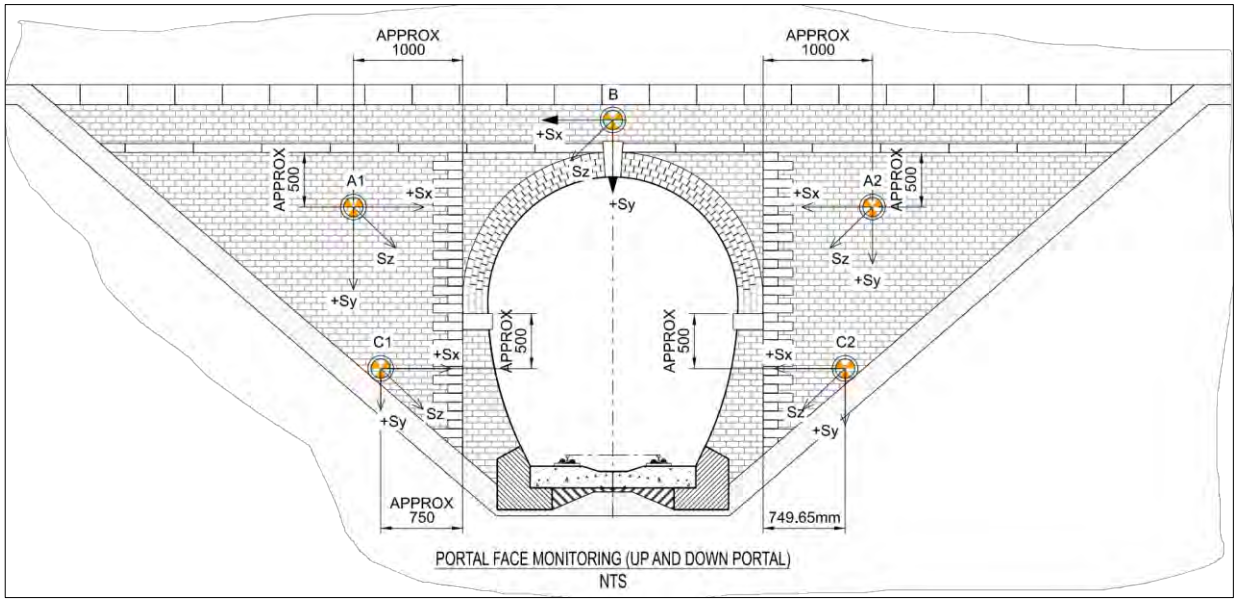
TABLE 1: IN TUNNEL MONITORING TRIGGER LEVELS

TRIGGER LEVELS FOR CONVERGENCE MONITORING POINTS		BRICK/SHOTCRETE			
		AMBER		RED	
		Sx(mm)	Sy (mm)	Sx (mm)	Sy (mm)
LOCATION	A1, A2	7	7	10	10
	B	5	7	8	10
	C1, C2	15	7	25	10

TABLE 2: PORTAL FACE MONITORING TRIGGER LEVELS

TRIGGER LEVELS FOR CONVERGENCE MONITORING POINTS		BRICK/SHOTCRETE					
		AMBER			RED		
		X(mm)	Y (mm)	Z(mm)	X(mm)	Y(mm)	Z(mm)
LOCATION	A1, A2	10	15	15	15	20	15
	B	10	20	15	15	25	15
	C1, C2	5	5	10	10	10	10

FIGURE 47: DRAWING SHOWING PROPOSED INSTRUMENT MONITORING INSIDE TUNNEL. (**SOURCE**: AURECON/VLINE)



PORTAL FACE MONITORING (UP AND DOWN PORTAL)

NTS

FIGURE 48: DRAWING SHOWING PROPOSED INSTRUMENT MONITORING ON PORTALS. (**SOURCE**: AURECON/VLINE)

4.3.4 Monitoring Review Levels

In tunnel lining deformation monitoring and tunnel portal face monitoring shall be undertaken with the amber and red levels as summarised in table:

Action Amber:

- contractor to submit relevant monitoring data within 4 hours to v/line or their representative. the data must be reviewed by a person experienced with tunnel monitoring.
- monitoring data including displacement rates to be interpreted by the contractor.
- carry out investigation immediately to study the cause of the undue response.
- monitoring frequency to be increased as per agreed outcomes of the review with v/line or their representative.
- contractor shall identify and implement immediately any remedial action to prevent their works inducing movements to exceed the red level.
- contractor make ready the necessary provisions to ensure the availability of resources, supply of material and required plant for carrying out the necessary contingency measures.
- contractor shall make preparation for the implementation of the contingency measures.
- if no construction activities identified to be the cause of the undue response construction shall continue

Action Red:

- stop work and immediately implement contingency measures as shown in Section 0 below.
- contractor to submit relevant monitoring data and report the red trigger exceedance to v/line or their representative immediately. the data must be reviewed by a person experienced with tunnel monitoring.
- carry out investigation immediately to study the cause of the red trigger exceedance.
- implementation of contingency measures to be reviewed and further actions to be agreed with v/line or their representative.

4.3.5 Crack width monitoring

As a minimum, crack width monitors shall be fitted to structurally significant cracks mapped by the contractor, and location reviewed by the designer. the frequency of crack width monitoring shall be the same as for the convergence monitoring. crack width monitoring results shall be provided to v/line or their representative for review together with the convergence monitoring results.

4.3.6 Rock bolt load cell monitoring

Rock bolt load cell shall be installed and monitored as per the following table and specification:

INSTRUMENT	No.	CHAINAGES	LOCATION / INCLINATION	FREQUENCY	PURPOSE
BOLT LOAD CELL	1 PER PFC CHANNEL	TO BE DISCUSSED WITH THE DESIGNER	SELECTED BOLT HEADS	DOWNLOAD IMMEDIATELY POST BOLT INSTALLATION, THEN DAILY FOR A WEEK, THEN WEEKLY	CONFIRMING THAT LOAD IS WITHIN DESIGN CAPACITY. IF LOAD GETS TOO HIGH ADDITIONAL BOLTS MAY BE REQUIRED.
NOTES: - INSTRUMENTS TO BE INSTALLED AND BASE-LINED IN ACCORDANCE WITH MANUFACTURERS GUIDELINES BY PERSONNEL EXPERIENCED IN INSTALLING THESE TYPE OF INSTRUMENTS					

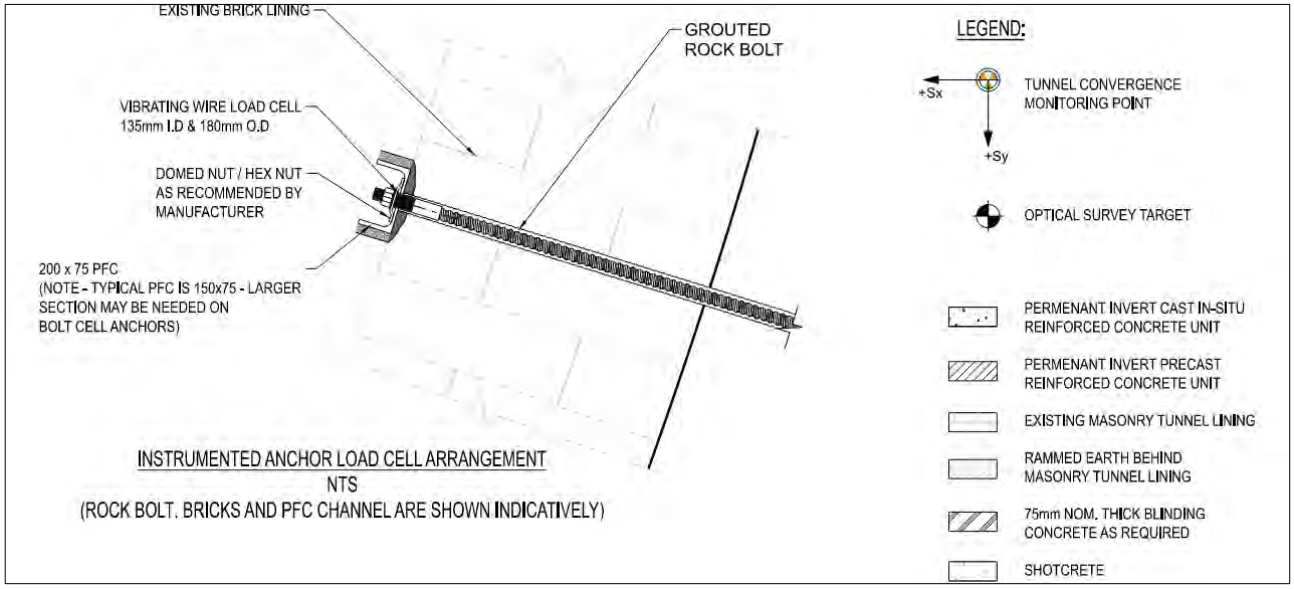


FIGURE 49: TYPICAL SECTION SHOWING PROPOSED INSTRUMENT MONITORING FOR ROCK BOLTS. (SOURCE: AURECON/VLINE)

Building monitoring within zone of construction works

As a minimum, survey prisms will be installed on buildings (heritage and non-heritage buildings) within the zone of influence of construction activities to monitor impacts of construction works.

FIGURE 50: AERIAL PHOTO SHOWING THE LOCATION OF BUILDINGS INSTALLED WITH MONITORING DEVICES WITHIN THE ZONE OF INFLUENCE OF TUNNEL CONSTRUCTION WORKS. (SOURCE: AURECON/VLINE)

4.4 Tunnel lining contingency and temporary support

Contingency measures are in place to respond to red trigger exceedance during construction monitoring. These measures may be required at areas where the existing invert is in place, or the invert is excavated out or the new invert partially or fully installed (see Figure 51).

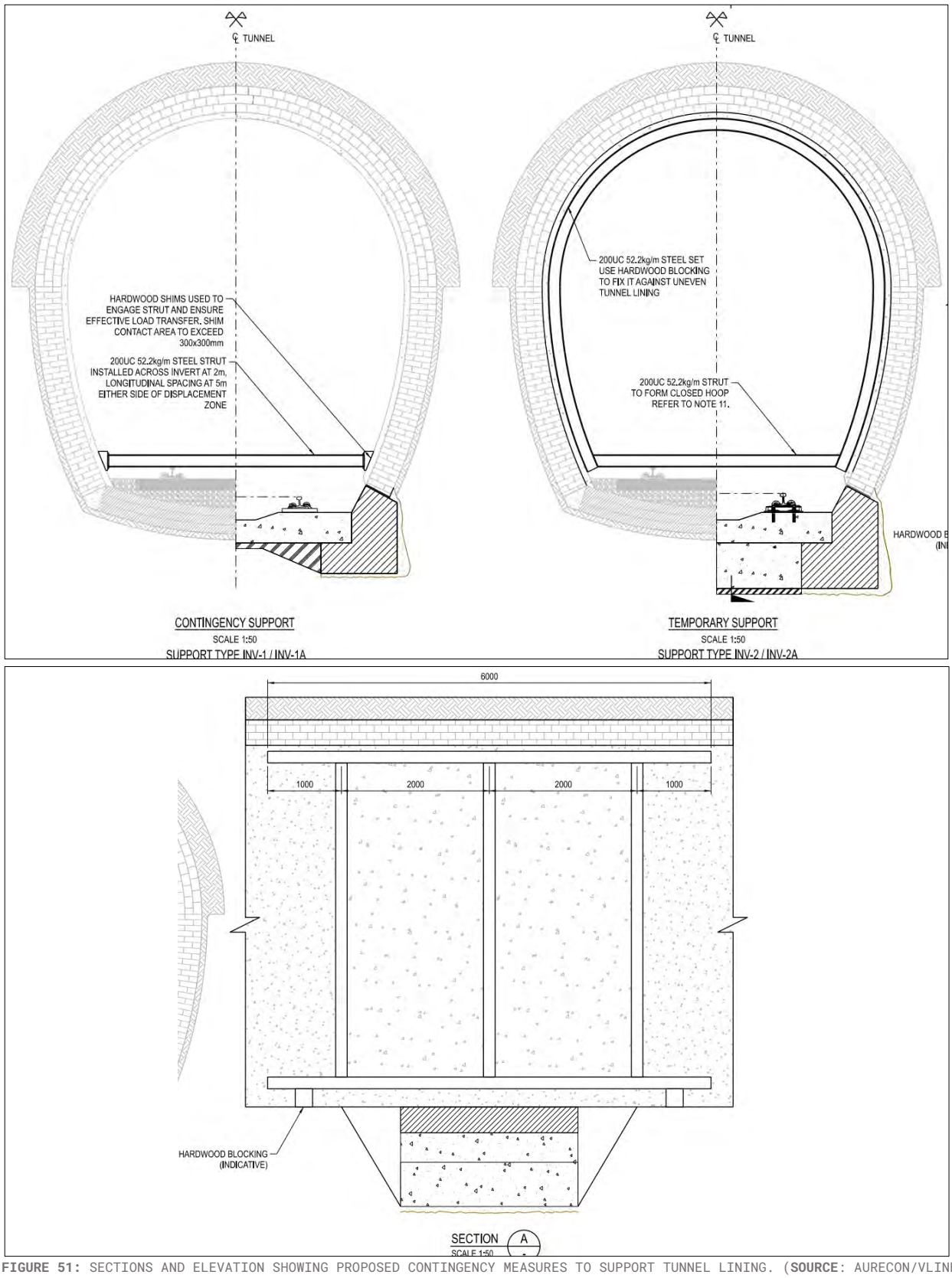


FIGURE 51: SECTIONS AND ELEVATION SHOWING PROPOSED CONTINGENCY MEASURES TO SUPPORT TUNNEL LINING. (**SOURCE**: AURECON/VLINE)

5.0 Assessment of heritage impact

5.1 Assessment under Victorian Heritage Act 2017

Section 101 of the Victorian Heritage Act 2017 (VHA 2017) sets out the considerations which must be made in determining permit applications. As per Heritage Victoria's guidelines for preparing HIS it is important to assess the proposal against s 101(2)(a) of the Heritage Act, but it may be useful to include other aspects of s 101(2) and s 101(3).

The potential impacts of proposed works and responses to the considerations under s101(2)(a) and s101(3) of VHA 2017 are noted in the table below:

Relevant aspects of VHA 2017	Response
101 (2)(a) *(2) In determining whether to approve an application for a permit, the Executive Director must consider the following—* *(a) the extent to which the application, if approved, would affect the cultural heritage significance of the registered place or registered object;*	Response to (a): Overall, removal of original brick invert and associated track works will be required to allow for a future waterproof lining to be installed and to improve the clearance within the tunnel to allow for freight cars carrying high-cube containers to utilise the line, making the line more attractive and efficient for freight operations. It is acknowledged that the proposed invert lowering works will have an impact on the original/early fabric (brick invert) of the tunnel, however, impacts of the proposed development on the heritage fabric and significance of the place are rationalised with the prior engineering investigations, conditions surveys and mitigation measures. As discussed in this report, overall impacts are mitigated and managed with advice from heritage and engineering experts. The proposed removal of brick invert is worthwhile in facilitating the tunnel meeting current requirements necessary to make tunnel operational for 50 years with new integrated drainage system. Proposed works will benefit the tunnel operations with a reduction in ongoing maintenance of track and invert and will improve the speed limit within the tunnel. Overall, the proposed works will result in a benefit to the long-term conservation of the place, improving flexibility and ability to upgrade and maintain the continued use of the heritage place. The impacts are to be managed by condition surveys and photographically recording the existing condition before any removal works for archival purposes.

Relevant aspects of VHA 2017	Response
101 (3) (a) & (b) *(3) In determining whether to approve an application for a permit, the Executive Director may consider—* *(a) the extent to which the application, if approved, would affect the cultural heritage significance of any adjacent or neighbouring property that is—* *(i) included in the Heritage Register; or* *(ii) subject to a heritage requirement or control in the relevant planning scheme; or*	**Response to (a):** Up-end portal on north and down-end portal on south side including the approaches (and their interface with the portals) of the tunnel are significant features. Proposed works inside and outside the tunnel will have no detrimental impacts on the portals. Old sections of brick retaining walls and interfaces with the portals are retained and will be strengthened with shotcrete and soil nails. Proposed works to improve drainage in the 5m area (within heritage boundary) beyond the faces of both portals will not detrimentally impact the heritage significance of the tunnel. Also, survey prisms will be installed on buildings (heritage and non-heritage buildings) within the zone of influence of tunnel construction activities to monitor impacts of construction works (see **Figure 50**). Dilapidation reports of heritage listed building will be produced pre and post construction works.
(b) any other relevant matter	**Response to (b):** The proposed works have been carefully managed and documented through: - Site inspections by architect (with heritage experience) in order to ensure that the proposed works to the heritage place and specification of proposed materials should mitigate and minimise impacts on the significant building features and overall heritage values; - Proposed removal of original building fabric (removal of brick invert) to facilitate invert lowering works will be archivally recorded prior to works; - The new concrete invert with integrated drainage and pre-cast concrete unit under brick wall in the tunnel will be detailed as new and modern, and will not replicate the details of existing. - Original and significant building fabric of the tunnel will be protected and monitored during the construction; - Construction work will be monitored to mitigate changes of accidental damage; - Any accidental damage to the original building fabric will be repaired on like-for-like basis; It is considered that the invert lowering works in the tunnel and associated track works in approaches near both portals, will have no detrimental impact on the cultural heritage of the place.

5.1.1 Assessment against VHR heritage significance

The following table provides responses that demonstrate the proposed invert lowering works at *Geelong railway tunnel* will not detrimentally impact on the heritage significance:

Statement of Significance	Response on impacts
The railway tunnel in Geelong was built between 1874 and 1875 by Overend and Robb, along the Geelong-Colac line. It is 426m long and constructed of bluestone and brick laid in the classic horseshoe shape. *The Railway Tunnel, Geelong is of architectural and historic value to Victoria.*	As the proposed works will require removing an original building fabric/feature that is buried under the railway track, the overall impact on aesthetic qualities will be minimal and non-detrimental. Brick lining, refuges and portals are retained, repaired and protected during the construction works. With this invert lowering and repair work in the railway tunnel and the approaches in front of both portals the aesthetic contribution (internally and externally) of the Geelong Railway Tunnel to both the immediate and wider urban environment will not be altered and will continue uninterrupted.
The tunnel is of architectural importance as a unique example of an early railway tunnel constructed in an urban environment in the 19th century that was also the longest in the state of Victoria, until the construction of the Melbourne underground loop. The structure demonstrates an historical association with the important expansion of the rail network in the 1870s that connected the Western District with the main lines.	The tunnel's historical association with the important expansion of the rail network in the 1870s will not be impacted by the proposed invert lowering works.
The railway tunnel in Geelong is a representative example of construction technology in accordance with 19th century railway engineering guidelines.	The attributes associated with the architectural importance as an early tunnel in an urban environment and as a representative example of 19th century railway engineering will be retained and will be minimally impacted by the proposed construction works. Any damage to the original building fabric during the construction works will be repaired on like-for-like basis.

5.1.2 Assessment against guidance from HV

The following table provides responses to the pre-lodgment guidelines/advice received to V/line from HV on 26 May and 5 Sep 2023. Responses demonstrate that the proposed invert lowering works will not detrimentally impact on the significance of the Geelong Railway Tunnel.

Relevant HV guidance/concerns (as received by V/line)	Response
1- *Concerned about altering the form and what the changes mean to the structural stability of the brick walls,*	As discussed above, except for the removal of brick invert, no significant changes are proposed within the tunnel which could alter the form of the tunnel. Lowering the invert will require inserting pre-cast concrete units under brick walls. It is acknowledged that this pre-cast concrete unit under the brick walls will change the original configuration of tunnel construction however, this addition will not alter the form of the tunnel and will not compromise the structural stability of original brick walls. The new concrete inverts (INV-1 and INV-2) with integrated drainage and pre-cast concrete unit under brick wall in the tunnel will be detailed as new and modern elements and will not replicate the details of existing.
2- *how the tunnel would be propped during any proposed construction works.*	See section 3.1.4 on PFC and rock bolt installation and See section 4.4 on Tunnel lining contingency and temporary support during construction. Pre-cast units will be installed below existing brickwork as soon as practical to minimize duration where brickwork is propped. Test areas will be undertaken to confirm sequence of works and method of propping will protect existing brickwork.
3- *Advised to demonstrate that the existing brickwork invert (or reinstated at a lower level) was considered:* • *Why the current proposal from an engineering perspective?* • *What alternatives are possible from engineering perspective?* • *What alternatives are possible with regards to keeping the heritage bricks footing – if possible and if not, why from engineering perspective.*	The proposed invert lowering was necessary to improve rail capacity and also the poor drainage were impacting the tunnel function. The existing 19th century brickwork cannot achieve the required modern design standards and minimum 50 year design life and therefore concrete components are required.
4- *how heritage fabric could be protected during the proposed works*	Brick lining within tunnel will be supported and strengthened with the help of pre-grouting, rock bolts and temporary propping to facilitate invert lowering works. Monitoring of brick lining within tunnel and portals during construction are in place to protect the tunnel from damage during construction. Additional contingency measures are in place to respond to red trigger exceedance during construction monitoring.

6.0 Conclusion

This HIS lists the heritage values of Geelong Railway Tunnel (proposed development site) based on the VHR entry, describes the proposed development works and assesses the impacts on the heritage significance of the place. The provisions of *Victorian Heritage Act*, pre-lodgment advice/guidelines from the Heritage Victoria have been used, together with the VHR statement of significance, to assess the impacts of the proposed development. This HIS has determined that the impacts of the proposed development works are appropriately managed and mitigated through expert advice from relevant heritage and engineering professionals. The proposed development responds to the guidance from HV, provided via pre-lodgment meetings.

It is considered the invert lowering works at the Geelong Railway Tunnel are appropriately designed and management measures in place for the works to proceed as heritage permit, in accordance with the guidance from HV.

7.0 Appendices

HV Entry

Victorian Heritage Database Report

Report generated 03/04/24

RAILWAY TUNNEL

RAILWAY TUNNEL SOHE 2008

RAILWAY TUNNEL SOHE 2008

1 railway tunnel geelong colac line geelong front view apr1997

H1106 tunnel extent

Location

GEELONG-COLAC LINE GEELONG, GREATER GEELONG CITY

Municipality

GREATER GEELONG CITY

Level of significance

Registered

Victorian Heritage Register (VHR) Number

H1106

Heritage Overlay Numbers

HO144

VHR Registration

May 23, 1996

Heritage Listing

Victorian Heritage Register

Statement of Significance

Last updated on - May 5, 1999

The railway tunnel in Geelong was built between 1874 and 1875 by Overend and Robb, along the Geelong-Colac line. It is 426m long and constructed of bluestone and brick laid in the classic horseshoe shape.

The Railway Tunnel, Geelong is of architectural and historic value to Victoria.

The tunnel is of architectural importance as a unique example of an early railway tunnel constructed in an urban environment in the 19th century that was also the longest in the state of Victoria, until the construction of the Melbourne underground loop. The structure demonstrates an historical association with the important expansion of the rail network in the 1870s that connected the Western District with the main lines.

The railway tunnel in Geelong is a representative example of construction technology in accordance with 19th century railway engineering guidelines.

Permit Exemptions

General Exemptions:

General exemptions apply to all places and objects included in the Victorian Heritage Register (VHR). General exemptions have been designed to allow everyday activities, maintenance and changes to your property, which don't harm its cultural heritage significance, to proceed without the need to obtain approvals under the Heritage Act 2017.

Places of worship: In some circumstances, you can alter a place of worship to accommodate religious practices without a permit, but you must notify the Executive Director of Heritage Victoria before you start the works or activities at least 20 business days before the works or activities are to commence.

Subdivision/consolidation: Permit exemptions exist for some subdivisions and consolidations. If the subdivision or

consolidation is in accordance with a planning permit granted under Part 4 of the *Planning and Environment Act 1987* and the application for the planning permit was referred to the Executive Director of Heritage Victoria as a determining referral authority, a permit is not required.

Specific exemptions may also apply to your registered place or object. If applicable, these are listed below. Specific exemptions are tailored to the conservation and management needs of an individual registered place or object and set out works and activities that are exempt from the requirements of a permit. Specific exemptions prevail if they conflict with general exemptions.

Find out more about heritage permit exemptions here.

Construction dates	1874,
Heritage Act Categories	Registered place,
Hermes Number	1928
Property Number	

Extent of Registration

AMENDMENT OF REGISTER OF HISTORIC BUILDINGS
Historic Building No. 1106:
Railway Tunnel, Geelong-Colac Line, Between Ryrie and Little Myers Streets, Geelong, City of Greater Geelong.
Extent:
To the extent of:
1. All of the structure known as the Railway Tunnel marked B-1 on Plan 601037 endorsed by the Chairperson, Historic Buildings Council and held by the Director, Historic Buildings Council.
2. All of the land 5 metres directly in front of the northern and southern portals marked L-1 and L-2 on Plan 601037, endorsed by the Chairperson, Historic Buildings Council and held by the Director, Historic Buildings Council.
[*Victoria Government Gazette* No. G20 23 May 1996 p.1339]

This place/object may be included in the Victorian Heritage Register pursuant to the Heritage Act 2017. Check the Victorian Heritage Database, selecting 'Heritage Victoria' as the place source.

For further details about Heritage Overlay places, contact the relevant local council or go to Planning Schemes Online http://planningschemes.dpcd.vic.gov.au/

Proposed drawings

(DATE)

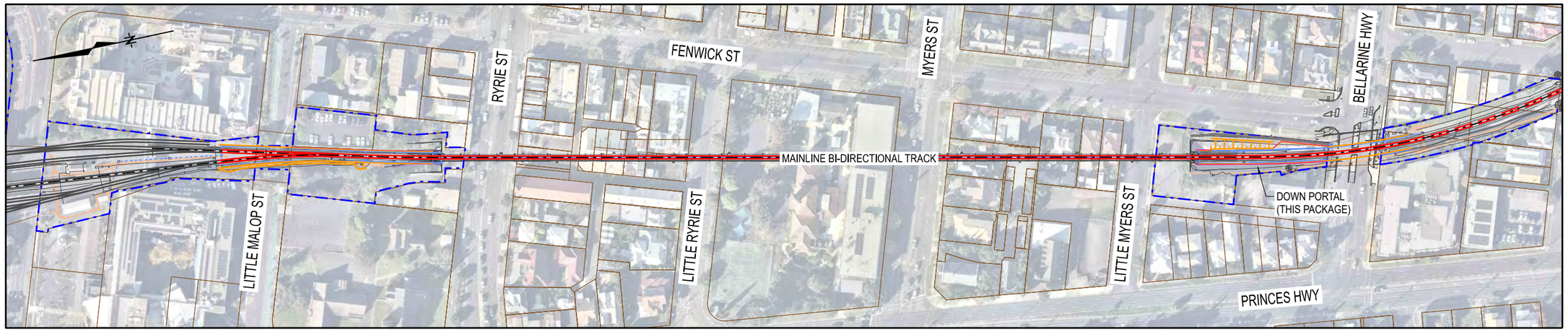
(SIGNATURE)

(BLOCK LETTERS)

Certified By:

DJILLONG TUNNEL REHABILITATION

GEOTECHNICAL DESIGN



LOCALITY PLAN
SCALE 1:2500

DRAWING No.		DRAWING TITLE
GEE_C1286	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - COVER SHEET AND DRAWING LIST
GEE_C1287	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - GENERAL NOTES SHEET 1
GEE_C1288	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN- GENERAL NOTES SHEET 2
GEE_C1289	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - GENERAL NOTES SHEET 3
GEE_C1293	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - GENERAL ARRANGEMENT PLAN DRAWING
GEE_C1295	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - ELEVATION PROFILE OF EAST CUT
GEE_C1296	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - ELEVATION PROFILE OF WEST CUT
GEE_C1297	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - TYPICAL SECTIONS - SHEET 1
GEE_C1298	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - TYPICAL SECTIONS - SHEET 2
GEE_C1299	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - TYPICAL SECTIONS - SHEET 3
GEE_C1300	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - TYPICAL SECTIONS - SHEET 4
GEE_C1301	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - SHEET PILE DETAILS
GEE_C1302	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - SOIL NAIL AND FACING DETAILS
GEE_C1304	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - SOIL NAIL SCHEDULE
GEE_C1305	GEELONG	DJILLONG TUNNEL REHABILITATION- GEOTECHNICAL DESIGN - TUNNEL PORTAL INTERFACE
GEE_C1306	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - MISCELLANEOUS DETAILS

25 0 25 50 75 100 125m
SCALE 1:2500

DRAFT IFC

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		C	20/03/24	DRAFT IFC	D.M.	H.N.	M.R.	M.B.
		B	02/02/24	FINAL DESIGN 2	D.M.	H.N.	M.R.	M.B.
		A	01/12/23	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

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Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
COVER SHEET AND DRAWING INDEX

Up Location	Down Location	Datum
East.	East.	MGA Z55
North.	North.	
ID#	ID#	

PUBLIC TRANSPORT VICTORIA PT

Document Number 523997-W00001-DRG-GR-1001	Version C
Drawn By JARUNEE R	Designed By D.MACPHIE
Checked By H.NELSON	Ind. Review M.RAMACHANDRAN
File Name	
Approved M.BUNNEY	Approval Date
Sheet No. 01 of 01	
In Serv.	
Scale N.T.S. / Sheet Size A3	Drawing Number GEE_C1286 / Revision C

(DATE)

(SIGNATURE)

(BLOCK LETTERS)

Certified By:

GENERAL

1. THIS DRAWING PACKAGE INCLUDES THE PROPOSED GOETECHNICAL ENGINEERING DRAWINGS FOR REMEDIATION OF THE CUTTING SLOPES ASSOCIATED WITH THE DOWN PORTAL OF DJILLONG TUNNEL. THIS PACKAGE SHALL BE READ TOGETHER WITH THE 'GEOTECHNICAL DESIGN REPORT FOR DOWN END PORTAL (523997-W00001-REP-GEO-003).
2. THESE DRAWINGS SHALL ALSO BE READ IN CONJUCTION WITH V/LINE INFRASTRUCTURE STANDARDS AND THE FOLLOWING DESIGN PACKAGES:
   - 523997-W00001-REP-GT-0001 - TUNNEL STRUCTURES DESIGN REPORT AND ASSOCIATED DRAWINGS
   - 523997-W00001-REP-RT-0001 - RAILWAY TRACK AND CIVIL DESIGN REPORT AND ASSOCIATED DRAWINGS
3. THIS PACKAGE IS BASED UPON INFORMATION PROVIDED BY V/LINE AND INVESTIGATIONS PERFORMED BY AURECON.
4. ALL DESIGN LEVELS IN METRES ABOVE AUSTRALIAN HEIGHT DATUM (AHD),
5. ALL CO-ORDINATES ARE EXPRESSED IN METRES TO GDA 2020, MGA Z55 (GEOCENTRIC DATUM OF AUSTRALIA, MAP GRID AUSTRALIA - ZONE 55).
6. ALL UNITS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE. RAIL CHAINAGES IN METRES.
7. THE DRAWINGS SHALL NOT BE SCALED.
8. ALL DIMENSIONS RELEVANT TO SETTING OUT SHALL BE CONFIRMED AND VERIFIED BY THE CONSTRUCTOR BEFORE CONSTRUCTION IS COMMENCED.
9. THE EXISTING GROUND LEVELS SHOWN ON THE CROSS SECTIONS ARE BASED ON AVAILABLE SURVEY INFORMATION. CLOSE TO THE TRACK THE SURVEY LEVELS ARE BASED ON AN AURECON SITE SPECIFIC SURVEY, WITH DISTANCE FROM THE TRACK, SURVEY INFORMATION IS BASED ON LIDAR AND IS LESS RELIABLE. THE CONSTUCTOR IS TO VERIFY EXISTING GROUND LEVELS AND COMMUNICATE ANY DIFFERENCES WHICH MAY IMPACT IMPLEMENTATION OF THE DESIGN TO THE DESIGNER PRIOR TO CONSTRUCTION.

SPECIFICATIONS

THESE DRAWINGS SHALL BE READ AND WORKS CARRIED OUT IN ACCORDANCE WITH THE PROJECT REQUIREMENTS, AS5100.3 AND VICROADS SPECIFICATION 610 STRUCTURAL CONCRETE, 683 SOIL NAIL WALLS AND 684 SPRAYED CONCRETE.

A. SOIL NAIL

1. RECORDS
   THE CONSTRUCTOR SHALL ENSURE ADEQUATE RECORDS OF ALL WORK ARE MAINTAINED AND THAT THE REQUIREMENTS FOR EACH SECTION OF THIS SPECIFICATION ARE MET IN THIS REGARD. THE DRILLING RECORDS SHALL CONTAIN THE FOLLOWING INFORMATION:
   - DRILLING LOCATION
   - CHANGES IN GROUND TYPE
   - GROUND WATER LEVELS ENCOUNTERED
   - DRILLED LENGTH
   - CASED LENGTH
   - VOLUME OF GROUT
   - TIME AND DATE OF START AND END OF DRILLING
   - TIME AND DATE OF GROUTING
   - COMPLIANCE CERTIFICATION

   RELEVANT RECORDS SHALL BE SUBMITTED TO THE PRINCIPAL.

2 CONSTRUCTION LOADS
THE MAXIMUM CONSTRUCTION LOADS ADJACENT TO THE SLOPE CREST SHALL BE LIMITED AS FOLLOWS: - HORIZONTAL SURFACE = 10kPa NOTE THAT OTHER LIMITS MAY APPLY AS SPECIFICALLY ADVISED BY THE GEOTECHNICAL ENGINEER.

B. BASIS OF DESIGN

1 THE DOCUMENTED GROUND SUPPORT HAS BEEN BASED UPON AVAILABLE GEOTECHNICAL INFORMATION AND CERTAIN ASSUMPTIONS ON SOIL PROPERTIES AND GROUND PROFILE THEREFORE, AS THE EXCAVATION PROGRESSES, ALL FACE EXPOSURES MUST BE ASSESSED TO CONFIRM SUITABLE SUPPORT TO BE INSTALLED.

2 GROUND CONDITIONS

GROUND CONDITIONS ASSUMED FOR DESIGN ARE AS FOLLOWS:

UNIT	EFFECTIVE COHESION c' (kPa)	EFFECTIVE FRICTION ANGLE (degrees)	ULTIMATE SKIN FRICTION (kPa)
CLAYEY SAND	2	32	36

LAYERS OF VERY STIFF SILTY CLAY MAY BE PRESENT IN SPECIFIC ZONES, PARTICULARLY TOWARDS THE TOP OF THE CUTTING. THESE SHALL BE VERIFIED BY THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST AS CONSTRUCTION PROCEEDS. WORK SHALL BE HALTED IF DESIGN CHANGES ARE REQUIRED.
DESIGN SKIN FRICTION = ULTIMATE SKIN FRICTION X GEOTECHNICAL STRENGTH REDUCTION FACTOR OF 0.55

3 SOIL PROPERTIES
THE DESIGN PARAMETERS SHALL BE VERIFIED BY THE GEOTECHNICAL ENGINEER/GEOLOGIST AS CONSTRUCTION PROCEEDS. IF THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST DETERMINES THAT SOIL CONDITIONS DIFFER ADVERSELY FROM ASSUMED DESIGN CONDITIONS, WORKS MAY NEED TO BE SUSPENDED TO ALLOW ANY REDESIGN REQUIRED TO SUIT ACTUAL SOIL CONDITIONS.

4 WATER TABLE
FOR THE PURPOSES OF THE DESIGN, THE WATER TABLE IS ASSUMED TO BE BELOW THE LEVEL OF EXCAVATION AND SOIL NAILS. IF A HIGHER WATER TABLE IS EXPECTED BASED ON ADDITIONAL GEOTECHNICALINVESTIGATION OR SEEPAGE IS ENCOUNTERED DURING CONSTRUCTION, THE CONSTRUCTOR SHALL STOP WORK AND CONTACT THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST IMMEDIATELY. WHERE THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST CONSIDERS THAT THE SEEPAGE IS LIKELY TO CONTINUE TO OCCUR, STRIP DRAINS SHALL BE PROVIDED AT THESE LOCATIONS.

5 DESIGN LOADS
THE MAXIMUM DESIGN LOADS ADJACENT TO THE SLOPE CREST ARE AS FOLLOWS: - HORIZONTAL SURFACE = 10kPA

6 CORROSION PROTECTION TREATMENT
TO ACHIEVE A 100 YEAR DESIGN LIFE THE FOLLOWING DOUBLE CORROSION PROTECTION SYSTEMS HAVE BEEN ADOPTED:
   a. GALVANISED BARS
   b. 2mm CORROSION ALLOWANCE
   c. 40mm MINIMUM GROUT COVER (40MPa) TO BAR
   d. VERY HEAVY DUTY AND ROBUST WRAPPING TAPE COMPLYING WITH REQUIREMENT OF AS/NZS 2312 TO UNDERSIDE OF NAIL HEAD (300 MIN EXTENT AND BEHIND SHOTCRETE)

C. UTILITY SERVICES

1 THE CONSTRUCTOR MUST CHECK THAT ANY CLEARANCES TO UTILITY SERVICES ARE ACHIEVED ON SITE.
2 ALL EXCAVATIONS IN THE VICINITY OF KNOWN UTILITY SERVICE LOCATIONS OR IN LOCATIONS WHERE THE EXACT UTILITY SERVICE LOCATION HAS NOT BEEN ESTABLISHED MUST BE CARRIED OUT SUCH THAT NO DAMAGE TO THE UTILITY SERVICE OCCURS.
3 ALL EXCAVATIONS MUST BE CARRIED OUT FOLLOWING THE REGULATIONS SET OUT BY EACH INDIVIDUAL UTILITY SERVICE AUTHORITY. IT IS THE CONSTRUCTORS RESPONSIBILITY TO OBTAIN THESE REGULATIONS AND TO COMPLY WITH THEM.
4 THE CONSTRUCTOR MUST MAKE ITSELF AWARE OF AND COMPLY WITH ALL UTILITY SERVICE REGULATIONS AND STANDARDS IN RELATION TO THE USE OF MACHINERY AND EQUIPMENT IN THE VICINITY OF SERVICES.
5 UNCHARTED UTILITY SERVICES MAY BE PRESENT ON SITE. THE CONSTRUCTOR MUST MAKE ALL EFFORTS TO IDENTIFY THE PRESENCE OF UTILITY SERVICES ON THE SITE AND ARRANGE FOR RELOCATION OR PROTECTION AS NECESSARY TO SUIT THE PARTICULAR WORKS IN CONJUNCTION WITH THE RELEVANT SERVICE AUTHORITY.
6. FOR THE EXISTING VICTRACKS FIBER OPTION AT CREST OF WEST SLOPE, THE BUILDING CONTRACTOR TO REVIEW GROUND PENETRATING RADAR SURVEY, COMPLETE POSITIVE IDENTIFICATION OF THE SERVICE AND ALSO ENSURE APPROPRIATE EXCAVATION CONTROLS DURING CONSTRUCTION ACTIVITIES.
7. CONTRACTOR TO TAKE NECESSARY STEPS TO AVOID ANY DAMAGE TO EXISTING UTILITIES DUE TO PROPOSED WORK AND ANY CONSTRUCTION ACTIVITIES.

D. SOIL NAILS - GENERAL

1 LOCATION
ALL SOIL NAILS SHALL BE INSTALLED AT THE LOCATIONS, LENGTHS AND INCLINATION SHOWN ON THE DRAWINGS AND AS DESIGNATED BY THE DESIGN GEOTECHNICAL ENGINEER OR AS INSTRUCTED BY THE SITE ENGINEERING GEOLOGIST OR THE SITE GEOTECHNICAL ENGINEER AFTER SITE ASSESSMENT.

2 GENERAL
   a. ALL SOIL REINFORCEMENT WORKS SHALL BE IN ACCORDANCE WITH THE DRAWINGS.
   b. SOIL NAILS SHALL BE INSTALLED AND GROUTED PRIOR TO PLACEMENT OF SHOTCRETE.
   c. SOIL NAIL LENGTH INDICATED ON THE DESIGN DRAWINGS MAY VARY TO SUIT CONDITIONS ENCOUNTERED ON SITE. THE CONSTRUCTOR SHALL THEREFORE MAINTAIN A MINIMUM SUPPLY OF VARIOUS SOIL NAIL LENGTHS ON SITE AT ALL TIMES.
   d. THE HOLES SHALL BE DRILLED WITHOUT LOSS OF GROUND WHICH MAY REQUIRE CASING. ONLY AIR FLUSHING TECHNIQUES OR AN ALTERNATIVE AS APPROVED BY SITE GEOTECHNICAL ENGINEER/GEOLOGIST AND THE DESIGNER MAY BE USED. NO WATER SHALL BE ADDED DURING THIS PROCESS. THE SOIL NAILS SHALL BE INSTALLED AND GROUTED AS SOON AS PRACTICABLE ON THE SAME DAY OF DRILLING. THE DRAIN OUTLETS AND SHOTCRETE FACING SHALL BE INSTALLED AS SOON AS PRACTICABLE FOLLOWING SOIL NAIL INSTALLATION.
   e. SOIL NAIL STEEL GRADE SHALL BE MINIMUM STEEL GRADE OF 500 MPa. THE SOIL NAIL WILL BE DEFORMED REINFORCING BAR, TO AS/NZS 4671 AND GALVANISED IN ACCORDANCE WITH DRAWINGS U.N.O.
   f. CONVENTIONAL SOIL NAILS HAVE BEEN SPECIFIED. CASING MAY BE REQUIRED FOR TEMPORARY CONSTRUCTION IF THE NAIL BORE EXPERIENCES INSTABILITY. THE ALTERNATIVE IS SELF-DRILLING SOIL NAILS HOWEVER THE DURABILITY ISSUES WOULD NEED TO BE ADDRESSED,
   g. WHERE SOIL NAILS ARE TO BE REPOSITIONED DUE TO OBSTRUCTIONS, THE NEW LOCATIONS SHALL BE AGREED WITH THE GEOTECHNICAL DESIGN ENGINEER.

3. GROUT

NAIL GROUT SHALL COMPLY WITH THE PROJECT STRUCTURAL SPECIFICATION AND THE FOLLOWING NOTES.
   a. THE GROUT SHALL BE A PUMPABLE MIXTURE WITH A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 40 MPa .
   b. THE WATER CEMENT RATIO SHALL TYPICALLY BE 0.4 FOR LEACHING AND SULPHATE RESISTANCE AND SHALL NOT BE LESS THAN 0.38 OR EXCEED 0.45 BY MASS. IF THE GROUND WATER TABLE IS LOCATED ABOVE THE SOIL NAILS AND A HIGH FLOW RATE IS PRESENT, TESTING SHALL BE CARRIED OUT TO ESTABLISH PRACTICAL LIMITS OF THE WATER CEMENT RATIO.

4 CENTRALISERS
CENTRALISERS SHALL BE FABRICATED FROM PLASTIC ONLY, SHALL BE NOT DETRIMENTAL TO THE PERFORMANCE OF THE NAIL AND SHALL BE OF SUFFICIENT STRENGTH TO HOLD THE BAR IN PLACE. THE CENTRALISER SHALL BE SPACED AT MAXIMUM CENTRES OF 1000mm AND MAINTAIN THE BAR IN THE CENTRE OF THE DRILL HOLE WITH REQUIRED COVER AND SHALL NOT PREVENT AIR FLUSHING AND GROUTING OF THE HOLE.

5 CLEANING OF HOLE
WATER OR OTHER LIQUIDS SHALL NOT BE USED TO FLUSH HOLES. HOWEVER, AIR FLUSHING TECHNIQUES MAY BE USED TO CLEAN HOLES. NAIL HOLES SHALL BE CLEANED BY BLASTING WITH COMPRESSED AIR FROM THE BOTTOM OF THE HOLE IMMEDIATELY BEFORE BAR INSTALLATION AND AGAIN AFTER BAR INSTALLATION WHICH IS IMMEDIATELY BEFORE GROUTING. CLEANING SHALL BE CONDUCTED AS SOON AS PRACTICABLE IN THE SAME DAY AFTER DRILLING. NAILS SHALL BE INSERTED AND GROUTED ON THE SAME DAY AS THE COMPLETION OF DRILLING THE HOLE.

E. CONSTRUCTION PHASE GEOTECHNICAL ASSESSMENT

1 THE FOLLOWING PERSONS ARE RESPONSIBLE FOR UNDERTAKING THE CONSTRUCTION PHASE GEOTECHNICAL ASSESSMENT:
   a. SITE GEOTECHNICAL ENGINEER/GEOLOGIST: THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST IS THE PERSON RESPONSIBLE FOR INSPECTION AND CARRYING OUT FACE MAPPING AND GEOLOGICAL LOGGING OF THE EARTHWORKS CUT FACES DURING CONSTRUCTION, TO THE EXTENT REQUIRED TO DETERMINE IF THE AS-EXPOSED CONDITIONS ARE CONSISTENT WITH THE DESIGN INTENT. THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST WILL INSPECT THE EXPOSED FACE.
   b. THE DESIGNER: THE DESIGNER IS THE PERSON, TOGETHER WITH THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST, RESPONSIBLE FOR THE ASSESSMENT OF THE EXPOSED CONDITIONS TO DETERMINE WHETHER THEY ARE CONSISTENT WITH THE DESIGN ASSUMPTIONS. THE DESIGNER SHALL VISIT THE EARTHWORKS AS REQUIRED BY THE CONSTRUCTOR DURING EXCAVATION WORKS. THE DESIGNER SHALL LIASE WITH THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST REGARDING THE EXPOSED CONDITIONS AND MONITORING RECORDS. THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST AND DESIGNER SHALL TOGETHER DETERMINE WHETHER ANY CHANGE TO THE DOCUMENTED FACE SUPPORT IS NECESSARY AND IF REQUIRED, JOINTLY ISSUE A SITE INSTRUCTION DETAILING THE REQUIRED CHANGES.
2. THE EXISTING SLOPE IS CONSIDERED TO HAVE A LOW EXISTING FACTOR OF SAFETY AGAINST SLIP INSTABILITY. TEMPORARY WORKS SHALL BE CARRIED OUT IN STAGES TO AVOID ANY EARTH SLIPS. AN OBSERVATIONAL APPROACH IS TO BE APPLIED. APPROPRIATE REMEDIATION WORK MAYBE REQUIRED IF THE SLOPES SHOW ANY SIGNS OF INSTABILITY. IF THE GROUND CONDITIONS ARE MORE ADVERSE THAN WHAT IS DESIGNED, THE CONTRACTOR IS TO ADJUST THE CONSTRUCTION SEQUENCE ACCORDINGLY AND IMMEDIATELY INFORM THE DESIGNER, WHO SHALL ASSESS IF ANY FURTHER DESIGN CHANGES ARE REQUIRED.
3. THE MONITORING FREQUENCY SHALL BE INCREASED IF THERE ANY SIGNS OF SLOPE INSTABILITY.
4. SITE GEOTECHNICAL ENGINEER TO INSPECT THE SLOPE SURFACE EVERY DAY, AND AFTER EVERY STAGE OF EXCAVATION (INCLUDING EACH EXCAVATION STAGE TO EACH SOIL NAIL ROW) OR RAINFALL EVENT TO CHECK FOR SIGNS OF INSTABILITY.
5. CONTRACTOR TO SEQUENCE EXCAVATIONS AND SOIL NAILING TO ENSURE TEMPORARY STABILITY. THERE IS POTENTIAL FOR EXCAVATION TO BE COMPLETED IN LIMITED LIFTS IN A TOP DOWN SEQUENCE (I.E. EXCAVATE TO 1ST ROW OF SOIL NAILS AND INSTALL SOIL NAILS PRIOR TO FURTHER EXCAVATION FOR NEXT ROW OF SOIL NAILS; AND THEN REPEAT METHODOLOGY). CONSTRUCTION METHODS MAY BE SUBJECT TO CHANGE IF GROUND CONDITION IS DIFFERENT FROM EXPECTED.
6. SLOPE SHOULD NOT BE LEFT EXPOSED FOR LONGER THAN NECESSARY DUE TO POTENTIAL FOR DETERIORATION OF SLOPE SURFACE CONDITION FROM RAINFALL. INSTALLATION OF PERMANENT EROSION PROTECTION (MAC-MAT R, GEOJUTE AND SEEDED TOPSOIL) TO BE EXPEDITED, WHERE POSSIBLE.

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Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
GENERAL NOTES - SHEET 1

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

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F. SEQUENCE

1 EXCAVATION

POTENTIAL CONSTRUCTION SEQUENCE:

a. INSTALL SHEET PILES (AND MONITORING POINTS ON SHEET PILES)
   - LOCALLY CUT AND REMOVE EXISTING SHOTCRETE BELOW FOOTPRINT OF SHEET PILES PRIOR TO INSTALLATION.
b. REMOVE SHOTCRETE AND REGRADE SLOPES.
c. INSTALL SOIL NAILS AND UNDERTAKE TESTING
d. INSTALL FLEXIBLE GEOTEXTILE FACING (MACMAT R) AND PINS
e. SPRAY SEEDED TOPSOIL AND PROTECT WITH GEOJUTE. INSTALL SOIL NAIL PLATES AND BOLTS AND CONCRETE COVER
f. EXCAVATION IN FRONT OF SLOPE TOES TO FINAL EXCAVATION LEVEL
g. CONSTRUCT NEW TRACKBED AND DRAINS
h. CONSTRUCT BALLAST.

THE ABOVE CONSTRUCTION SEQUENCE IS INDICATIVE AND BEST CASE SCENARIO. THE CONTRACTOR IS LIKELY TO UNDERTAKE A MORE PHASED APPROACH TO MITIGATE RISKS OF TEMPORARY INSTABILITY (REFER TO SECTION E ON DWG. C1287)
TO BEST CONTROL WALL MOVEMENTS, TEMPORARY EXCAVATIONS SHALL BE BACKFILLED (COMPLETION OF TRACK FORMATION WORKS AND DRAINAGE) AS SOON AS REASONABLY POSSIBLE, PREFERABLY WITHIN THE SAME SHIFT. THE TEMPORARY EXCAVATION IN FRONT OF RETAINING WALLS OR FOR THE EXISTING SLOPES SHALL NOT BE LEFT EXPOSED IN WET WEATHER, WHICH MAY CAUSE SUBGRADE WEAKENING.

2 HOLES

a. ALL HOLES SHALL BE DRILLED AT THE LOCATIONS INDICATED. ALL DRILLED HOLES AS PER VICROADS SPECIFICATION 683 SOIL NAIL WALLS UNLESS OTHERWISE DETERMINED BY THE GEOTECHNICAL ENGINEER/GEOLOGIST. DETERMINATION SHALL BE ON THE BASIS OF ACTUAL GROUND CONDITIONS.
b. THE CONSTRUCTOR SHALL DRILL THE MINIMUM HOLE DIAMETER INDICATED ON THE DRAWINGS USING APPROPRIATE DRILLING METHODS.
c. THE NAILS SHALL BE INSTALLED AND GROUTED ON THE SAME DAY AS DRILLING

3 HANDLING OF NAILS

NAILS SHALL BE HANDLED AND STORED IN A MANNER TO AVOID DAMAGE OR CORROSION. DAMAGE TO THE NAIL STEEL AS A RESULT OF ABRASIONS, CUTS, NECKS, WELDS AND WELD SPLATTER WILL BE CAUSE FOR REJECTION. THE NAIL STEEL SHALL BE PROTECTED IF WELDING IS TO BE PERFORMED IN THE VICINITY. GROUNDING OF WELDING LEADS TO THE NAIL STEEL WILL NOT BE ALLOWED. NAIL STEEL SHALL BE PROTECTED FROM DIRT, RUST, AND DELETERIOUS SUBSTANCES. IF HEAVY CORROSION OR PITTING IS NOTED THE NAILS WILL BE REJECTED. THE BAR SHALL BE INSERTED INTO THE HOLE TO THE REQUIRED DEPTH WITHOUT DIFFICULTY.

4 GROUTING

a. THE GROUT MAY BE PUMPED THROUGH GROUT TUBES ONLY.
b. THE GROUT SHALL BE PLACED IMMEDIATELY AFTER INSERTION OF THE NAIL AND CLEANING OF THE HOLE, USING EQUIPMENT WHICH PRODUCES GROUT IN ACCORDANCE WITH THE PROJECT STRUCTURAL SPECIFICATION. THE GROUT EQUIPMENT SHALL PRODUCE A UNIFORMLY MIXED GROUT.
c. THE GROUTING EQUIPMENT SHALL BE SIZED TO ENABLE THE GROUT TO BE PUMPED IN ONE CONTINUOUS OPERATION. THE MIXER SHALL BE CAPABLE OF CONTINUOUSLY AGITATING THE GROUT.
d. THE QUANTITY AND PRESSURE OF THE GROUT INJECTED INTO EACH DRILL HOLE SHALL BE CAREFULLY MONITORED. THE DESIGNER SHALL BE NOTIFIED IF EXCESSIVE OR LESS GROUT IS REQUIRED DURING THE GROUTING OPERATION.
e. THE GROUTING PROCEDURE SHALL ENABLE GROUT TO COMPLETELY FILL THE HOLE TO THE REAR OF SHOTCRETE FACING IN ONE OPERATION.

5 FACING

a. REFER TO GEE1302 FOR FACING DETAILS FOR SOIL NAILS.

6 TOLERANCES

- VERTICAL LOCATION OF SOIL NAIL: + 50mm, - 50mm
- HORIZONTAL LOCATION OF SOIL NAIL: + 50mm, - 50mm
- SOIL NAIL/ROCK BOLT INCLINATION: -3° TO 0°
- HOLE DIAMETER: NO LESS THAN STATED ON THE DRAWINGS
- COVER: -0mm CONSTRUCTOR TO ENSURE DRILLED HOLE SIZE ACHIEVES 40mm MINIMUM GROUT COVER THROUGHOUT

G. DRAINAGE

1. WEEP HOLES THROUGH SHEET PILE WALL SHALL BE JET FILTER MAINTABLE WEEP HOLE FILTER SYSTEM OR SIMILAR.
2. WEEP HOLES TO BE MIN 100MM DIAMETER WITH NOMINAL FALL OF 1:100.

H. SITE SAFETY

1. ALL WORK SHALL BE PERFORMED TO THE MINIMUM REQUIREMENTS OF ALL RELEVANT LOCAL AUTHORITIES.
2. TEMPORARY OPEN CUTS ARE NOT COVERED BY THIS DESIGN DOCUMENTATION.
3. EXCAVATION SHALL NOT PROCEED BELOW ELEVATIONS (BASE OF TRACKBED AND DRAINAGE INVERT LEVEL) SHOWN ON THIS DRAWING SET WITHOUT CONFIRMATION FROM THE GEOTECHNICAL DESIGN ENGINEER, DUE TO RISK OF DESTABILISING THE SLOPE/RETAINING WALL.
4. NO SURCHARGING, STATIONARY MACHINARY OR STOCKPILING OF MATERIAL IS PERMITTED BEHIND THE SHEET PILE WALL OR 2m BEHIND THE SLOPE CREST.
5. CONTRACTOR TO BEST MINIMISE THE FOOTPRINTS OF TEMPORARY EXCAVATION FOR INSTALLING DRAINAGE AND TRACKBED FORMATION, BY USING DISCRETE BAY EXCAVATION AND REPLACEMENT APPROACH, WHERE PRACTICAL.
6. TREE REMOVAL IN FRONT OF HOUSE, THE CONTRACTOR TO DEVELOP A SAFE METHODOLOGY FOR REMOVAL OF TREE. ANY OVER EXCAVATION TO BE BACKFILLED WITH CEMENT STABILISED FILL (4%).

I. SHOTCRETE

1. EXISTING SHOTCRETE IN ZONES A AND I TO BE LEFT IN-SITU.
2. NEW SHOTCRETE FOR WRAPAROUND DETAIL TO BE APPLIED IN ACCORDANCE WITH VICROADS SECTION 684.

J. SOIL NAIL TESTING

THREE TYPES OF TEST ARE TO BE PERFORMED.
1. PULLOUT (VERIFICATION) TESTS ON SACRIFICIAL NAILS,
2. EXHUMATION TESTS ON SACRIFICIAL NAILS, AND
3. PULLOUT (PROOF) TESTS ON PRODUCTION NAILS

EXHUMATION TESTS ARE RECOMMENDED TO BE UNDERTAKEN IN ZONE M WHICH IS TO EXCAVATED IN FRONT OF THE SHEET PILES.

RECORDS OF NAIL TESTING : THE FOLLOWING INFORMATION IS TO BE REPORTED :
- SPECIFIC POSITION OF TEST NAIL IN THE FACE.
- HOLE DIAMETER AND DEPTH/LENGTH.
- GEOTECHNICAL SOIL UNIT (TO BE LOGGED BY GEOTECHNICAL ENGINEER). - METHOD OF DRILLING - NAIL LENGTH
- LENGTH OF NAIL GROUTED
- GROUT TYPE, MIX PROPORTIONS AND DESIGN STRENGTH.

THE CONSTRUCTOR SHALL KEEP RECORDS OF ALL RESULTS OF ALL TESTS. RECORDS OF RESULTS SHALL BE SUBMITTED TO THE ALLIANCE OR DESIGNER.

1 PULLOUT (VERIFICATION) TESTS ON SACRIFICIAL NAILS :

a. AT LEAST 3 PULLOUT TESTS ARE TO BE CARRIED OUT IN ACCORDANCE WITH THE TEST LOADS.
b. UNLESS NOTED OTHERWISE, DRILLING AND NAIL INSTALLATION SYSTEM FOR THE VERIFICATION NAILS SHALL BE THE SAME AS THE PRODUCTION NAILS TO VERIFY THE DESIGN ASSUMPTIONS.
c. HOLE AND NAIL DIAMETER SHOULD BE THE SAME AS THE PRODUCTION NAILS.
d. THE PROPOSED LOCATIONS OF THE TESTS SHALL BE SUBMITTED FOR APPROVAL OF THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST PRIOR TO TESTING.
e. TEST NAILS ARE TO HAVE A BONDED LENGTH OF 3m AND A MINIMUM FREE LENGTH OF 1m
f. MEASUREMENTS SHOULD BE TAKEN TO EXACTLY RECORD THE INITIAL HOLE DEPTH AND THE GROUTED LENGTH.
g. NAILS SHOULD BE INCLINED AT LEAST 15° DOWN FROM THE HORIZONTAL PLANE TO ENSURE THAT THE GROUT FILLS THE THE HOLE SPACE AROUND THE BAR OVER THE GROUTED LENGTH.
h. THE REACTION PLATE OR BEAM SYSTEM SHOULD BE PROPORTIONED TO LIMIT THE FACE STRESSES TO NOT MORE THAN THE BEARING CAPACITY FAILURE OF THE REACTION SYSTEM.
i. PULL-OUT TESTING SHALL BE PERFORMED IN ACCORDANCE WITH VICROADS SPECIFICATION 683 SOIL NAIL WALLS.
j. NAIL EXTENSION (RELATIVE TO THE EXCAVATION FACE) DURING THE TESTS SHALL BE MEASURED INDEPENDENTLY FROM ANY LOADING PLATES OR FRAMES TO AN ACCURACY OF 0.1mm. THE DEFLECTION REFERENCE SHOULD BE SHIELDED FROM DIRECT SUNLIGHT TO MINIMISE TEMPERATURE INFLUENCES.
k. VERIFICATION TEST AND SACRIFICIAL TEST SHALL HAVE LOADING CYCLES IN ACCORDANCE WITH TABLE 683.161.

2 VERIFICATION OF MINIMUM GROUT COVER :

a. PRIOR TO COMMENCEMENT OF PRODUCTION NAILING, THE BATCH OF NAILS USED FOR THE SACRIFICIAL PULLOUT TESTS SHALL BE EXHUMED. EXHUMED NAILS SHALL BE CUT THROUGH AT BOTH ENDS AND AT 500mm SPACING. MEASURE THE MINIMUM COVER AT EACH CROSS SECTION. THE GROUT COVER WILL BE VERIFIED TO ENSURE THAT THE MINIMUM COVER IS NOT LESS THAN THE DOCUMENTED COVER.
b. IF THE NAILS FAIL TO MEET THE MINIMUM COVER REQUIREMENT THEN THE CONSTRUCTOR SHALL CHANGE THE WORK METHOD AND/OR EQUIPMENT AND A SECOND BATCH OF NAILS SHALL BE INSTALLED AND EXHUMED.
c. IN THE EVENT THERE IS A CHANGE IN THE CONSTRUCTOR, WORK METHOD, EQUIPMENT OR FIXTURE USED FOR THE NAIL INSTALLATION, THE TESTING SHALL BE REPEATED TO VERIFY THE MINIMUM COVER REQUIREMENTS HAVE BEEN MET.

3 PULL OUT (PROOF) TESTING ON PRODUCTION NAILS :

a. PROOF TESTING SHALL BE PERFORMED ON PRODUCTION NAILS FOR EACH ROW OF SOIL NAILS, UNIFORMLY DISTRIBUTED OVER THE AREA OF EACH ROW, SUCH THAT TESTING INCLUDES THE GREATEST NUMBER OF THE FOLLOWING:
   - 5% OF THE TOTAL NUMBER OF SOIL NAILS.
   - 2 No. SOIL NAILS
   - 2 No. SOIL NAILS PER INSTALLATION METHOD
   - 2 No. SOIL NAILS PER EACH SOIL TYPE THE LOCATIONS OF TESTS SHALL BE DETERMINED BY THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST.
b. PRODUCTION NAIL TEST SHALL HAVE LOADING CYCLES IN ACCORDANCE WITH TABLE 683.162.
c. THE MAXIMUM TEST LOAD IS TO BE SELECTED BASED ON THE BONDED LENGTH AS PER TABLE 2, WHICH REPRESENTS LOAD.
d. THE MAXIMUM TEST LOAD IS TO BE THE LESSER OF 90% OF THE BAR YIELD LOAD AND 1.5 TIMES THE DESIGN ALLOWABLE GROUND-GROUT PULL OUT RESISTANCE BASED ON THE BONDED LENGTH OF THE TEST NAIL.
e. 4m TEST NAILS SHALL HAVE A FREE LENGTH OF AT LEAST 1m USING APPROVED CLOSE FITTING PVC SHEATH TAPE SEALED TO NAIL.
f. PRODUCTION NAILS ARE CONSIDERED ACCEPTABLE IF THE CRITERIA IN VICROADS SECTION 683 ARE MET.
g. AT THE COMPLETION OF TESTING, FULL RECORDS OF LOAD AND NAIL EXTENSION SHALL BE SUPPLIED TO THE GEOTECHNICAL ENGINEER ALONG WITH A COPY OF CURRENT JACK CALIBRATION CERTIFICATES.
h. ALL EQUIPMENT SHALL BE CALIBRATED TO THE RELEVANT AUSTRALIAN STANDARD BY A NATA REGISTERED LABORATORY.
i. TEST RESULTS SHALL BE REVIEWED BY DESIGN REPRESENTATIVE. PRODUCTION NAILS WHICH PASS THE PROOF TESTING WILL REMAIN. NAILS WHICH FAIL THE TEST SHALL BE REMOVED AND NEW NAILS INSTALLED AND RE-TESTED.
j. NO FURTHER EXCAVATION BELOW THE COMPLETED ROW OF NAILS SHALL TAKE PLACE UNTIL PROOF TESTING CONFIRMS THE DESIGN SKIN FRICTION HAS BEEN ACHIEVED.
k. A TEST NAIL SHALL NOT FORM PART OF THE PRODUCTION NAILS UNLESS OTHERWISE APPROVED BY THE SITE GEOTECHNICAL ENGINEER. ALL TEST NAILS WHICH DO NOT FORM PART OF THE PRODUCTION NAILS SHALL BE TRIMMED TO A MINIMUM OF 100 mm BELOW THE FINISHED BATTER FACE AND SHALL BE FULLY GROUTED ON COMPLETION OF THE PULL OUT TEST.

TABLE 1 BELOW GIVES THE MAXIMUM TEST LOADS FOR PULLOUT TESTS.
A 3m BOND LENGTH HAS BEEN ASSUMED AND ADJUSTMENTS WILL NEED TO BE MADE FOR BONDED LENGTHS OTHER THAN 3m.

TABLE 1 - NOMINATED TEST LOADS FOR DESIGN VERIFICATION TYPE I PULLOUT TESTS (150mm HOLE)

PULLOUT TESTS (VERIFICATION TEST)		
	TEST NAIL BOND LENGTH = 3m, 15 deg.	
MATERIAL THAT NAIL IS EXPECTED TO BE EMBEDDED INTO	ULTIMATE SKIN FRICTION (kPA)	NOMINATED TEST LOAD (kN)
CLAYEY SAND	36	51

TABLE 2 PROVIDES MAXIMUM QA TEST ON PRODUCTION NAILS
TYPE 2- SACRIFICIAL AND EXUMATION TESTS SHALL BE UNDERTAKEN IN ACCORDANCE WITH VICROADS SECTION 683.14

TABLE 2 - MAXIMUM TEST LOADS (kN) (150mm HOLE)

PROOF TESTING ON PRODUCTION NAILS		
MATERIAL THAT NAIL IS EXPECTED TO BE EMBEDDED INTO	15 deg. INCLINATION	
	BONDED LENGTH (M)	MAXIMUM TEST LOAD (kN)
CLAYEY SAND	2	20
	3	30

NOTE - MAXIMUM TEST LOADS IS BASED ON GEOTECHNICAL DESIGN SKIN RESISTANCE (DESIGN LOAD) AND AREA OF GROUT-SOIL INTERFACE MULTIPLIED BY 1.5. TEST LOADS ARE NOT TO EXCEED 90% OF THE BAR YIELD.
MINIMUM BOND LENGTH IS TO BE 2M WITH 1M FREE LENGTH (UNGROUTED LENGTH), EXCEPT FOR SOIL NAILS LESS THAN 3M (DUE TO SPACE CONSTRAINTS).

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Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
GENERAL NOTES - SHEET 2

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K. MONITORING

TABLE 3 -INSTRUMENTATION AND MONITORING DETAILS

LOCATION	DETAILS
SHEET PILED WALL AT DOWN PORTAL (EAST SIDE)	3 SURVEY POINTS AT TOP OF SHEET PILE
SHEET PILED WALL (WEST SIDE)	5 SURVEY POINTS AT TOP OF SHEET PILE
WALL AT LAYDOWN AREA	4 SURVEY POINTS AT TOP OF SHEET PILE
SOIL NAIL SLOPE	TOP OF SLOPE TYPICALLY EVERY 20M
PROPERTY	3 SURVEY POINTS ON CREST OF SLOPE BELOW PROPERTY
	EXISTING CONDITION SURVEY OF PROPERTY TO BE UNDERTAKEN PRIOR TO WORKS AND POST WORKS.
CAR PARKS	2 SURVEY POINTS ON CREST OF SLOPE.
	EXISTING CONDITION SURVEY OF CAR PARK TO BE UNDERTAKEN PRIOR TO WORKS AND POST WORKS.
TUNNEL PORTAL	EXISTING CONDITION SURVEY OF TUNNEL PORTAL REQUIRED BEFORE AND AFTER THE WORKS.
SERVICES	EXISTING SERVICES AND INFRASTRUCTURE TO BE MONITORED AS PER REQUIREMENTS OF THE 3RD PARTY ASSET OWNERS.

1. APPROXIMATE LOCATION OF MONITORING POINTS IS SHOWN ON PLAN LAYOUT
2. AS CONSTRUCTION TAKES PLACE, THE CONTRACTOR SHALL RECORD LEVELS OF SOIL NAILS AND LATERAL DEFLECTION OF THE WALL.
3. AFTER TAKING READINGS THE RESULTS SHALL BE RECORDED IN ELECTRONIC AND HARD COPY FORMAT AND ARE TO BE FORWARDED TO THE DESIGNER. MONITORING TRIGGER LEVELS ARE PROVIDED IN THE TABLE.
   - GREEN - CONTINUE EXCAVATION
   - AMBER - INCREASE MONITORING FREQUENCY
   - RED - IMPLEMENT MEASURES TO CEASE MOVEMENT THIS MAY INVOLVE HALTING EXCAVATION IN FRONT OF RETAINING WALLS OR SLOPE. IF WALL MOVEMENT CONTINUES TO BECOME EXCESSIVE BACKFILL MAY BE REQUIRED IN FRONT OF WALL.
4. MONITORING SHALL BE TWICE A WEEK DURING CONSTRUCTION. ONCE CONSTRUCTION IS COMPLETED, MONITORING SHALL CONTINUE ONCE A WEEK FOR FOUR WEEKS. AFTER THAT MONITORING INTERVAL SHALL NOT EXCEED ONE MONTH FOR FIRST SIX MONTHS IMMEDIATELY FOLLOWING COMPLETION OF AND AT INTERVALS NOT EXCEEDING SIX MONTHS THEREAFTER UNTIL END OF DEFECTS LIABILITY PERIOD.
5. PARTICULAR ATTENTION TO MONITORING IS DURING THE TEMPORARY EXCAVATION STAGE (I.E TO AND AT FINAL EXCAVATION LEVEL).

	MONITORING TRIGGER LEVELS (mm)		
	GREEN	AMBER	RED
EAST RETAINING WALL	10	15	20
WEST RETAINING WALL	15	20	25
SLOPES	10	15	20

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Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
GENERAL NOTES - SHEET 3

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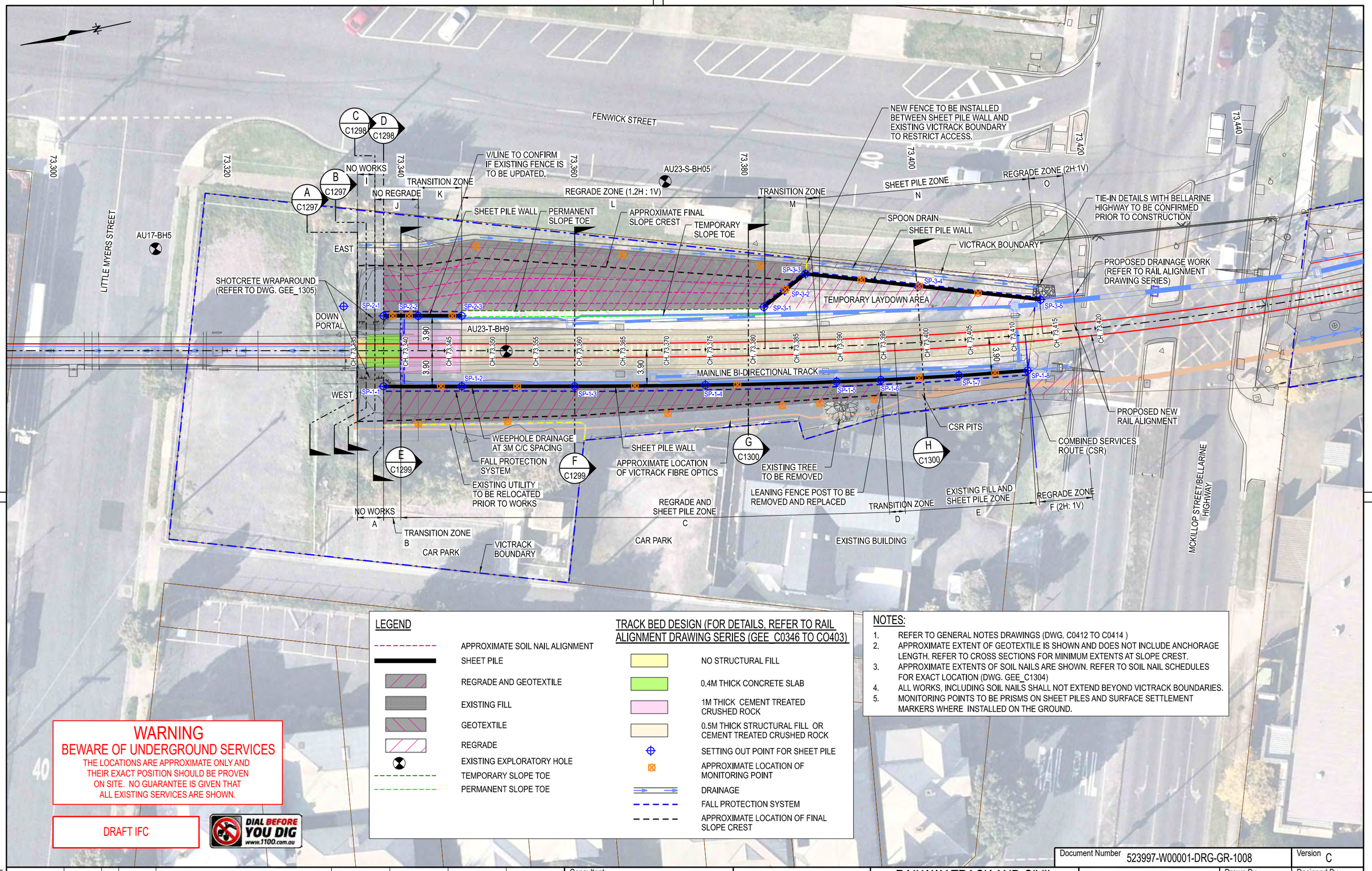

LEGEND

- APPROXIMATE SOIL NAIL ALIGNMENT
- SHEET PILE
- REGRADE AND GEOTEXTILE
- EXISTING FILL
- GEOTEXTILE
- REGRADE
- EXISTING EXPLORATORY HOLE
- TEMPORARY SLOPE TOE
- PERMANENT SLOPE TOE

TRACK BED DESIGN (FOR DETAILS, REFER TO RAIL ALIGNMENT DRAWING SERIES (GEE_C0346 TO CO403)

- NO STRUCTURAL FILL
- 0.4M THICK CONCRETE SLAB
- 1M THICK CEMENT TREATED CRUSHED ROCK
- 0.5M THICK STRUCTURAL FILL OR CEMENT TREATED CRUSHED ROCK
- SETTING OUT POINT FOR SHEET PILE
- APPROXIMATE LOCATION OF MONITORING POINT
- DRAINAGE
- FALL PROTECTION SYSTEM
- APPROXIMATE LOCATION OF FINAL SLOPE CREST

NOTES:

1. REFER TO GENERAL NOTES DRAWINGS (DWG. C0412 TO C0414)
2. APPROXIMATE EXTENT OF GEOTEXTILE IS SHOWN AND DOES NOT INCLUDE ANCHORAGE LENGTH. REFER TO CROSS SECTIONS FOR MINIMUM EXTENTS AT SLOPE CREST.
3. APPROXIMATE EXTENTS OF SOIL NAILS ARE SHOWN. REFER TO SOIL NAIL SCHEDULES FOR EXACT LOCATION (DWG. GEE_C1304)
4. ALL WORKS, INCLUDING SOIL NAILS SHALL NOT EXTEND BEYOND VICTRACK BOUNDARIES.
5. MONITORING POINTS TO BE PRISMS ON SHEET PILES AND SURFACE SETTLEMENT MARKERS WHERE INSTALLED ON THE GROUND.

WARNING
BEWARE OF UNDERGROUND SERVICES
THE LOCATIONS ARE APPROXIMATE ONLY AND THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. NO GUARANTEE IS GIVEN THAT ALL EXISTING SERVICES ARE SHOWN.

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Consultant: aurecon
Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
GENERAL ARRANGEMENT PLAN DRAWING

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

Drawn By: JARUNEE R	Designed By: D.MACPHIE
Checked By: H.NELSON	Ind. Review: M.RAMACHANDRAN
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Document Number: 523997-W00001-DRG-GR-1008
Version: C
Drawing Number: GEE_C1293
Revision: C

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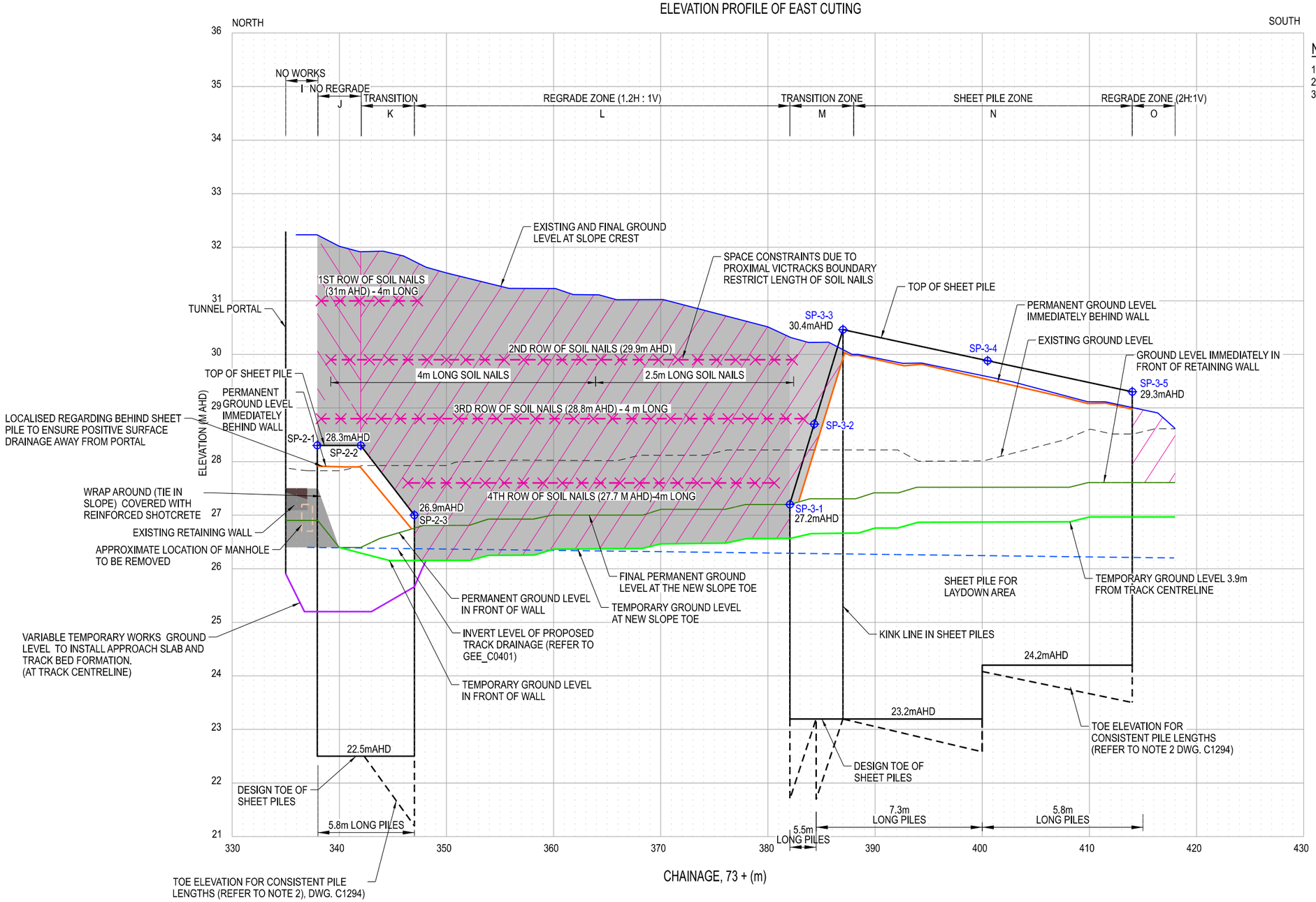
ELEVATION PROFILE OF EAST CUTING



NOTES:

1. ALL NAILS ARE HORIZONTALLY SPACED AT 1.8M C/C.
2. KEY FOR HATCHED AREAS IS PROVIDED ON DWG. C1293
3. REFER TO SOIL NAIL SCHEDULE (DWG. C1304).

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Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
ELEVATION PROFILE OF EAST CUT

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

Document Number	523997-W00001-DRG-GR-1010
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Designed By	D.MACPHIE
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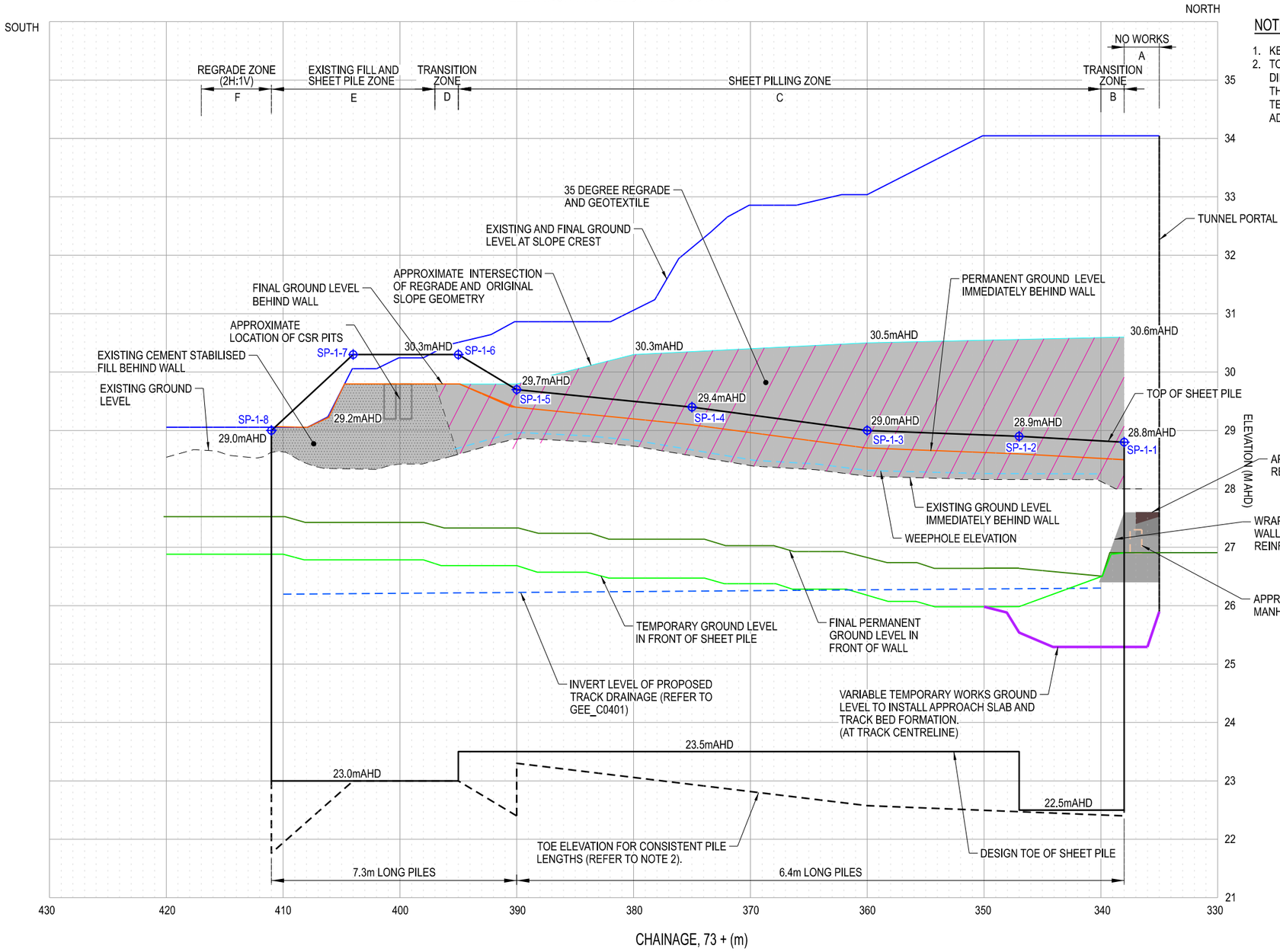
ELEVATION PROFILE OF WEST CUTING



NOTES:

1. KEY FOR HATCHED AREAS IS PROVIDED ON DWG. C1293
2. TOE ELEVATION TO ENSURE CONSISTENT PILE LENGTH FOR DIFFERENT ZONES TO FACILITATE EASY CONSTRUCTION BY THE CONTRACTOR. IN THE EVENT WHERE PILE DEPTH TERMINATES PREMATURELY, THERE IS AN OPTION TO ADOPT THE DESIGN TOE OF SHEET PILE.

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RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
ELEVATION PROFILE OF WEST CUT

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

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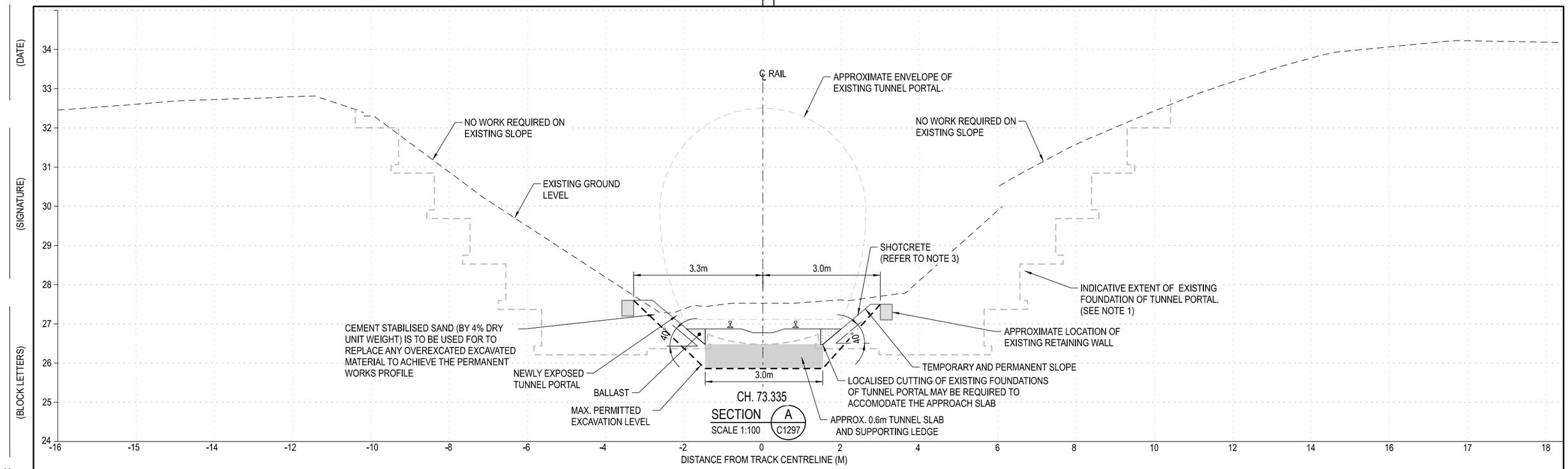

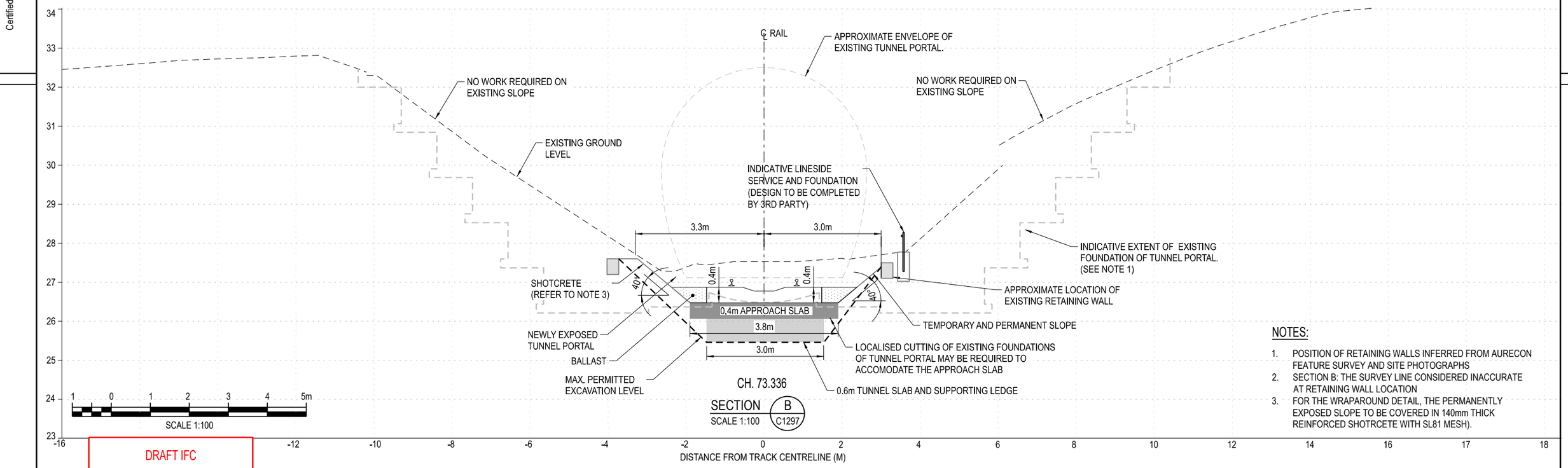

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NOTES:

1. POSITION OF RETAINING WALLS INFERRED FROM AURECON FEATURE SURVEY AND SITE PHOTOGRAPHS
2. SECTION B: THE SURVEY LINE CONSIDERED INACCURATE AT RETAINING WALL LOCATION
3. FOR THE WRAPAROUND DETAIL, THE PERMANENTLY EXPOSED SLOPE TO BE COVERED IN 140mm THICK REINFORCED SHOTRCETE WITH SL81 MESH).

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RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
TYPICAL SECTIONS - SHEET 1

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

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H.NELSON	M.RAMACHANDRAN
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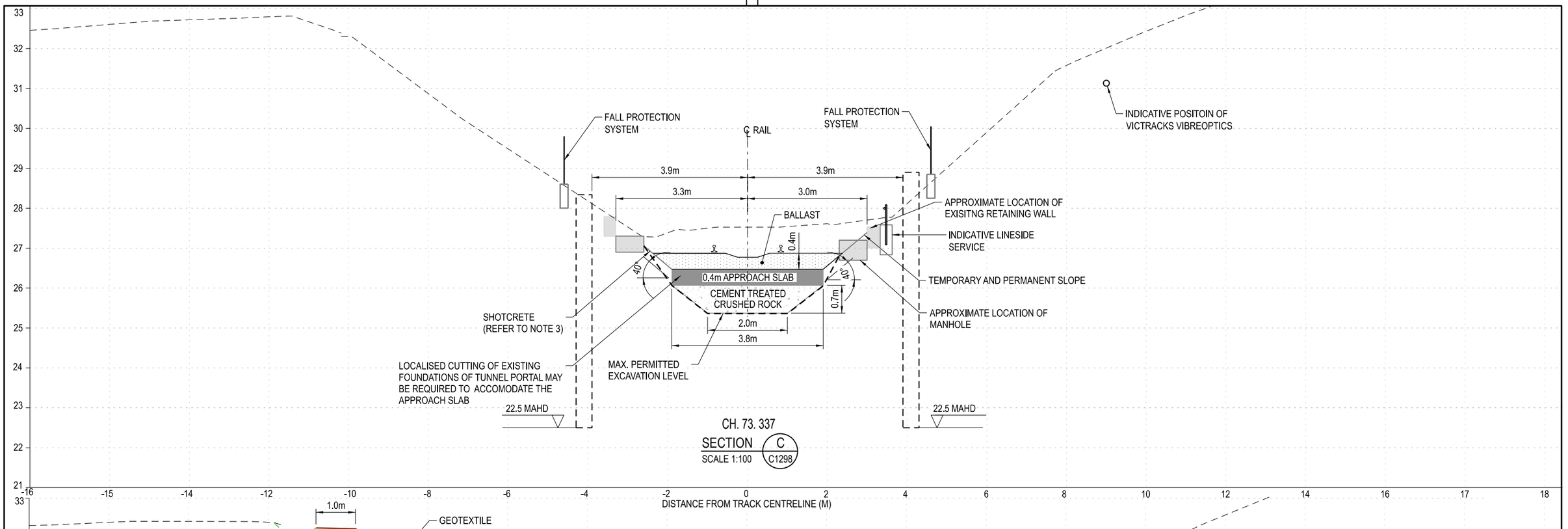

NOTES:

1. SECTION C: POSITION OF RETAINING WALL AND MANHOLE INFERRED FROM AURECON FEATURE SURVEY AND SITE PHOTOGRAPHS
2. FOR CH.73,337 SECTION THE EXISTING GROUND LEVEL SURVEY DATA FROM CH.73,336 HAS BEEN USED.
3. FOR THE WRAPAROUND DETAIL, THE PERMANENTLY EXPOSED SLOPE TO BE COVERED IN 140mm THICK REINFORCED SHOTRCETE WITH SL81 MESH).

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RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
TYPICAL SECTIONS - SHEET 2

Up Location	Down Location	Datum
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M.BUNNEY	

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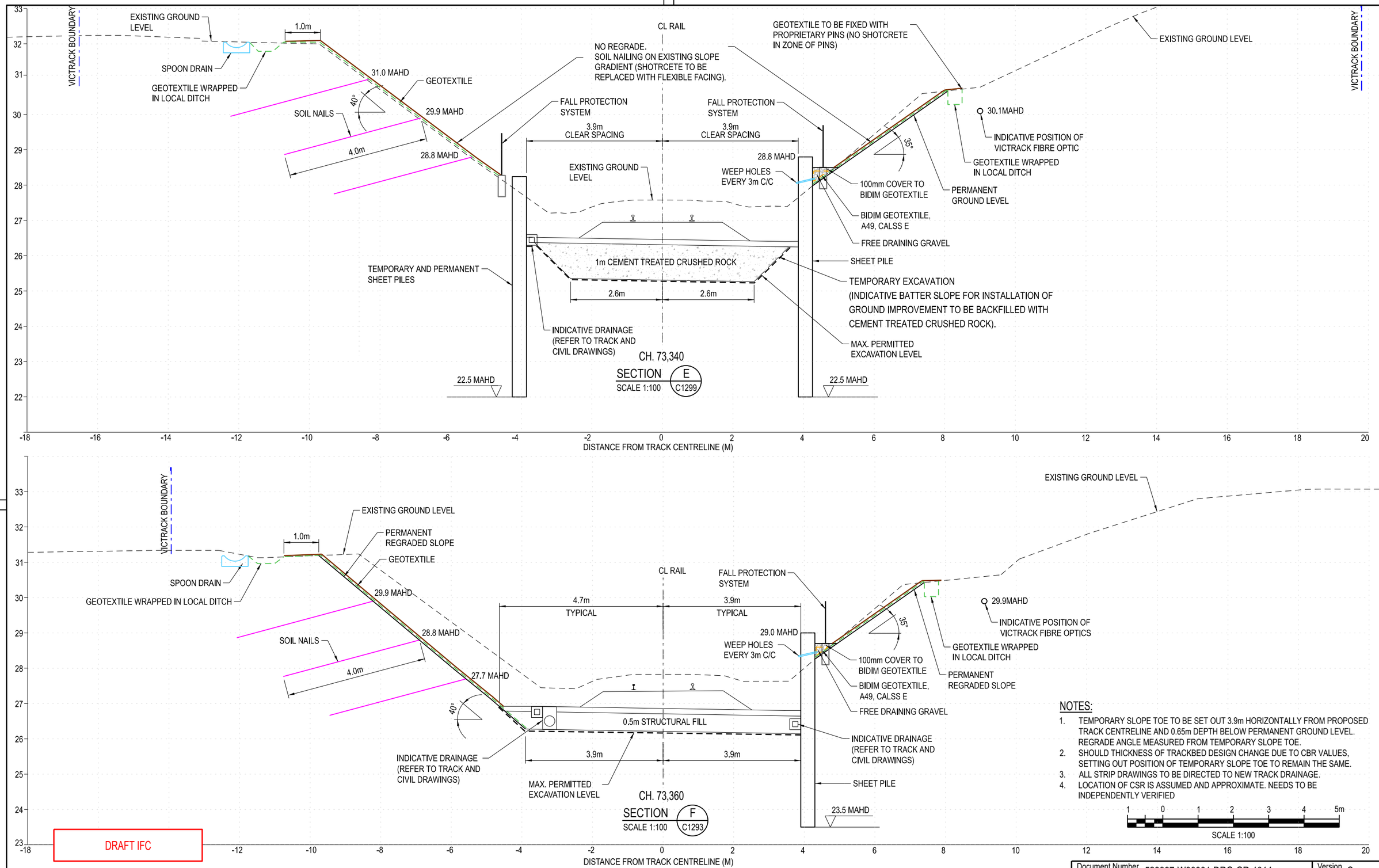

NOTES:

1. TEMPORARY SLOPE TOE TO BE SET OUT 3.9m HORIZONTALLY FROM PROPOSED TRACK CENTRELINE AND 0.65m DEPTH BELOW PERMANENT GROUND LEVEL. REGRADE ANGLE MEASURED FROM TEMPORARY SLOPE TOE.
2. SHOULD THICKNESS OF TRACKBED DESIGN CHANGE DUE TO CBR VALUES, SETTING OUT POSITION OF TEMPORARY SLOPE TOE TO REMAIN THE SAME.
3. ALL STRIP DRAWINGS TO BE DIRECTED TO NEW TRACK DRAINAGE.
4. LOCATION OF CSR IS ASSUMED AND APPROXIMATE. NEEDS TO BE INDEPENDENTLY VERIFIED

SCALE 1:100

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Consultant: aurecon

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RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
TYPICAL SECTIONS - SHEET 3

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

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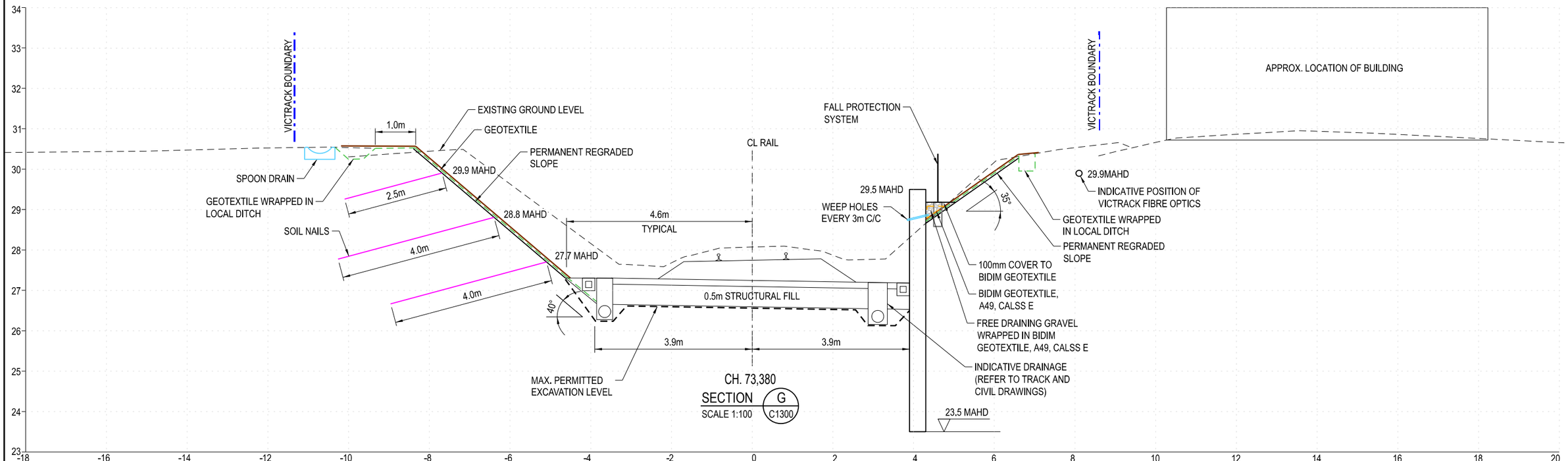

NOTES:

1. TEMPORARY SLOPE TOE TO BE SET OUT 3.9m HORIZONTALLY FROM PROPOSED TRACK CENTRELINE AND 0.65m DEPTH BELOW PERMANENT GROUND LEVEL. REGRADE ANGLE MEASURED FROM TEMPORARY SLOPE TOE.
2. SHOULD THICKNESS OF TRACKBED DESIGN CHANGE DUE TO CBR VALUES, SETTING OUT POSITION OF TEMPORARY SLOPE TOE TO REMAIN THE SAME.
3. ALL STRIP DRAWINGS TO BE DIRECTED TO NEW TRACK DRAINAGE.
4. LOCATION OF CSR IS ASSUMED AND APPROXIMATE. NEEDS TO BE INDEPENDENTLY VERIFIED
5. FROM CH.73,395 TO CH.73,412, CEMENT STABILISED SOIL TO BE LOCALLY CUT WITHIN FOOTPRINT OF SHEET PILE TO FACILITATE INSTALLATION.
6. UTILITIES FROM CSR PIT WILL BE REQUIRED TO PASS THROUGH A LOCALISED HOLE IN THE SHEET PILE WALL BETWEEN CH.73,401 AND 73,405 AND LIKELY FIXED TO THE TRACK SIDE OF THE WALL TO THE TUNNEL PORTAL. THE DESIGN IS BEING UNDERTAKEN BY A 3RD PARTY AND WILL NEED TO BE CONFIRMED.

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RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
TYPICAL SECTIONS - SHEET 4

Up Location	Down Location	Datum
East.	East.	MGA Z55
North.	North.	
ID#	ID#	

PUBLIC TRANSPORT VICTORIA PTV

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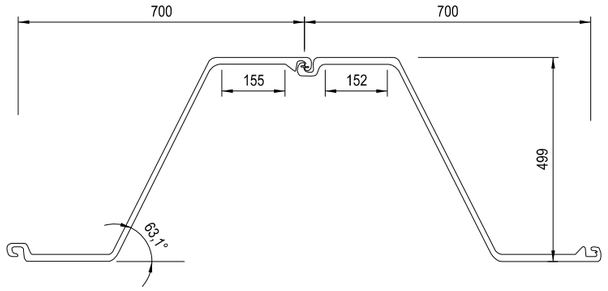
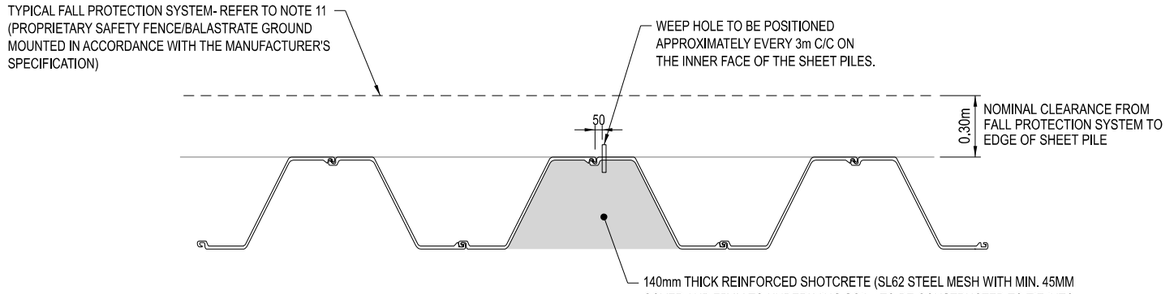


CROSS SECTION OF SHEET PILE (E.G. HOESCH 3607)
SCALE NTS.



CROSS SECTION OF SHEET PILE (E.G. HOESCH 3607)
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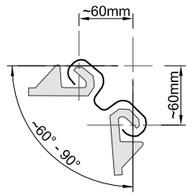

CORNER SECTION
SCALE NTS.

NOTES:

1. REFER TO GENERAL NOTES, PLAN LAYOUT, ELEVATION AND SECTION DRAWINGS.
2. SHEET PILE TO BE INSTALLED A MINIMUM OF 2m AWAY FROM TUNNEL PORTAL
3. TOP OF SHEET PILE IS TO STAND MIN. OF 300mm PROUD OF RETAINED GROUND SURFACE.
4. A CLEAR DISTANCE OF 3900mm FROM FRONT OF SHEET PILE TO CENTRELINE OF TRACK IS TO REQUIRED TO ALLOW EXCAVATION AND DRAINAGE INSTALLATION IN FRONT OF WALL.
5. CONTRACTOR TO REVIEW GROUND CONDITIONS AND SELECT APPROPRIATE EQUIPMENT TO ENABLE DRIVING OF SHEET PILES TO THE PROPOSED ELEVATION. BUILDING CONTRACTOR TO SELECT APPROPRIATE EQUIPMENT TO DRIVE THE SHEET PILES WITHOUT INCURRING PERMANENT DEFORMATION AT THE SHEET PILE HEAD.
6. MINIMUM SHEET PILE PROPERTIES:
   HOT ROLLED
   STEEL GRADE - S430 GP
   MOMENT OF INERTIA (I) = 89,000 cm^4 /m
   SECTION MODULUS (Z) 3,600 cm^3 /m
   UNIT MASS (W) = 168 kg/m^2 A COMPARABLE SHEET PILE CAN BE ADOPTED IF THE ABOVE PROPERTIES BE MET. CONTRACTOR MAY PREFER TO STIFFER OR HEAVIER PILES FOR ENHANCED DRIVABILITY.
7. SHEET PILE TOE ELEVATIONS ARE PROVIDED IN THE ELEVATION PROFILES.
8. CONTRACTOR TO SELECT APPROPRIATE CORNER SECTION. EXAMPLE PROVIDED IS INDICATIVE.
9. THE DESIGN ALLOWS FOR CORROSION OVER THE 100 YEAR DESIGN LIFE.
10. NO SURCHARGING, STATIONARY MACHINARY OR STOCKPILING OF MATERIAL IS PERMITTED BEHIND RETAINING WALLS.
11. FALL PROTECTION SYSTEM (HANDRAILS) BEHIND SHEET PILED WALL TO BE GALVANISED WEBFORGE MONOWILLS IN-GROUND FALL PROTECTION SYSTEMIN ACCORDANCE WITH AS 1657: 2018 AND MANUFACTURER'S SPECIFICATION. FALL PROTECTION SYSTEM TO A MINIMUM OF 1200mm HIGH AND TO BE EMPLOYED WHERE DROP EXCEEDS 1m.

SETTING OUT ID

WALL LOCATION	ID	EASTING	NORTHING	PILE TOP (mAHD)	MIN. PILE DESIGN TOE (mAHD)	MIN. PILE DESIGN LENGTH (m)
WEST	SP-1-1	268050.016	5774102.653	28.8	22.5	6.3
WEST	SP-1-2	268048.130	5774093.848	28,9	22.5/23.5	6.4/5.4
WEST	SP-1-3	268045.419	5774081.137	29	23.5	5.5
WEST	SP-1-4	268042.414	5774066.399	29.4	23.5	5.9
WEST	SP-1-5	268039.627	5774051.545	29.7	23.5	6.2
WEST	SP-1-6	268038.755	5774046.525	30.3	23.5/23	6.8/7.3
WEST	SP-1-7	268037.372	5774037.621	30.3	23	7.3
WEST	SP-1-8	268036.278	5774029.776	29	23	6
EAST PORTAL	SP-2-1	268057.945	5774100.951	28.3	22.5	5.8
EAST PORTAL	SP-2-2	268057.110	5774097.046	28.3	22.5	5.8
EAST PORTAL	SP-2-3	268056.072	5774092.152	26.9	22.5	4.4
LAYDOWN AREA	SP-3-1	268049.786	5774057.929	27.2	23.2	4
LAYDOWN AREA	SP-3-2	268051.149	5774055.209	28.7	23.2	5.5
LAYDOWN AREA	SP-3-3	268052.516	5774052.447	30.4	23.2	7.2
LAYDOWN AREA	SP-3-4	268048.415	5774040.069	29.9	24.2/23.2	5.7/6.7
LAYDOWN AREA	SP-3-5	268043.945	5774026.592	29.3	24.2	5.1

STANDARDISED PILE LENGTH FOR EASE OF CONSTRUCTION

SETTING OUT POINTS	PILE LENGTH (m)
SP 1-1 TO SP-1-5	6.4
SP 1-5 TO SP-1-8	7.3
SP-2-1 TO SP-2-3	5.8
SP-3-1 TO SP-3-2	5.5
SP-3-2 TO SP-3-4	7.3
SP-3-4 TO SP-3-5	5.8

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		B	02/02/24	FINAL DESIGN 2	D.M.	H.N.	M.R.	M.R.
		A	01/12/23	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

Consultant: aurecon
Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
SHEET PILE DETAILS

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

Drawn By: JARUNEE R	Designed By: D.MACPHIE
Checked By: H.NELSON	Ind. Review: M.RAMACHANDRAN
Approved: M.BUNNEY	Approval Date:
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Scale: N.T.S.	Sheet Size: A3

Document Number: 523997-W00001-DRG-GR-1016
Version: C
Drawing Number: GEE_C1301
Revision: C

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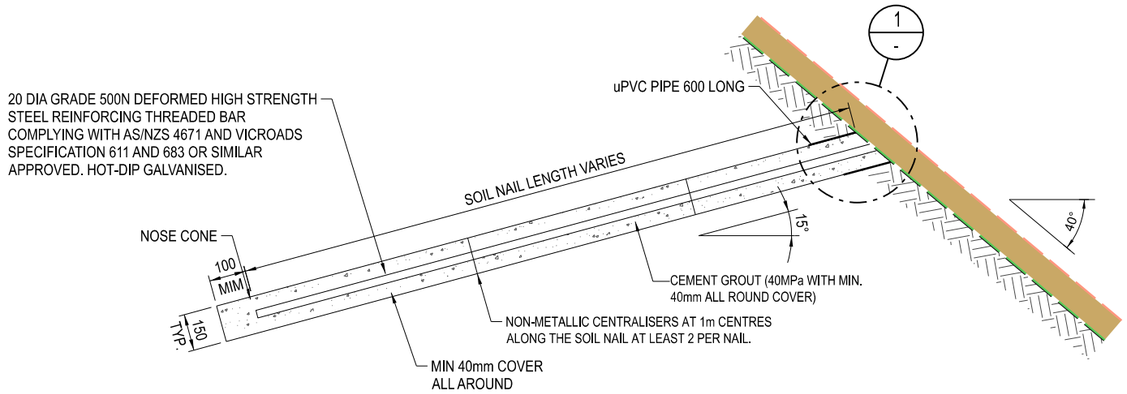
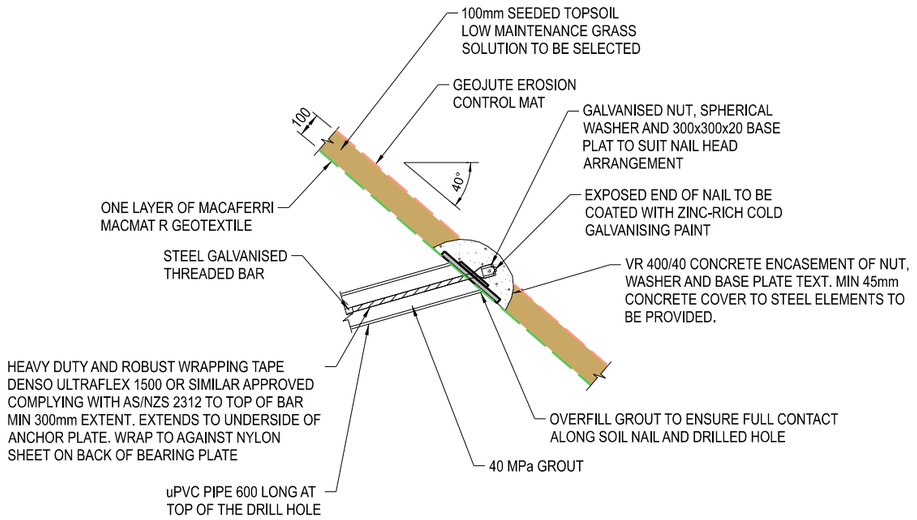


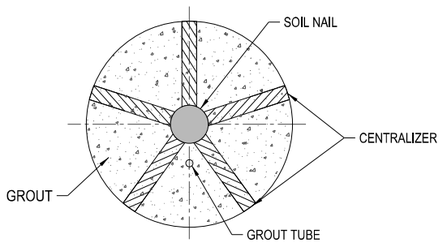
CROSS SECTION OF SOIL NAIL - GENERAL

NTS.



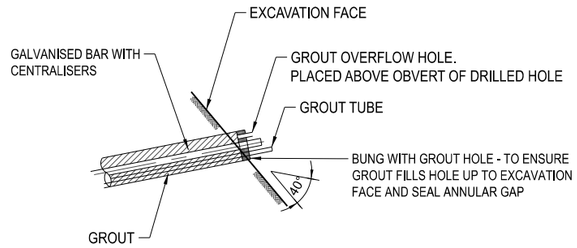
DETAIL 1 -

NTS.



TYPICAL SECTION

NTS.



TYPICAL SOIL NAIL GROUTING PROCEDURE DETAIL

NTS.

NOTES:

1. REFER TO GENERAL NOTES, PLAN LAYOUT, ELEVATION AND SECTION DRAWINGS.
2. FLEXIBLE FACING DETAILS AS FOLLOWS:
   REINFORCEMENT - WOVEN STEEL WIRE MESH (8 X 10MM)
   REINFORCEMENT COATING - GALMAC ALU-ZINC ALLOY WITH TOUGH POLYMERIC SHEATHING BBA CERTFIED TO 120 YEAR DESIGN LIFE
   TENSILE STRENGTH 55kN/m
   PUNCH RESISTANCE - 70kN
3. THE INSTALLATION OF THE MACMAT R SHALL BE IN COMPLIANCE WITH THE MANUFACTURERS SPECIFICATIONS.
4. MACMAT R PINS AS A MINIMUM ARE REQUIRED AT THE PERIMETER OF THE GEOTEXTILE.

DRAFT IFC

C 20/03/24 DRAFT IFC

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Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		C	20/03/24	DRAFT IFC	D.M.	D.M.	M.R	M.B.
		B	02/02/24	FINAL DESIGN 2	D.M.	H.N.	M.R.	M.B.
		A	01/12/23	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
SOIL NAIL AND FACING DETAILS

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

File Name

Sheet No. 01 of 01

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Scale N.T.S. | Sheet Size A3

Drawn By	Designed By
JARUNEE R	D.MACPHIE
Checked By	Ind. Review
H.NELSON	M.RAMACHANDRAN
Approved	Approval Date
M.BUNNEY	

Drawing Number GEE_C1302 | Revision C

Document Number 523997-W00001-DRG-GR-1017 | Version C

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SOIL NAIL SCHEDULE OF EAST SIDE

1ST ROW OF SOIL NAILS			2ND ROW OF SOIL NAILS			3RD ROW OF SOIL NAILS			4TH ROW OF SOIL NAILS		
CHAINAGE (M)	ELEVATION (MAHD)	LENGTH (M)	CHAINAGE (M)	ELEVATION (MAHD)	LENGTH (M)	CHAINAGE (M)	ELEVATION (MAHD)	LENGTH (M)	CHAINAGE (M)	ELEVATION (MAHD)	LENGTH (M)
338.3	31	4	339.2	29.9	4	338.3	28.8	4			
340.1	31	4	341	29.9	4	340.1	28.8	4			
341.9	31	4	342.8	29.9	4	341.9	28.8	4			
343.7	31	4	344.6	29.9	4	343.7	28.8	4			
345.5	31	4	346.4	29.9	4	345.5	28.8	4	346.4	27.7	4
347.3	31	4	348.2	29.9	4	347.3	28.8	4	348.2	27.7	4
			350	29.9	4	349.1	28.8	4	350	27.7	4
			351.8	29.9	4	350.9	28.8	4	351.8	27.7	4
			353.6	29.9	4	352.7	28.8	4	353.6	27.7	4
			355.4	29.9	4	354.5	28.8	4	355.4	27.7	4
			357.2	29.9	4	356.3	28.8	4	357.2	27.7	4
			359	29.9	4	358.1	28.8	4	359	27.7	4
			360.8	29.9	4	359.9	28.8	4	360.8	27.7	4
			362.6	29.9	4	361.7	28.8	4	362.6	27.7	4
			364.4	29.9	4	363.5	28.8	4	364.4	27.7	4
			366.2	29.9	2.5	365.3	28.8	4	366.2	27.7	4
			368	29.9	2.5	367.1	28.8	4	368	27.7	4
			369.8	29.9	2.5	368.9	28.8	4	369.8	27.7	4
			371.6	29.9	2.5	370.7	28.8	4	371.6	27.7	4
			373.4	29.9	2.5	372.5	28.8	4	373.4	27.7	4
			375.2	29.9	2.5	374.3	28.8	4	375.2	27.7	4
			377	29.9	2.5	376.1	28.8	4	377	27.7	4
			378.8	29.9	2.5	377.9	28.8	4	378.8	27.7	4
			380.6	29.9	2.5	379.7	28.8	4	380.6	27.7	4
			382.4	29.9	2.5	381.5	28.8	4			
						383.3	28.8	4			

NOTES

1. ALL SOIL NAIL INCLINATION IS 15 DEGREES DOWNWARD FROM THE HORIZONTAL.

DRAFT IFC

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		C	20/03/24	DRAFT IFC	D.M.	D.M.	M.R.	M.B.
		B	02/02/24	FINAL DESIGN 2	D.M.	H.N.	M.R.	M.B.
		A	01/12/23	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

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Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
SOIL NAIL SCHEDULE

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

File Name	
Sheet No.	01 of 01
In Serv.	
Scale	N.T.S.
Sheet Size	A3

Drawn By	JARUNEE R
Designed By	D.MACPHIE
Checked By	H.NELSON
Ind. Review	M.RAMACHANDRAN
Approved	M.BUNNEY
Approval Date	
Drawing Number	GEE_C1304
Revision	C

Document Number 523997-W00001-DRG-GR-1019 | Version C

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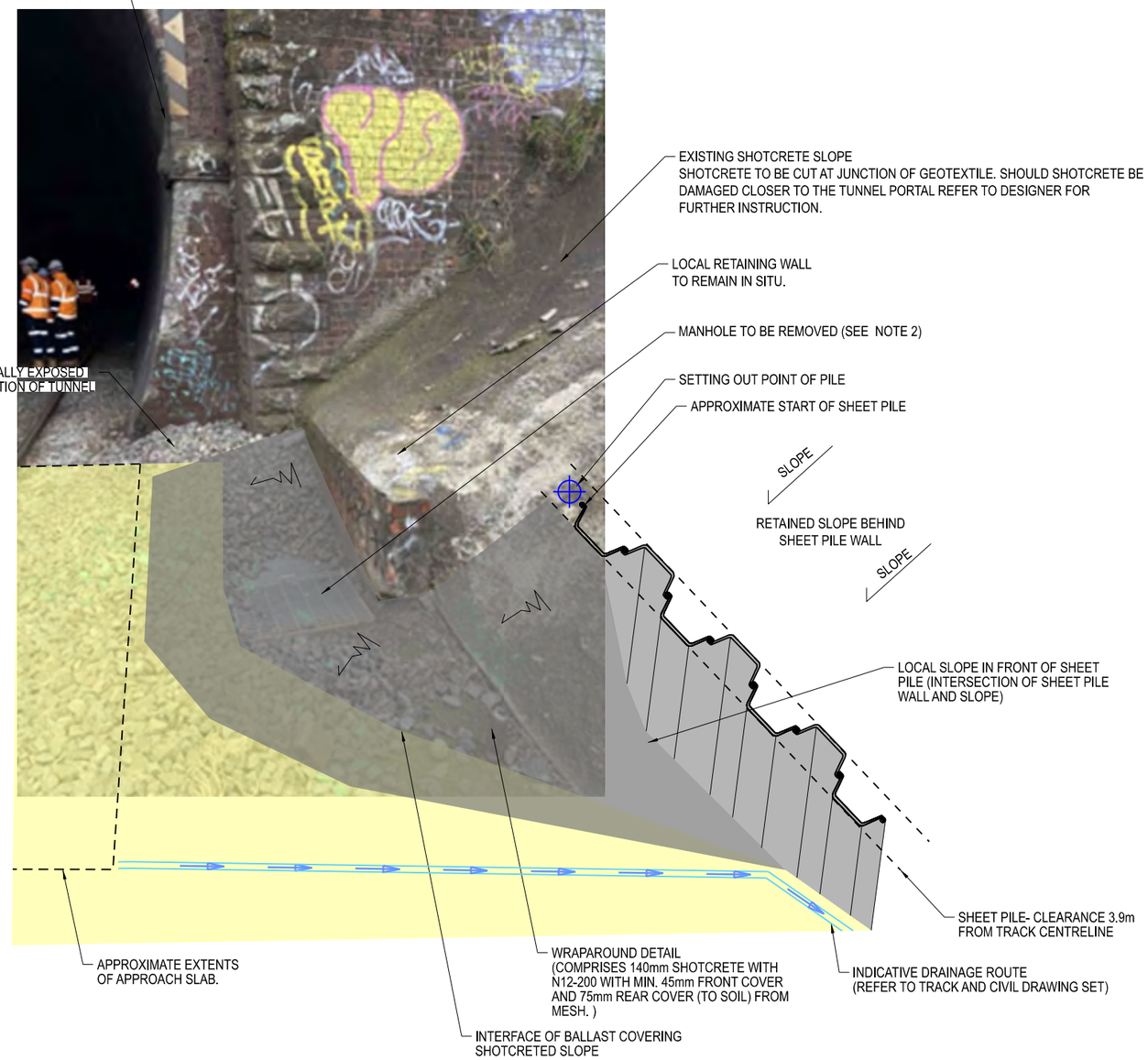
NOTES

1. THIS DRAWING ILLUSTRATES THE CONCEPT OF THE WRAPAROUND DETAIL CLOSE TO THE TUNNEL PORTAL.
2. CONTRACTOR TO DEVELOP SAFE METHODOLOGY FOR REMOVAL OF THE MANHOLE. IT IS RECOMMENED TO REMOVE AND BACKFILL THE MANHOLE HOLE, PRIOR TO MAIN EXCAVATION WORKS FOR TRACKBED INSTALLATION. LOCAL EXCAVATION TO BE BACKFILLED WITH STRUCTURAL FILL.
3. DRAWING TO BE READ IN CONJUNCTION WITH CROSS SECTIONS A TO D, ELEVATION PROFILES AND THE PLAN LAYOUT.



LOOKING NORTH ONTO EAST SIDE OF PORTAL
SCALE NTS.

DRAFT IFC

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		B	20/03/24	DRAFT IFC	D.M.	D.M.	M.R.	M.B.
		A	02/02/24	FINAL DESIGN 2	D.M.	H.N.	M.R.	M.B.

Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
TUNNEL PORTAL INTERFACE

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

Document Number	523997-W00001-DRG-GR-1021
Version	B
Drawn By	JARUNEE R
Designed By	D.MACPHIE
Checked By	H.NELSON
Ind. Review	M.RAMACHANDRAN
Approved	M.BUNNEY
Approval Date	
File Name	
Sheet No.	01 of 01
In Serv.	
Scale	N.T.S.
Sheet Size	A3
Drawing Number	GEE_C1305
Revision	B

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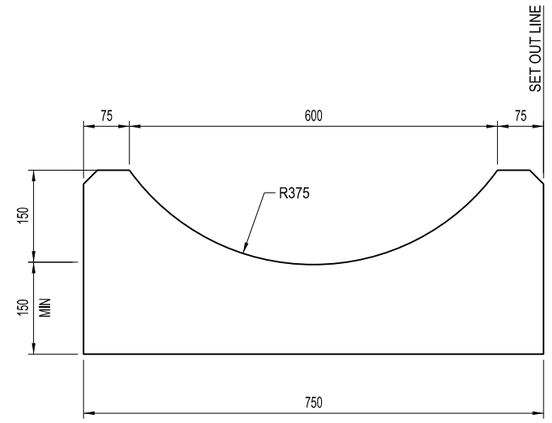
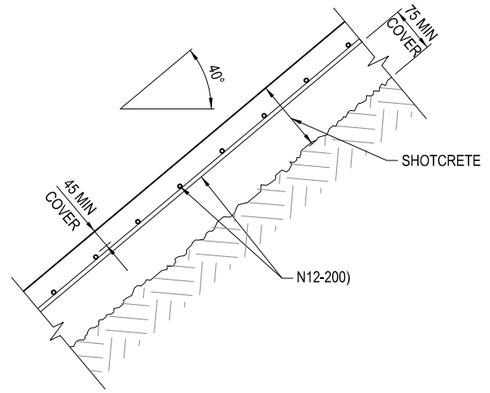


CD3 CHANNEL
SCALE 1:10

NOTES:

1. AN EXPOSURE CLASSIFICATION IN ACCORDANCE WITH AS 5100.5 OF B2 HAS BEEN ASSUMED FOR THE SHOTCRETE DEISGN. THIS IS TO BE CONFIRMED BY THE CONTRACTOR.



SHOTCRETE DETAIL AT WRAPAROUND (REFER TO GEE_C1305)
N.T.S

DRAFT IFC

100 0 100 200 300 400 500mm
SCALE 1:10

Document Number 523997-W00001-DRG-GR-1022 | Version B

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		A	02/02/24	FINAL DESIGN 2	D.M.	H.N.	M.R.	M.B.

Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
MISCELLANEOUS DETAILS

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

File Name

Sheet No. 01 of 01

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JARUNEE R	D.MACPHIE
Checked By	Ind. Review
H.NELSON	M.RAMACHANDRAN
Approved	Approval Date
M.BUNNEY	

Drawing Number GEE_C1306 | Revision B

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DJILLONG TUNNEL REHABILITATION

TUNNEL WORKS EARLY WORKS

LOCALITY PLAN
SCALE 1:2500

PROJECT DRAWING No.		DRAWING TITLE
523997-W00001-DRG-GT-0001	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - COVER SHEET, DRAWING INDEX & GA
523997-W00001-DRG-GT-0005	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - GENERAL NOTES - SHEET 1
523997-W00001-DRG-GT-0006	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - GENERAL NOTES - SHEET 2
523997-W00001-DRG-GT-0007	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - GENERAL NOTES - SHEET 3
523997-W00001-DRG-GT-0020	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - TYPICAL ROCK BOLT DETAILS
523997-W00001-DRG-GT-0100	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - LONGITUDINAL SECTION - SHEET 1
523997-W00001-DRG-GT-0101	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - LONGITUDINAL SECTION - SHEET 2
523997-W00001-DRG-GT-0150	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - TYPICAL CROSS SECTION
523997-W00001-DRG-GT-0201	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - GEOTECHNICAL LONG SECTION
523997-W00001-DRG-GT-0300	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - SUPPORT SELECTION CRITERIA
523997-W00001-DRG-GT-0301	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - TEMPORARY SUPPORT TYPE INV-1 - SHEET 1
523997-W00001-DRG-GT-0302	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - TEMPORARY SUPPORT TYPE INV-1 - SHEET 2
523997-W00001-DRG-GT-0311	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - TEMPORARY SUPPORT TYPE INV-2 - SHEET 1
523997-W00001-DRG-GT-0312	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - TEMPORARY SUPPORT TYPE INV-2 - SHEET 2

PROJECT DRAWING No.		DRAWING TITLE
523997-W00001-DRG-GT-0320	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - PRECAST UNIT DETAIL
523997-W00001-DRG-GT-0321	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - CAST IN-SITU INVERT REINFORCEMENT - SHEET 1
523997-W00001-DRG-GT-0322	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - CAST IN-SITU INVERT REINFORCEMENT - SHEET 2
523997-W00001-DRG-GT-0323	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - TUNNEL INVERT CONNECTION DETAIL
523997-W00001-DRG-GT-0325	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - TUNNEL INVERT AT REFUGE SPACES
523997-W00001-DRG-GT-0340	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - TUNNEL LINING CONTINGENCY AND TEMPORARY SUPPORT
523997-W00001-DRG-GT-0350	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - TUNNEL INVERT & APPROACH SLAB CONNECTION REINFORCEMENT DETAILS
523997-W00001-DRG-GT-0420	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - EXISTING LINING DEFECTS REPAIRS
523997-W00001-DRG-GT-0421	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - MASONRY TUNNEL PRE-GROUTING
523997-W00001-DRG-GT-0450	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - TUNNEL TEMPORARY DRAINAGE AND WEEP HOLES
523997-W00001-DRG-GT-0470	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - TUNNEL CONSTRUCTION SEQUENCE
523997-W00001-DRG-GT-0500	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - TUNNEL INSTRUMENT MONITORING - SHEET 1
523997-W00001-DRG-GT-0501	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - TUNNEL INSTRUMENT MONITORING - SHEET 2
523997-W00001-DRG-GT-0510	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - GROUND SURFACE MONITORING AND SETTLEMENT CONTOURS
523997-W00001-DRG-GT-0600	GEELONG	DJILLONG TUNNEL REHABILITATION - TUNNEL DESIGN - CONSTRUCTION SURCHARGE LIMITATIONS

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SCALE 1:2500

EARLY WORKS CHECKPRINT - NOT FOR CONSTRUCTION

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		D	26/03/24	IFC - CHECKPRINT (EARLY WORKS ONLY)	T.M	N.M	A.V	J.M
		C	23/02/24	EARLY WORKS	T.M.	N.M.	A.V.	J.M.
		B	03/11/23	FINAL DESIGN	T.M.	N.M.	A.V.	J.M.
		A	27/07/23	PRELIMINARY DESIGN	T.M.	N.M.		J.M.

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Consultant: aurecon

Franchisee / Lessee: V/Line

CIVIL STRUCTURAL
GEELONG
DJILLONG TUNNEL REHABILITATION
TUNNEL DESIGN
COVER SHEET, DRAWING INDEX & GA

Up Location	Down Location	Datum
East.	East.	MGA Z55
North.	North.	
ID#	ID#	

PUBLIC TRANSPORT VICTORIA PT

Drawn By: B DEMERIS	Designed By: T MEGYERI
Checked By: N MAKIN	Ind. Review
Approved: J MUIR	Approval Date: 20/02/24
File Name	
Sheet No.: 01 of 01	
In Serv.	
Scale: 1:2500	Sheet Size: A3
Drawing Number: GEE_C1226	Revision: D

Document Number: 523997-W00001-DRG-GT-0001 | Version: D

(DATE)

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Certified By:

GENERAL

G1 THESE GENERAL NOTES APPLY TO ALL TUNNEL DRAWINGS UNO.

G2 'APPROVED', 'DIRECTED', 'REFERRED TO FOR DECISION' ETC. SHALL BE TAKEN AS APPROVED BY THE CONTRACTOR UPON CONSULTATION WITH THE DESIGNER.

G3 THESE DRAWINGS SHALL BE READ IN CONJUNCTION WITH THE PROJECT SPECIFICATIONS, THE QUALITY ASSURANCE/CONTROL PROCEDURES AND WITH OTHER SUCH WRITTEN INSTRUCTIONS AS ISSUED DURING THE COURSE OF THE PROJECT. ALL DISCREPANCIES AND VARIATIONS SHALL BE REFERRED TO THE DESIGNER'S REPRESENTATIVE FOR DECISION BEFORE PROCEEDING WITH THE WORK.

G4 ALL DIMENSIONS RELEVANT TO SETTING OUT AND OFF-SITE WORK SHALL BE VERIFIED BEFORE CONSTRUCTION AND FABRICATION IS COMMENCED. THE DRAWINGS SHALL NOT BE SCALED.

G5 WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH THE RELEVANT CURRENT AUSTRALIAN STANDARDS AND CODES INCLUDING ALL AMENDMENTS AND LOCAL STATUTORY AUTHORITIES REGULATIONS EXCEPT WHERE VARIED BY THE DRAWINGS AND/OR SPECIFICATIONS.

G6 ALL DIMENSIONS ARE IN MILLIMETERS UNLESS NOTED OTHERWISE.
ALL LEVELS AND CHAINAGES ARE IN METERS. ALL COORDINATES ARE IN METERS.

G7 THE LEVEL DATUM REFERRED TO IN THESE DRAWINGS IS AUSTRALIAN HEIGHT DATUM (AHD).

G8 THE COORDINATES SHOWN ON THE DRAWINGS ARE TO MGA.

G9 UNO DENOTES "UNLESS NOTED OTHERWISE". N/A DENOTES "NOT APPLICABLE". TBC DENOTES "TO BE CONFIRMED"

G10 THE CONTRACTOR MAY SUBSTITUTE AN EQUIVALENT FOR A PROPRIETARY SYSTEM SPECIFIED IF APPROVED BY V/LINE AND THE DESIGNER IN WRITING BEFORE USE.

G11 NOTES ON SPECIFIC DRAWINGS/DOCUMENTS SHALL TAKE PRECEDENCE OVER THESE GENERAL NOTES.

G12 FOR TRACK AND CIVIL DESIGN REFER TO DESIGN PACKAGE 523997-W00001-REP-RT-0001 AND THE ASSOCIATED DRAWINGS.

G13 MIN. 10 BUSINESS DAYS SHALL BE PROVIDED FOR THE DESIGNER TO REVIEW THE PROVIDED INFORMATION UNLESS AGREED OTHERWISE BY V/LINE, THE DESIGNER AND THE CONTRACTOR.

G14 PROJECT SPECIFICATIONS TO BE DEVELOPED BEFORE COMMENCEMENT OF THE WORKS.

STRUCTURAL CONCRETE

C01 ALL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH AS 5100.

C02 CONCRETE FOR TUNNEL WORKS SHALL HAVE A MIN. CHARACTERISTIC CYLINDER STRENGTH OF 50 MPa AT 28 DAYS UNO.

C03 THE CONCRETE SHALL BE COMPACTED USING HIGH FREQUENCY VIBRATORS.

C04 ALL FORMWORK SHALL BE IN ACCORDANCE WITH AS 5100.5, AS 3610 AND REQUIREMENTS OF THE PROJECT SPECIFICATION.

C05 NO HOLES OR CHASES SHALL BE MADE IN CONCRETE MEMBERS WITHOUT PRIOR APPROVAL OF THE DESIGNER.

C06 THE CONCRETE MIX SHALL COMPLY WITH THE REQUIREMENTS OF THE PROJECT SPECIFICATION.

C07 CONCRETE JOINTS:
CJ - DENOTES CONSTRUCTION JOINTS
CTRJ - DENOTES CONTRACTION JOINTS
CONCRETE JOINTS SHALL BE USED ONLY AS SHOWN ON THE DRAWINGS, CONCRETE JOINTS SHALL NOT BE OMITTED OR ADDED WITHOUT THE APPROVAL OF THE DESIGNER.

C08 ALL EXPOSED CONCRETE EDGES SHALL HAVE A 20mm CHAMFER.

GROUTING

G1 THE CONTRACTOR SHALL DEVELOP THE GROUTING METHODOLOGY AND SUBMIT FOR THE DESIGNER'S REVIEW BEFORE COMMENCEMENT OF THE CONSTRUCTION WORKS.

G2 THE GROUT STRENGTH DEVELOPMENT OVER TIME, THE GROUTING PRESSURE USED AND THE MIX DESIGN SHALL BE REVIEWED BY THE DESIGNER BEFORE COMMENCEMENT OF THE CONSTRUCTION WORKS.

G3 THE GROUTING SHALL MINIMISE THE MOVEMENTS OF THE EXISITNG AND THE NEWLY INSTALLED STRUCTURES.

G4 THE GROUTING SEQUENCE SHALL CONSIDER THAT THE LINING MAY MOVE DUE TO ADJACENT INVERT REPLACEMENT AND MAY REQUIRE MULTIPLE GROUTING STAGES.

G5 THE CONTRACTOR SHALL USE ADEQATE MEANS AND METHODS TO STABILISE THE BLOCKS DURING GROUTING.

ROCK REINFORCEMENT

R1 ALL ROCK REINFORCEMENT AND GROUTING OF ROCK REINFORCEMENT SHALL BE IN ACCORDANCE WITH THE PROJECT SPECIFICATION.

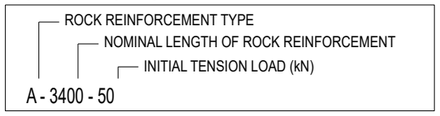
R2 ROCK BOLT AND PLATE DETAILS SHALL BE AS SHOWN ON DESIGN DRAWING GEE_C1230.

R3 ROCK BOLTS SHALL BE INSTALLED TENSIONED AND GROUTED IN ACCORDANCE WITH THE RELEVANT DRAWINGS.

R4 THE CONTRACTOR SHALL MAINTAIN A MINIMUM SUPPLY OF ROCK BOLTS AT A LENGTH AS SHOWN ON THE DESIGN DRAWINGS. AN ADDITIONAL LIMITED QUANTITY OF ROCK BOLTS WITH COUPLERS TO ENABLE INSTALLATION A LENGTH OF 4.5m SHALL ALSO BE MAINTAINED ON SITE AND SHALL BE USED WHERE THE SPECIFIED PRE-LOAD OF 50kN CANNOT BE ACHIEVED.

R5 USE OF ROCK BOLT COUPLERS IS PERMITTED.

R6 ROCK BOLT DESIGNATION.



R7 FOR ROCK BOLT PULL TESTING AND LOAD CELL MONITORING REFER TO DRAWING GEE_1261.

STEEL BAR REINFORCEMENT

SB01 REINFORCEMENT SYMBOL

N HOT ROLLED DEFORMED BAR TO AS/NZS 4671 (GRADE D500N)
SL SQUARE DEFORMED REINFORCING FABRIC TO AS/NZS 4671 (GRADE D500L)

SB02 STEEL SHALL BE IN ACCORDANCE WITH AS/NZS 4671.

SB03 THE MINIMUM CONCRETE COVER TO THE STEEL BAR SHALL BE 40mm. WHERE CONCRETE IS CAST AGAINST THE GROUND, THE MINIMUM COVRE SPECIFIED SHALL INCREASE BY 10mm IF A DAMP PROOF MEMBRANE IS PLACED. OTHERWISE THE COVER SHALL INCREASE BY 30mm. THE CONTRACTOR SHALL CONFIRM THE ASSUMED B2 EXPOSURE CLASSIFICATION BEFORE COMMENCEMENT OF THE PRECAST FABRICATION.

SB04 COGS AND HOOKS SHALL BE IN ACCORDANCE WITH AS5100.5. UNO.

SB05 ALL ON SITE HANDLING OF D500N REINFORCEMENT BARS SHALL BE IN ACCORDANCE WITH STEEL REINFORCEMENT INSTITUTE OF AUSTRALIA'S (SRIA) REQUIREMENTS.

SB06 COGS, HOOKS AND MINIMUM INTERNAL DIAMETER OF BENDS SHALL BE IN ACCORDANCE WITH AS5100.5 UNO.

SB07 SHEAR REINFORCEMENT NOTATION:

SB08 REINFORCEMENT IS SHOWN DIAGRAMATICALLY ON THE DRAWINGS AND THEREFORE DOES NOT DEPICT THE PRECISE POSITIONS OF BARS.

SB09 SPLICES IN REINFORCEMENT SHALL BE MADE ONLY IN THE POSITIONS SHOWN, OR AS OTHERWISE APPROVED BY THE DESIGNER, ALL LAPS SHALL BE FULL STRENGTH SPLICES COMPLYING WITH AS 5100:2017.

SB10 DEVELOPMENT AND SPLICE LAP LENGTHS SHALL BE DETAILED IN ACCORDANCE WITH TABLE 1 UNLESS STATED OTHERWISE ON THE DRAWINGS.

TABLE 1: DEVELOPMENT AND SPLICE LENGTHS

GRADE AND DIAMETER	N12	N16	N20	N24
MINIMUM DEVELOPMENT LENGTH	350	500	600	750
MINIMUM LAP LENGTH	350	500	700	900

SB11 FOR HORIZONTAL BARS WITH MORE THAN 300mm OF CONCRETE CAST BELOW THE BAR, THE LAP LENGTH SHALL BE INCREASED BY 30% FROM THE VALUES SHOWN IN TABLE 1.

SB12 PROVIDE LAP SPLICE OF SAME SIZE BAR ANNOTATED AS:

SB13 WHERE POCKETS OF BLOCKOUTS ARE REQUIRED (E.G. FOR WATER PRESSURE RELEASE HOLES), PROVIDE THE REQUIRED COVER TO REINFORCEMENT BY DISPLACING BARS TO SUIT.

SB14 WHERE PERMITTED ON THE DRAWINGS, '7 WIRE ORDINARY STRAND' IN ACCORDANCE WITH AS 5100.5:2017 AND AS/NZS 4672.1 MAY SUBSTITUTE CONVENTIONAL BAR REINFORCEMENT. ALL STRAND MATERIALS SHALL BE SUITABLY HANDLED ON SITE TO AVOID ANY DAMAGE TO THE MATERIAL.

STEELWORK

ST1 STRUCTURAL STEEL SHALL CONFORM TO AS/NZS 3678.

ST2 ALL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH AS4100.

ST3. WELDING SHALL BE IN ACCORDANCE WITH AS1554 AND PERFORMED BY AN EXPERIENCED OPERATOR IN ACCORDANCE WITH THE STANDARD.

ST4 ALL WELDS SHALL BE GP UNO.

ST5 ALL JOINTS SHALL BE FULLY WELDED UNO.

ST6 ALL BUTT WELDS, WHERE SHOWN, SHALL BE FULL PENETRATION UNO.

ST7 SURFACE TREATMENT SHALL BE UNPAINTED UNO.

ST8 ALL WELDING SHALL BE 6mm CONTINUOUS FILLET WELDS UNO.

ST9 ALL STEEL SHALL BE GRADE 350 AS3678 UNO.

ST10 ALL BOLTS NUTS AND WASHERS SHALL BE TO CATEGORY 4.6/S UNO AND BE IN ACCRODANCE WITH AS 1110, AS 1111 AND AS 1112. ALL MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH AS 4100.

ST11 TEMPORARY BOLTING ASSEMBLIES USED FOR LEVELLING SHALL HAVE A NUT FRICTION FACTOR OF K≤0.2.

WATER PROOFING

W1 THIS DESIGN PACKAGE DOES NOT ADDRESS THE WATERPROOFING OF THE TUNNEL OTHER THAN MAKING SPATIAL ALLOWANCE FOR THE FUTURE WATERPROOFING SYSTEM. FUTURE APPLICATION OF WATERPROOFING TREATMENTS SHOULD ONLY BE INSTALLED IN ACCORDANCE WITH A WATERPROOFING DESIGN THAT CONSIDERS THE SPATIAL AND STRUCTURAL CONSTRAINTS OF THIS TUNNEL.

CONSTRUCTION TOLERANCES

CT1 THE CONTRACTOR SHALL UNDERTAKE THE REQUIRED EXCAVATION WORKS SHOWN ON THE DESIGN DRAWINGS WITHIN THE CONSTRUCTION TOLERANCES (OVER-EXCAVATION) OF -0, +100mm (I.E. 100mm OVER-EXCAVATION IS PERMITTED.

CT2 CONCRETE ELEMENTS SHALL BE PLACED WITHIN 25mm VERTICAL (EXCEPT THE TRACK SLAB) AND HORIZONTAL TOLERANCE. FOR TRACK SLAB PLACEMENT TOLERANCES REFER TO RAILWAY TRACK AND CIVIL WORKS PACKAGE.

CT3 REINFORCING STEEL SHALL BE PLACED IN ACCORDANCE WITH AS5100.5:2017.

SET OUT

SO1 THE NEW ELEMENTS OF THE TUNNEL INVERT SHALL BE SET OUT RELATIVE TO THE TRACK GEOMETRY. REFER TO THE TRACK AND CIVIL DESIGN PACKAGE (523997-W00001-REP-RT-0001 AND THE ASSOCIATED DRAWINGS).

SO2 THE SET OUT SHALL CONSIDER THE INSTALLATION TOLERANCES OF THE RAIL FIXING SYSTEM, CONSTRUCTION TOLERANCES AND THE THICKNESS OF WATERPROOFING MEMBRANE OR GEOTEXTILE IN CASE PRESENT.

EXCAVATION AND SUBBASE

EX1 THE BASE AND SIDEWALLS OF THE EXCAVATION SHOULD BE APPROVED BY THE SITE GEOTECHNICAL ENGINEER PRIOR TO PLACEMENT OF CONCRETE PANELS.

EX2 THE BASE OF THE EXCAVATION SHOULD COMPRISE STIFF (OR BETTER) CLAY OR MEDIUM DENSE SANDS. IN CASE THE SUBGRADE DOES NOT MEET THIS THEN SEEK THE DESIGNER'S ADVICE.

EX3 APPROVED BACKFILL MATERIAL SHALL COMPRISE CAPPING LAYER MATERIAL IN ACCORDANCE WITH NIST-2659, OR OTHER MATERIAL APPROVED BY THE SITE GEOTECHNICAL ENGINEER OR THE DESIGNER'S REPRESENTATIVE.

EX4 BLINDING CONCRETE STRENGTH SHALL BE 20MPa AT 28 DAYS. THE BLINDING CONCRETE IS PERMITTED TO BE LOADED AT 3MPa STRENGTH. BLINDING MAY BE LOADED BEFORE IT ATTIANS FULL STRENGTH.

EARLY WORKS CHECKPRINT - NOT FOR CONSTRUCTION

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		D	26/03/24	IFC - CHECKPRINT (EARLY WORKS ONLY)	T.M	N.M	A.V	J.M
		C	23/02/24	EARLY WORKS	T.M	N.M	A.V	J.M
		B	03/11/23	FINAL DESIGN	T.M.	N.M.	A.V.	J.M.
		A	28/07/23	PRELIMINARY DESIGN	T.M.	N.M.		J.M.

Consultant: aurecon

Franchisee / Lessee: V/Line

CIVIL STRUCTURAL
GEELONG
DJILLONG TUNNEL REHABILITATION
TUNNEL DESIGN EARLY WORKS
GENERAL NOTES - SHEET 1

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

File Name

Sheet No. 01 of 01

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Certified By:

ADDITIONAL SITE INVESTIGATIONS IN THE TUNNEL

SI1 V/LINE SHALL EXTRACT A MINIMUM OF SIX FULL WALL DEPTH CORES (OD≥100mm) FROM THE TUNNEL.

SI2 THE CORES SHALL BE EXTRACTED AS FOLLOWS:
- 2 CORES IN TOE OF BRICK WALL WITHIN 10m OF EACH PORTAL
- 2 CORES AT WET AREAS AND 2 CORES AT GENERAL AREAS IN TOE OF CONCRETE WALL EVENLY SPACED WITHIN THE TUNNEL.

SI3 SHOTCRETE CORES SHALL BE SUBJECTED TO THE FOLLOWING TESTING REGIMES:
- INTEGRITY TESTING ALONG THE LENGTH OF EACH CORE UTILISING ULTRASONIC TESTING EQUIPMENT SUCH AS PUNDIT PL-200 OR SIMILAR
- CORES SHALL ALSO BE SUBJECT TO A 1% PHENOLPHTHALEIN SOLUTION TEST TO ASSESS THE CONCRETE DETERIORATION I.E. LOSS OF ALKALINITY
- UCS TESTING TO BENCHMARK SCHMIDT HAMMER AND INTEGRITY TEST
- PETROGRAPHIC EXAMINATION

SI4 BRICK CORES SHALL BE CAREFULLY EXAMINED WITH SPECIFIC FOCUS ON THE INTEGRITY OF THE BRICK MORTAR. THE DEPTH OF ANY DISINTEGRATED AND SOFTENED MORTAR SHALL BE LOGGED AND RECORDED ON BOTH INTRADOS AND THE EXTRADOS OF THE BRICK CORE. A QUALITATIVE TEST (SCRATCH TEST OR SIMILAR) SHALL BE USED TO DETERMINETHE DEPTH OF THE DISINTEGRATED MORTAR BED ON THE INTRADOS AND EXTRADOS OF THE CORE. THIS INFORMATION NEEDS TO BE REVIEWED BY THE DESIGNER BEFORE THE COMMENCEMENT OF THE WORK.

SI5 ALL LOGS, TEST RESULTS AND OBSERVATIONS SHALL BE COMPREHENSIVELY RECORDED AND SUBMITTED TO THE DESIGNER FOR REVIEW PRIOR TO THE COMMENCEMENT OF ANY TRIMMING / EXCAVATION WORKS IN THE TUNNEL.

SI6 WATER SAMPLES SHALL BE TAKEN IN THE TUNNEL AND SHALL BE TESTED FOR DISSOLVED C02.

SI7 NOTING THAT TESTING IS ONGOING AT PRE CONSTRUCTION AWARD STAGE THE ABOVE TESTING REQUIREMENTS SHALL BE REVISED AND AGREED WITH THE DESIGNER BEFORE COMMENCEMENT OF THE CONSTRUCTION WORKS.

SI8 ADDITIONAL GROUND INVESTIGATIONS REQUIRED BEFORE COMMENCEMENT OF THE CONSTRUCTION WORKS SHALL BE AGREED WITH THE DESIGNER.

DRAINAGE

DR1 20mm TO 50mm DIAMETER WEEP HOLES SHALL BE DRILLED THROUGH THE EXISTING CONCRETE / BRICK MASONRY AS SPECIFIED ON DRG GEE_C1259. WEEP HOLES SHALL BE CASED AS REQUIRED TO AVOID WEEP HOLE COLLAPSE.

DR2 WEEP HOLES SHALL BE FILLED WITH GROUT FOLLOWING COMPLETION OF THE INVERT LOWERING WORKS TO AVOID THE RISK OF LOOSENING UP THE GROUND.

DR3 HORIZONTAL DRAINAGE PIPES ARE TO BE INSTALLED INTO MOORABOOL VIADUCT SANDS. HORIZONTAL PIPES TO BE INSTALLED FROM PORTAL FACE, LONGITUDINAL TO LOWERED INVERT LEVEL. REFER TO DRG GEE_C1259.

BRICKWORK REPOINTING

BR1 THE PORTAL AND IN TUNNEL MASONRY SURFACES SHALL BE THOROUGHLY AND CAREFULLY CLEANED AS REQUIRED TO HELP THE VISUAL INSPECTION WITH WATER PRESSURE WASHING PRIOR TO COMMENCEMENT OF THE BRICKWORK REPOINTING OF THE INVERT REPLACEMENT WORKS. CARE SHALL BE TAKEN TO AVOID LOOSENING OF THE EXISTING MORTAR BY THE WATER PRESSURE WASHING.

BR2 A CONDITION ASSESSMENT OF THE MORTAR IN THE TUNNEL LINING IS REQUIRED PRIOR TO REMOVAL OF THE INVERT.

BR3 ALL DEGRADED/SOFTENED MORTAR AT THE PORTALS AND WITHIN THE TUNNEL TO BE REPOINTED AS PER DETAIL B1 SHOWN ON DRG GEE_C1256.

BR4 FOR THE REPAIR WORKS (E.G. REPOINTING OF THE BRICKS) THE MORTAR SHALL HAVE SIMILAR CHARACTERISTICS AS THE EXISTING MORTAR.

EXISTING SHOTCRETE

ES1 V/LINE SHALL INSPECT THE CONDITION OF THE EXISTING SHOTCRETE AND SUMMARISE THE FINDINGS PRIOR TO COMMENCEMENT OF CONSTRUCTION. REFER TO DRG GEE_C1229 FOR DETAILS.

ES2 THE FINDINGS OF THE EXISTING SHOTCRETE DILAPIDATION SURVEY SHALL BE PROVIDED TO THE DESIGNER FOR REVIEW.

ES3 LOCAL TIE BACK OF THE SHOTCRETE TO THE MASONRY MAY BE REQUIRED SUBJECT TO THE FINDINGS OF THE EXISTING SHOTCRETE DILAPIDATION SURVEY.

CONSTRUCTION MONITORING / MEASUREMENTS

CM1 TO VALIDATE THE DESIGN ASSUMPTIONS, THE CONTRACTOR SHALL DRILL HOLES AT 10m MAX CENTRES ON BOTH SIDEWALLS AT 1m TO 2m ABOVE THE EXISTING TRACK LEVEL. THE INSPECTION HOLES SHALL BE MIN. 45mm MAX 75mm DIAMETER AND SHALL EXTEND MIN. 300mm INTO THE NATURAL GROUND. HOLES FOR ROCK BOLTS OR WEEPHOLES MAY BE USED FOR THIS PURPOSE. ADDITIONAL TEST PITS MAY BE USED INSTEAD OF DRILL HOLES. THE DRILL HOLES/TEST PITS SHALL BE TARGETED TO AREAS WITH INTERFACING GROUND CONDITIONS AND UNSTABLE GROUND CONDITIONS.

CM2 ADDITIONAL CORE HOLES SHALL BE DRILLED IN THE INVERT TO VALIDATE THE SUPPORT SELECTION CRITERIA FOR INSTALLATION OF SUPPORT TYPE INV-1 OR INV-1A. FOR SUPPORT TYPE SELECTION CRITERIA REFER TO DRAWING GEE_C1238.
- CORING SHALL BE DONE EVERY 10m OF ALLOCATED SUPPORT TYPE AND FURTHER CORES SHALL BE DONE UP TO 20m ON BOTH SIDES OF THIS AREA. FOR SUPPORT TYPE ALLOCATION REFER TO DRAWING GEE_C1237.
- CORES SHALL BE MIN 2m DEEP

CM3 THE POSITION OF EACH EXECUTED DRILL HOLE SHALL BE SURVEYED BY THE CONTRACTOR ON SITE. INFORMATION RECORDS MUST INCLUDE HOLE COORDINATES AND LEVELS (ON LINING INTRADOS) TOGETHER WITH THE CORRESPONDING ENDOSCOPE WALL DEPTH MEASUREMENT AND GROUND BEHIND THE LINING.

CM4 UNDERTAKE SITE MEASUREMENTS AT CRITICAL SHOTCRETE SECTIONS WITHIN TUNNEL TO CONFIRM ABSOLUTE MINIMUM KE+25mm (BOTTOM SECTION) AND KE+100mm (TOP SECTION) IS ACHIEVED. WHERE NOT ACHIEVED, LOCALLY MODIFY SHOTCRETE TO SUIT.

CM5 A COMPREHENSIVE RECORD OF ALL MEASURED AND SURVEYED DATA FOR EACH HOLE INSTALLED SHALL BE SUBMITTED TO THE DESIGNER FOR REVIEW PRIOR TO THE COMMENCEMENT OF ANY EXCAVATION WORKS.

CM6 PROFILE CONTROL MONITORING SHALL BE UNDERTAKEN ON SITE AT REGULAR INTERVALS TO ENSURE THAT THE LINING DOES NOT MOVE BEYOND THE TARGET LEVEL OF MOVEMENT.
REFER TO GEE_C1261 AND GEE_C1262 FOR TARGET LEVELS.

CM7 INITIAL EXCAVATIONS SHALL BE USED TO MEASURE THE EXISTING MINIMUM WALL AND INVERT THICKNESSES OF THE REMAINING INTERMEDIATE BAYS. ALTERNATIVELY INVESTIGATIONS PITS MAY BE USED AS AGREED WITH V/LINE.

CM8 CONVERGENCE MONITORING SHALL BE UNDERTAKEN IN ACCORDANCE WITH THE REQUIREMENTS SPECIFIED ON DRG GEE_C1261 AND GEE_C1262.

CM9 PRIOR TO COMMENCEMENT OF WORKS CRACK WIDTH GAUGES SHALL BE INSTALLED BY THE CONTRACTOR OVER EXISTING CRACKS AND CRACK WIDTHS SHALL BE MONITORED DURING THE INVERT BREAK OUT AND INVERT INSTALLATION WORKS.

CM10 VIBRATION MONITORING SHALL BE UNDERTAKEN BY THE CONTRACTOR DIRECTLY ABOVE THE PROPOSED WORK AREA. THE OBJECTIVE IS TO PROVIDE AMBIENT BACKGROUND MONITORING RESULTS DURING TRAIN MOVEMENTS AND TO MONITOR VIBRATION IMPACTS DURING BREAK OUT AND INVERT EXCAVATION WORKS.

CM11 POST COMPLETION BUT PRIOR TO HANDING THE TUNNELS BACK TO V/LINE, THE CONTRACTOR SHALL UNDERTAKE AN AS-BUILT SURVEY AND CONFIRM THAT THE REQUIRED CLEARANCES HAVE BEEN ACHIEVED.

GEOLOGICAL MAPPING

GM1 ALL AREAS OF TUNNEL EXCAVATION THAT EXPOSE GROUND SHOULD BE FACE LOGGED BY A GEOLOGIST OR GEOTECHNICAL ENGINEER WITH EXPERIENCE IN GEOLOGICAL MAPPING. LOGGING SHOULD BE UNDERTAKEN IN ACCORDANCE WITH AS 1726 AND INCLUDE LITHOLOGY, STRENGTH, WEATHERING AND ANY OTHER COMMENTS.

GM2 THE LOGGING SHOULD BE COLLATED AND PRESENTED ON A LONG SECTION OF THE TUNNEL. THE GEOLOGICAL MAPPING SHOULD BE OF THE STANDARD THAT IT CAN BE USED TO PRODUCE STEREONETS, CHARACTERISE GROUND CONDITIONS AND IDENTIFY ZONES ALONG THE TUNNEL. THIS IS VALUABLE INFORMATION FOR ANY FUTURE TUNNEL MAINTENANCE OR UPGRADE WORKS.

LIMITATIONS

L1 THE TUNNEL DESIGN IS BASED UPON ASSUMPTIONS OF THE EXISTING GROUND CONDITIONS AND LINING CONSTRUCTION. THE FOLLOWING TABLE LISTS SOME OF THE SITUATIONS THAT WOULD INVALIDATE THE DESIGN. IF SUCH CASES ARE FOUND DURING CONSTRUCTION, THE WORKS SHALL CEASE, ADEQIATE SUPPORT SHALL BE PROVIDED IMMEDIATELY AND THE DESIGNER SHALL BE CONTACTED TO REVIEW THE SITUATION AND PROVIDE ADVICE.

ELEMENT	SITUATION	COMMENTS
EXISTING LINING	MAJOR DEFECT: EXTENSIVE CRACKING, CRUSHING, AREA OF REDUCED OR THICKNESS OR EXTENSIVELY DEGRADED MORTAR	STABILITY OF LINING IN QUESTION
GROUND CONDITIONS	MAJOR WEAKNESS ZONE EVIDENT ABOVE INVERT (E.G. PRESENCE OF THICK ZONE OF SATURATED RUNNING SAND)	BEHAVIOUR AND STABILITY OF TUNNEL IN QUESTION
HYDROGEOLOGICAL CONDITIONS	EXCESSIVE WATER INFLOW (E.G. : WATER INFLOW WHICH MAY WASH OUT THE GROUND AND CONSEQUENTLY DESTABILISE A PORTION OF THE TUNNEL)	BEHAVIOUR AND STABILITY OF TUNNEL IN QUESTION

FOREPROBING

FP1 A MIN 30m LONG HORIZONTAL BOREHOLE SHALL BE DRILLED ALONG TUNNEL FROM THE NORTH PORTAL BEFORE COMMENCEMENT OF THE CONSTRUCTION WORKS. THIS MAY BE OMITTED SUBJECT TO REVIEW OF THE INVESTIGATION PITS FINDINGS BY THE DESIGNER.

LIABILITY AND SCOPE OF THIS DESIGN INFORMATION

THIS TECHNICAL ADVICE HAS BEEN PREPARED AT THE REQUEST OF V/LINE AND PROVIDES ADVANCED DESIGN INFORMATION ON THE EARLY WORKS ASSOCIATED WITH THE DETAILED DESIGN INFORMATION CAPTURED IN THE TUNNEL STRUCTURAL DESIGN REPORT (523997-W00001-REP-GT-0001) AND ON THE RELATED DESIGN DRAWINGS. V/LINE SHALL USE THIS AS ADVANCE INFORMATION AT ITS OWN RISK AND DISCRETION AS THE ISSUED FOR FINAL DESIGN (IFC) MAY CHANGE, DUE TO REVIEW COMMENTS, SITE INVESTIGATIONS, DESIGN DEVELOPMENT ... ETC.

AURECON REJECTS ALL LIABILITY ARISEN FROM THE USE OF THE INFORMATION CONTAINED IN THIS TECHNICAL ADVICE UNLESS IT IS REPEATED IN THE IFC DESIGN PACKAGE.

THE EARLY WORKS DESIGN ELEMENTS SHALL NOT BE USED AS STRUCTURAL MEMBERS OR RELIED UPON OR WHATSOEVER BY V/LINE UNLESS IT IS REPEATED IN THE IFC DESIGN PACKAGE AND USED AT THE TIME AND FOR THE DESIGN PURPOSE AS STATED IN THE IFC DESIGN. THIS MEANS THAT THIS DESIGN ADVICE PERMITS THE INSTALLATION OF THE ELEMENTS DESCRIBED IN THIS ADVICE TO DE-COUPLE FROM THE CRITICAL PATH SOME STRUCTURALLY NON-SIGNIFICANT ACTIVITIES FROM THE MAIN CONSTRUCTION PROGRAM AND NOT THEIR USE AS LONG AS THE IFC DESIGN BECOMES AVAILABLE.

IT SHALL BE NOTED THAT THE EARLY WORKS DESIGN DRAWINGS ARE PROVIDED BY FADING IN THE BACKGROUND THE DESIGN INFORMATION WHICH IS NOT COVERED BY THIS TECHNICAL ADVICE TO HELP THE INTERPRETATION OF THE DESIGN INFORMATION. THE FADED INFORMATION IS FOR INFORMATIONAL PURPOSES ONLY AND SHALL NOT BE RELIED UPON BY ANY MEANS.

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		D	26/03/24	IFC - CHECKPRINT (EARLY WORKS ONLY)	T.M	N.M	A.V	J.M
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Consultant: aurecon

Franchisee / Lessee: V/Line

CIVIL STRUCTURAL

GEELONG

DJILLONG TUNNEL REHABILITATION
TUNNEL DESIGN EARLY WORKS
GENERAL NOTES - SHEET 2

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

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File Name

Sheet No. 01 of 01

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DILAPIDATION SURVEYS

DI1 DILAPIDATION SURVEY OF GROUND SURFACE STRUCTURES AND STREET PAVEMENTS WITHIN THE ZONE OF INFLUENCE SHALL BE CARRIED OUT PRIOR TO COMMENCEMENT OF THE EXCAVATION WORKS. REFER TO GEE_C1264 FOR ZONE OF INFLUENCE AND STRUCTURES WITHIN.

DI2 DETAILED TUNNEL DILAPIDATION SURVEY INCLUDING BOTH PORTALS AND EXISITNG MECHANICAL AND ELECTRICAL EQUIPMENT SHALL BE CARRIED OUT PRIOR TO COMMENCEMENT OF THE EXCAVATION WORKS. THIS AS A MINIMUM SHALL INCLUDE:
- SHOTCRETE SURFACES:
  - STRUCTURAL CRACKING SHALL BE MAPPED.
  - DETERMINE SHOTCRETE BONDING STRENGTH TO BRICKWORK LINING AT THE CROWN AT MIN.THREE SEPARATE LOCATIONS.
  - SHOTCRETE DRUMMINESS TEST SHALL BE CARRIED OUT AT MAX. 5m INTERVALS ALONG THE TUNNEL AXIS AND THE TUNNEL AT EACH SECTION SHALL BE TESTED AT LEAST AT THE CROWN, AT THE SHOULDERS AND AT THE SIDEWALLS.
- EXISTING BRICKWORK:
  - ANY LARGE CRACKS (>5mm) OF THE BRICKWORK, DETERIORATION OF BRICKS AND MORTAR SHALL BE RECORDED AND MAPPED PRIOR TO ROCK BOLT INSTALLATION AND PROBING BEHIND BRICKWORK LINING OR COMMENCEMENT OF THE EXCAVATION WORKS.
- WATER INFLOW INTO THE TUNNEL:
  - WATER INFLOW SHALL BE RECORDED.
  - WATER INFLOW FROM BEHIND THE SHOTCRETE LINING AFTER PENETRATING THE LINING FOR THE WEEP HOLES SHALL BE RECORDED.

DI3 THE CONDITION OF THE EXISTING TUNNEL INVERT TO BE ASSESSED AND MAPPED BEFORE COMMENCEMENT OF THE INVERT REPLACEMENT. DETAILS SHALL BE REVIEWED BY THE DESIGNER AND THE INVERT SHALL BE STRENGTHENED AS REQUIRED BASED ON THE DESIGNER'S REVIEW OF THE INFORMATION.

UTILITIES

UT1 BASED ON A DIAL BEFORE YOUR DIG (DBYD) QUERY THERE ARE NO UNDERGROUND ASSETS LOCATED WITHIN THE ROCK BOLTED ZONE OF SUPPORT TYPE INV-1.

UT2 OTHER UNDERGROUND UTILITIES MAY BE PRESENT ABOVE THE TUNNEL. THE CONTRACTOR SHALL MAKE ITS OWN ASSESSMENT OF THE UTILITIES.

CONSTRUCTION LOADS

CL01 CONSTRUCTION LOADS ON THE FINISHED INVERT SHALL NOT EXCEED 40kPa UNLESS ACCEPTED IN WRITING BY THE DESIGNER.

KEY REPAIR/SUPPORT REQUIREMENTS

K1. SIDEWALL ROCK BOLTS WHERE REQUIRED MUST BE INSTALLED PRIOR TO ANY INVERT EXCAVATION.

K2. INVERT EXCAVATION TO BE UNDERTAKEN USING 'HIT & MISS' METHOD WITH LIMITATIONS AS SHOWN ON THE SUPPORT TYPE DRAWINGS (DRG GEE_C1239, C1240, C1244 AND C1245).

K3. CONTRACTOR TO CONFIRM REPAIR STRATEGY/STAGING WITH DESIGNER PRIOR TO COMMENCEMENT OF WORK.

K4. ALL SAFETY DOCUMENTATION AND PROCESSES TO BE REVIEWED BY THE DESIGNER PRIOR TO COMMENCING WORKS.

IMPORTANT CONSTRUCTION PRINCIPLES

IC1. THE TUNNEL WAS CONSTRUCTED APPROXIMATELY 150 YEARS AGO AND THEREFORE CONSTRUCTION DETAILS ARE NOT CERTAIN. IT IS POSSIBLE THAT UNDOCUMENTED AREAS EXIST WHERE THE TUNNEL WAS BESET BY POOR GROUND CONDITIONS, OR WHERE CONSTRUCTION IS DEFECTIVE.

IC2. THE EXISTING TUNNEL LINING HAS BEEN REPAIRED SEVERAL TIMES IN THE PAST. REFER TO DRG GEE_C1232 AND GEE_C1233 FOR DETAILS.
THE CONSTRUCTION WORKS ARE REMOVING AND REPLACING SHORT SECTIONS OF THE TUNNEL INVERT LINING. THIS WORK MUST BE DONE WITH CAREFUL ATTENTION TO MAINTAINING THE STRENGTH OF THE EXISTING LINING, AND ENSURING THAT NEW WORK IS PROPERLY CONNECTED TO THE OLD.

IC3. IT'S LIKELY SOME OF THE TUNNEL IS FOUNDED IN SANDS DESCRIBED AT THE TIME OF CONSTRUCTION AS "FLOWING" WITH VERY SHORT STAND UP TIME. IT IS CRITICAL THAT EXCAVATIONS ARE MADE AND FULLY SUPPORTED IN THE SHORTEST TIME POSSIBLE.

IC4. THE "SAND" AND "CLAY" STRATA MAY BE HIGHLY SUSCEPTIBLE TO WEAKENING FROM WATER AND THE "CLAY" MAY SWELL WHEN IN CONTACT WITH IT. PARTICULARLY IN THE INVERT OF THE TUNNEL. THEREFORE IT IS IMPORTANT TO PREVENT WATER ENTERING EXCAVATIONS FROM OTHER PARTS OF THE TUNNEL.

IC5. THE NEW INVERT IS DEEPER THAN THE OLD INVERT AND THE LOAD ON THE NEW INVERT WILL BE SIGNIFICANT. IT IS ESSENTIAL FOR THE STABILITY OF THE TUNNEL THAT QUALITY IS NOT COMPROMISED (I.E. WATER, REBOUND, COLLAPSED MATERIAL MUST BE REMOVED FROM THE NEWLY FORMED INVERT). GROUT AND CAST INSITU CONCRETE OF THE NEW INVERT MUST ALSO BE CURED PROPERLY AND LOADED ONLY WHEN IT HAS GAINED SUFFICIENT STRENGTH AS SHOWN ON THE CONSTRUCTION SEQUENCE DRAWINGS.

IC6. SAW CUTTING FOR HIT 'BITES' SHALL BE MADE ALONG MORTAR BEDS AS MUCH AS PRACTICAL

OBSERVATION METHOD

O1 THE OBSERVATIONAL CONSTRUCTION METHOD IS LIMITED TO THE DESIGN ELEMENTS LISTED IN THE BELOW TABLE. THESE ARE TO BE IMPLEMENTED THROUGH DAILY REVIEW MEETING (DRM) AND REQUIRED EXCAVATION AND SUPPORT SHEET (RESS) PROCEDURES.

DESIGN ELEMENT	SUBJECT TO OBSERVATION	CONTINGENCY MEASURES IF OBSERVATIONS ARE ADVERSE	OPPORTUNITIES TO REDUCE MEASURES
ROCK BOLT DENSITY	TUNNEL LINING MOVEMENT MONITORING	INCREASE BOLTING DENSITY	N/A
ROCK BOLT INSTALLATION PRIOR TO INVERT EXCAVATION	BOLT PULL OUT TEST RESULTS (% OF BOLTS TESTED AS SPECIFIED)	INCREASE TESTING FREQUENCY REDUCE BOLT SPACING OR USE SUPPORT TYPE INV-2	REDUCE TESTING FREQENCY
INVERT LOWERING ROCK CONDITIONS OF CUT FACE	ADVERSE JOINTING, WEATHERING OR FAULTING	APPLY SHOTCRETE AND/OR CONTINGENCY BOLTS	N/A
INVERT LOWERING GROUND CONDITIONS OF CUT FACE	PRESENCE OF SHORT STAND UP TIME MATERIAL AT THE OPENED UP FACE (E.G. RUNNING SANDS)	APPLY SHOTCRETE LOCALLY	N/A
EXISTING LINING CONDITIONS	BEHAVIOUR/DAMAGE DURING EXCAVATION /PRESENCE OF POOR MORTAR, LOSS OF MORTER, DEGRADED BRICKS	ADDITIONAL BOLTING, STRENGTHENING OR SHOTCRETING OF EXISTING LINING	N/A
INVERT ARCH EXCAVATION WIDTH OF HIT AND MISS "BITES"	MONITORING OF VERTICAL AND HORIZONTAL MOVEMENT OF LINING	REDUCE LENGTH OF THE HIT "BITES" INSTALL TEMPORARY PROPPING INSIDE HIT "BITES" INCREASE DISTANCE BETWEEN ADJACENT HIT "BITES" USE OF MICROPILES TO CARRY SOME LOADING	INCREASE LENGTH OF "BITE" IN AREAS OF WHERE GEOTECHNICAL AND/OR GROUNDWATER CONDITIONS ARE FAVOURABLE
GENERAL LINING BEHAVIOUR, EXISTING OR NEW LINING	DEFORMATIONS EXCEED SPECIFIED TRIGGER LEVELS OR LINING DISPLAYS SIGNS OF DISTRESS I.E ADDITIONAL CRACKS DEVELOP OR EXISTING CRACK WIDTH INCREASES	CEASE EXCAVATION AND IMMEDIATELY INSTALL CONTINGENCY SUPPORT ELEMENTS INCLUDING BUT NOT LIMITED TO HORIZONTAL PROPS AND WALERS, OR INSTALL STEEL FRAMES, AND OR ADDITIONAL ROCK BOLTS WHERE REQUIRED	N/A

NOTES: [1] APPLICABLE ONLY FOR TUNNEL SECTIONS ENTIRELY IN NEWER VOLCANICS.

O2 UNDER THE OBSERVATIONAL AND DESIGN APPROACH, IN ADDITION TO THE INSTALLATION OF THE SUPPORT AS SHOWN ON THE DRAWINGS, A DAILY REVIEW MEETING (DRM) SHALL BE HELD TO EVALUATE THE EXCAVATION AND SUPPORT MEASURES IN USE AND TO BE USED. THIS SHALL BE DETAILED IN A REQUIRED EXCAVATION AND SUPPORT SHEET (RESS). THE RESS SHALL BE USED AS A PERMIT TO EXCAVATE A DEFINED SECTION OF THE EXCAVATION WORKS. THE DAILY REVIEW MEETING SHALL CONFIRM THAT CONTINUATION UNDER THE EXISTING RESS IS ACCEPTABLE OTHERWISE SHALL MAKE THE NECESSARY CHANGES.

O3 THE FOLLOWING SHALL BE REVIEWED AT THE DRM:
- GENERAL PERFORMANCE OF THE LINING
- CONVERGENCE MONITORING RESULTS
- CRACK MONITORING RESULTS
- EXISTING LINING QUALITY – PROFILE, THICKNESS AND CONDITIONS
- NEW LINING QUALITY WITH PARTICULAR ATTENTION TO THE CONNECTION DETAILS TO THE EXISTING LINING
- GEOLOGICAL AND/OR GROUNDWATER CONDITIONS
- SUBGRADE CONDITIONS BELOW THE INVERT
- CONFIRMATION OF THE RESS

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Consultant: aurecon

Franchisee / Lessee: V/Line

CIVIL STRUCTURAL
GEELONG
DJILLONG TUNNEL REHABILITATION
TUNNEL DESIGN EARLY WORKS
GENERAL NOTES - SHEET 3

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

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Sheet No.: 01 of 01	
Approved: J MUIR	Approval Date: 20/02/24
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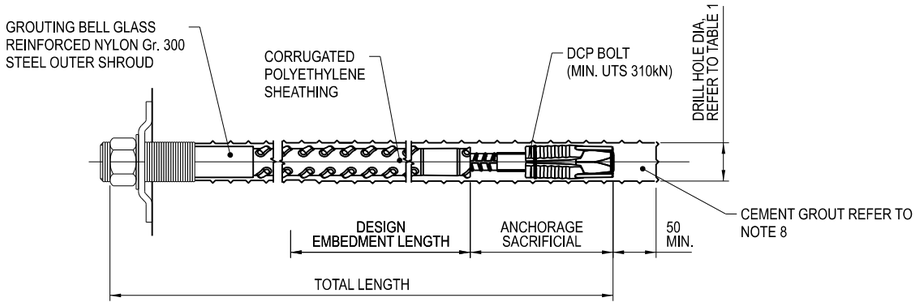
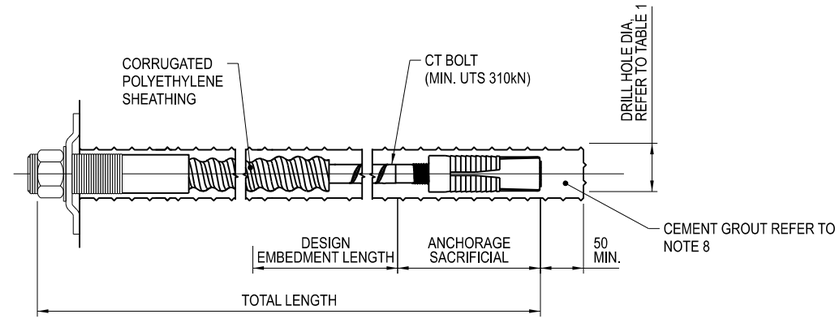
LEGEND:

- EXISTING MASONRY TUNNEL LINING
- RAMMED EARTH BEHIND MASONRY TUNNEL LINING
- MODERATELY WEATHERED OR BETTER NEWER VOLCANICS UNIT BASALT
- DRY PACK MORTAR OR NON-SHRINK GROUT
- NON-SHRINK GROUT



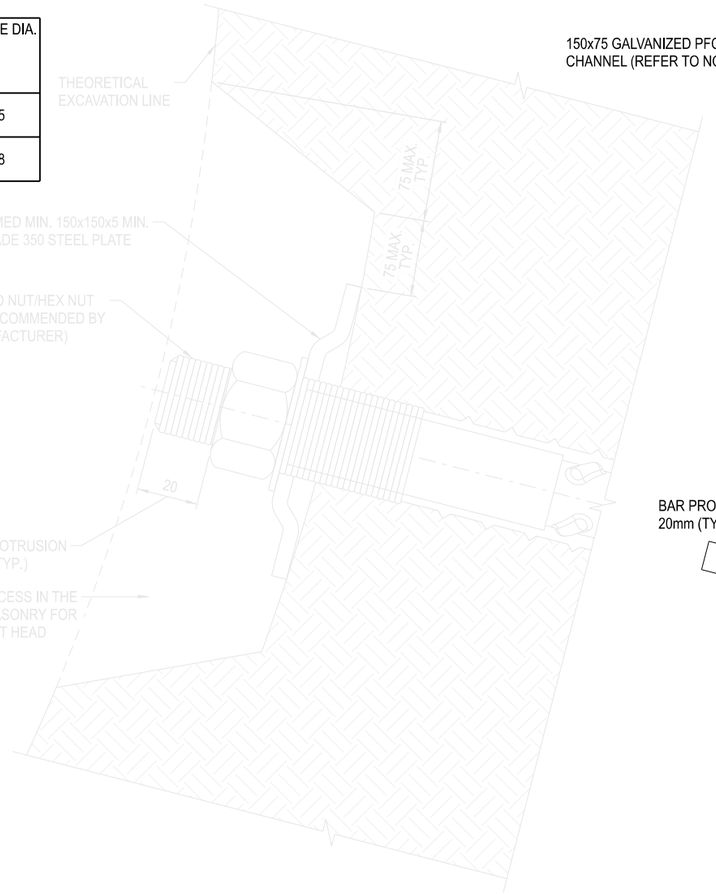
310 DCP ROCK BOLT - TYPE A
(PRETENSIONED TO 50kN PRIOR TO GROUTING)



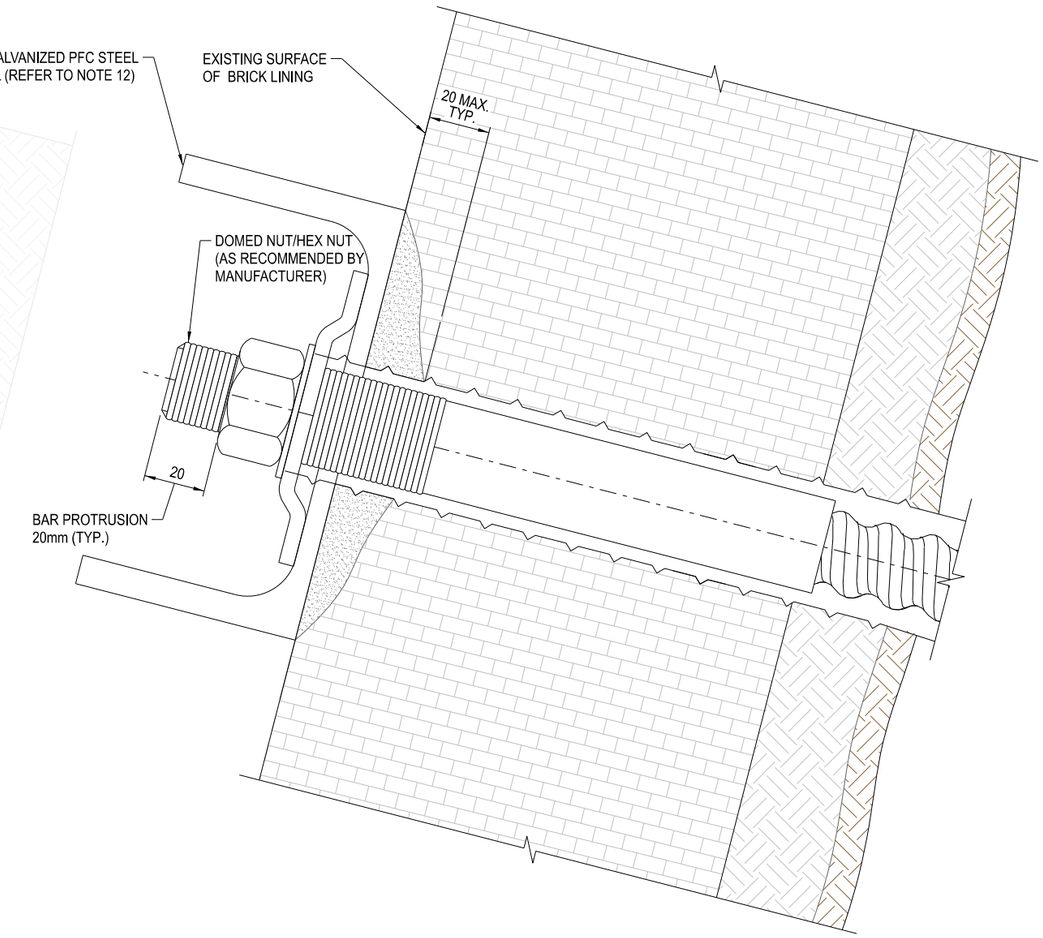
310 CT ROCK BOLT - TYPE B
(PRETENSIONED TO 50kN PRIOR TO GROUTING)

TABLE 1: ROCK BOLT DETAILS

TYPE	TOTAL LENGTH (TL)	DESIGN EMBEDMENT LENGTH (DEL)	ANCHOR SACRIFICIAL LENGTH (A)	HARDWARE LENGTH (H)	ANCHOR SACRIFICIAL (A) PLUS HARDWARE LENGTH (H)	DRILL HOLE DIA.
TYPE A	2000	MIN. 1000	204	75	279	43 - 45
	3400	MIN. 2000				
TYPE B	2000	MIN. 1000	200	75	275	45 - 48
	3400	MIN. 2000				



DETAIL 1A- PLATE FASTENING
SCALE 1:2
(REFER TO NOTE 11)



DETAIL 1B - PLATE FASTENING WITH PFC CHANNEL
SCALE 1:2
(REFER TO NOTE 11 AND 13)

25 0 25 50 75 100mm
SCALE 1:2

NOTES:

1. BOLTS SHALL SATISFY THE REQUIREMENTS FOR REINFORCING BARS TO AS/NZ 4671.
2. BOLTS WHERE REQUIRED TO BE CONNECTED WITH PFC, REFER TO RELEVANT DRAWINGS FOR LOCATION.
3. IF SPLICE OF THE BOLTS IS REQUIRED, COUPLER WITH TENSION CAPACITY NOT LESS THAN THE BOLT, AS RECOMMENDED BY THE MANUFACTURER, SHALL BE USED.
4. PLATES TO BE GRADE 350 STEEL.
5. CEMENT GROUT SHALL HAVE A COMPRESSIVE STRENGTH OF NOT LESS THAN 20MPa AT 7 DAYS AND 40MPa AT 28 DAYS.
6. REFER TO PROJECT SPECIFICATION FOR FURTHER INSTALLATION DETAILS AND ANCHOR TESTING REQUIREMENTS.
7. IN CASE OF MORE THAN 1m SOFT MATERIALS NOTED FROM DRILLING OF THE HOLE, THE LENGTH OF THE ROCK BOLTS SHALL BE EXTENDED AND AT LEAST 2m BOND LENGTH BEYOND THE SOFT MATERIALS SHALL BE MAINTAINED.
8. IN CASE CEMENT GROUT IS USED SUITABLE ANNULUS SIZE SHALL BE USED BASED ON THE MANUFACTURERS RECOMMENDATION.
9. ROCK BOLTS SHALL HAVE A MINIMUM DESIGN EMBEDMENT IN MODERATELY WEATHERED OR BETTER BASALT AS INDICATED IN TABLE 1.
10. DRILL HOLE DIAMETERS TO BE VERIFIED BY TESTING AND MANUFACTURERS SPECIFICATION.
11. THE PLATE FASTENING DETAILS SHALL BE USED AS FOLLOWS:
    - DETAIL 1A IS APPLICABLE FOR ROCK BOLTS INSTALLED TO SECURE UNSTABLE WEDGES AND FOR ROCK BOLTS INSTALLED AS CONTINGENCY SUPPORTS.
    - DETAIL 1B IS APPLICABLE AT THE TOE OF THE MASONRY TUNNEL SIDEWALL IN SUPPORT TYPE INV-1 AND INV-1A. FOR DETAILS REFER TO DRG GEE_C1239.
12. FOR PFC LINTEL DETAILS REFER TO DRG GEE_C1239.
13. THE PFC CHANNEL IS PLACED ON THE INTERNAL FACE OF THE MASONRY TUNNEL LINNING IN SUPPORT TYPE INV-1A. RECESSING INTO THE MASONRY IS OPTIONAL.
14. SELF DRILLING ANCHOR (ISCHEBECK TITAN OR EQUIVALENT MAY BE USED SUBJECT TO DESIGNER'S CONFIRMATION.

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Consultant: aurecon

Franchisee / Lessee: V/Line

CIVIL STRUCTURAL
GEELONG
DJILLONG TUNNEL REHABILITATION
TUNNEL DESIGN EARLY WORKS
TYPICAL ROCK BOLT DETAILS

Up Location	Down Location	Datum
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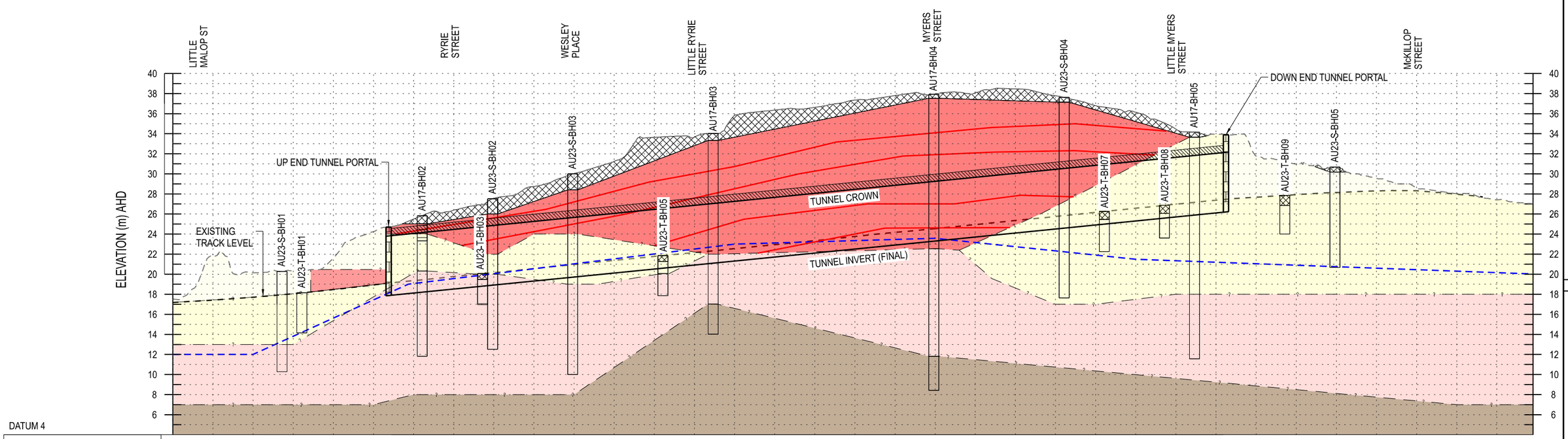
NOTES:

1. FOR GENERAL CONSTRUCTION NOTES REFER DRG. GEE_C1227, GEE_C1228 AND GEE_C1229.
2. INVERT LEVEL IS INDICATIVE ONLY.
3. FOR SUPPORT SELECTION CRITERIA DRG GEE_C1238.
4. DUE TO THE ORIGINAL CONSTRUCTION THE GROUND MAY BE DISTURBED AROUND THE TUNNEL.
5. REFER TO INDIVIDUAL GEOTECHNICAL LOGS FOR FURTHER INFORMATION
6. NEWER VOLCANICS HAS BEEN USED AS A COLLECTIVE TERM FOR CONTINUOUS SUB HORIZONTAL BANDS OF VARIOUSLY WEATHERED MATERIALS RANGING FROM MODERATELY WEATHERED ROCK TO RESIDUAL CLAYS.

BOREHOLE LOCATION	APPROX CHAINAGE	DISCRIPTION	BOREHOLE ELEVATION (mAHD)	BOREHOLE DEPTH (BGL)
AU17-BH02	72925	SURFACE- 15M SOUTH INTO TUNNEL FROM UP PORTAL	25.7	14
AU17-BH03	73070	SURFACE LITTLE RYRIE ST	33.8	20
AU17-BH04	73180	SURFACE MYERS ST	37.8	29.5
AU17-BH05	73310	SURFACE LITTLE MYERS ST	33.8	22.6
AU23-S-BH01	72855	SURFACE SERVICE ROAD OFF LITTLE MALOP STREET	22.25	10
AU23-S-BH02	72960	SURFACE WESLEY STREET	30.86	15
AU23-S-BH03	73000	SURFACE GOODALL LANE	32.36	20
AU23-S-BH04	73245	SURFACE FENWICK ST	38.25	20
AU23-S-BH05	73380	FENWICK ST PORTAL	34.14	10
AU23-T-BH01	72865	45M NORTH OF UP PORTAL (NOT IN TUNNEL)	17.98	4
AU23-T-BH03	72955	45M SOUTH INTO TUNNEL FROM UP PORTAL	19.91	3.1
AU23-T-BH05	73045	135M SOUTH INTO TUNNEL FROM UP PORTAL	21.65	4
AU23-T-BH07	73265	70M NORTH INTO TUNNEL FROM DN PORTAL	25.65	4
AU23-T-BH08	73295	40M NORTH INTO TUNNEL FROM DN PORTAL	26.76	3.25
AU23-T-BH09	73355	15M SOUTH OF DN PORTAL (NOT IN TUNNEL)	27.51	3.85

LEGEND:

- NEWER VOLCANICS
- MOORABOOL VIADUCT SANDS
- FYANSFORD CLAYS
- WAURN PONDS LIMESTONE
- FILL
- TUNNEL ZONE OF DISTURBANCE (APPROX. 500mm)
- TUNNEL PORTAL (INDICATIVE)
- TOP OF RAIL (EXISTING TRACKS)
- GROUND SURFACE LEVEL
- INFERRED GROUNDWATER TABLE



CHAINAGE	72800	72850	72900	72950	73000	73050	73100	73150	73200	73250	73300	73350	73400	73450
INDICATIVE SUPPORT TYPE (REFER NOTE 3)			UP END TUNNEL ORTAL	INV-2 / INV-2A					INV-1 / INV-1A	INV-2 / INV-2A		DOWN END TUNNEL PORTAL		

100000

GEOTECHNICAL LONGITUDINAL SECTION
(GEE_C1232 AND GEE_C1233 SECTION B)
SCALE H:1;2000 V:1:400

20 0 20 40 60 80 100m
4 0 4 8 12 16 20m
SCALE H2000:V400

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Consultant: aurecon

Franchisee / Lessee: V/Line

CIVIL STRUCTURAL
GEELONG
DJILLONG TUNNEL REHABILITATION
TUNNEL DESIGN EARLY WORKS
GEOTECHNICAL LONG SECTION

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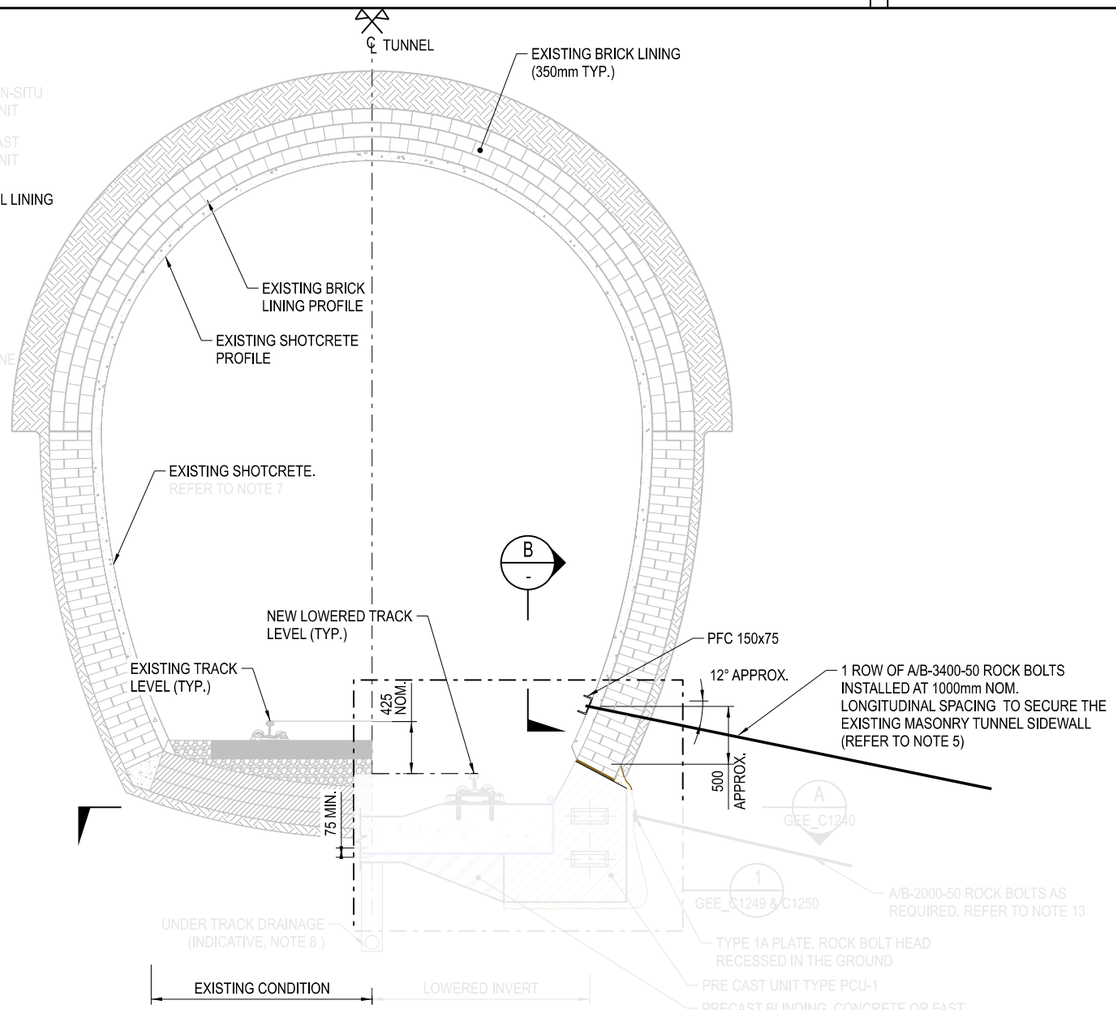
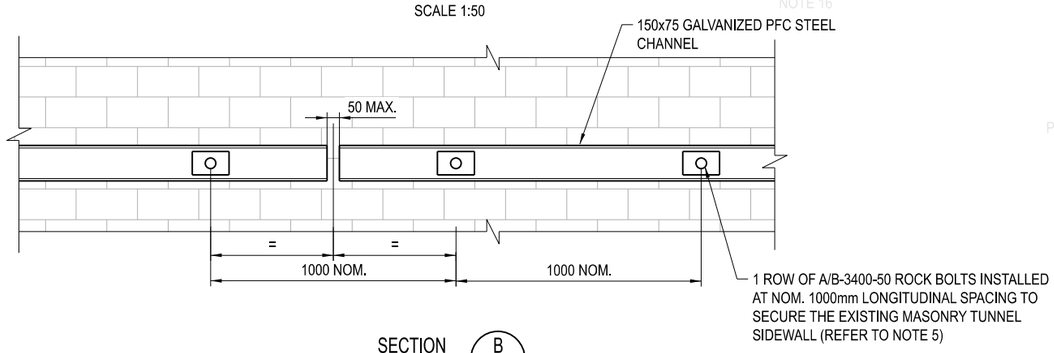
LEGEND:

- PERMENANT INVERT CAST IN-SITU REINFORCED CONCRETE UNIT
- PERMENANT INVERT PRECAST REINFORCED CONCRETE UNIT
- EXISTING MASONRY TUNNEL LINING
- RAMMED EARTH BEHIND MASONRY TUNNEL LINING
- NON-SHRINK GROUT (REFER TO NOTE 14)
- WATERPROOFING MEMBRANE
- NO FINES CONCRETE
- LINE OF SYMMETRY



INVERT REPLACEMENT (SUPPORT TYPE - INV-1) - CROSS SECTION

SCALE 1:50



SECTION B - SCALE 1:25

NOTES:

1. FOR GENERAL CONSTRUCTION NOTES REFER DRG. GEE_C1227, GEE_C1228 AND GEE_C1229.
2. REFER TO GENERAL NOTES (GEE_C1227) FOR OBSERVATIONAL METHOD LIMITATIONS AND CONTINGENCIES.
3. THIS DRAWING SHALL BE USED IN CONJUNCTION WITH DRG.GEE_C1240.
4. INVERT REPLACEMENT TYPE INV-1 SHALL ONLY BE USED, AS PERMITTED BY THE SUPPORT SELECTION SHOWN IN DRG. GEE_C1238.
5. MIN 3 x No. OF ROCK BOLTS PER PFC CHANNEL SECTION SHALL BE INSTALLED.
6. THE EXISTING TUNNEL LINING MAY BE COVERED WITH SHOTCRETE.
7. THE PRECAST REINFORCED CONCRETE LINING UNITS PROVIDE TEMPORARY SUPPORT FOR THE MASONRY TUNNEL LINING. THEREFORE, THESE SHALL BE INSTALLED IMMEDIATELY AFTER THE OPENING UP OF THE INVERT. GROUT SHALL BE PLACED BETWEEN THE PRECAST UNIT AND THE GROUND AND THE PRECAST UNIT AND THE MASONRY TUNNEL LINING IN ACCORDANCE WITH THE PROJECT SPECIFICATION.
8. REFER TO TO RAILWAY TRACK AND CIVIL WORKS PACKAGE FOR DRAINAGE DETAILS.
9. THE CONTRACTOR SHALL ENSURE ADEQUATE MEANS AND METHODS ARE USED TO LEVEL AND INSTALL THE PRECAST REINFORCED CONCRETE LINING UNITS.
10. THE SIDEWALL SHALL BE FULLY SUPPORTED BY THE PRECAST REINFORCED CONCRETE LINING UNITS BEFORE OPENING UP THE NEXT SIDEWALL SECTION. REFER TO THE HIT 'BITE' SCHEMATIC CONSTRUCTION SEQUENCE ON DRG. GEE_C1240.
11. ONCE THE GROUND BELOW THE EXISTING FOOTING IS EXPOSED, GEOLOGIST/GEOTECHNICAL ENGINEER SHALL INSPECT AND ASSESS THE GROUND CONDITION. IF REQUIRED, LOCALISE SPOT BOLTS SHALL BE INSTALLED.
12. THE EXISTING LINING PROFILE IS INDICATIVE ONLY AND SHALL BE VERIFIED ON SITE.
13. ROCKBOLT INSTALLATION AS DIRECTED BY ON-SITE GEOTECHNICAL ENGINEER. ROCK BOLT LENGTH IS INDICATIVE AND LONGER BOLTS MAY BE REQUIRED DEPENDING ON THE ENCOUNTERED GROUND CONDITIONS.
14. GROUT BAGS ARE REQUIRED TO BE USED AT THE BASE OF THE PRECAST UNIT TO RE-ESTABLISH SOME OF THE HOOP STRESS IN THE LINING. GROUT BAGS MAY BE USED AT THE BACK OF THE PRE CAST UNIT. GROUT BAGS ARE NOT A SUBSTITUTE FOR GROUTING.
15. LOCAL OVEREXCAVATION TO FACILITATE THE PLACEMENT OF THE PRECAST UNIT IS INDICATIVE ONLY. IT SHALL BE BACKFILLED WITH BLINDING CONCRETE OR FAST SET CONCRETE.
16. SUPPORT TYPE INV-1A IS AN ALTERNATIVE OF SUPPORT TYPE INV-1. USE OF SUPPORT TYPE INV-1A WILL REQUIRE THE TRACK SLAB TO BE REMOVED FOR THE WATERPROOFING TO BE INSTALLED UNDERNEATH SHOULD THE TUNNEL BE WATERPROOFED AT A LATER STAGE. CONSEQUENTLY THIS ALTERNATIVE SUPPORT TYPE SHALL ONLY BE USED WITH THE PERMISSION OF V/LINE. THIS SUPPORT TYPE MAY NOT REQUIRE RECESSED ROCKBOLT HEADS, MAY PERMIT THE PFC CHANNEL TO BE INSTALLED ON THE INTERNAL SURFACE OF THE EXISITNG TUNNEL LINING AND MAY PERMIT THE USE OF TEMPORARY ROCK BOLTS.

ALTERNATIVE INVERT REPLACEMENT (SUPPORT TYPE - INV-1A) - CROSS SECTION

SCALE 1:50
(FOR CLARITY UNDER TRACK DRAINAGE IS NOT SHOWN)

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PFC INSTALLATION

1. PRE-DRILL HOLES ON PFC CHANNEL.
2. FIX THE PFC CHANNEL TO THE SIDEWALL WITH ADEQUATE CONSTRUCTION MEANS AND METHODS.
3. INSTALL MORTAR BED FOR UNIFORM BEARING BETWEEN THE CHANNEL AND THE MASONRY/SHOTCRETE TUNNEL LINING.
4. INSTALL ROCK BOLTS THROUGH PRECUT HOLES IN PFC CHANNEL. THE ROCK BOLTS MAY BE PRE-DRILLED / PRE-INSTALLED.

250 0 250 500 750 1000 1250mm — SCALE 1:25

0.5 0 0.5 1 1.5 2 2.5m — SCALE 1:50

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Consultant: aurecon

Franchisee / Lessee: V/Line

CIVIL STRUCTURAL

GEELONG

DJILLONG TUNNEL REHABILITATION
TUNNEL DESIGN EARLY WORKS
TEMPORARY SUPPORT TYPE INV-1 - SHEET 1

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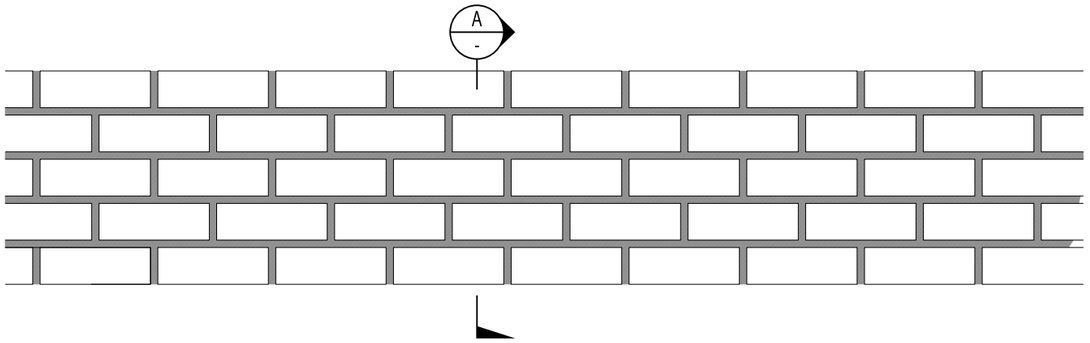
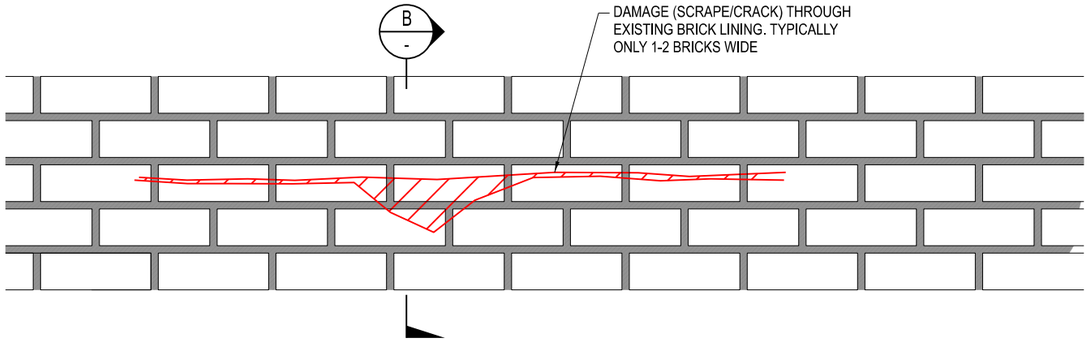
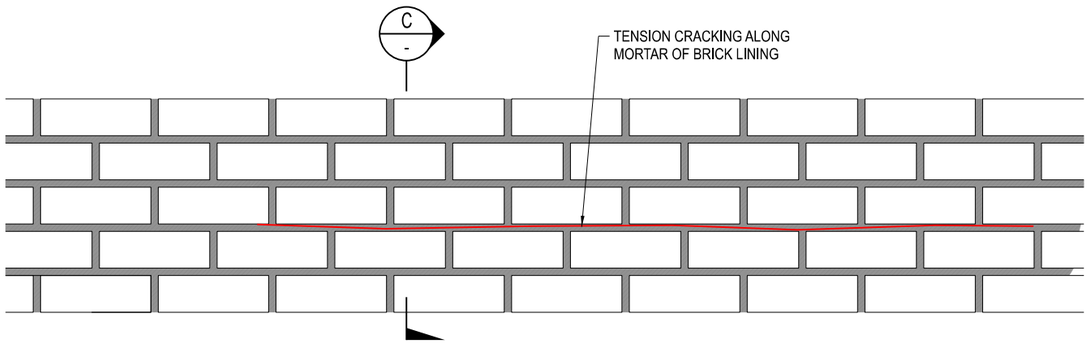


DETAIL B1
BRICK REPOINTING TYPICAL
N.T.S.



DETAIL B2
REPLACEMENT OF DAMAGED BRICKS
N.T.S.



DETAIL B3
REPAIR OF TENSION CRACKS IN BRICK JOINTS (>3mm)
N.T.S.

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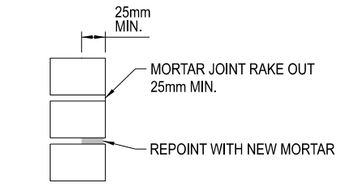
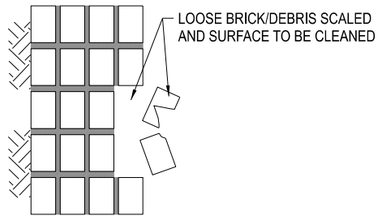
NOTES:

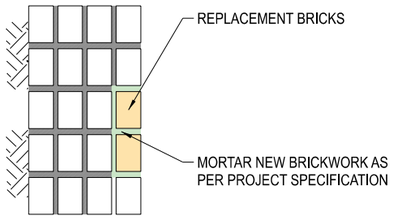
1. FOR GENERAL CONSTRUCTION NOTES REFER DRG GEE_C1227, GEE_C1228 AND GEE_C1229.
2. THE LOCATION AND CAUSE OF CRACKS / DAMAGE TO BE REPAIRED SHALL BE CONFIRMED ON SITE BY THE DESIGNER AND THE APPROPRIATE REPAIR METHOD TO BE SELECTED IN CONSULTATION WITH THE DESIGNER.
3. REFER TO THE PROJECT SPECIFICATION FOR REPAIR PRODUCTS TO BE USED.
4. REPAIRS TO BE CARRIED OUT BEFORE COMMENCEMENT OF THE INVERT LOWERING. REPAIR AND CONSTRUCTION WORKS SHALL BE AGREED WITH THE DESIGNER.
5. REPAIRS SHALL ALSO BE CARRIED OUT AS REQUIRED FOLLOWING COMPLETION OF THE INVERT LOWERING CONSTRUCTION WORKS.
6. BRICKS AND BRICK BOND ARE SHOWN INDICATIVELY.



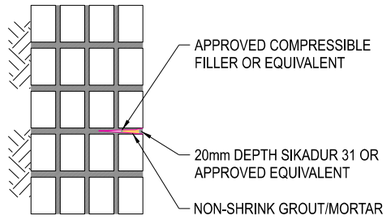
SECTION A
NTS



SECTION B-1
NTS
REMOVE DAMAGED BRICKS



SECTION B-2
NTS
REPLACE BRICK WORK & MORTAR



SECTION C
NTS
REPAIR OF TENSION CRACKS
IN BRICK JOINTS (>3mm)

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Consultant
aurecon

Franchisee / Lessee
V/Line

CIVIL STRUCTURAL
GEELONG
DJILLONG TUNNEL REHABILITATION
TUNNEL DESIGN EARLY WORKS
EXISTING LINING DEFECT REPAIRS

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

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Sheet Size A3

Drawing Number GEE_C1256

Revision D

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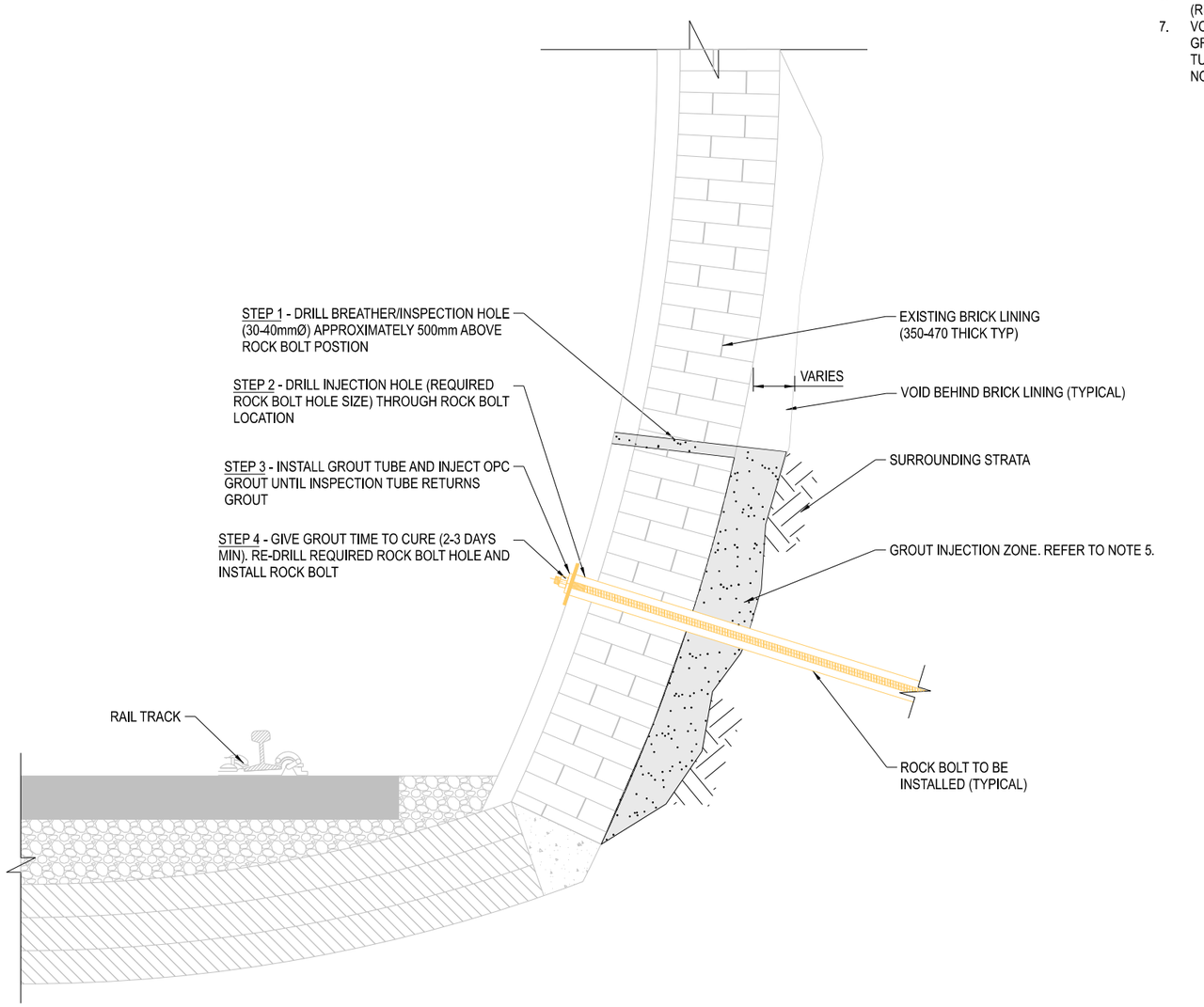
NOTES:

1. FOR GENERAL CONSTRUCTION NOTES REFER DRGGEE_C1227, GEE_C1228 AND GEE_C1229.
2. DRAWING SHOWS SEQUENCING ONLY. REFER TO RELEVANT DESIGN DRAWINGS FOR FURTHER INSTALLATION DETAILS.
3. RELEVANT HEALTH AND SAFETY PRECAUTIONS TO BE TAKEN, WITH PARTICULAR CONSIDERATION TO:
   - 3.1 PRESSURIZED LINES (BURST, EJECTION ETC.)
   - 3.2 AGREED / APPROVED METHODOLOGY (MAXIMUM OPERATION PRESSURES ETC.)
   - 3.3 APPROPRIATE PPE (FULL COVERALLS, EYE PROTECTION ETC.)
   - 3.4 CHEMICAL BURNS (FULL BODY COVERAGE, WASH-DOWN FACILITIES)
4. INJECTION TUBES AND GROUT NIPPLES TO BE INSTALLED WHERE POSSIBLE IN ANCHOR LOCATIONS TO REDUCE PERFORATIONS THROUGH BRICK LINING.
5. W/C RATIO TO BE CALIBRATED TO REDUCE LONGITUDINAL GROUT TRAVEL.
6. PRE-GROUTING SHALL BE CARRIED OUT BEFORE INSTALLATION OF THE WEEP HOLES (REFER TO DRG GEE_C1259)
7. VOID INFILL GROUT INJECTION PRESSURE SHALL BE CONTROLLED AND IT SHALL BE ENSURED THAT THE GROUT CAN RETURN AT THE BREATHER/INSPECTION HOLE IN ORDER TO REDUCE THE RISK OF MASONRY TUNNEL LINING CONVERGENCE DURING THE GROUT INSTALLATION. THE MAXIMUM GROUT PRESSURE SHALL NOT EXCEED 25kPa.



DETAIL 1 - PRE-GROUTING PROCESS AT ROCK BOLTED ZONES

SCALE 1:20

250 0 250 500 750 1000mm

SCALE 1:20

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Consultant: aurecon

Franchisee / Lessee: V/Line

CIVIL STRUCTURAL

GEELONG

DJILLONG TUNNEL REHABILITATION
TUNNEL DESIGN EARLY WORKS
MASONRY TUNNEL PRE-GROUTING

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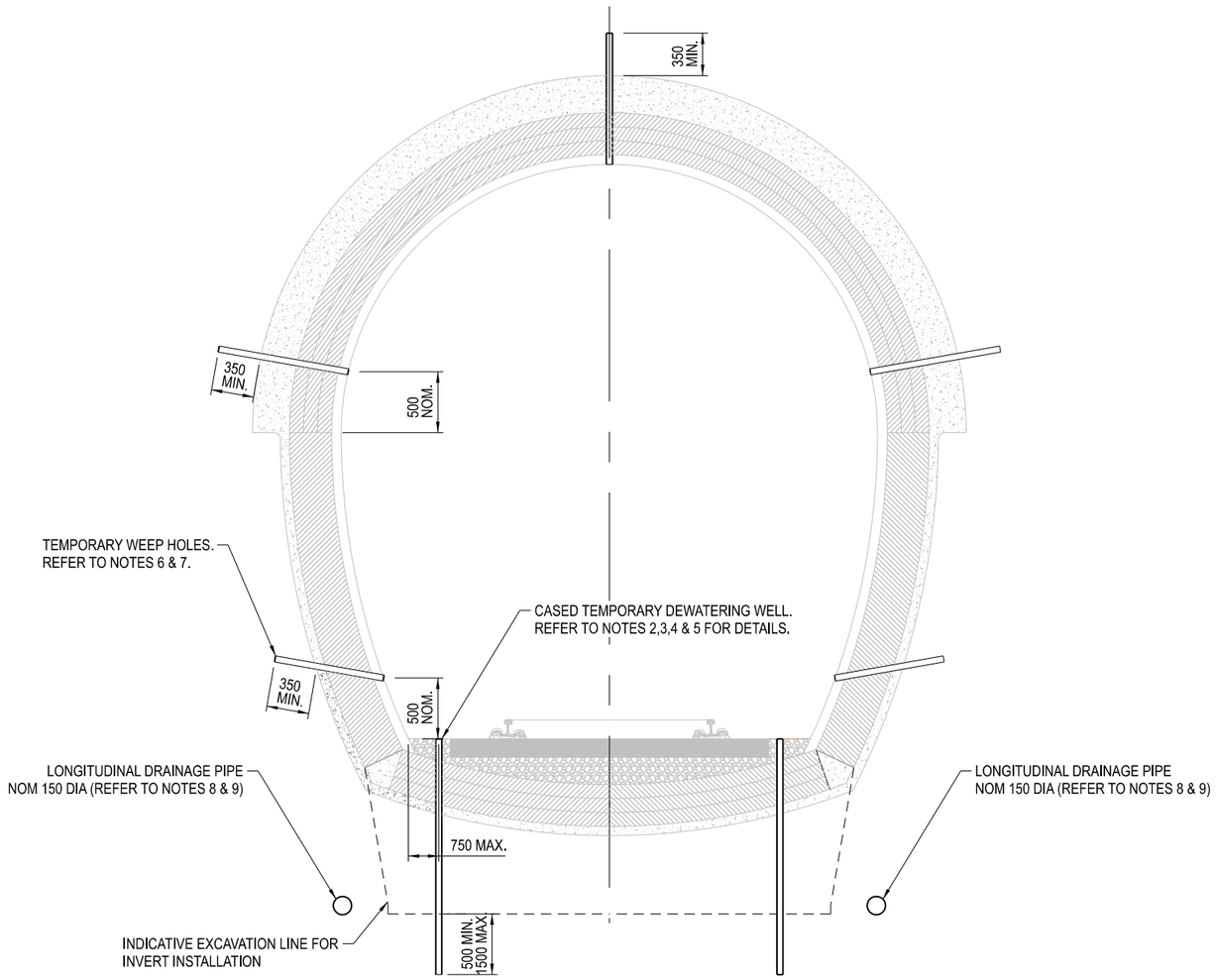

WEEP HOLE AND TEMPORARY DRAINAGE (TYPICAL)
SCALE 1:50

NOTES:

1. FOR GENERAL CONSTRUCTION NOTES REFER DRG GEE_C1227, GEE_C1228 AND GEE_C1229.
2. V/LINE/CONTRACTOR SHALL USE ADEQUATE DEWATERING SYSTEM AT AREAS WHERE THE TUNNEL INVERT IS IN SAND OR CLAY UNITS TO ENSURE THAT NO PORE PRESSURE IS ACTING ON THE EXISTING TUNNEL INVERT AT THE TIME OF INVERT REMOVAL.
3. THE DEWATERING WELLS SHALL BE PLACED AT A MAXIMUM 10m SPACING EACH SIDE OF THE RAIL ALONG THE TUNNEL AXIS AND SHALL BE STAGGERED.
4. THE CONTRACTOR SHALL MAINTAIN AND OPERATE THE TEMPORARY DEWATERING WELLS AS LONG AS THE INVERT SECTION IT IS PLACED IN IS EXCAVATED.
5. THE CONTRACTOR SHALL ENSURE THAT THE WATER COLLECTED BY THE WELLS IS DELIVERED TO A SUITABLE WATER COLLECTOR OUTSIDE THE TUNNEL. IT IS SUGGESTED TO USE PVC PIPES OR HOSES ATTACHED TO THE REMAINING TUNNEL LINING AT A SUITABLE HEIGHT AND WITH A SUITABLE GRADIENT.
6. WEEP HOLES SHALL BE MIN. 35mm MAX. 50mm DIAMETER HOLES. THE WEEP HOLES SHALL BE CASED AS REQUIRED AND SHALL BE DRILLED AT MIN. 10° TO THE HORIZONTAL. THE WEEP HOLES SHALL BE INSTALLED AT MAX. 10m SPACING ALONG THE TUNNEL AXIS.
7. AFTER COMPLETION OF THE INVERT LOWERING WORKS, THE WEEP HOLES AND THE DEWATERING WELL HOLES SHALL BE FILLED UP WITH CEMENTITIOUS GROUT.
8. HORIZONTAL DRAINAGE PIPES TO BE INSTALLED INTO MOORABOOL VIADUCT SANDS WITH THE FOLLOWING APPROXIMATE CHAINAGES. CHAINAGES TO BE CONFIRMED BY FURTHER GROUND INVESTIGATION SPECIFIED ON DRG GEE_C1227:
   - UP END PORTAL TO CH 72970
   - CH 72970 TO CH 73060
   - CH 73210 TO DOWN END PORTAL
9. HORIZONTAL DRAINAGE PIPES TO BE INSTALLED FROM THE PORTAL FACE, LONGITUDINAL TO AND AT THE LOWERED INVERT LEVEL. PUMPING AND COLLECTION SUMP TO BE PROVIDED AT DOWN END PORTAL.

250 0 250 500 750 1000 1250mm
SCALE 1:25

0.5 0 0.5 1 1.5 2 2.5m
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		C	23/02/24	EARLY WORKS	T.M.	N.M.	A.V.	J.M.
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		A	28/07/23	PRELIMINARY DESIGN	T.M.	N.M.		J.M.

Consultant: aurecon
Franchisee / Lessee: V/Line

CIVIL STRUCTURAL
GEELONG
DJILLONG TUNNEL REHABILITATION
TUNNEL DESIGN EARLY WORKS
TUNNEL TEMPORARY DRAINAGE AND WEEP HOLES

Up Location	Down Location	Datum
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Sheet No. 01 of 01
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NOTES:

1. FOR GENERAL CONSTRUCTION NOTES REFER DRG GEE_C1227, GEE_C1228 AND GEE_C1229.

2.1 IN TUNNEL LINING DEFORMATION MONITORING AND TUNNEL PORTAL FACE MONITORING SHALL BE UNDERTAKEN WITH THE AMBER AND RED LEVELS AS SUMMARISED IN TABLE 1 AND TABLE 2 IN DRG GEE_C1262.

2.2 DIGITAL TAPE EXTENSOMETER READINGS (I.E. A PRECISION MEASURING TAPE) SHOULD BE TAKEN IN ADDITION TO OPTICAL SURVEY, BETWEEN CONVERGENCE POINTS A1-A2, C1-C2, B-C1, B-C2. THIS WILL REQUIRE FIXINGS (E.G. HOOKS/EYEBOLTS) TO THE TUNNEL LINING ADJACENT TO THE OPTICAL SURVEY FIXINGS

2.3 REPEATABILITY OF MONITORING DATA SHOULD BE +/- 2mm FOR OPTICAL SURVEY AND +/- 0.5mm FOR TAPE EXTENSOMETER.

2.4 BASELINE READINGS SHOULD BE ESTABLISHED PRIOR TO EXCAVATION COMMENCING BY THREE READINGS OF EACH MONITORING DEVICES SPREAD OVER AT LEAST ONE WEEK AND NO MORE THAN TWO WEEKS.

2.5 WHERE SHOTCRETE IS PRESENT IT SHALL BE RETAINED AND MONITORED FOR CRACKING AND MOVEMENT.

2.6 AMBER AND RED ACTIONS ARE SPECIFIED AS BELOW.

ACTION - AMBER

- CONTRACTOR TO SUBMIT RELEVANT MONITORING DATA WITHIN 4 HOURS TO V/LINE OR THEIR REPRESENTATIVE. THE DATA MUST BE REVIEWED BY A PERSON EXPERIENCED WITH TUNNEL MONITORING.
- MONITORING DATA INCLUDING DISPLACEMENT RATES TO BE INTERPRETED BY THE CONTRACTOR.
- CARRY OUT INVESTIGATION IMMEDIATELY TO STUDY THE CAUSE OF THE UNDUE RESPONSE.
- MONITORING FREQUENCY TO BE INCREASED AS PER AGREED OUTCOMES OF THE REVIEW WITH V/LINE OR THEIR REPRESENTATIVE.
- CONTRACTOR SHALL IDENTIFY AND IMPLEMENT IMMEDIATELY ANY REMEDIAL ACTION TO PREVENT THEIR WORKS INDUCING MOVEMENTS TO EXCEED THE RED LEVEL.
- CONTRACTOR MAKE READY THE NECESSARY PROVISIONS TO ENSURE THE AVAILABILITY OF RESOURCES, SUPPLY OF MATERIAL AND REQUIRED PLANT FOR CARRYING OUT THE NECESSARY CONTINGENCY MEASURES.
- CONTRACTOR SHALL MAKE PREPARATION FOR THE IMPLEMENTATION OF THE CONTINGENCY MEASURES.
- IF NO CONSTRUCTION ACTIVITIES IDENTIFIED TO BE THE CAUSE OF THE UNDUE RESPONSE CONSTRUCTION SHALL CONTINUE.

ACTION - RED

- STOP WORK AND IMMEDIATELY IMPLEMENT CONTINGENCY MEASURES AS SHOWN ON DRG GEE_C1254.
- CONTRACTOR TO SUBMIT RELEVANT MONITORING DATA AND REPORT THE RED TRIGGER EXCEEDANCE TO V/LINE OR THEIR REPRESENTATIVE IMMEDIATELY. THE DATA MUST BE REVIEWED BY A PERSON EXPERIENCED WITH TUNNEL MONITORING.
- CARRY OUT INVESTIGATION IMMEDIATELY TO STUDY THE CAUSE OF THE RED TRIGGER EXCEEDANCE.
- IMPLEMENTATION OF CONTINGENCY MEASURES TO BE REVIEWED AND FURTHER ACTIONS TO BE AGREED WITH V/LINE OR THEIR REPRESENTATIVE.

3.1 MONITORING ARRAYS SHALL BE INSTALLED AND MONITORED AS PER THE FOLLOWING TABLE:

TUNNELS	MINIMUM NUMBER OF ARRAYS	MONITORING FREQUENCY
GENERAL SECTION	ONE EVERY 10m	ONCE PER SHIFT DURING ACTIVE PHASE AND WEEKLY IN TRANSITIONAL PHASE
WITHIN 20m OF THE PORTALS	ONE EVERY 5m	
WITHIN 10m OF REFUGES	ONE EVERY 5m	

3.2 THE MONITORING ARRAYS ARE TO BE INSTALLED PRIOR TO COMMENCEMENT OF INVERT LOWEREING EXCAVATION TO ALLOW FOR BASE READING TO BE ESTABLISHED.

3.3 THE ACTIVE MONITORING PHASE IS APPLIED WHERE AN ARRAY IS LOCATED WITHIN 20m OF AN ACTIVE EXCAVATION FACE.

3.4 THE TRANSITIONAL MONITORING PHASE IS APPLIED WHERE AN ARRAY IS LOCATED BETWEEN 20m AND 40m OF AN ACTIVE EXCAVATION FACE. THIS MEANS RECORDING ONLY OF THE MONITORING RESULTS.

3.5 MONITORING SHALL BE IMPLEMENTED THROUGHOUT THE CONSTRUCTION PERIOD AND CAN BE CEASED WHEN READINGS HAVE STABILISED AFTER THE CONSTRUCTION OF THE WHOLE TUNNEL.

3.6 STABILISED MEANS THAT THE RATE OF INCREASE IS SUFFICIENTLY SMALL OR HAS CEASED ENTIRELY SUCH THAT PRACTICALLY NO FURTHER MOVEMENT OCCURS.

3.7 ADDITIONAL MONITORING EQUIPMENT AND/OR FREQUENCY MAY BE SPECIFIED BY V/LINE OR THEIR REPRESENTATIVE. THIS COULD INCLUDE CONTINUOUSLY OPERATING WALL MOUNTED TOTAL STATION(S), WIRELESS TILTMETERS OR EXTRA INSTRUMENTS OF THE TYPE ALREADY SPECIFIED.

4. ROCK BOLT LOAD CELL SHALL BE INSTALLED AND MONITORED AS PER THE FOLLOWING TABLE AND SPECIFICATION:

INSTRUMENT	No.	CHAINAGES	LOCATION / INCLINATION	FREQUENCY	PURPOSE
BOLT LOAD CELL	1 PER PFC CHANNEL	TO BE DISCUSSED WITH THE DESIGNER	SELECTED BOLT HEADS	DOWNLOAD IMMEDIATELY POST BOLT INSTALLATION, THEN DAILY FOR A WEEK, THEN WEEKLY	CONFIRMING THAT LOAD IS WITHIN DESIGN CAPACITY. IF LOAD GETS TOO HIGH ADDITIONAL BOLTS MAY BE REQUIRED.
NOTES: - INSTRUMENTS TO BE INSTALLED AND BASE-LINED IN ACCORDANCE WITH MANUFACTURERS GUIDELINES BY PERSONNEL EXPERIENCED IN INSTALLING THESE TYPE OF INSTRUMENTS					

SPECIFICATIONS:

4.1 BOLT LOAD CELLS

(i) MATERIALS

LOAD CELLS SHALL BE CENTRE HOLE TYPE WITH A MINIMUM INTERNAL DIAMETER OF 160mm. THE CELL SHALL HAVE A MAXIMUM RANGE OF 2000 KN. ACCESSORIES SHALL INCLUDE THE LOCAL DISTRIBUTOR, BEARING PLATES AND CENTRALISING BUSHINGS. THE LOAD-BEARING ELEMENT OF THE LOAD CELL IS TO BE A SPOOL OF HEAT-TREATED STEEL ALLOY. FOUR OR MORE STRAIN GAUGE ROSETTES ARE TO BE BONDED TO THE SPOOL. THE STRAIN GAUGE ROSETTES SHALL BE PROTECTED FROM MOISTURE AND IMPACT DAMAGE BY STRONG ALUMINIUM HOUSING FILLED WITH A HIGH DENSITY RESIN. THE LOAD CELL IS TO BE CENTRED ON THE BAR AND BEARING PLATES ARE TO BE PLACED ABOVE AND BELOW THE CELL. BEARING PLATES MUST BE ABLE TO DISTRIBUTE THE LOAD WITHOUT BENDING OR YIELDING.

(ii) INSTALLATION

THE LOAD CELL IS TO BE INSTALLED AS PER THE MANUFACTURERS RECOMMENDATIONS. THE LOAD CELL SHALL BE INSTALLED DIRECTLY ONTO THE ANCHOR, CENTRED ON THE BAR WITH BEARING PLATES ABOVE AND BELOW THE CELL AS SHOWN ON THE DRAWINGS. BEARING PLATES MUST BE ABLE TO DISTRIBUTE THE LOAD WITHOUT BENDING OR YIELDING.

(iii) BASELINE READING / CALIBRATION

FOLLOWING INSTALLATION THE LOCATION OF THE INSTRUMENT SHALL BE ACCURATELY SURVEYED. CALIBRATION AND TESTING SHOULD BE UNDERTAKEN IN ACCORDANCE WITH THE MANUFACTURER'S RECOMMENDATIONS PRIOR TO INSTALLATION.

4.2 PULL TEST FOR FAILURE

SPECIFICATIONS FOR PULL TEST FOR FAILURE ON SHORT BOLTS TO BE CREATED BY THE PREFERRED CONTRACTOR AND REVIEWED BY THE DESIGNER.

THE DESIGNER REQUIRES THE FOLLOWING TO BE INCLUDED IN THE SPECIFICATIONS:
(i) PULL OUT TEST FOR FAILURE (ON SHORT BOLTS) TO BE CARRIED OUT ON SACRIFICIAL BOLTS.
(ii) PROPOSED FREQUENCY: ONE PULL TEST TO BE CARRIED OUT PER EVERY 10m WHERE ROCK BOLTS ARE INSTALLED.
(iii) LOAD, DEFLECTION AND TIME TO BE RECORDED FOR EVERY LOAD INCREMENT OF TESTS AND RECORDS ARE TO BE PROVIDED TO THE DESIGNER FOR REVIEW.

4.3 PULL TEST FOR WORKING LOAD

SPECIFICATIONS FOR PULL TEST FOR WORKING LOAD TO BE CREATED BY THE PREFERRED CONTRACTOR AND REVIEWED BY THE DESIGNER.

THE DESIGNER REQUIRES THE FOLLOWING TO BE INCLUDED IN THE SPECIFICATIONS:
(i) PULL TEST TO BE CARRIED OUT WITH LOADING AND UNLOADING OF BOLTS WITH A PROPOSED MAXIMUM LOAD OF 150kN
(ii) PROPOSED FREQUENCY: PULL OUT TEST FOR WORKING LOAD TO BE CARRIED OUT ON EVERY SECOND BOLT INSTALLED PRIOR TO THE COMMENCEMENT OF ANY INVERT LOWERING WORKS.
(iii) LOAD, DEFLECTION AND TIME TO BE RECORDED FOR EVERY LOAD INCREMENT OF TESTS AND RECORDS ARE TO BE PROVIDED TO THE DESIGNER FOR REVIEW.

CRACK WIDTH MONITORING

CW1 AS A MINIMUM, CRACK WIDTH MONITORS SHALL BE FITTED TO STRUCTURALLY SIGNIFICANT CRACKS MAPPED BY THE CONTRACTOR, AND LOCATION REVIEWED BY THE DESIGNER.

CW2 THE FREQUENCY OF CRACK WIDTH MONITORING SHALL BE THE SAME AS FOR THE CONVERGENCE MONITORING.

CW3 CRACK WIDTH MONITORING RESULTS SHALL BE PROVIDED TO V/LINE OR THEIR REPRESENTATIVE FOR REVIEW TOGETHER WITH THE CONVERGENCE MONITORING RESULTS.

0.5 0 0.5 1 1.5 2 2.5m

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CIVIL STRUCTURAL
GEELONG
DJILLONG TUNNEL REHABILITATION
TUNNEL DESIGN EARLY WORKS
TUNNEL INSTRUMENT MONITORING - SHEET 1

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Drawing Number: GEE_C1261 | Revision: D

IN TUNNEL LINNING DEFORMATION MONITORING ARRAY

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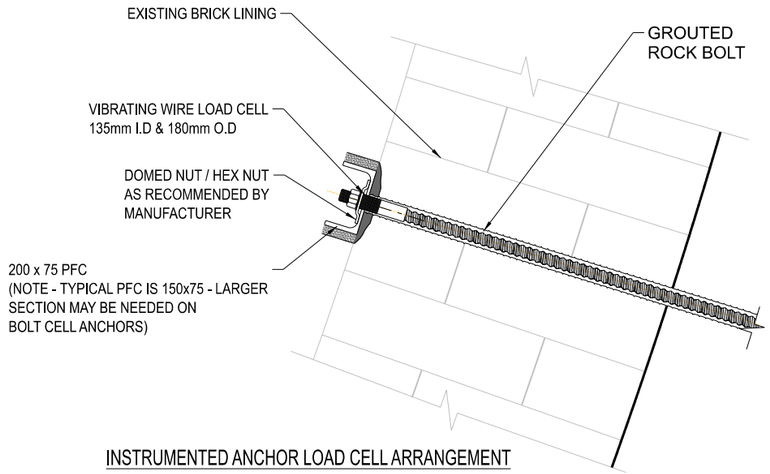
(SUPPORT TYPE INV-1 IS SHOWN, MONITORING INTENT IS SIMILAR FOR ALL SUPPORT TYPES)



INSTRUMENTED ANCHOR LOAD CELL ARRANGEMENT

NTS

(ROCK BOLT, BRICKS AND PFC CHANNEL ARE SHOWN INDICATIVELY)

LEGEND:

- TUNNEL CONVERGENCE MONITORING POINT
- OPTICAL SURVEY TARGET
- PERMENANT INVERT CAST IN-SITU REINFORCED CONCRETE UNIT
- PERMENANT INVERT PRECAST REINFORCED CONCRETE UNIT
- EXISTING MASONRY TUNNEL LINING
- RAMMED EARTH BEHIND MASONRY TUNNEL LINING
- 75mm NOM. THICK BLINDING CONCRETE AS REQUIRED
- SHOTCRETE

PORTAL FACE MONITORING (UP AND DOWN PORTAL)

NTS

TABLE 1: IN TUNNEL MONITORING TRIGGER LEVELS

TRIGGER LEVELS FOR CONVERGENCE MONITORING POINTS		BRICK/SHOTCRETE			
		AMBER		RED	
		Sx(mm)	Sy (mm)	Sx (mm)	Sy (mm)
LOCATION	A1, A2				
	B				
	C1, C2				

TABLE 2: PORTAL FACE MONITORING TRIGGER LEVELS

TRIGGER LEVELS FOR CONVERGENCE MONITORING POINTS		BRICK/SHOTCRETE					
		AMBER			RED		
		X(mm)	Y (mm)	Z(mm)	X(mm)	Y(mm)	Z(mm)
LOCATION	A1, A2						
	B						
	C1, C2						

NOTE:

1. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH DRG GEE_C1261,
2. THE LINING DEFORMATION MONITORING POINTS SHALL BE OPTICAL PRISM OR EQUIVALENT, ATTACHED AND FIXED ONTO THE TUNNEL LINING, WITH
   X HORIZONTAL MOVEMENT
   Y VERTICAL MOVEMENT
   Z LONGITUDINAL MOVEMENT (IN CASE OF IN TUNNEL MONITORING TO BE RECORDED ONLY)
   VALUES PRESENTED IN TABLE 1 AND 2 ARE FOR OPTICAL PRISMS

DRAWING SHALL BE READ IN CONJUNCTION WITH DRG GEE_C1261

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Consultant: aurecon

Franchisee / Lessee: V/Line

CIVIL STRUCTURAL

GEELONG

DJILLONG TUNNEL REHABILITATION

TUNNEL DESIGN EARLY WORKS

TUNNEL INSTRUMENT MONITORING - SHEET 2

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Sheet No.	01 of 01
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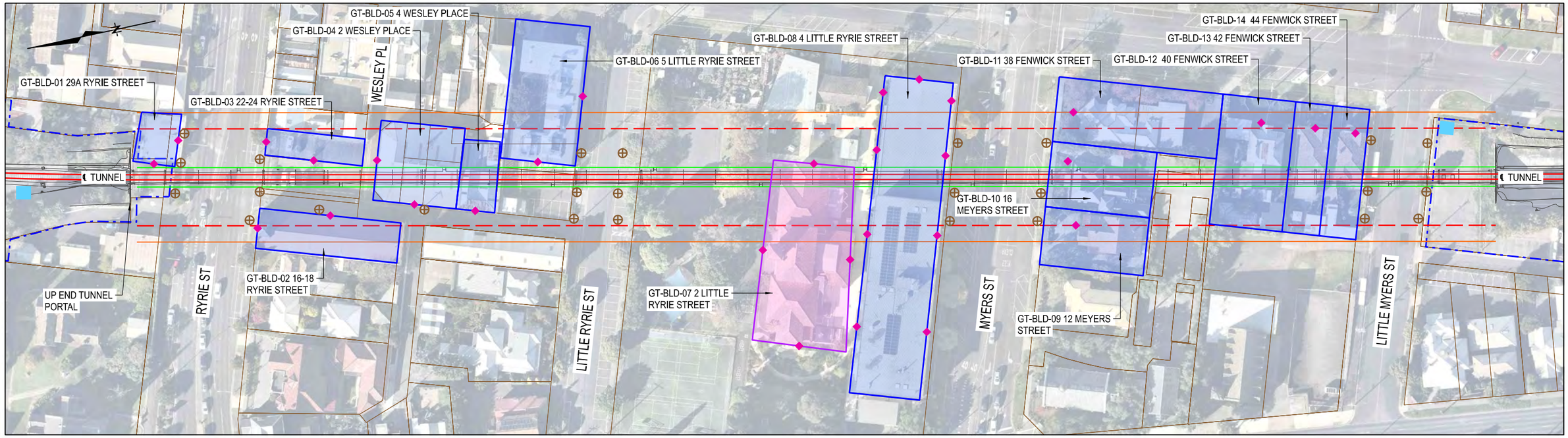
Certified By:

NOTES:
1. FOR GENERAL CONSTRUCTION NOTES REFER DRG GEE_C1227, GEE_C1228 AND GEE_C1229.



LEGEND:
- BUILDING WITHIN ZONE OF INFLUENCE OF CONSTRUCTION WORKS
- HERITAGE LISTED BUILDING WITHIN ZONE OF INFLUENCE OF CONSTRUCTION WORKS
- TUNNEL CONSTRUCTION WORKS IMPACT BOUNDARY (15m FROM TUNNEL CENTERLINE)

INSTRUMENTATION LEGEND
- SURVEY PINS (NOTE: "CATS EYE" TO BE USED ON THE PAVED SURFACE)
- SURVEY PRISMS (ON STRUCTURES)
- GROUNDWATER MONITORING WELL (WITH LOGGER)

SETTLEMENT LEGEND
- 1mm (APPROX. 20m FROM TUNNEL CENTERLINE)
- 5mm (APPROX. 3m FROM TUNNEL CENTERLINE)

12.5 0 12.5 15 17.5 20 22.5m
SCALE 1:1250

EARLY WORKS CHECKPRINT - NOT FOR CONSTRUCTION

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		D	26/03/24	IFC - CHECKPRINT (EARLY WORKS ONLY)	T.M	N.M	A.V	J.M
		C	23/02/24	EARLY WORKS	T.M.	N.M.	A.V.	J.M.
		B	03/11/23	FINAL DESIGN	T.M.	N.M.	A.V.	J.M.
		A	28/07/23	PRELIMINARY DESIGN	T.M.	N.M.		J.M.

Consultant: aurecon

Franchisee / Lessee: V/Line

CIVIL STRUCTURAL

GEELONG

DJILLONG TUNNEL REHABILITATION
TUNNEL DESIGN EARLY WORKS

GROUND SURFACEMONITORING AND SETTLEMENT CONTOURS

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

File Name

Sheet No. 01 of 01

In Serv.

Scale 1:2500 | Sheet Size A3

Drawn By	Designed By
B DEMERIS	T MEGYERI
Checked By	Ind. Review
N MAKIN	
Approved	Approval Date
J MUIR	20/02/24

Drawing Number GEE_C1264 | Revision D

Document Number 523997-W00001-DRG-GT-0510 | Version D

26/03/2024 4:23:24 PM

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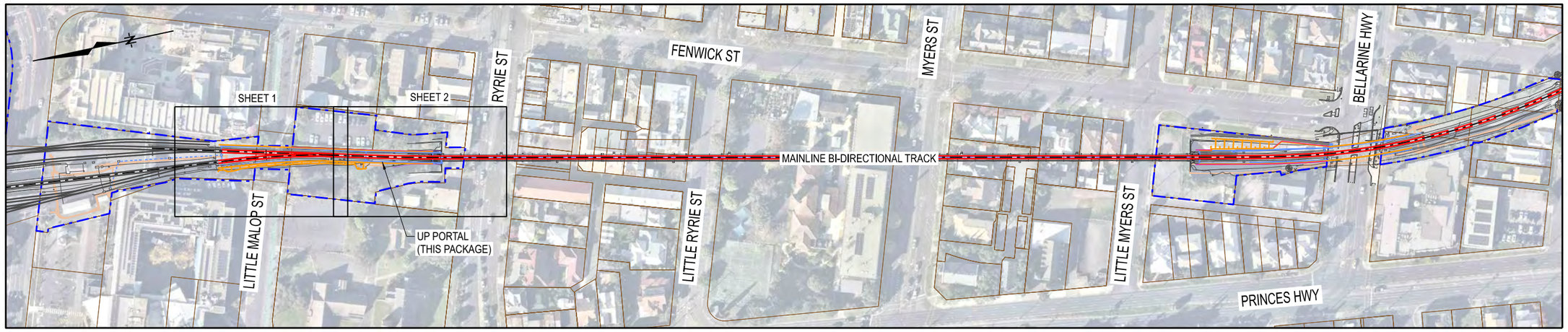
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN



LOCALITY PLAN
SCALE 1:2500

DRAWING No.		DRAWING TITLE
GEE_C1307	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - COVER SHEET AND DRAWING INDEX
GEE_C1308	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - GENERAL NOTES - SHEET 1
GEE_C1309	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - GENERAL NOTES - SHEET 2
GEE_C1310	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - GENERAL NOTES - SHEET 3
GEE_C1313	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - GENERAL ARRANGEMENT PLAN - SHEET 1
GEE_C1314	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - GENERAL ARRANGEMENT PLAN - SHEET 2
GEE_C1315	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - SET OUT INFORMATION
GEE_C1317	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - ELEVATION - EAST - SHEET 1
GEE_C1318	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - ELEVATION - EAST - SHEET 2
GEE_C1319	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - ELEVATION - EAST - SHEET 3
GEE_C1320	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - ELEVATION - EAST - SHEET 4
GEE_C1321	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - ELEVATION - WEST - SHEET 1
GEE_C1322	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - ELEVATION - WEST - SHEET 2
GEE_C1323	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - TYPICAL SECTIONS - SHEET 1
GEE_C1324	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - TYPICAL SECTIONS - SHEET 2
GEE_C1325	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - TYPICAL SECTIONS - SHEET 3
GEE_C1326	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - TYPICAL SECTIONS - SHEET 4
GEE_C1327	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - TYPICAL SECTIONS - SHEET 5
GEE_C1329	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - BORED PILE AND SHOTCRETE DETAILS - SHEET 1
GEE_C1330	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - BORED PILE AND SHOTCRETE DETAILS - SHEET 2
GEE_C1331	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - PILE CAPPING BEAM - SHEET 1
GEE_C1332	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - PILE CAPPING BEAM - SHEET 2
GEE_C1333	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - SOIL NAIL AND FACING DETAILS - SHEET 1
GEE_C1334	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - SOIL NAIL AND FACING DETAILS - SHEET 2
GEE_C1335	GEELONG	DJILLONG TUNNEL REHABILITATION - GEOTECHNICAL DESIGN - CONSTRUCTION SEQUENCE

FINAL DESIGN

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SCALE 1:2500

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		A	15/03/24	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

Consultant: aurecon
Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
COVER SHEET AND DRAWING INDEX

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

Drawn By JARUNEE R	Designed By D.MACPHIE
Checked By H.NELSON	Ind. Review M.RAMACHANDRAN
File Name	
Sheet No. 01 of 01	
Approved M.BUNNEY	Approval Date
In Serv.	
Scale N.T.S. / Sheet Size A3	Drawing Number GEE_C1307 / Revision A

15/03/2024 9:18:11 AM

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Certified By: (SIGNATURE) (BLOCK LETTERS) (DATE)

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Certified By:

GENERAL

1. THIS DRAWING PACKAGE INCLUDES THE PROPOSED GOETECHNICAL ENGINEERING DRAWINGS FOR REMEDIATION OF THE CUTTING SLOPES ASSOCIATED WITH THE UP PORTAL OF DJILLONG TUNNEL. THIS PACKAGE SHALL BE READ TOGETHER WITH THE 'GEOTECHNICAL DESIGN REPORT FOR UP END PORTAL (523997-W00001-REP-GEO-002).
2. THESE DRAWINGS SHALL ALSO BE READ IN CONJUCTION WITH V/LINE INFRASTRUCTURE STANDARDS AND THE FOLLOWING DESIGN PACKAGES:
   - 523997-W00001-REP-GT-0001 - TUNNEL STRUCTURES DESIGN REPORT AND ASSOCIATED DRAWINGS
   - 523997-W00001-REP-RT-0001 - RAILWAY TRACK AND CIVIL DESIGN REPORT AND ASSOCIATED DRAWINGS
3. THIS PACKAGE IS BASED UPON INFORMATION PROVIDED BY V/LINE AND INVESTIGATIONS PERFORMED BY AURECON.
4. ALL DESIGN LEVELS IN METRES ABOVE AUSTRALIAN HEIGHT DATUM (AHD),
5. ALL CO-ORDINATES ARE EXPRESSED IN METRES TO GDA 2020, MGA Z55 (GEOCENTRIC DATUM OF AUSTRALIA, MAP GRID AUSTRALIA - ZONE 55).
6. ALL UNITS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE. RAIL CHAINAGES IN METRES.
7. THE DRAWINGS SHALL NOT BE SCALED.
8. ALL DIMENSIONS RELEVANT TO SETTING OUT SHALL BE CONFIRMED AND VERIFIED BY THE CONSTRUCTOR BEFORE CONSTRUCTION IS COMMENCED.
9. THE EXISTING GROUND LEVELS SHOWN ON THE CROSS SECTIONS ARE BASED ON AVAILABLE SURVEY INFORMATION. CLOSE TO THE TRACK THE SURVEY LEVELS ARE BASED ON AN AURECON SITE SPECIFIC SURVEY, WITH DISTANCE FROM THE TRACK, SURVEY INFORMATION IS BASED ON LIDAR AND IS LESS RELIABLE. THE CONSTUCTOR IS TO VERIFY EXISTING GROUND LEVELS AND COMMUNICATE ANY DIFFERENCES WHICH MAY IMPACT IMPLEMENTATION OF THE DESIGN TO THE DESIGNER PRIOR TO CONSTRUCTION.

SPECIFICATIONS

THESE DRAWINGS SHALL BE READ AND WORKS CARRIED OUT IN ACCORDANCE WITH THE PROJECT REQUIREMENTS, AS5100.3 , AS2159 VICROADs SECTION 606 AND VICROADS SPECIFICATION 610 STRUCTURAL CONCRETE, 683 SOIL NAIL WALLS AND 684 SPRAYED CONCRETE.

A. SOIL NAIL

1. RECORDS
   THE CONSTRUCTOR SHALL ENSURE ADEQUATE RECORDS OF ALL WORK ARE MAINTAINED AND THAT THE REQUIREMENTS FOR EACH SECTION OF THIS SPECIFICATION ARE MET IN THIS REGARD. THE DRILLING RECORDS SHALL CONTAIN THE FOLLOWING INFORMATION:
   - DRILLING LOCATION
   - CHANGES IN GROUND TYPE
   - GROUND WATER LEVELS ENCOUNTERED
   - DRILLED LENGTH
   - CASED LENGTH
   - VOLUME OF GROUT
   - TIME AND DATE OF START AND END OF DRILLING
   - TIME AND DATE OF GROUTING
   - COMPLIANCE CERTIFICATION

   RELEVANT RECORDS SHALL BE SUBMITTED TO THE PRINCIPAL.

2 CONSTRUCTION LOADS
THE MAXIMUM CONSTRUCTION LOADS ADJACENT TO THE SLOPE CREST SHALL BE LIMITED AS FOLLOWS: - HORIZONTAL SURFACE = 5kPa NOTE THAT OTHER LIMITS MAY APPLY AS SPECIFICALLY ADVISED BY THE GEOTECHNICAL ENGINEER.

B. BASIS OF DESIGN

1 THE DOCUMENTED GROUND SUPPORT HAS BEEN BASED UPON AVAILABLE GEOTECHNICAL INFORMATION AND CERTAIN ASSUMPTIONS ON SOIL PROPERTIES AND GROUND PROFILE THEREFORE, AS THE EXCAVATION PROGRESSES, ALL FACE EXPOSURES MUST BE ASSESSED BY AN SUITABLY QUALIFIED GEOTECHNICAL ENGINEER TO CONFIRM SUITABLE SUPPORT TO BE INSTALLED. GEOTECHNICAL ENGINEER SHALL ASSESS THE EXCAVATED TEMPORARY SLOPE BEFORE BEGINNING OF ANY CONSTRUCTION.

2 GROUND CONDITIONS
GROUND CONDITIONS ASSUMED FOR DESIGN ARE AS FOLLOWS:

UNIT	EFFECTIVE COHESION c' (kPa)	EFFECTIVE FRICTION ANGLE (degrees)	ULTIMATE SKIN FRICTION (kPa)
CLAYEY SAND	5	34	36
CLAY	10	26	36

BASALT FLOATERS OR LAYERS MAY BE LOCALLY ENCOUNTERED CLOSE TO THE TUNNEL PORTAL

THESE DESIGN PARAMETERS SHALL BE VERIFIED BY THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST AS CONSTRUCTION PROCEEDS.
WORK SHALL BE HALTED IF DESIGN CHANGES ARE REQUIRED.
DESIGN SKIN FRICTION = ULTIMATE SKIN FRICTION X GEOTECHNICAL STRENGTH REDUCTION FACTOR OF 0.55 X IMPORTANCE CATEGORY REDUCTION LEVEL OF 0.7.

3 SOIL PROPERTIES
THE DESIGN PARAMETERS SHALL BE VERIFIED BY THE GEOTECHNICAL ENGINEER/GEOLOGIST AS CONSTRUCTION PROCEEDS. IF THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST DETERMINES THAT SOIL CONDITIONS DIFFER ADVERSELY FROM ASSUMED DESIGN CONDITIONS, WORKS MAY NEED TO BE SUSPENDED TO ALLOW ANY REDESIGN REQUIRED TO SUIT ACTUAL SOIL CONDITIONS.

4 WATER TABLE
FOR THE PURPOSES OF THE DESIGN, THE WATER TABLE IS ASSUMED TO BE BELOW THE LEVEL OF EXCAVATION AND SOIL NAILS. IF A HIGHER WATER TABLE IS EXPECTED BASED ON ADDITIONAL GEOTECHNICALINVESTIGATION OR SEEPAGE IS ENCOUNTERED DURING CONSTRUCTION, THE CONSTRUCTOR SHALL STOP WORK AND CONTACT THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST IMMEDIATELY. WHERE THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST CONSIDERS THAT THE SEEPAGE IS LIKELY TO CONTINUE TO OCCUR, STRIP DRAINS SHALL BE PROVIDED AT THESE LOCATIONS.

5 DESIGN LOADS
THE MAXIMUM DESIGN LOADS ADJACENT TO THE SLOPE CREST ARE AS FOLLOWS: - HORIZONTAL SURFACE = 5kPA

6 CORROSION PROTECTION TREATMENT
TO ACHIEVE A 100 YEAR DESIGN LIFE THE FOLLOWING DOUBLE CORROSION PROTECTION SYSTEMS HAVE BEEN ADOPTED:
a. GALVANISED BARS
b. 2mm CORROSION ALLOWANCE
c. 40mm MINIMUM GROUT COVER (40MPa) TO BAR
d. VERY HEAVY DUTY AND ROBUST WRAPPING TAPE COMPLYING WITH REQUIREMENT OF AS/NZS 2312 TO UNDERSIDE OF NAIL HEAD (300 MIN EXTENT AND BEHIND SHOTCRETE)

C. UTILITY SERVICES

1 THE CONSTRUCTOR MUST CHECK THAT ANY CLEARANCES TO UTILITY SERVICES ARE ACHIEVED ON SITE.
2 ALL EXCAVATIONS IN THE VICINITY OF KNOWN UTILITY SERVICE LOCATIONS OR IN LOCATIONS WHERE THE EXACT UTILITY SERVICE LOCATION HAS NOT BEEN ESTABLISHED MUST BE CARRIED OUT SUCH THAT NO DAMAGE TO THE UTILITY SERVICE OCCURS.
3 ALL EXCAVATIONS MUST BE CARRIED OUT FOLLOWING THE REGULATIONS SET OUT BY EACH INDIVIDUAL UTILITY SERVICE AUTHORITY. IT IS THE CONSTRUCTORS RESPONSIBILITY TO OBTAIN THESE REGULATIONS AND TO COMPLY WITH THEM.
4 THE CONSTRUCTOR MUST MAKE ITSELF AWARE OF AND COMPLY WITH ALL UTILITY SERVICE REGULATIONS AND STANDARDS IN RELATION TO THE USE OF MACHINERY AND EQUIPMENT IN THE VICINITY OF SERVICES.
5 UNCHARTED UTILITY SERVICES MAY BE PRESENT ON SITE. THE CONSTRUCTOR MUST MAKE ALL EFFORTS TO IDENTIFY THE PRESENCE OF UTILITY SERVICES ON THE SITE AND ARRANGE FOR RELOCATION OR PROTECTION AS NECESSARY TO SUIT THE PARTICULAR WORKS IN CONJUNCTION WITH THE RELEVANT SERVICE AUTHORITY.

D. SOIL NAILS - GENERAL

1 LOCATION
ALL SOIL NAILS SHALL BE INSTALLED AT THE LOCATIONS, LENGTHS AND INCLINATION SHOWN ON THE DRAWINGS AND AS DESIGNATED BY THE DESIGN GEOTECHNICAL ENGINEER OR AS INSTRUCTED BY THE SITE ENGINEERING GEOLOGIST OR THE SITE GEOTECHNICAL ENGINEER AFTER SITE ASSESSMENT.

2 GENERAL
a. ALL SOIL REINFORCEMENT WORKS SHALL BE IN ACCORDANCE WITH THE DRAWINGS.
b. SOIL NAILS SHALL BE INSTALLED AND GROUTED PRIOR TO PLACEMENT OF SHOTCRETE.
c. SOIL NAIL LENGTH INDICATED ON THE DESIGN DRAWINGS MAY VARY TO SUIT CONDITIONS ENCOUNTERED ON SITE. THE CONSTRUCTOR SHALL THEREFORE MAINTAIN A MINIMUM SUPPLY OF VARIOUS SOIL NAIL LENGTHS ON SITE AT ALL TIMES.
d. THE HOLES SHALL BE DRILLED WITHOUT LOSS OF GROUND WHICH MAY REQUIRE CASING. ONLY AIR FLUSHING TECHNIQUES OR AN ALTERNATIVE AS APPROVED BY SITE GEOTECHNICAL ENGINEER/GEOLOGIST AND THE DESIGNER MAY BE USED. NO WATER SHALL BE ADDED DURING THIS PROCESS. THE SOIL NAILS SHALL BE INSTALLED AND GROUTED AS SOON AS PRACTICABLE ON THE SAME DAY OF DRILLING. THE DRAIN OUTLETS AND SHOTCRETE FACING SHALL BE INSTALLED AS SOON AS PRACTICABLE FOLLOWING SOIL NAIL INSTALLATION.
e. SOIL NAIL STEEL GRADE SHALL BE MINIMUM STEEL GRADE OF 500 MPa. THE SOIL NAIL WILL BE DEFORMED REINFORCING BAR, TO AS/NZS 4671 AND GALVANISED IN ACCORDANCE WITH DRAWINGS U.N.O.
f. CONVENTIONAL SOIL NAILS HAVE BEEN SPECIFIED. CASING MAY BE REQUIRED FOR TEMPORARY CONSTRUCTION IF THE NAIL BORE EXPERIENCES INSTABILITY. THE ALTERNATIVE IS SELF-DRILLING SOIL NAILS HOWEVER THE DURABILITY ISSUES WOULD NEED TO BE ADDRESSED,
g. WHERE SOIL NAILS ARE TO BE REPOSITIONED DUE TO OBSTRUCTIONS, THE NEW LOCATIONS SHALL BE AGREED WITH THE GEOTECHNICAL DESIGN ENGINEER.

3. GROUT
NAIL GROUT SHALL COMPLY WITH THE PROJECT STRUCTURAL SPECIFICATION AND THE FOLLOWING NOTES.
a. THE GROUT SHALL BE A PUMPABLE MIXTURE WITH A MINIMUM 28 DAY COMPRESSIVE STRENGTH OF 40 MPa .
b. THE WATER CEMENT RATIO SHALL TYPICALLY BE 0.4 FOR LEACHING AND SULPHATE RESISTANCE AND SHALL NOT BE LESS THAN 0.38 OR EXCEED 0.45 BY MASS. IF THE GROUND WATER TABLE IS LOCATED ABOVE THE SOIL NAILS AND A HIGH FLOW RATE IS PRESENT, TESTING SHALL BE CARRIED OUT TO ESTABLISH PRACTICAL LIMITS OF THE WATER CEMENT RATIO.

4 CENTRALISERS
CENTRALISERS SHALL BE FABRICATED FROM PLASTIC ONLY, SHALL BE NOT DETRIMENTAL TO THE PERFORMANCE OF THE NAIL AND SHALL BE OF SUFFICIENT STRENGTH TO HOLD THE BAR IN PLACE. THE CENTRALISER SHALL BE SPACED AT MAXIMUM CENTRES OF 1000mm AND MAINTAIN THE BAR IN THE CENTRE OF THE DRILL HOLE WITH REQUIRED COVER AND SHALL NOT PREVENT AIR FLUSHING AND GROUTING OF THE HOLE.

5 CLEANING OF HOLE
WATER OR OTHER LIQUIDS SHALL NOT BE USED TO FLUSH HOLES. HOWEVER, AIR FLUSHING TECHNIQUES MAY BE USED TO CLEAN HOLES. NAIL HOLES SHALL BE CLEANED BY BLASTING WITH COMPRESSED AIR FROM THE BOTTOM OF THE HOLE IMMEDIATELY BEFORE BAR INSTALLATION AND AGAIN AFTER BAR INSTALLATION WHICH IS IMMEDIATELY BEFORE GROUTING. CLEANING SHALL BE CONDUCTED AS SOON AS PRACTICABLE IN THE SAME DAY AFTER DRILLING. NAILS SHALL BE INSERTED AND GROUTED ON THE SAME DAY AS THE COMPLETION OF DRILLING THE HOLE.

E. CONSTRUCTION PHASE GEOTECHNICAL ASSESSMENT

1 THE FOLLOWING PERSONS ARE RESPONSIBLE FOR UNDERTAKING THE CONSTRUCTION PHASE GEOTECHNICAL ASSESSMENT:
a. SITE GEOTECHNICAL ENGINEER/GEOLOGIST: THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST IS THE PERSON RESPONSIBLE FOR INSPECTION AND CARRYING OUT FACE MAPPING AND GEOLOGICAL LOGGING OF THE EARTHWORKS CUT FACES DURING CONSTRUCTION, TO THE EXTENT REQUIRED TO DETERMINE IF THE AS-EXPOSED CONDITIONS ARE CONSISTENT WITH THE DESIGN INTENT. THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST WILL INSPECT THE EXPOSED FACE.
b. THE DESIGNER: THE DESIGNER IS THE PERSON, TOGETHER WITH THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST, RESPONSIBLE FOR THE ASSESSMENT OF THE EXPOSED CONDITIONS TO DETERMINE WHETHER THEY ARE CONSISTENT WITH THE DESIGN ASSUMPTIONS. THE DESIGNER SHALL VISIT THE EARTHWORKS AS REQUIRED BY THE CONSTRUCTOR DURING EXCAVATION WORKS. THE DESIGNER SHALL LIASE WITH THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST REGARDING THE EXPOSED CONDITIONS AND MONITORING RECORDS. THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST AND DESIGNER SHALL TOGETHER DETERMINE WHETHER ANY CHANGE TO THE DOCUMENTED FACE SUPPORT IS NECESSARY AND IF REQUIRED, JOINTLY ISSUE A SITE INSTRUCTION DETAILING THE REQUIRED CHANGES.

FINAL DESIGN

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		A	15/03/24	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

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15/03/2024

Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
GENERAL NOTES - SHEET 1

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PTV

File Name	
Sheet No.	01 of 01
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Scale	N.T.S.
Sheet Size	A3

Drawn By	JARUNEE R.
Designed By	D.MACPHIE
Checked By	H.NELSON
Ind. Review	M.RAMACHANDRAN
Approved	M.BUNNEY
Approval Date	
Drawing Number	GEE_C1308
Revision	A

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Certified By:

F. SEQUENCE

1 EXCAVATION
THE ENVISAGED CONSTRUCTION SEQUENCE AS SHOWN ON GEE_C1335.

2 HOLES

a. ALL HOLES SHALL BE DRILLED IN ACCORDANCE WITH THE DESIGN PHILOSOPHY SHOWN IN THE DRAWINGS ALL DRILLED HOLES AS PER VICROADS SPECIFICATION 683 SOIL NAIL WALLS UNLESS OTHERWISE DETERMINED BY THE GEOTECHNICAL ENGINEER/GEOLOGIST. DETERMINATION SHALL BE ON THE BASIS OF ACTUAL GROUND CONDITIONS.
b. THE CONSTRUCTOR SHALL DRILL THE MINIMUM HOLE DIAMETER INDICATED ON THE DRAWINGS USING APPROPRIATE DRILLING METHODS.
c. THE NAILS SHALL BE INSTALLED AND GROUTED ON THE SAME DAY AS DRILLING

3 HANDLING OF NAILS
NAILS SHALL BE HANDLED AND STORED IN A MANNER TO AVOID DAMAGE OR CORROSION. DAMAGE TO THE NAIL STEEL AS A RESULT OF ABRASIONS, CUTS, NECKS, WELDS AND WELD SPLATTER WILL BE CAUSE FOR REJECTION. THE NAIL STEEL SHALL BE PROTECTED IF WELDING IS TO BE PERFORMED IN THE VICINITY. GROUNDING OF WELDING LEADS TO THE NAIL STEEL WILL NOT BE ALLOWED. NAIL STEEL SHALL BE PROTECTED FROM DIRT, RUST, AND DELETERIOUS SUBSTANCES. IF HEAVY CORROSION OR PITTING IS NOTED THE NAILS WILL BE REJECTED. THE BAR SHALL BE INSERTED INTO THE HOLE TO THE REQUIRED DEPTH WITHOUT DIFFICULTY.

4 GROUTING

a. THE GROUT MAY BE PUMPED THROUGH GROUT TUBES ONLY.
b. THE GROUT SHALL BE PLACED IMMEDIATELY AFTER INSERTION OF THE NAIL AND CLEANING OF THE HOLE, USING EQUIPMENT WHICH PRODUCES GROUT IN ACCORDANCE WITH THE PROJECT STRUCTURAL SPECIFICATION. THE GROUT EQUIPMENT SHALL PRODUCE A UNIFORMLY MIXED GROUT.
c. THE GROUTING EQUIPMENT SHALL BE SIZED TO ENABLE THE GROUT TO BE PUMPED IN ONE CONTINUOUS OPERATION. THE MIXER SHALL BE CAPABLE OF CONTINUOUSLY AGITATING THE GROUT.
d. THE QUANTITY AND PRESSURE OF THE GROUT INJECTED INTO EACH DRILL HOLE SHALL BE CAREFULLY MONITORED. THE DESIGNER SHALL BE NOTIFIED IF EXCESSIVE OR LESS GROUT IS REQUIRED DURING THE GROUTING OPERATION.
e. THE GROUTING PROCEDURE SHALL ENABLE GROUT TO COMPLETELY FILL THE HOLE TO THE REAR OF SHOTCRETE FACING IN ONE OPERATION.

5 FACING

a. REFER TO GEE1332 AND 1333 FOR FACING DETAILS FOR SOIL NAILS.

6 TOLERANCES

- VERTICAL LOCATION OF SOIL NAIL: + 50mm, - 50mm
- HORIZONTAL LOCATION OF SOIL NAIL: + 50mm, - 50mm
- SOIL NAIL/ROCK BOLT INCLINATION: -3° TO 0°
- HOLE DIAMETER: NO LESS THAN STATED ON THE DRAWINGS
- COVER: -0mm CONSTRUCTOR TO ENSURE DRILLED HOLE SIZE ACHIEVES 40mm MINIMUM GROUT COVER THROUGHOUT

G. DRAINAGE

1. A STRIP DRAIN SHALL BE INSTALLED BETWEEN EVERY NEW PILE AND BETWEEN EVERY SOIL NAIL ON THE SLOPE.

H. SITE SAFETY

1. ALL WORK SHALL BE PERFORMED TO THE MINIMUM REQUIREMENTS OF ALL RELEVANT LOCAL AUTHORITIES.
2. TEMPORARY OPEN CUTS ARE NOT COVERED BY THIS DESIGN DOCUMENTATION.
3. EXCAVATION SHALL NOT PROCEED BELOW ELEVATIONS (BASE OF TRACKBED AND DRAINAGE INVERT LEVEL) SHOWN ON THIS DRAWING SET WITHOUT CONFIRMATION FROM THE GEOTECHNICAL DESIGN ENGINEER, DUE TO RISK OF DESTABILISING THE SLOPE/RETAINING WALL.
4. NO SURCHARGING, STATIONARY MACHINARY OR STOCKPILING OF MATERIAL IS PERMITTED BEHIND THE SHEET PILE WALL OR 2m BEHIND THE SLOPE CREST.
5. CONTRACTOR TO BEST MINIMISE THE FOOTPRINTS OF TEMPORARY EXCAVATION FOR INSTALLING DRAINAGE AND TRACKBED FORMATION, BY USING DISCRETE BAY EXCAVATION AND REPLACEMENT APPROACH, WHERE PRACTICAL.
6. THE CONTRACTOR TO DEVELOP A SAFE METHODOLOGY FOR REMOVAL OF TREES. ANY OVER EXCAVATION TO BE BACKFILLED WITH CEMENT STABILISED FILL (4%).

I. SHOTCRETE

1. SHOTCRETE TO BE CONSTRUCTED IN ACCORDANCE WITH VICROADS 684: SPRAYED CONCRETE.

J. SOIL NAIL TESTING

THREE TYPES OF TEST ARE TO BE PERFORMED.
1. PULLOUT (VERIFICATION) TESTS ON SACRIFICIAL NAILS,
2. EXHUMATION TESTS ON SACRIFICIAL NAILS, AND
3. PULLOUT (PROOF) TESTS ON PRODUCTION NAILS

EXHUMATION TESTS ARE RECOMMENDED TO BE UNDERTAKEN IN ZONE M WHICH IS TO EXCAVATED IN FRONT OF THE SHEET PILES.

RECORDS OF NAIL TESTING : THE FOLLOWING INFORMATION IS TO BE REPORTED :
- SPECIFIC POSITION OF TEST NAIL IN THE FACE.
- HOLE DIAMETER AND DEPTH/LENGTH.
- GEOTECHNICAL SOIL UNIT (TO BE LOGGED BY GEOTECHNICAL ENGINEER). - METHOD OF DRILLING - NAIL LENGTH
- LENGTH OF NAIL GROUTED
- GROUT TYPE, MIX PROPORTIONS AND DESIGN STRENGTH.

THE CONSTRUCTOR SHALL KEEP RECORDS OF ALL RESULTS OF ALL TESTS. RECORDS OF RESULTS SHALL BE SUBMITTED TO THE ALLIANCE OR DESIGNER.

1 PULLOUT (VERIFICATION) TESTS ON SACRIFICIAL NAILS :

a. AT LEAST 3 PULLOUT TESTS ARE TO BE CARRIED OUT IN ACCORDANCE WITH THE TEST LOADS.
b. UNLESS NOTED OTHERWISE, DRILLING AND NAIL INSTALLATION SYSTEM FOR THE VERIFICATION NAILS SHALL BE THE SAME AS THE PRODUCTION NAILS TO VERIFY THE DESIGN ASSUMPTIONS.
c. HOLE AND NAIL DIAMETER SHOULD BE THE SAME AS THE PRODUCTION NAILS.
d. THE PROPOSED LOCATIONS OF THE TESTS SHALL BE SUBMITTED FOR APPROVAL OF THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST PRIOR TO TESTING.
e. TEST NAILS ARE TO HAVE A BONDED LENGTH OF 3m AND A MINIMUM FREE LENGTH OF 1m
f. MEASUREMENTS SHOULD BE TAKEN TO EXACTLY RECORD THE INITIAL HOLE DEPTH AND THE GROUTED LENGTH.
g. NAILS SHOULD BE INCLINED AT LEAST 15° DOWN FROM THE HORIZONTAL PLANE TO ENSURE THAT THE GROUT FILLS THE THE HOLE SPACE AROUND THE BAR OVER THE GROUTED LENGTH.
h. THE REACTION PLATE OR BEAM SYSTEM SHOULD BE PROPORTIONED TO LIMIT THE FACE STRESSES TO NOT MORE THAN THE BEARING CAPACITY FAILURE OF THE REACTION SYSTEM.
i. PULL-OUT TESTING SHALL BE PERFORMED IN ACCORDANCE WITH VICROADS SPECIFICATION 683 SOIL NAIL WALLS.
j. NAIL EXTENSION (RELATIVE TO THE EXCAVATION FACE) DURING THE TESTS SHALL BE MEASURED INDEPENDENTLY FROM ANY LOADING PLATES OR FRAMES TO AN ACCURACY OF 0.1mm. THE DEFLECTION REFERENCE SHOULD BE SHIELDED FROM DIRECT SUNLIGHT TO MINIMISE TEMPERATURE INFLUENCES.
k. VERIFICATION TEST AND SACRIFICIAL TEST SHALL HAVE LOADING CYCLES IN ACCORDANCE WITH TABLE 683.161.

2 VERIFICATION OF MINIMUM GROUT COVER :

a. PRIOR TO COMMENCEMENT OF PRODUCTION NAILING, THE BATCH OF NAILS USED FOR THE SACRIFICIAL PULLOUT TESTS SHALL BE EXHUMED. EXHUMED NAILS SHALL BE CUT THROUGH AT BOTH ENDS AND AT 500mm SPACING. MEASURE THE MINIMUM COVER AT EACH CROSS SECTION. THE GROUT COVER WILL BE VERIFIED TO ENSURE THAT THE MINIMUM COVER IS NOT LESS THAN THE DOCUMENTED COVER.
b. IF THE NAILS FAIL TO MEET THE MINIMUM COVER REQUIREMENT THEN THE CONSTRUCTOR SHALL CHANGE THE WORK METHOD AND/OR EQUIPMENT AND A SECOND BATCH OF NAILS SHALL BE INSTALLED AND EXHUMED.
c. IN THE EVENT THERE IS A CHANGE IN THE CONSTRUCTOR, WORK METHOD, EQUIPMENT OR FIXTURE USED FOR THE NAIL INSTALLATION, THE TESTING SHALL BE REPEATED TO VERIFY THE MINIMUM COVER REQUIREMENTS HAVE BEEN MET.

3 PULL OUT (PROOF) TESTING ON PRODUCTION NAILS :

a. PROOF TESTING SHALL BE PERFORMED ON PRODUCTION NAILS FOR EACH ROW OF SOIL NAILS, UNIFORMLY DISTRIBUTED OVER THE AREA OF EACH ROW, SUCH THAT TESTING INCLUDES THE GREATEST NUMBER OF THE FOLLOWING:
  - 5% OF THE TOTAL NUMBER OF SOIL NAILS.
  - 2 No. SOIL NAILS
  - 2 No. SOIL NAILS PER INSTALLATION METHOD
  - 2 No. SOIL NAILS PER EACH SOIL TYPE THE LOCATIONS OF TESTS SHALL BE DETERMINED BY THE SITE GEOTECHNICAL ENGINEER/GEOLOGIST.
b. PRODUCTION NAIL TEST SHALL HAVE LOADING CYCLES IN ACCORDANCE WITH TABLE 683.162.
c. THE MAXIMUM TEST LOAD IS TO BE SELECTED BASED ON THE BONDED LENGTH AS PER TABLE 2, WHICH REPRESENTS LOAD.
d. THE MAXIMUM TEST LOAD IS TO BE THE LESSER OF 90% OF THE BAR YIELD LOAD AND 1.5 TIMES THE DESIGN ALLOWABLE GROUND-GROUT PULL OUT RESISTANCE BASED ON THE BONDED LENGTH OF THE TEST NAIL.
e. 4m TEST NAILS SHALL HAVE A FREE LENGTH OF AT LEAST 1m USING APPROVED CLOSE FITTING PVC SHEATH TAPE SEALED TO NAIL.
f. PRODUCTION NAILS ARE CONSIDERED ACCEPTABLE IF THE CRITERIA IN VICROADS SECTION 683 ARE MET.
g. AT THE COMPLETION OF TESTING, FULL RECORDS OF LOAD AND NAIL EXTENSION SHALL BE SUPPLIED TO THE GEOTECHNICAL ENGINEER ALONG WITH A COPY OF CURRENT JACK CALIBRATION CERTIFICATES.
h. ALL EQUIPMENT SHALL BE CALIBRATED TO THE RELEVANT AUSTRALIAN STANDARD BY A NATA REGISTERED LABORATORY.
i. TEST RESULTS SHALL BE REVIEWED BY DESIGN REPRESENTATIVE. PRODUCTION NAILS WHICH PASS THE PROOF TESTING WILL REMAIN. NAILS WHICH FAIL THE TEST SHALL BE REMOVED AND NEW NAILS INSTALLED AND RE-TESTED.
j. NO FURTHER EXCAVATION BELOW THE COMPLETED ROW OF NAILS SHALL TAKE PLACE UNTIL PROOF TESTING CONFIRMS THE DESIGN SKIN FRICTION HAS BEEN ACHIEVED.
k. A TEST NAIL SHALL NOT FORM PART OF THE PRODUCTION NAILS UNLESS OTHERWISE APPROVED BY THE SITE GEOTECHNICAL ENGINEER. ALL TEST NAILS WHICH DO NOT FORM PART OF THE PRODUCTION NAILS SHALL BE TRIMMED TO A MINIMUM OF 100 mm BELOW THE FINISHED BATTER FACE AND SHALL BE FULLY GROUTED ON COMPLETION OF THE PULL OUT TEST.

TABLE 1 BELOW GIVES THE MAXIMUM TEST LOADS FOR PULLOUT TESTS.
A 3m BOND LENGTH HAS BEEN ASSUMED AND ADJUSTMENTS WILL NEED TO BE MADE FOR BONDED LENGTHS OTHER THAN 3m.

TABLE 1 - NOMINATED TEST LOADS FOR DESIGN VERIFICATION TYPE I PULLOUT TESTS (150mm HOLE)

PULLOUT TESTS (VERIFICATION TEST)		
	TEST NAIL BOND LENGTH = 3m, 15 deg.	
MATERIAL THAT NAIL IS EXPECTED TO BE EMBEDDED INTO	ULTIMATE SKIN FRICTION (kPA)	NOMINATED TEST LOAD (kN)
CLAYEY SAND OR CLAY	36	51

TABLE 2 PROVIDES MAXIMUM QA TEST ON PRODUCTION NAILS
TYPE 2- SACRIFICIAL AND EXUMATION TESTS SHALL BE UNDERTAKEN IN ACCORDANCE WITH VICROADS SECTION 683.14

TABLE 2 - MAXIMUM TEST LOADS (kN) (150mm HOLE)

PROOF TESTING ON PRODUCTION NAILS		
MATERIAL THAT NAIL IS EXPECTED TO BE EMBEDDED INTO	15 deg. INCLINATION	
	BONDED LENGTH (M)	MAXIMUM TEST LOAD (kN)
CLAYEY SAND OR CLAY	3	30

NOTE - MAXIMUM TEST LOADS IS BASED ON GEOTECHNICAL DESIGN SKIN RESISTANCE (DESIGN LOAD) AND AREA OF GROUT-SOIL INTERFACE MULTIPLIED BY 1.5. TEST LOADS ARE NOT TO EXCEED 90% OF THE BAR YIELD.
MINIMUM BOND LENGTH IS TO BE 2M WITH 1M FREE LENGTH (UNGROUTED LENGTH)

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Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
GENERAL NOTES - SHEET 2

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K. MONITORING

TABLE 3 -INSTRUMENTATION AND MONITORING DETAILS

LOCATION	DETAILS
EAST TOE RETAINING WALL (WALL 3)	5 SURVEY POINTS AT TOP OF WALL
EAT TOE RETAINING WALL (WALL 4)	5 SURVEY POINTS AT TOP OF WALL
WEST TOE RETAINING WALL (WALL 2)	6 SURVEY POINTS AT TOP OF WALL
SOIL NAIL SLOPE	8 SURVEY POINTS AT TOP OF WALL
EXISTING CREST RETAINING WALL	4 SURVEY POINTS ALONG WALL
PROPERTY	▪ 3 SURVEY POINTS ON CREST OF SLOPE BELOW PROPERTY ▪ EXISTING CONDITION SURVEY OF PROPERTY TO BE UNDERTAKEN PRIOR TO WORKS AND POST WORKS.
CAR PARKS (WEST AND EAST)	EXISTING CONDITION SURVEY OF TUNNEL PORTAL REQUIRED BEFORE AND AFTER THE WORKS.
TUNNEL PORTAL	
EXISTING LITTLE MALLOP STREET BRIDGE AND ABUTMENT	
EXISTING PROPERTY (AT WEST CAR PARK), EXISTING PROPERTIES AT CREST OF EAST SLOPE.	
SERVICES	EXISTING SERVICES AND INFRASTRUCTURE TO BE MONITORED AS PER REQUIREMENTS OF THE 3RD PARTY ASSET OWNERS.

1. APPROXIMATE LOCATION OF MONITORING POINTS IS SHOWN ON PLAN LAYOUT
2. AS CONSTRUCTION TAKES PLACE, THE CONTRACTOR SHALL RECORD LEVELS OF SOIL NAILS AND LATERAL DEFLECTION OF THE WALL.
3. AFTER TAKING READINGS THE RESULTS SHALL BE RECORDED IN ELECTRONIC AND HARD COPY FORMAT AND ARE TO BE FORWARDED TO THE DESIGNER. MONITORING TRIGGER LEVELS ARE PROVIDED IN THE TABLE.
   - GREEN - CONTINUE EXCAVATION
   - AMBER - INCREASE MONITORING FREQUENCY
   - RED - IMPLEMENT MEASURES TO CEASE MOVEMENT THIS MAY INVOLVE HALTING EXCAVATION IN FRONT OF RETAINING WALLS OR SLOPE. IF WALL MOVEMENT CONTINUES TO BECOME EXCESSIVE BACKFILL MAY BE REQUIRED IN FRONT OF WALL.
4. MONITORING SHALL BE TWICE A WEEK DURING CONSTRUCTION. ONCE CONSTRUCTION IS COMPLETED, MONITORING SHALL CONTINUE ONCE A WEEK FOR FOUR WEEKS. AFTER THAT MONITORING INTERVAL SHALL NOT EXCEED ONE MONTH FOR FIRST SIX MONTHS IMMEDIATELY FOLLOWING COMPLETION OF AND AT INTERVALS NOT EXCEEDING SIX MONTHS THEREAFTER UNTIL END OF DEFECTS LIABILITY PERIOD.
5. PARTICULAR ATTENTION TO MONITORING IS DURING THE TEMPORARY EXCAVATION STAGE (I.E TO AND AT FINAL EXCAVATION LEVEL).

	MONITORING TRIGGER LEVELS (mm)		
	GREEN	AMBER	RED
EAST RETAINING WALL AT CAR PARK (WALL 1)	10	15	25
EAST RETAINING WALL AT PORTAL (WALL 2)	10	20	30
WEST RETAINING WALL AT PORTAL (WALL 3)	20	30	40
SLOPES	10	20	30
EXISTING CREST RETAINING WALL	10	15	20

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Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION

GEOTECHNICAL DESIGN

GENERAL NOTES - SHEET 3

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NOTES:

1. DESIGN ON HOLE DUE TO INCACURATE LIDAR INFORMATION AND A POTENTIAL RE-ASSESSMENT OF THE VIABILITY OF THE PROPOSED EXCAVATION WORKS AND DRAINAGE AT AND NEAR THE THE BRIDGE ABUTMENTS.
2. FOR PILE SETTING OUT POINTS REFER TO DWG. GEE_C1314.
3. EXISTING PILES AND ANCHORS ARE NOT SHOWN ON PLAN LAYOUT.
4. MAXIMUM SPACING BETWEEN CONSTRUCTION JOINTS ON CAPPING BEAM IS 11 METRES. INDICATIVE POSITION SHOWN IN PLAN. EXACT LOCATION TO BE DETERMINED ON SITE.

BUILDINGS

72.780

72.800

LITTLE MALOP ST

72.820

72.840

CAR PARK

A C1323

B C1323

C C1324

DESIGN ON HOLD (SEE NOTE 1).

LITTLE MALOP ST. BRIDGE

INDICATIVE CONSTRUCTION JOINT (SEE NOTE 4, DWG. C1331)

EXISTING EAST RETAINING WALL AT CAR PARK

AU23-RW-BH03

AU23-RW-BH02

NEW EAST RETAINING WALL AT CAR PARK (WALL 1)

EROSON PROTECTION (EXTENTS TO BE CONFIRMED)

S1-1

CH. 72.780 CH. 72.785 CH. 72.790 CH. 72.795 CH. 72.800 CH. 72.805 CH. 72.810 CH. 72.815 CH. 72.820 CH. 72.825 CH. 72.830 CH. 72.835 CH. 72.840 CH. 72.845 CH. 72.850

WEST CUTTING

COMBINED SERVICES ROUTE

EXTENT OF PERMANENT REGRADE

EXISTING MAINTENANCE ACCESS TRACK TO TIE INTO TRAIN TRACK

72.851

FOR CONTINUATION REFER DRG GEE_C1314

LEGEND

- APPROXIMATE SOIL NAIL ALIGNMENT
- NEW RETAINING WALL (FRONT FACE)
- EXISTING RETAINING WALL (FRONT FACE)
- SHOTCRETE
- REGRADE
- EXTENT OF PERMANENT REGRDE
- NEW PILE AND PILE CAP

TRACK BED DESIGN (FOR DETAILS, REFER TO RAIL ALIGNMENT DRAWING SERIES (GEE C0346 TO CO403)

- NO STRUCTURAL FILL
- 0.7m / 1m THICK CEMENT TREATED CRUSHED ROCK
- 0.5m THICK STRUCTURAL FILL OR CEMENT TREATED CRUSHED ROCK
- APPROXIMATE LOCATION OF MONITORING POINT
- DRAINAGE
- FALL PROTECTION SYSTEM
- CONSTRUCTION JOINT

EXISTING EXPLORATORY HOLE KEY

- STATEWIDE (1993)
- GEOTESTA (2017)
- AURECON (2017)
- AURECON (2023)

WARNING

BEWARE OF UNDERGROUND SERVICES

THE LOCATIONS ARE APPROXIMATE ONLY AND THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. NO GUARANTEE IS GIVEN THAT ALL EXISTING SERVICES ARE SHOWN.

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72.760

72.780

72.800

LITTLE MALOP ST

72.820

72.840

CAR PARK

2.5 0 2.5 5 7.5 10 12.5m

SCALE 1:250

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RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION

GEOTECHNICAL DESIGN

GENERAL ARRANGEMENT PLAN - SHEET 1

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D C1324

E C1325

F C1326

G C1327

72.860

72.880

72.900

72.920

72.940

BUILDING

RYRIE STREET

AU23-RW -BH02

AU23-RW-BH01

NEW EAST RETAINING WALL AT CAR PARK (WALL 1)

EXISTING EAST RETAINING WALL AT CAR PARK

EXISTING EAST RETAINING WALL AT PORTAL

NEW EAST RETAINING WALL AT PORTAL (WALL 2)

INDICATIVE CONSTRUCTION JOINT (SEE NOTE 4, DWG. C1331)

APPROXIMATE TRANISTION BETWEEN EXISTING WALL TYPES AT CH.72.888.

BH2

BH3

SW93-BH3

EAST CUTTING

S1-2

S2-1

S2-2

S2-3

S2-4

BH1

1.8m CLEAR DISTANCE FROM EDGE OF PILE FROM TUNNEL PORTAL

INTERFACE DETAIL WITH TUNNEL PORTAL TO BE CONFIRMED PRIOR TO CONSTRUCTION.

TUNNEL SLAB AND SUPPORTING LEDGE

UP PORTAL

CH. 72.860 CH. 72.865 CH. 72.870 CH. 72.875 CH. 72.880 CH. 72.885 CH. 72.890 CH. 72.895 CH. 72.900 CH. 72.905 CH. 72.910 CH. 72.915 CH. 72.920 CH. 72.925 CH. 72.930 CH. 72.935 CH. 72.940 CH. 72.945

AU23-T-BH01

FOR CONTINUATION REFER DRG GEE_C1313

EARTHWORKS 2H: 1V

EARTHWORKS 2H:1V TO 3H: 1V TRANSITION

EARTHWORKS WRAPAROUND TIE- IN 3H:1V

S3-2

S3-1

APPROACH SLAB

VICTRACK BOUNDARY

1.8m CLEAR DISTANCE FROM EDGE OF PILE FROM TUNNEL PORTAL

INTERFACE DETAIL WITH TUNNEL PORTAL TO BE CONFIRMED PRIOR TO CONSTRUCTION.

RYRIE STREET

fdfd

AU23-S-BH01

S3-3

S3-4

EXTENT OF PERMANENT REGRADE

COMBINED SERVICES ROUTE

SW93-BH4

EXISTING WEST TOE RETAINING WALL AT PORTAL

WEST CUTTING

EXISTING CREST RETAINING WALL AT PORTAL

NEW WEST RETAINING WALL AT PORTAL (WALL 3)

CAR PARK

EXTENT OF WALL TO BE CONFIRMED BY CONTRACTOR PRIOR TO CONSTRUCTION. SHOULD IT DIFFER FROM SHOWN, GEOTECHNICAL DEISGN MAY BE SUBJECT TO CHANGE.

INDICATIVE ALIGNMENT OF EXISTING WALL BASED ON SITE PHOTOGRAPHS (NOT CURRENTLY SURVEYED)

EXISTING MAINTENANCE ACCESS TRACK TO TIE INTO TRAIN TRACK

BUILDING

NOTES:

1. EXISTING PILES AND ANCHORS ARE NOT SHOWN ON PLAN LAYOUT.

SETTING OUT POINTS FOR NEW PILES

	SET-OUT POINTS	PILE DIAMETER (mm)	DISTANCE FROM FRONT FACE OF EXISTING WALL TO CENTRE POINT OF PROPOSED PILE (mm)
"WALL 1 EAST SIDE (CAR PARK)"	S1-1	600	850
	S1-2	600	850
"WALL 2 EAST SIDE (PORTAL)"	S2-1	750	925
	S2-2	750	925
	S2-3	750	1350
	S2-4	750	1350
"WALL 3 WEST (PORTAL)"	S3-1	750	1425
	S3-2	750	1225
	S3-3	750	1225
	S3-4	750	1225

1. REFER TO DRAWING GEE_C1315 FOR DETAILED SKETCH OF SETTING OUT METHODOLOGY.

EXISTING EXPLORATORY HOLE KEY

- STATEWIDE (1993)
- GEOTESTA (2017)
- AURECON (2017)
- AURECON (2023)

LEGEND

- APPROXIMATE SOIL NAIL ALIGNMENT
- NEW RETAINING WALL (FRONT FACE)
- EXISTING RETAINING WALL (FRONT FACE)
- SHOTCRETE
- REGRADE
- EXTENT OF PERMANENT REGRADE
- NEW PILE AND PILE CAP

TRACK BED DESIGN (FOR DETAILS, REFER TO RAIL ALIGNMENT DRAWING SERIES (GEE_C0346 TO C0403)

- NO STRUCTURAL FILL
- 0.7m / 1m THICK CEMENT TREATED CRUSHED ROCK
- 0.5m THICK STRUCTURAL FILL OR CEMENT TREATED CRUSHED ROCK
- APPROXIMATE LOCATION OF MONITORING POINT
- DRAINAGE
- FALL PROTECTION SYSTEM
- CONSTRUCTION JOINT

2.5 0 2.5 5 7.5 10 12.5m

SCALE 1:250

WARNING

BEWARE OF UNDERGROUND SERVICES

THE LOCATIONS ARE APPROXIMATE ONLY AND THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. NO GUARANTEE IS GIVEN THAT ALL EXISTING SERVICES ARE SHOWN.

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RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION

GEOTECHNICAL DESIGN

GENERAL ARRANGEMENT PLAN - SHEET 2

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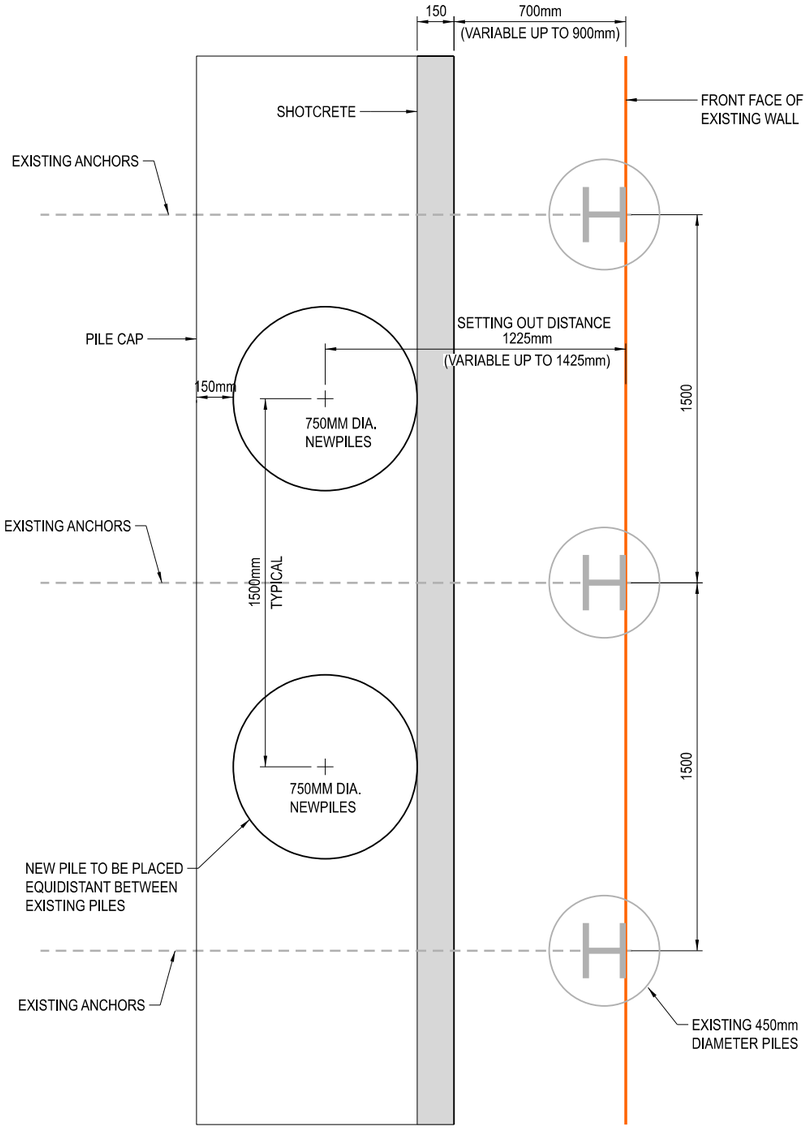
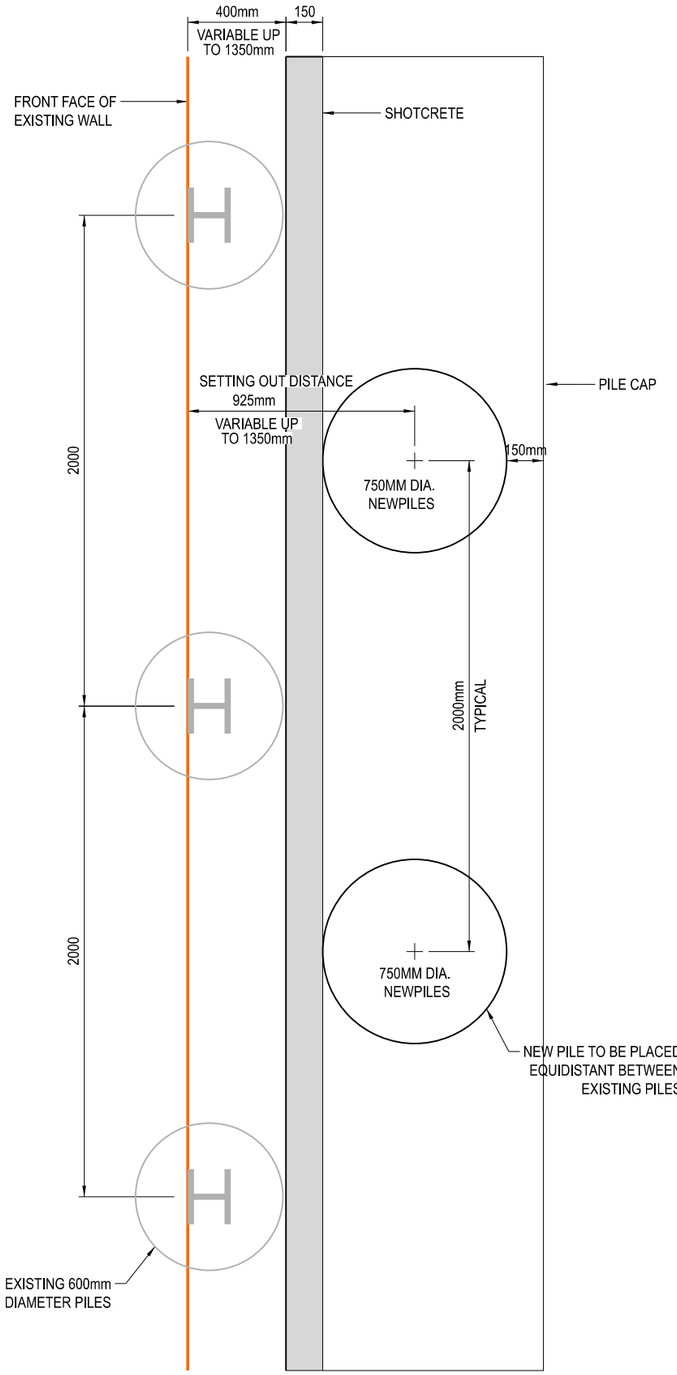
NOTES:

1. FOR THE LOCATION OF SETTING OUT POINTS REFER TO PLAN LOCATION, DWG. GEE_C1313 & 1314.
2. THE CONTRACTOR IS TO DEVELOP A SAFE PILING SEQUENCE. IT IS RECOMMENDED THAT EVERY SECOND PILE IS CONSTRUCTED TO ALLOW SUFFICIENT CURING TIME PRIOR TO CONSTRUCTING THE INTERMEDIATE PILES.
3. NEW PILES TO INSTALLED EQUIDISTANT BETWEEN EXISTING PILES. CONTRACTOR TO CONFIRM SETTING OUT POSITION ON SITE AS PILE SPACING ON SITE COULD BE DIFFERENT THAN SHOWN.



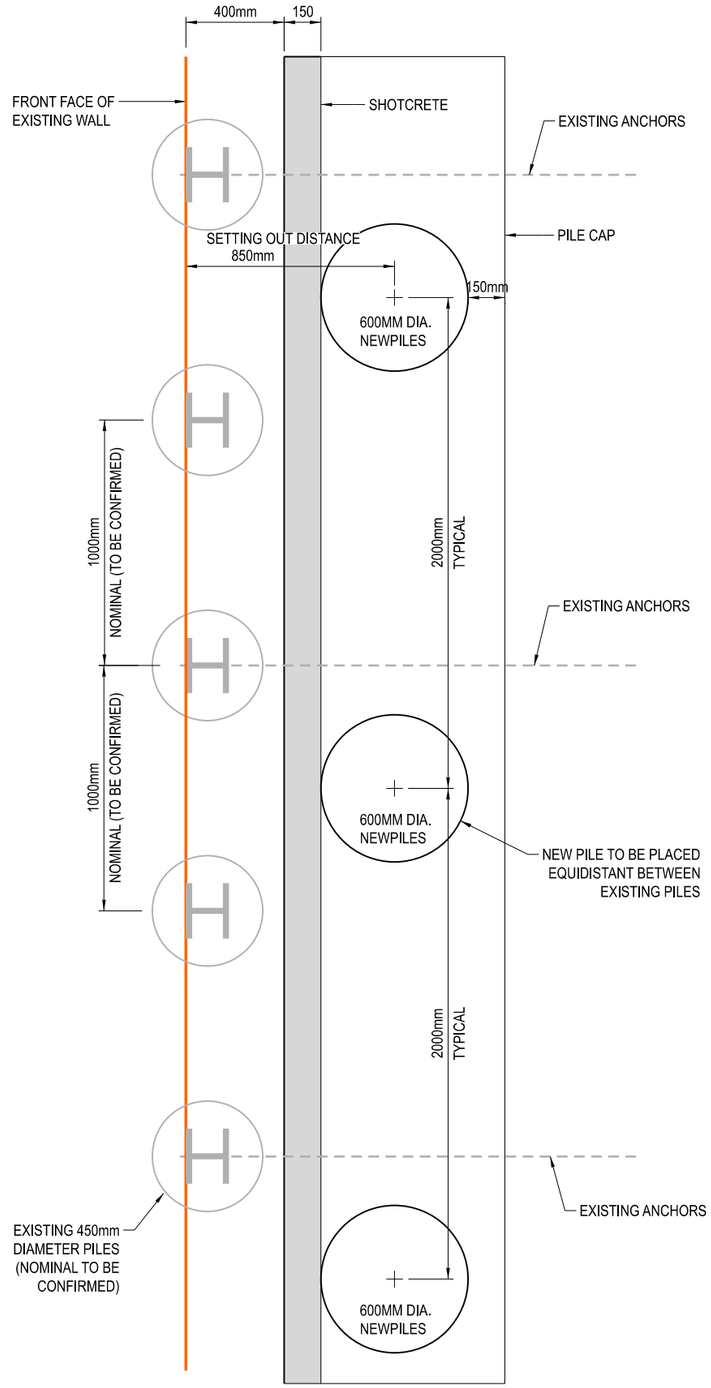
PLAN LAYOUT - WEST SIDE (PORTAL)
SCALE 1:25

WALL 3



PLAN LAYOUT- EAST SIDE (PORTAL)
SCALE 1:25

WALL 2



PLAN LAYOUT - EAST SIDE (CAR PARK)
SCALE 1:25

WALL 1

250 0 250 500 750 1000 1250mm
SCALE 1:25

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RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
SET OUT INFORMATION

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

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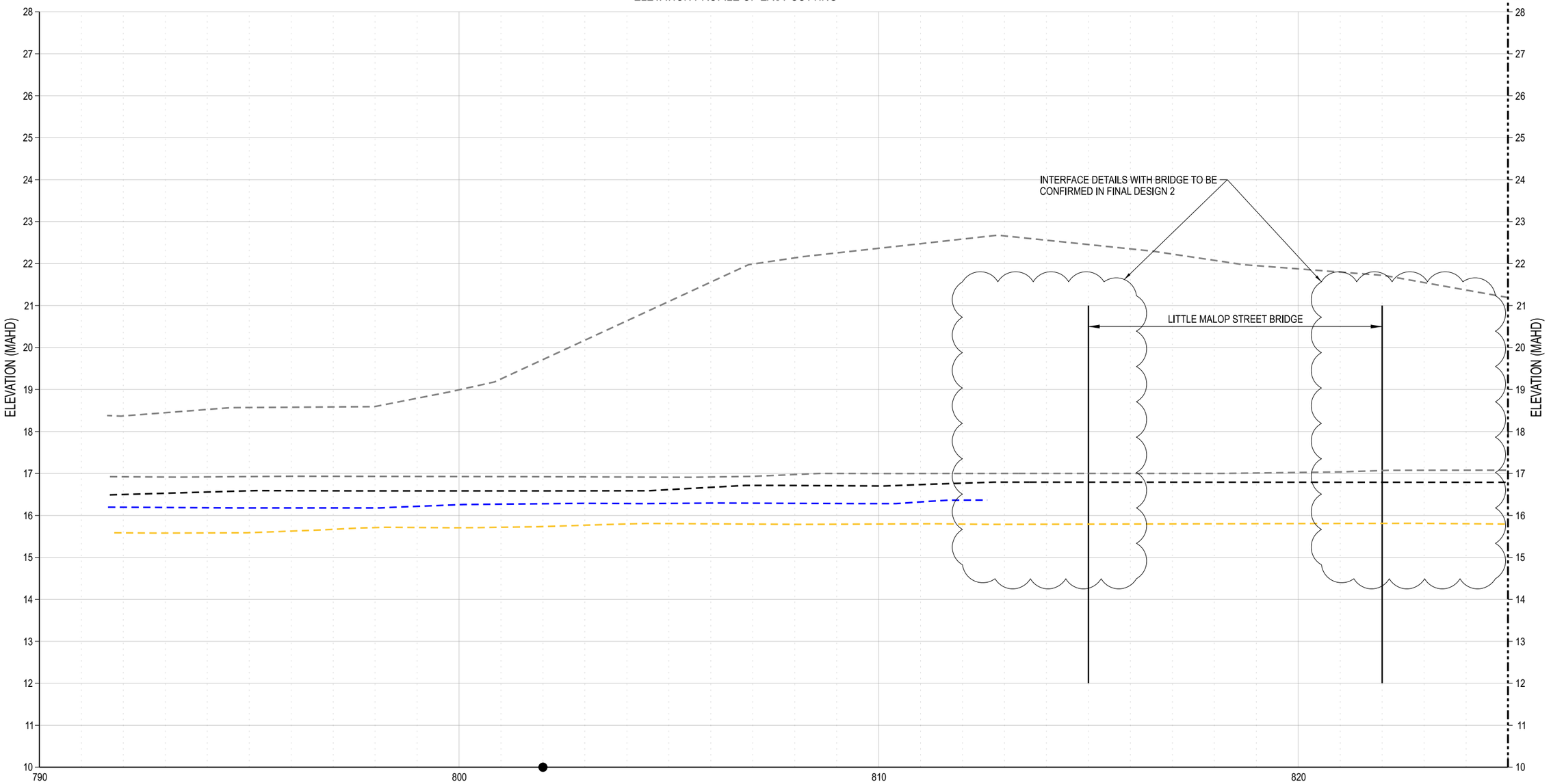
ELEVATION PROFILE OF EAST CUTTING



LEGEND

- TOP OF EXISTING TOE WALL / TOP OF NEW TOE WALL
- GROUND LEVEL IMMEDIATELY IN FRONT OF EXISTING TOE WALL
- PERMANENT GROUND LEVEL IMMEDIATELY IN FRONT OF NEW WALL
- BASE OF STRUCTURAL FILL
- DRAIN INVERT LEVEL
- NEW PILE
- SHOTCRETE
- APPROXIMATE EXTENT OF REGRADE
- SOIL NAIL
- PILE CAPPING BEAM

FINAL DESIGN

1 0 1 2 3 4 5m
SCALE 1:100

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		A	15/03/24	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
ELEVATION - EAST - SHEET 1

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

File Name	
Sheet No.	01 of 01
In Serv.	
Scale	1:100
Sheet Size	A3

Drawn By	JARUNEE R.
Designed By	D.MACPHIE
Checked By	H.NELSON
Ind. Review	M.RAMACHANDRAN
Approved	M.BUNNEY
Approval Date	
Drawing Number	GEE_C1317
Revision	A

Document Number 523997-W00001-DRG-GR-1040 Version A

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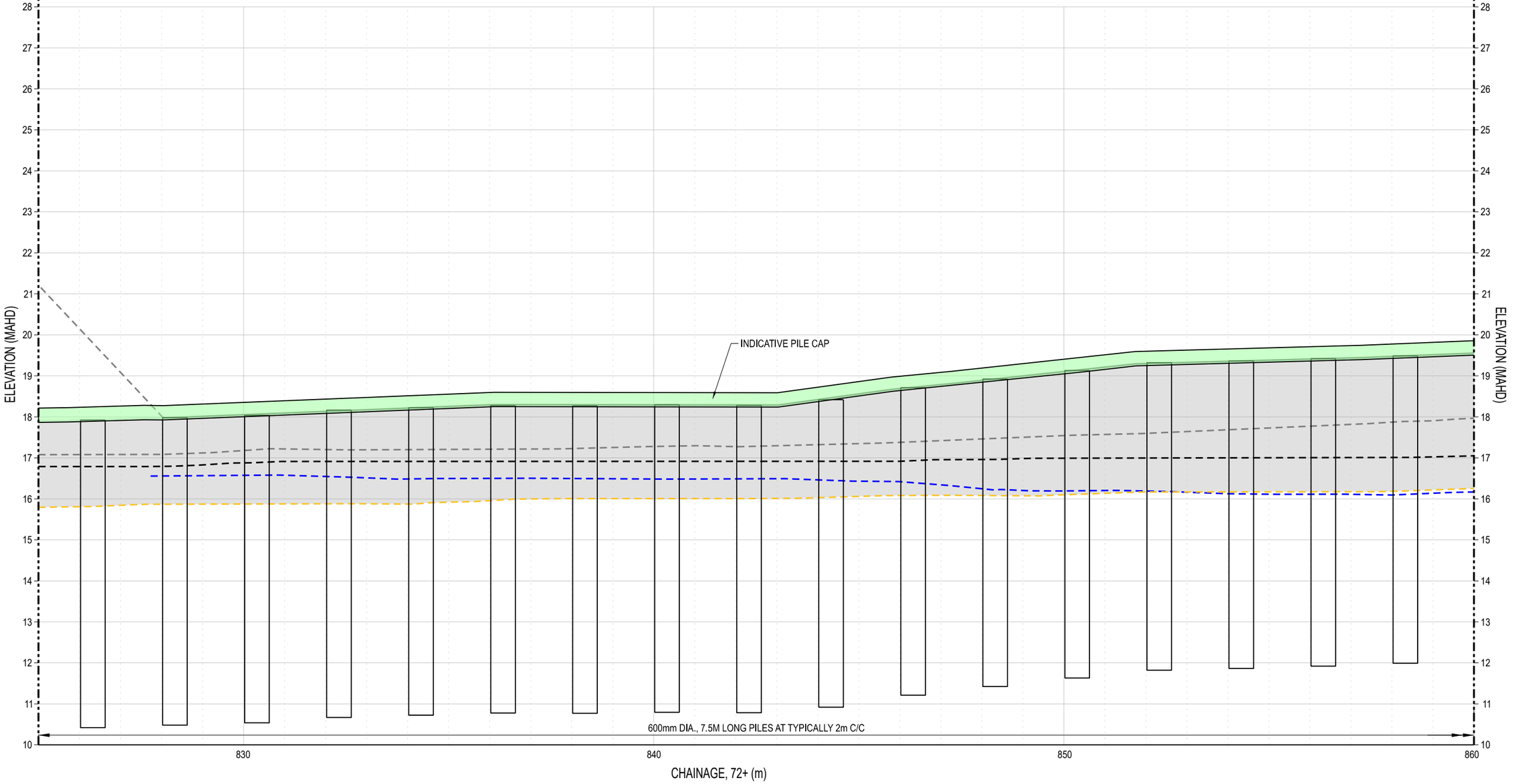
ADJOINS GEE_C1317

ADJOINS GEE_C1319

ELEVATION PROFILE OF EAST CUTTING



LEGEND

- TOP OF EXISTING TOE WALL / TOP OF NEW TOE WALL
- GROUND LEVEL IMMEDIATELY IN FRONT OF EXISTING TOE WALL
- PERMANENT GROUND LEVEL IMMEDIATELY IN FRONT OF NEW WALL
- BASE OF STRUCTURAL FILL
- DRAIN INVERT LEVEL
- NEW PILE
- SHOTCRETE
- APPROXIMATE EXTENT OF REGRADE
- SOIL NAIL
- PILE CAPPING BEAM

FINAL DESIGN

1 0 1 2 3 4 5m

SCALE 1:100

Document Number 523997-W00001-DRG-GR-1041 | Version A

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		A	15/03/24	FINAL DESIGN	D.M.	D.M.	M.R.	M.B.

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Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION

GEOTECHNICAL DESIGN

ELEVATION - EAST - SHEET 2

Up Location	Down Location	Datum
East.	East.	MGA Z55
North.	North.	
ID#	ID#	

PUBLIC TRANSPORT VICTORIA PT

Drawn By: JARUNEE R.	Designed By: D.MACPHIE
Checked By: H.NELSON	Ind. Review: M.RAMACHANDRAN
Approved: M.BUNNEY	Approval Date:
File Name:	
Sheet No.: 01 of 01	
In Serv.	
Scale: 1:100	Sheet Size: A3
Drawing Number: GEE_C1318	Revision: A

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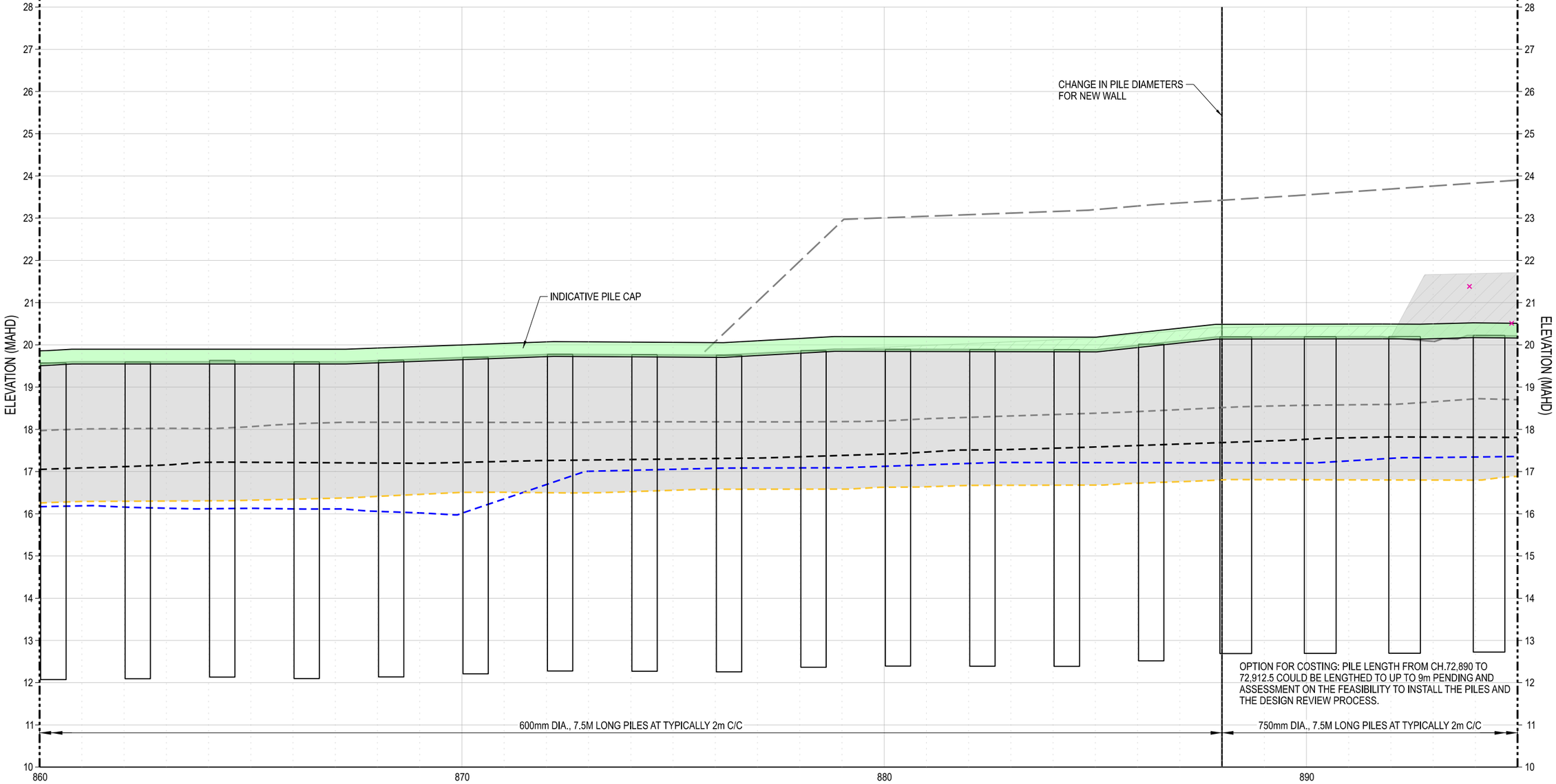
Certified By: (BLOCK LETTERS) (SIGNATURE) (DATE)

ADJOINS GEE-C1318

ADJOINS GEE_C1320

ELEVATION PROFILE OF EAST CUTTING



LEGEND

- TOP OF EXISTING TOE WALL / TOP OF NEW TOE WALL
- GROUND LEVEL IMMEDIATELY IN FRONT OF EXISTING TOE WALL
- PERMANENT GROUND LEVEL IMMEDIATELY IN FRONT OF NEW WALL
- BASE OF STRUCTURAL FILL
- DRAIN INVERT LEVEL
- NEW PILE
- SHOTCRETE
- APPROXIMATE EXTENT OF REGRADE
- SOIL NAIL
- PILE CAPPING BEAM

FINAL DESIGN

1 0 1 2 3 4 5m

SCALE 1:100

Document Number 523997-W00001-DRG-GR-1042 | Version A

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		A	15/03/24	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION

GEOTECHNICAL DESIGN

ELEVATION - EAST - SHEET 3

Up Location	Down Location	Datum
East.	East.	MGA Z55
North.	North.	
ID#	ID#	

PUBLIC TRANSPORT VICTORIA PT

Drawn By: JARUNEE R.	Designed By: D.MACPHIE
Checked By: H.NELSON	Ind. Review: M.RAMACHANDRAN
Approved: M.BUNNEY	Approval Date:
File Name:	
Sheet No.: 01 of 01	
In Serv.	
Scale: 1:100	Sheet Size: A3
Drawing Number: GEE_C1319	Revision: A

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(DATE)

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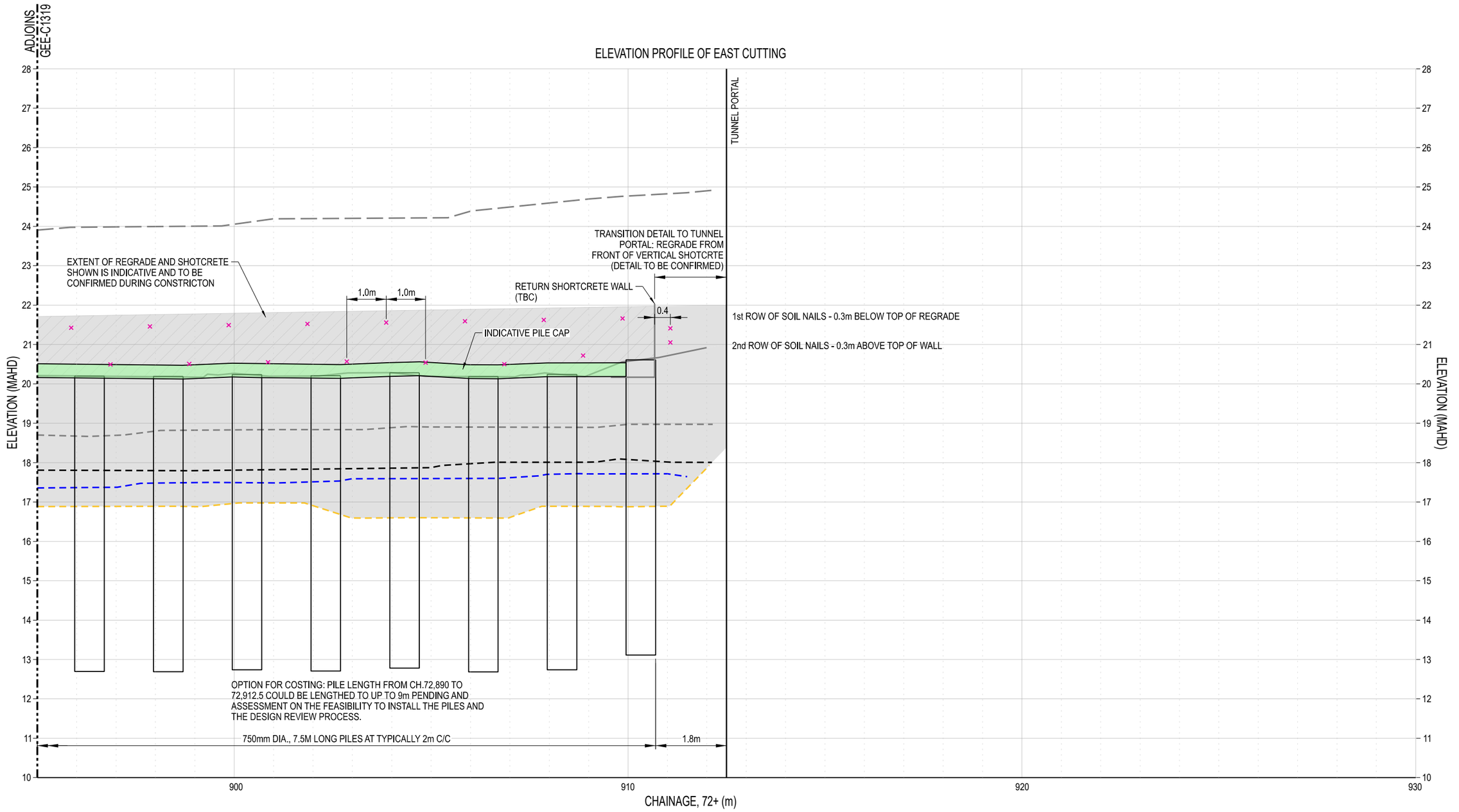
Certified By:

ELEVATION PROFILE OF EAST CUTTING



LEGEND

- TOP OF EXISTING TOE WALL / TOP OF NEW TOE WALL
- GROUND LEVEL IMMEDIATELY IN FRONT OF EXISTING TOE WALL
- PERMANENT GROUND LEVEL IMMEDIATELY IN FRONT OF NEW WALL
- BASE OF STRUCTURAL FILL
- DRAIN INVERT LEVEL
- NEW PILE
- SHOTCRETE
- APPROXIMATE EXTENT OF REGRADE
- SOIL NAIL
- PILE CAPPING BEAM

FINAL DESIGN

0.5 0 0.5 1 1.5 2 2.5m

SCALE 1:50

Document Number 523997-W00001-DRG-GR-1043 | Version A

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
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Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
ELEVATION - EAST - SHEET 4

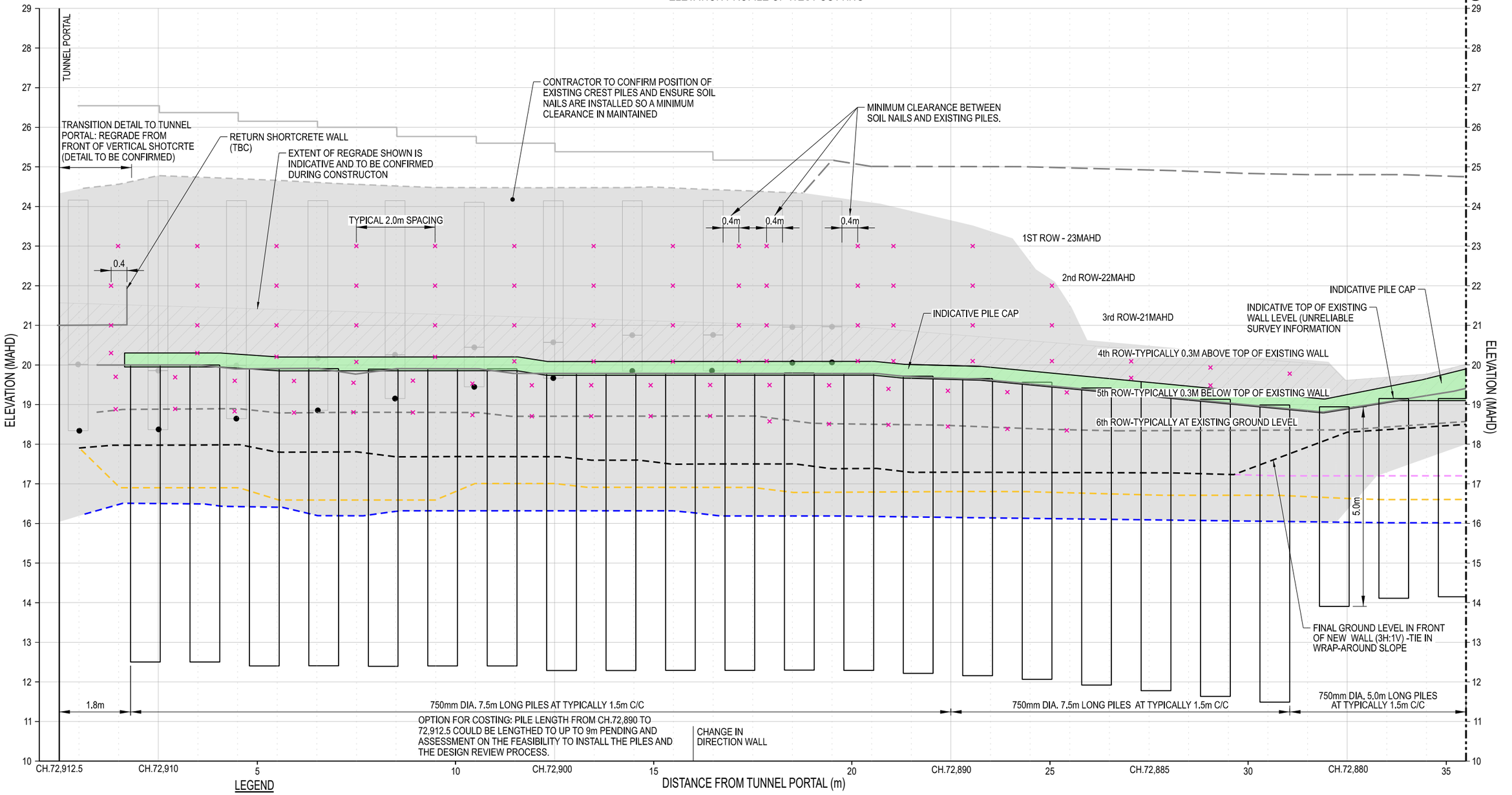
Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

Drawn By: JARUNEE R.	Designed By: D.MACPHIE
Checked By: H.NELSON	Ind. Review: M.RAMACHANDRAN
Approved: M.BUNNEY	Approval Date:
File Name:	
Sheet No.: 01 of 01	
In Serv.	
Scale: 1:100	Sheet Size: A3
Drawing Number: GEE_C1320	Revision: A

Certified By: (BLOCK LETTERS) (SIGNATURE) (DATE)

ELEVATION PROFILE OF WEST CUTTING



LEGEND

- TOP OF EXISTING CREST WALL
- CREST OF EXISITNG SLOPE
- GROUND LEVEL IMMEDIATELY IN FRONT OF EXISTING CREST WALL
- BASE OF EXISTING PANELS
- PILE TOE OF EXISTING CREST WALL (UPPER BOUND)
- PILE TOE OF EXISTING CREST WALL (LOWER BOUND)
- TOP OF EXISTING TOE WALL / TOP OF NEW TOE WALL
- GROUND LEVEL IMMEDIATELY IN FRONT OF EXISTING TOE WALL
- PERMANENT GROUND LEVEL IMMEDIATELY IN FRONT OF NEW WALL
- BASE OF STRUCTURAL FILL
- DRAIN INVERT LEVEL
- NEW PILE
- SHOTCRETE
- APPROXIMATE EXTENT OF REGRADE
- SOIL NAIL
- PILE CAPPING BEAM
- FINSHED GROUND LEVEL ABOVE NEW TRACK DRAINGE

FINAL DESIGN

1 0 1 2 3 4 5m
SCALE 1:100

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		A	15/03/24	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
ELEVATION - WEST - SHEET 1

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PTV

File Name

Sheet No. 01 of 01

In Serv.

Scale 1:100 | Sheet Size A3

Drawn By	Designed By
JARUNEE R.	D.MACPHIE
Checked By	Ind. Review
H.NELSON	M.RAMACHANDRAN
Approved	Approval Date
M.BUNNEY	

Drawing Number GEE_C1321 | Revision A

Document Number 523997-W00001-DRG-GR-1044 | Version A

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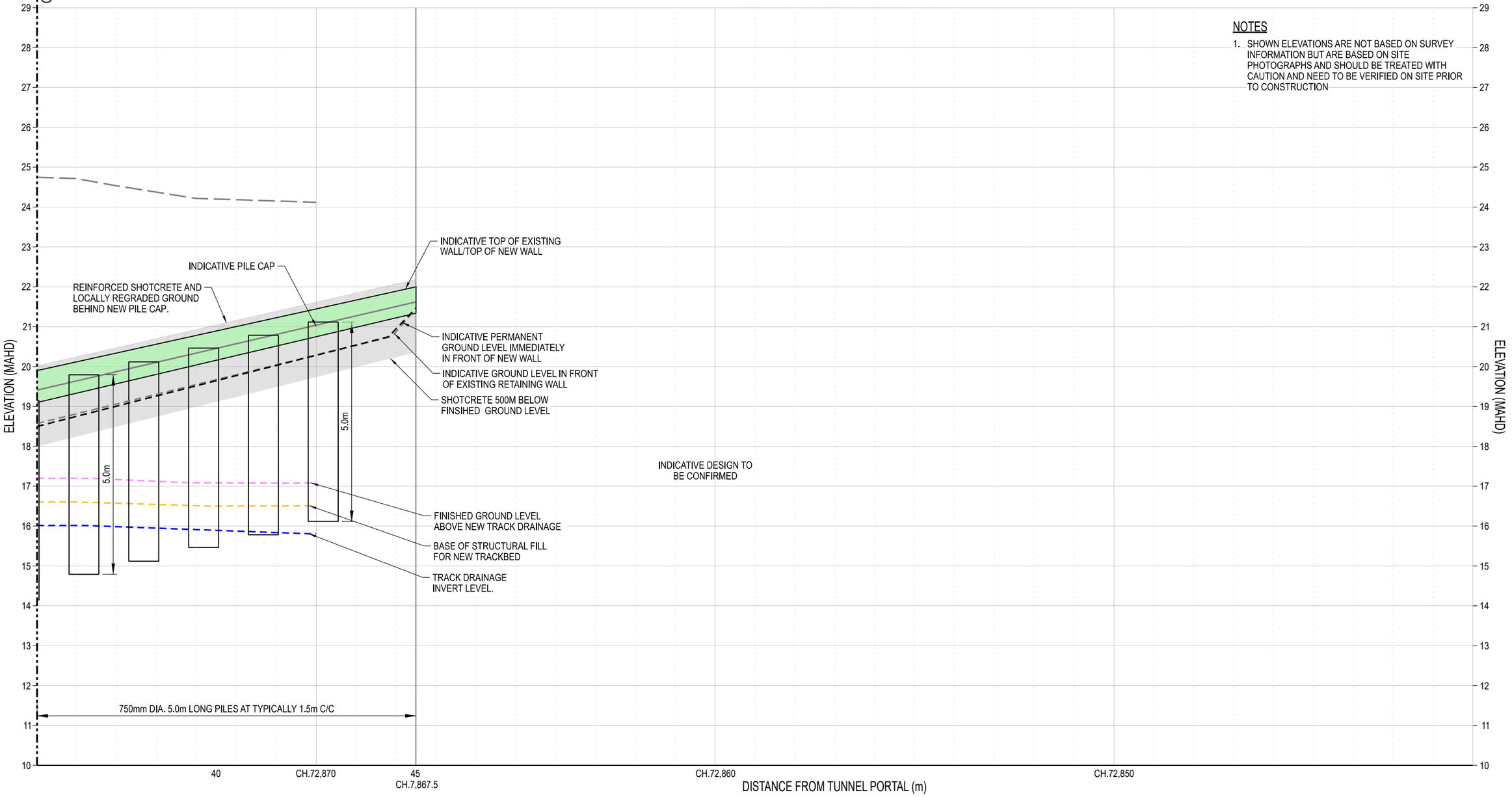
(SIGNATURE)

(BLOCK LETTERS)

Certified By:

ADJOINS GEE_C1321

ELEVATION PROFILE OF WEST CUTTING



NOTES

1. SHOWN ELEVATIONS ARE NOT BASED ON SURVEY INFORMATION BUT ARE BASED ON SITE PHOTOGRAPHS AND SHOULD BE TREATED WITH CAUTION AND NEED TO BE VERIFIED ON SITE PRIOR TO CONSTRUCTION

LEGEND

- TOP OF EXISTING TOE WALL / TOP OF NEW TOE WALL
- GROUND LEVEL IMMEDIATELY IN FRONT OF EXISTING TOE WALL
- PERMANENT GROUND LEVEL IMMEDIATELY IN FRONT OF NEW WALL
- BASE OF STRUCTURAL FILL
- DRAIN INVERT LEVEL
- NEW PILE
- SHOTCRETE
- APPROXIMATE EXTENT OF REGRADE
- SOIL NAIL
- PILE CAPPING BEAM
- FINSHED GROUND LEVEL ABOVE NEW TRACK DRAINGE

FINAL DESIGN

1 0 1 2 3 4 5m

SCALE 1:100

Document Number 523997-W00001-DRG-GR-1045 | Version A

9:19:02 AM

15/03/2024

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		A	15/03/24	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION

GEOTECHNICAL DESIGN

ELEVATION - WEST - SHEET 2

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

Drawn By JARUNEE R.	Designed By D.MACPHIE
Checked By H.NELSON	Ind. Review M.RAMACHANDRAN
Approved M.BUNNEY	Approval Date
File Name	
Sheet No. 01 of 01	
In Serv.	
Scale 1:100	Sheet Size A3
Drawing Number GEE_C1322	Revision A

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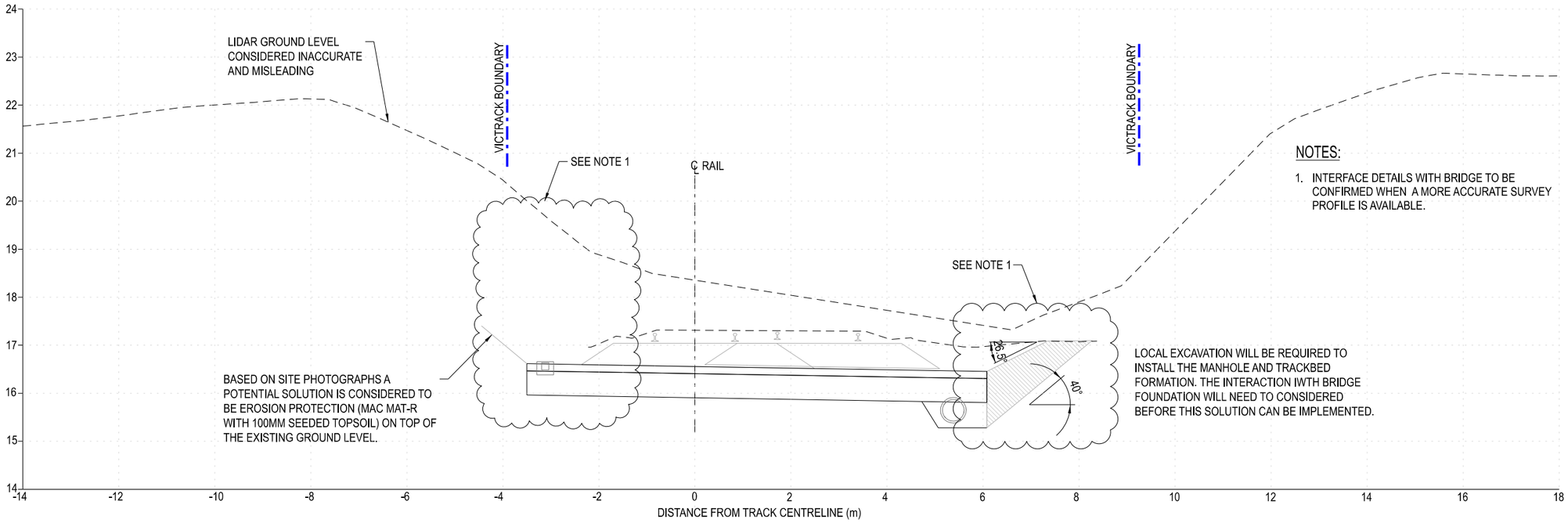


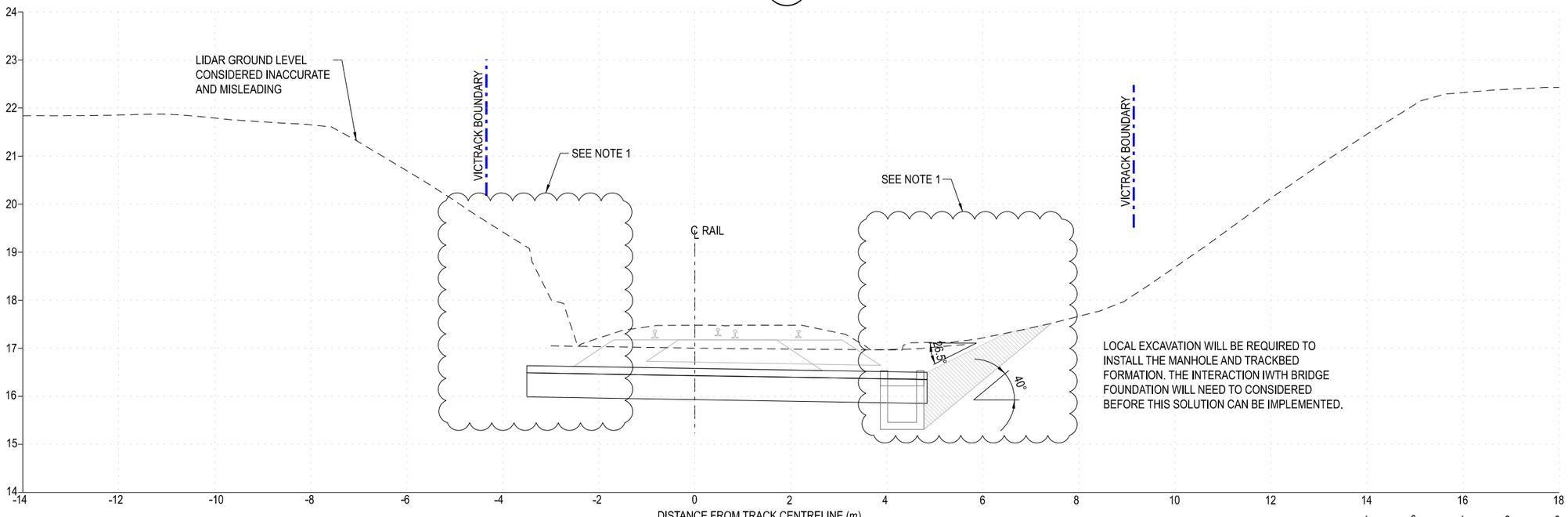
NOTES:

1. INTERFACE DETAILS WITH BRIDGE TO BE CONFIRMED WHEN A MORE ACCURATE SURVEY PROFILE IS AVAILABLE.

CH. 72,813

SECTION A

SCALE 1:100 C1313



CH. 72,825

SECTION B

SCALE 1:100 C1313

1 0 1 2 3 4 5m

SCALE 1:100

FINAL DESIGN

Certified By: (DATE) (SIGNATURE) (BLOCK LETTERS)

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		A	15/03/24	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

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Consultant

aurecon

Franchisee / Lessee

V/Line

RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
TYPICAL SECTIONS - SHEET 1

Up Location	Down Location	Datum
East.	East.	MGA Z55
North.	North.	
ID#	ID#	

PUBLIC TRANSPORT VICTORIA PT

Document Number	523997-W00001-DRG-GR-1046
Version	A
Drawn By	JARUNEE R.
Designed By	D.MACPHIE
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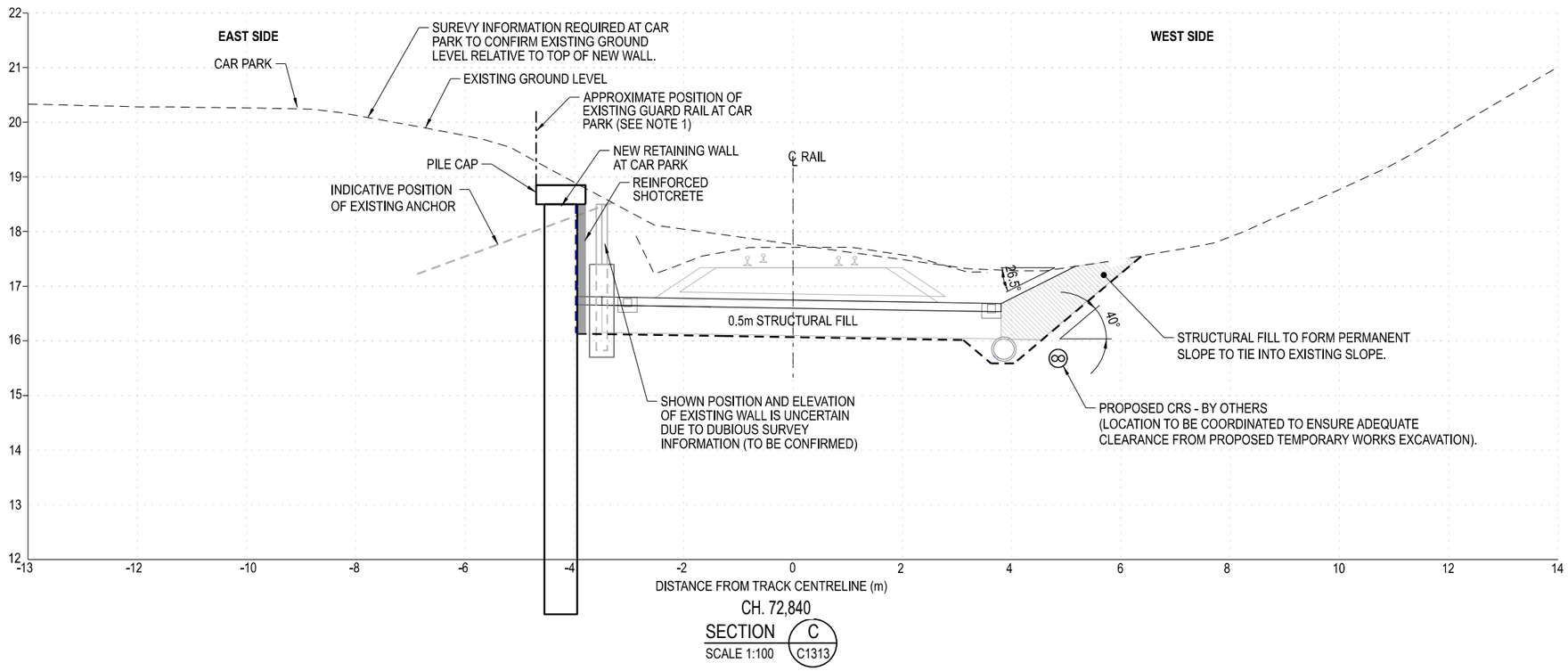
Ind. Review	M.RAMACHANDRAN
Approved	M.BUNNEY
Approval Date	
File Name	
Sheet No.	01 of 01
In Serv.	
Scale	1:100
Sheet Size	A3
Drawing Number	GEE_C1323
Revision	A



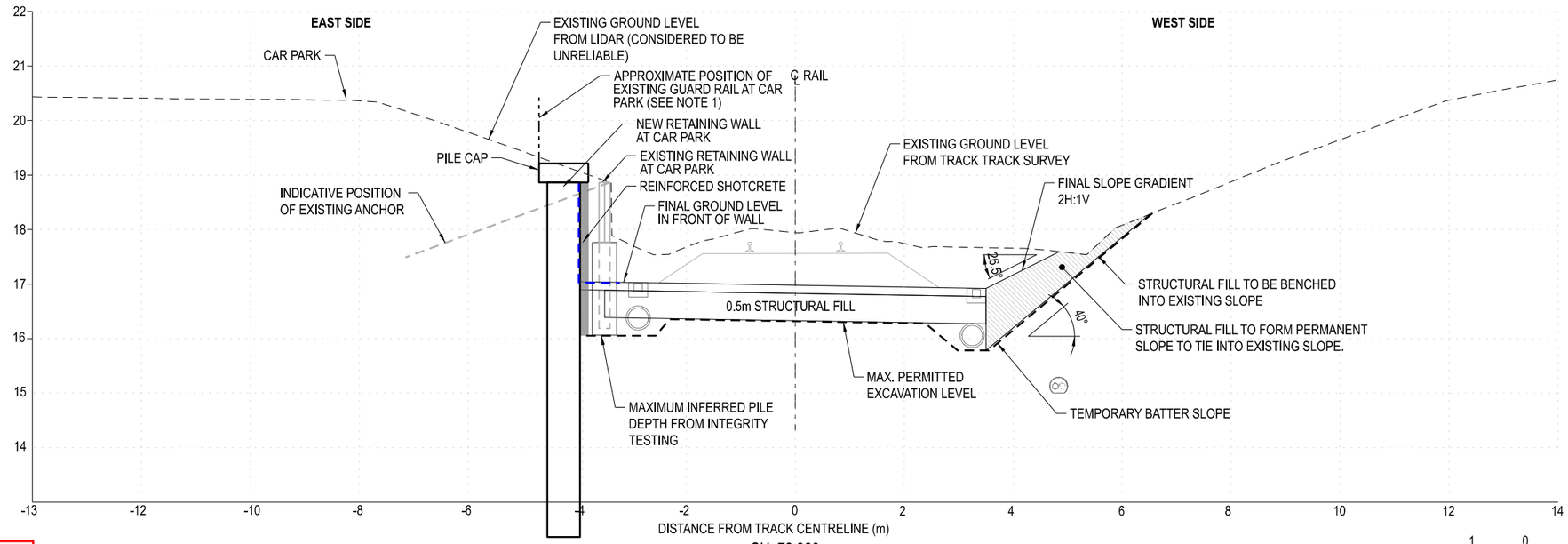
CH. 72,840

SECTION C (C1313)

SCALE 1:100

NOTES:

1. PROPOSED PILES/ CAPPING BEAM MAY CLASH WITH THE EXISTING GUARD RAIL AND ITS FOUNDATIONS. MORE EXACT DETAILS ARE REQUIRED TO ESTABLISH WHETHER THE GUARD RAIL AND ITS FOUNDATIONS CAN REMAIN IN-SITU OR NEEDS TO BE REMOVED.



CH. 72,860

SECTION D (C1314)

SCALE 1:100

1 0 1 2 3 4 5m

SCALE 1:100

FINAL DESIGN

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		A	15/03/24	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION

GEOTECHNICAL DESIGN

TYPICAL SECTIONS - SHEET 2

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

File Name

Sheet No. 01 of 01

In Serv.

Scale 1:100 | Sheet Size A3

Drawn By	Designed By
JARUNEE R.	D.MACPHIE
Checked By	Ind. Review
H.NELSON	M.RAMACHANDRAN
Approved	Approval Date
M.BUNNEY	

Drawing Number GEE_C1324 | Revision A

Document Number 523997-W00001-DRG-GR-1047 | Version A

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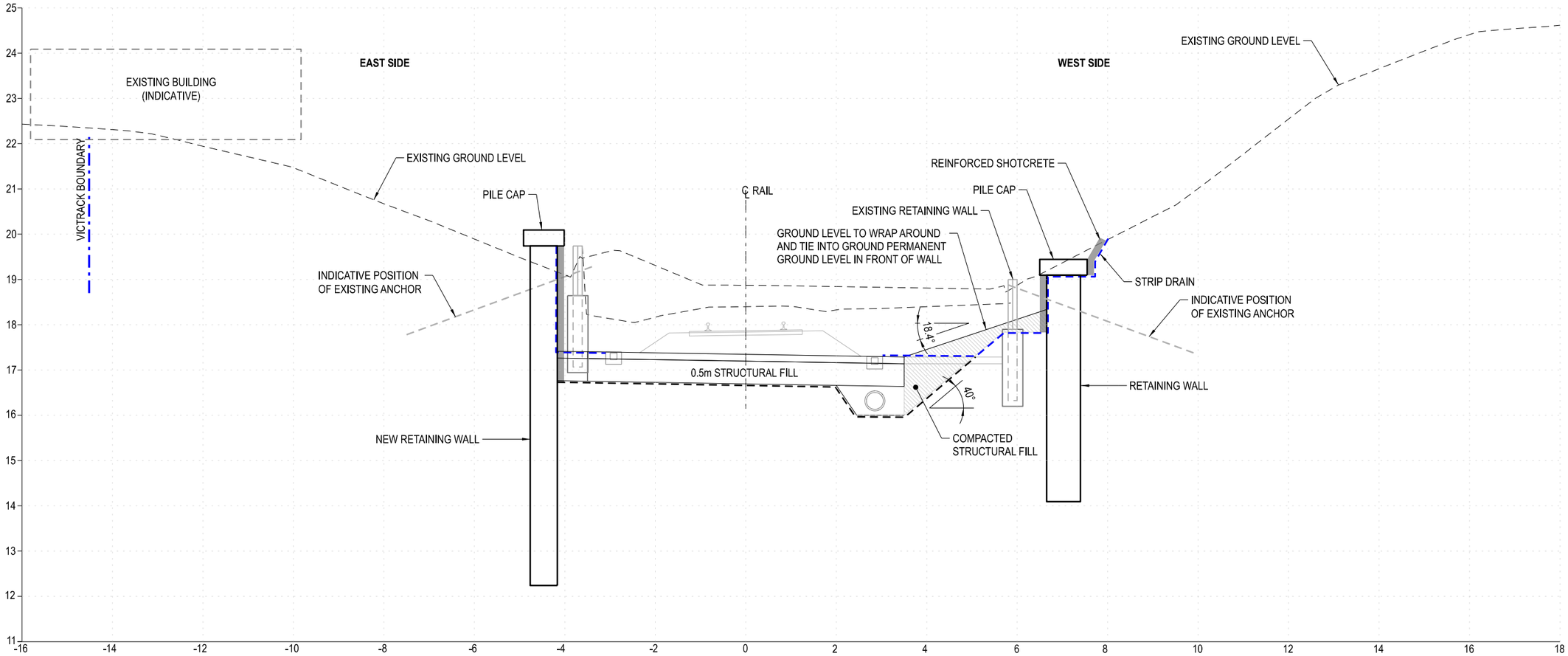

CH. 72,880

SECTION E C1314

SCALE 1:100

FINAL DESIGN

1 0 1 2 3 4 5m

SCALE 1:100

Certified By:

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(SIGNATURE)

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15/03/2024

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		A	15/03/24	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

Consultant

aurecon

Franchisee / Lessee

V/Line

RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
TYPICAL SECTIONS - SHEET 3

Up Location	Down Location	Datum
East.	East.	MGA Z55
North.	North.	
ID#	ID#	

PUBLIC TRANSPORT VICTORIA PT

File Name

Sheet No. 01 of 01

In Serv.

Scale 1:100 | Sheet Size A3

Drawn By	Designed By
JARUNEE R.	D.MACPHIE
Checked By	Ind. Review
H.NELSON	M.RAMACHANDRAN
Approved	Approval Date
M.BUNNEY	

Drawing Number GEE_C1325 | Revision A

Document Number 523997-W00001-DRG-GR-1048 | Version A

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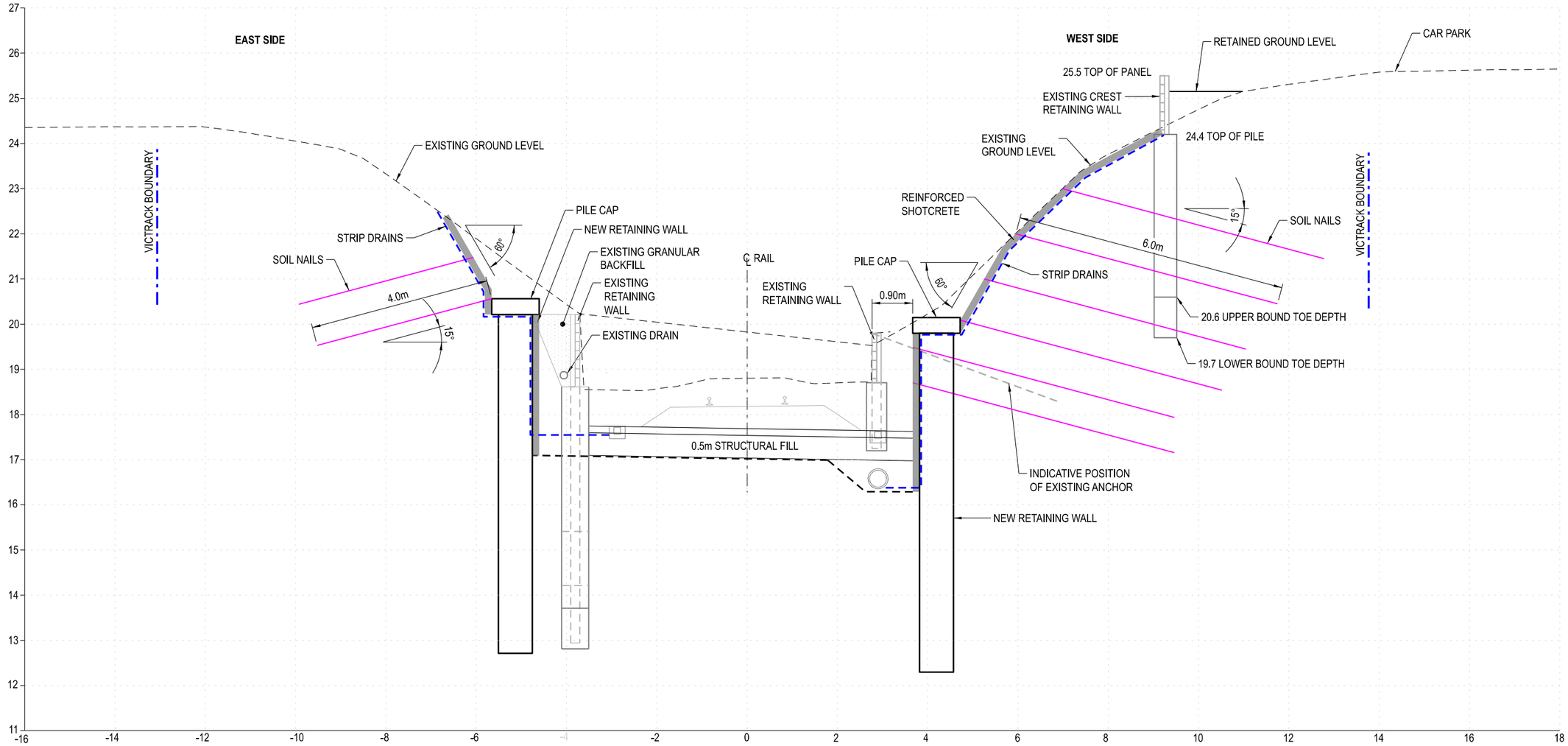

CH. 72,900

SECTION F

SCALE 1:100 C1314

FINAL DESIGN

1 0 1 2 3 4 5m

SCALE 1:100

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		A	15/03/24	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION

GEOTECHNICAL DESIGN

TYPICAL SECTIONS - SHEET 4

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

File Name

Sheet No. 01 of 01

In Serv.

Scale 1:100 | Sheet Size A3

Drawn By	Designed By
JARUNEE R.	D.MACPHIE
Checked By	Ind. Review
H.NELSON	M.RAMACHANDRAN
Approved	Approval Date
M.BUNNEY	

Drawing Number GEE_C1326 | Revision A

Document Number 523997-W00001-DRG-GR-1049 | Version A

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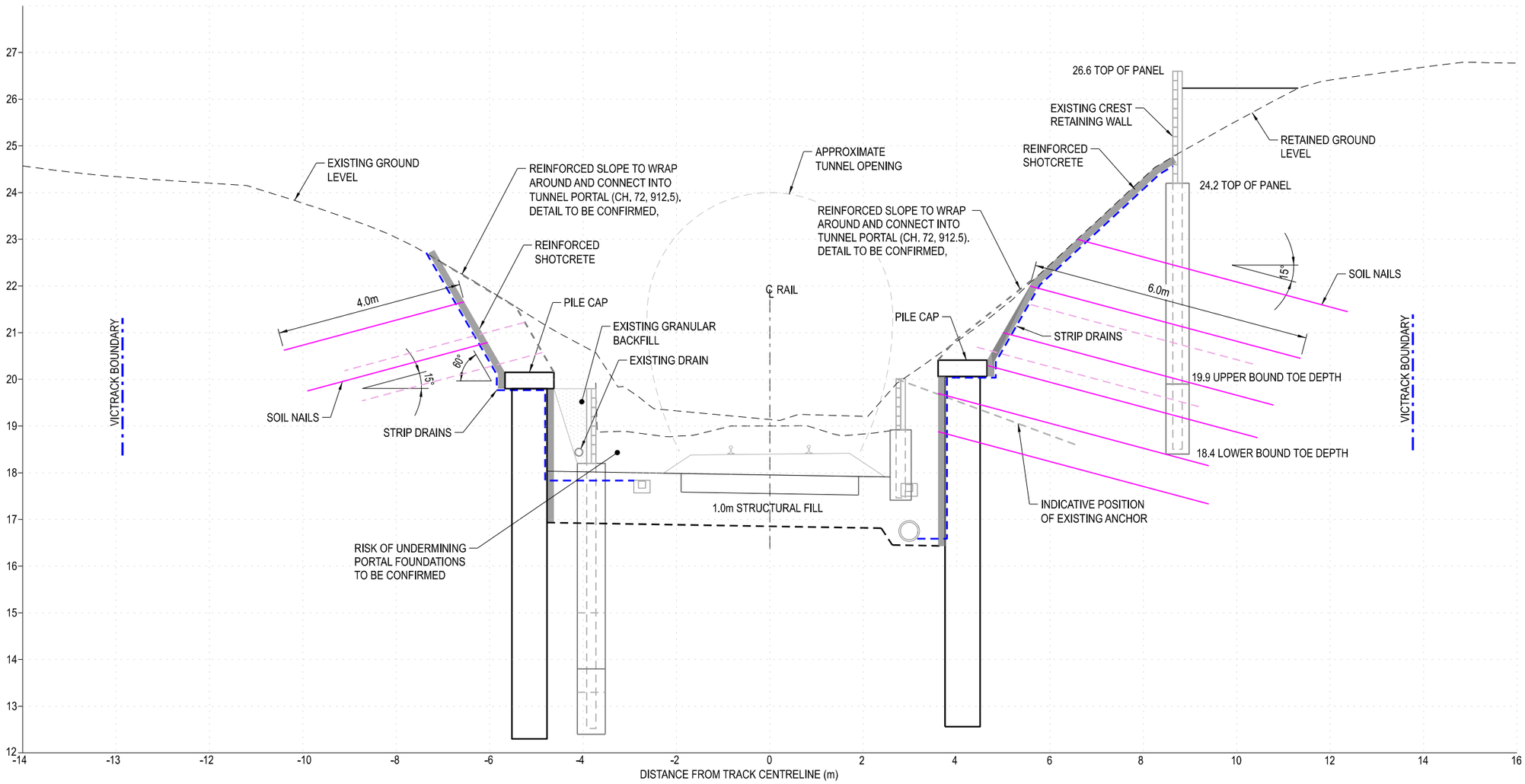

CH. 72,910

SECTION G (C1314)

SCALE 1:100

FINAL DESIGN

1 0 1 2 3 4 5m

SCALE 1:100

Certified By: (BLOCK LETTERS) (SIGNATURE) (DATE)

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		A	15/03/24	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

Consultant: aurecon

Franchisee / Lessee: V/Line

BUILDING SERVICES

GEELONG

DJILLONG TUNNEL REHABILITATION

GEOTECHNICAL DESIGN

TYPICAL SECTIONS - SHEET 5

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

Drawn By: JARUNEE R.	Designed By: D.MACPHIE
Checked By: H.NELSON	Ind. Review: M.RAMACHANDRAN
Approved: M.BUNNEY	Approval Date:
File Name:	
Sheet No.: 01 of 01	
In Serv.	
Scale: 1:100	Sheet Size: A3
Drawing Number: GEE_C1327	Revision: A

Document Number: 523997-W00001-DRG-GR-1050 | Version: A

15/03/2024 9:19:10 AM

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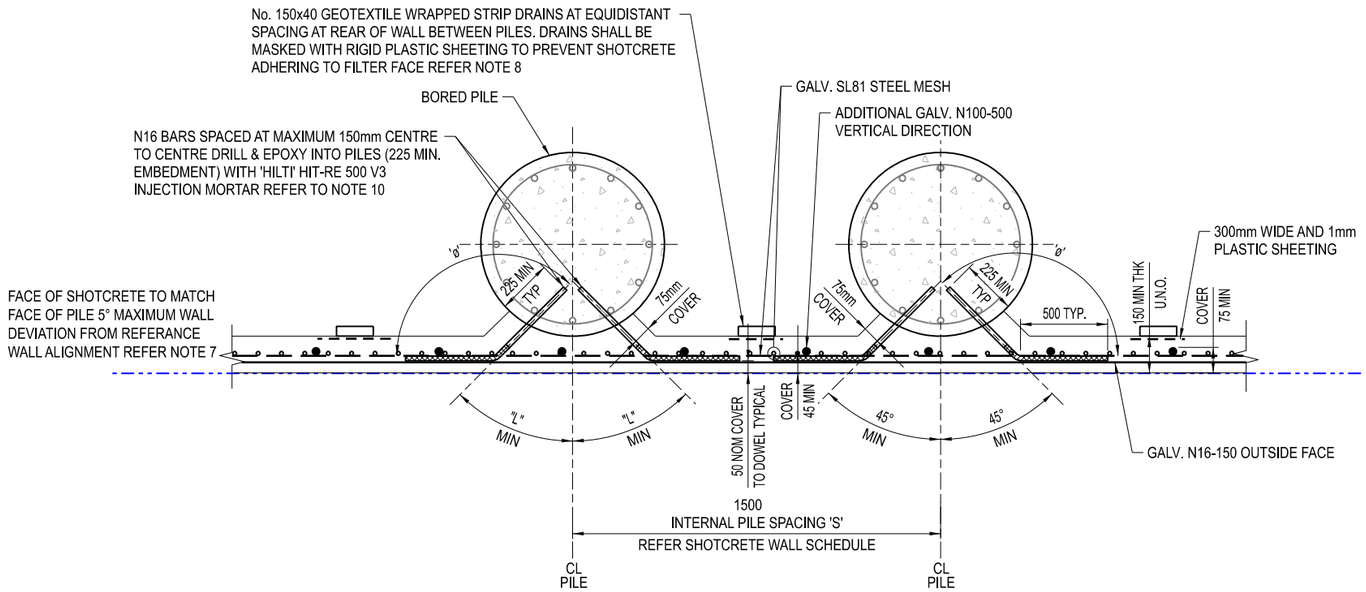


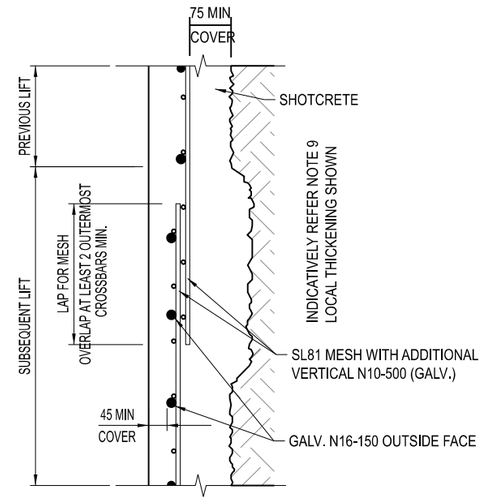
TYPICAL SHOTCRETE WALL (REINFORCEMENT)

SCALE 1:25

SHOTCRETE WALL SCHEDULE			
PILE TYPE	DOWEL ANGLE 'Ø'	PILE SPACING 'S'	'L' REFER NOTE 4
WEST WALL AT PORTAL	135°	1500 (TYPICAL)	295
EAST WALL AT PORTAL	135°	2000 (TYPICAL)	295
EAST WALL AT CAR PARK	135°	1000 (TYPICAL)	295

NOTES

1. PILES TO BE POSITIONED EQUIDISTANT FROM EXISTING PILES UNLESS SPECIFIED OTHERWISE.



SHOTCRETE INFILL-TYPICAL SECTION AT CONSTRUCTION JOINT

N.T.S

NOTES

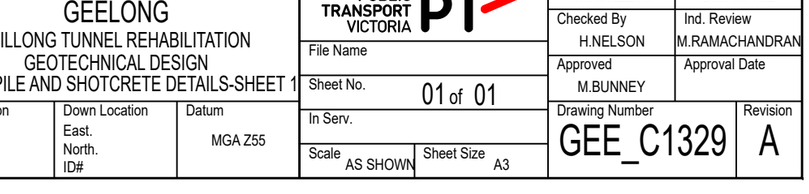
1. FOR GENERAL NOTES REFER DRAWING NO. 523997-W00001-DRG-GR-1031 TO 523997-W00001-DRG-GR-1033
2. CONSTRUCTION TEAM TO ENSURE THAT PILE MAIN REINFORCEMENT IS NOT DAMAGED DURING INSTALLATION OF DRILLED BARS.
3. BORED PILE SURFACE SHALL BE PROPERLY PREPARED USING HIGH PRESSURE WATER BLAST, CLEAN OUT ALL DEBRIS, LOOSE AGGREGATE AND SOIL PRIOR TO SHOTCRETING.
4. DIMENSIONS 'L' REFER TO ARC DISTANCE FROM CENTRELINE OF PILE TO THE CENTRE OF DOWEL PLACING HOLE.
5. HILTI HIT-RE 500 V3 INJECTION SYSTEM MUST BE USED FOR ALL CHEMICAL ANCHORING WORKS AND CANNOT BE SUBSTITUTED FOR ANY OTHER PRODUCTS WITHOUT PRIOR AGREEMENT FROM THE RELEVANT AUTHORITY AND THE DESIGNER.
6. DEPTH OF EACH LIFT OF SHOTCRETE INFILL SHALL BE A MAXIMUM OF 2m. EXCAVATION CAN BE INCREASED BASED ON SITE MAPPING AND TO BE CONFIRMED BY GEOTECHNICAL ENGINEER DURING EXCAVATION.
7. FACE OF SHOTCRETE IS COVERED BY STEEL CLADDING AND NOT EXPOSED HAS BEEN ASSUMED.
8. THE STRIP DRAINS TO BE CENTRALLY POSITIONED AT REAR OF WALL BETWEEN PILES.
9. LOCAL THICKENING REQUIRED AT REAR OF WALL AT CONSTRUCTION JOINT WHERE MESH OVERLAPS TO ACHIEVE 75mm MINIMUM COVER AT REAR OF WALL AND 45mm MINIMUM COVER AT FRONT FACE OF WALL REQUIRED.
10. WHERE THE BLACK STEEL BAR EXTENDS BEYOND THE PILE IT SHALL BE COATED WITH SHERWIN WILLIAMS ZINC CLAD 1001 OR APPROVED EQUIVALENT. APPLICATION OF THE ZINC RICH COAT SHALL EXTEND 20MM (NOM) INTO BONDED ANCHOR EMBEDMENT DEPTH WITH THE REMAINDER OF THE BONDED EMBEDMENT DEPTH TO REMAIN UNCOATED. THE ZINC RICH COATING SHALL BE INSTALLED AS PER COATING MANUFACTURERS SPECIFICATIONS.
11. CONCRETE SHALL BE AS NOTED BELOW AND IN ACCORDANCE WITH VICROADS SPECIFICATION SECTION 610.

STRUCTURAL ELEMENT	CONCRETE GRADE	EXPOSURE CLASSIFICATION
BORED PILES	VR400/40	B1
SHOTCRETE WALL	VR400/40	B1

12. MINIMUM COVER (mm) TO ALL REINFORCEMENT UNO SHOWN ON THE DRAWINGS SHALL BE AS FOLLOWS:

ELEMENT	CONCRETE COVER (mm)			
	CAST AGAINST#			PRECAST**
	FORMS	BLINDING	GROUND	
BORED PILES	N/A	N/A	75	N/A
SHOTCRETE WALL	45	N/A	75	N/A

13. STEEL REINFORCEMENT GRADE SHALL BE HOT ROLLED DEFORMED BARS TO AS/NZ4671 (GRADE 500N)
14. MINIMUM MESH REINFORCEMENT LAP SHALL BE 1 SPACE + 25mm (25mm MIN.)
    - VALUES INCLUDE K7 = 1.25 FACTOR FOR NON-STAGGERED LAPS
    - LAPS BASED ON 30mm COVER AND CONCRETE f'c = 40MPa, BAR SPACING 150mm
    - WHERE THE BAR SIZES AT A LAP VARY, THE LAP LENGTH SHALL BE BASED ON THE SIZE OF THE SMALLER BAR
    - INCREASE THE LENGTH BY 20% FOR A 3-BAR BUNDLE AND 33% FOR A 4-BAR BUNDLE.
    - SPLICES IN THE REINFORCEMENT SHALL BE MADE ONLY AT LOCATION SHOWN ON THE DRAWING OR OTHERWISE APPROVED BY THE ENGINEER.



TYPICAL SHOTCRETE REINFORCEMENT ELEVATION VIEW

SCALE 1:25

FINAL DESIGN

Certified By: (DATE) (SIGNATURE) (BLOCK LETTERS)

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
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Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
BORED PILE AND SHOTCRETE DETAILS-SHEET 1

Up Location: East. North. ID#
Down Location: East. North. ID#
Datum: MGA Z55

PUBLIC TRANSPORT VICTORIA PT

File Name
Sheet No. 01 of 01
In Serv.
Scale AS SHOWN | Sheet Size A3

Drawn By: JARUNEE R. | Designed By: D.MACPHIE
Checked By: H.NELSON | Ind. Review: M.RAMACHANDRAN
Approved: M.BUNNEY | Approval Date

Drawing Number: GEE_C1329 | Revision: A

Document Number: 523997-W00001-DRG-GR-1052 | Version: A

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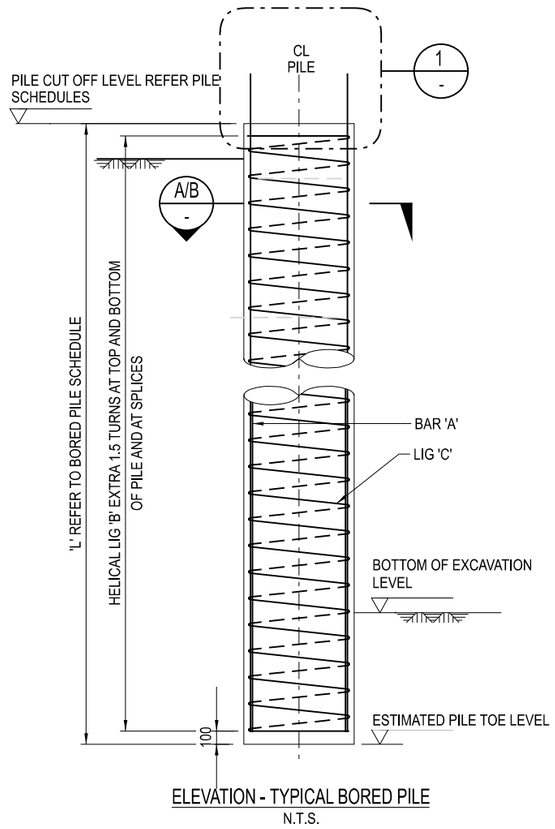
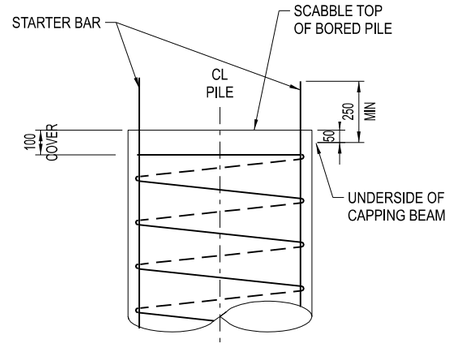


ELEVATION - TYPICAL BORED PILE

N.T.S.

BORED PILE REINFORCEMENT SCHEDULE		
PILE TYPE	BAR 'A'	LIG 'C'
1	12 N32	N10-100 PITCH
2	8 N24	N10-150 PITCH



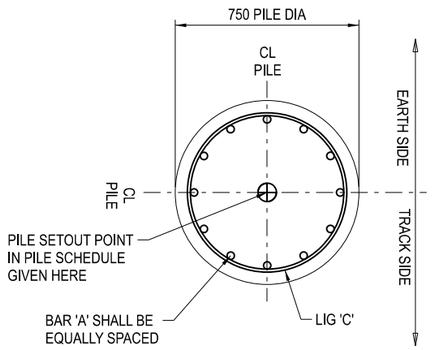
TOP OF PILE

DETAIL 1 / -

SCALE 1:25

BORED PILE NOTES

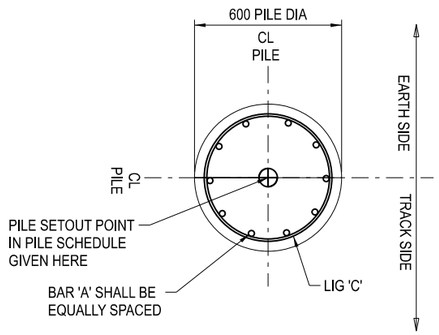
1. FOR GENERAL NOTES REFER AS2159-2009 AND VICROADS SECTION 606 FOR PILING DESIGN AND INSTALLATION.
2. THIS DRAWING TO BE READ IN CONJUNCTION WITH PILE SCHEDULES AND VICROADS SECTION 606 BORED CAST IN PLACE PILES.
3. THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE LATEST REVISION OF GEOTECHNICAL INFORMATION PROVIDED IN DESIGN REPORT (523997-W00001-REP-GEO-0002).
4. BORED PILE TOE LEVELS ARE INDICATIVE ONLY. LEVELS SHALL BE CONFIRMED ON SITE BY THE GEOTECHNICAL ENGINEER IN ACCORDANCE WITH AN APPROVED CONSTRUCTION METHOD. THE GEOTECHNICAL ENGINEER SHALL BE INFORMED PRIOR TO ANY DRILLING TAKING PLACE. PILE DRILLING SHALL BE WITNESSED BY THE GEOTECHNICAL ENGINEER.
5. WORKMANSHIP AND MATERIALS ARE TO BE IN ACCORDANCE WITH THE DRAWINGS. WHERE NOT SPECIFIED THEY SHALL BE IN ACCORDANCE WITH THE RELEVANT AUSTRALIAN STANDARDS.
6. ALL DIMENSIONS SHALL BE OBTAINED FROM THE RELEVANT STRUCTURAL OR SERVICE DRAWINGS AND CONFIRMED ON SITE BY THE CONTRACTOR. WHERE ANY AMBIGUITY, DISCREPANCY OR INCONSISTENCY IS FOUND THE CONTRACTOR SHALL IMMEDIATELY REPORT IT TO THE SUPERVISING ENGINEER FOR A DECISION BEFORE PROCEEDING WITH THE WORK.
7. THE CONTRACTOR SHALL ENSURE ADEQUATE RECORDS OF ALL WORKS ARE MAINTAINED AND THAT THE REQUIREMENTS FOR EACH SECTION OF THE SPECIFICATION ARE MET IN THIS REGARD. THE DRILLING RECORDS FOR EACH PILE SHALL CONTAIN INFORMATION AS PER AS2159.
8. SITE DESIGN PARAMETERS, ANALYSIS OUTCOMES, DESIGN LOADS. EXPECTED GROUND CONDITIONS ARE BASED ON GEOTECHNICAL INVESTIGATIONS.
9. PILE REINFORCEMENT SHALL BE INSTALLED AS A CONTINUOUS CAGE BY:
   - WELDING ALL LONGITUDINAL BARS TO THE SPIRAL REINFOCEMENT AT TOP, BOTTOM AND MIDDLE OF THE PILE.
   - CONTINUITY BETWEEN STEEL ELEMENTS SHALL BE PROVIDED BY GENERAL PURPOSE (GP) TACK WELDING OF ISOLATED ELEMENTS.
10. 10kPa HAS BEEN ASSUMED BEHIND RETAINING WALL WHERE PILES ARE WITHIN THE CAR PARK AREA. NO ADDITIONAL TEMP SURCHARGES HAVE BEEN ASSUMED IN DESIGN.
11. BASE OF PILE SHALL BE CLEANED OUT. THE TEMPORARY CASING (WHERE USED) SHALL BE REMOVED.
12. CONCRETE SHALL BE PLACED AS SOON AS POSSIBLE AFTER BORING AND AFTER APPROVAL HAS BEEN GIVEN BY THE NOMINATED AUTHORITY.
13. GROUNDWATER LEVEL ASSUMED IN DESIGN BELOW THE TOE OF THE PILES AND IS BASED ON STANDPIPE READINGS FROM BOREHOLES.
14. PILE CAGES SHALL BE ORIENTATED AND INSTALLED AS SHOWN TO ALLOW SUFFICIENT ROOM FOR INSTALLATION OF DOWEL BARS ON SITE
15. REFER ELEVATION PROFILES FOR MINIMUM PILE LENGTHS



FOR PILE TYPE 1

SECTION A / -

SCALE 1:25



FOR PILE TYPE 2

SECTION B / -

SCALE 1:25

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Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION

GEOTECHNICAL DESIGN

BORED PILE AND SHOTCRETE DETAILS-SHEET 2

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

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JARUNEE R.	D.MACPHIE
Checked By	Ind. Review
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Approved	Approval Date
M.BUNNEY	

Drawing Number GEE_C1330 | Revision A

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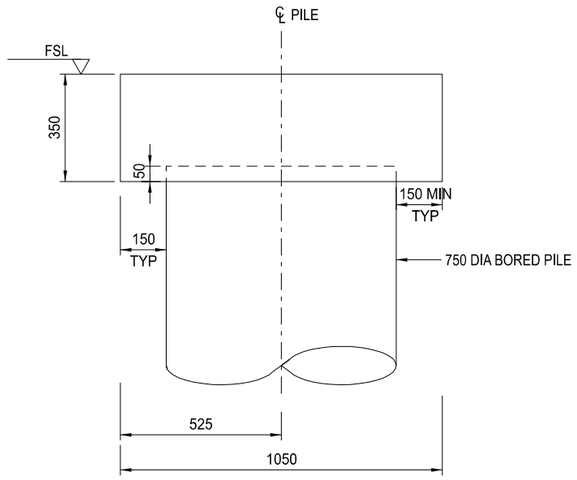
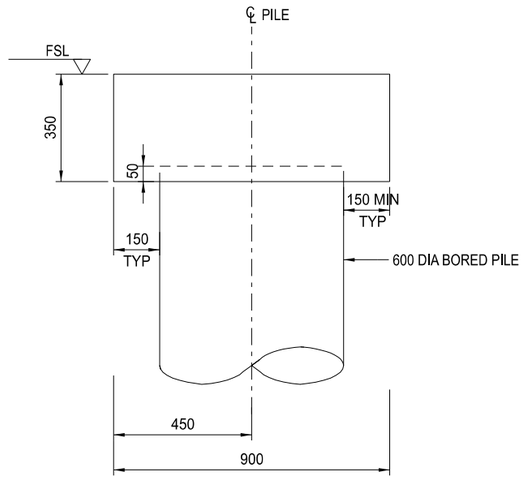
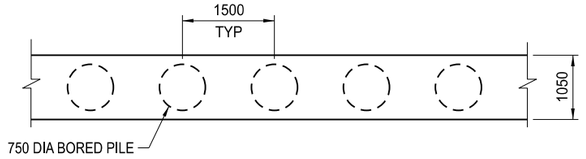


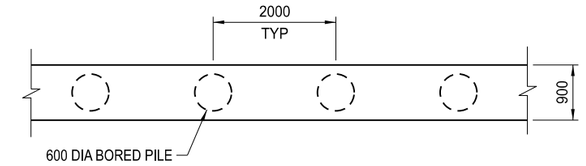
CAPPING BEAM SECTION - TYPE 1 (CONCRETE)
SCALE 1:20



CAPPING BEAM SECTION - TYPE 2 (CONCRETE)
SCALE 1:20



TYPICAL CAPPING BEAM PLAN- TYPE 1
SCALE 1:100



TYPICAL CAPPING BEAM PLAN- TYPE 2
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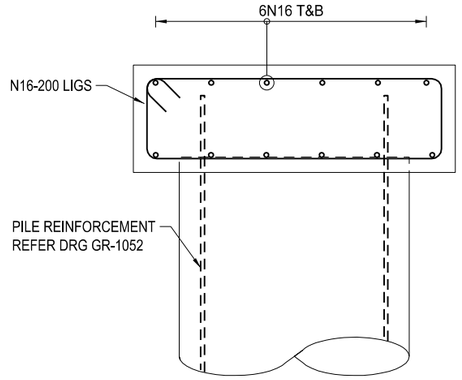

CAPPING BEAM SECTION - TYPE 1 (REINFORCEMENT)
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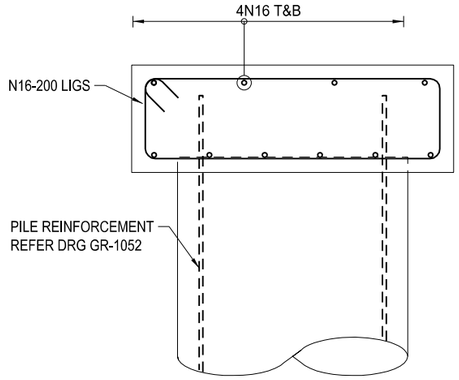
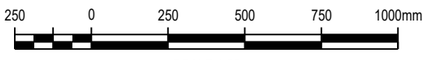


CAPPING BEAM SECTION - TYPE 2 (REINFORCEMENT)
SCALE 1:20

NOTES

1. FOR CONCRETE AND STEEL GRADE REFER DRG GR-1052



SCALE 1:20

SCALE 1:100

FINAL DESIGN

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Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
PILE CAPPING BEAM - SHEET 1

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

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Checked By	Ind. Review
H.NELSON	M.RAMACHANDRAN
Approved	Approval Date
M.BUNNEY	

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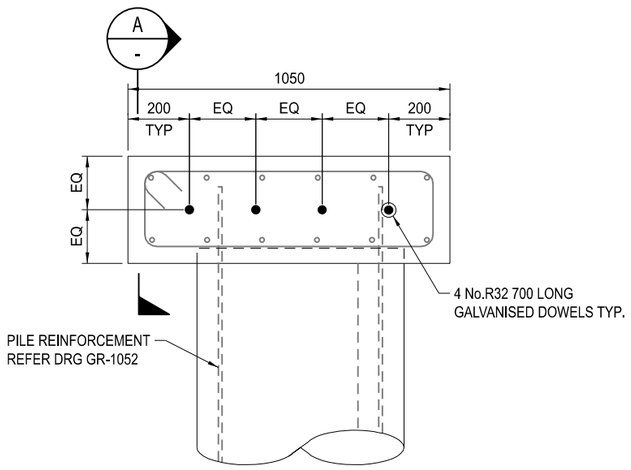
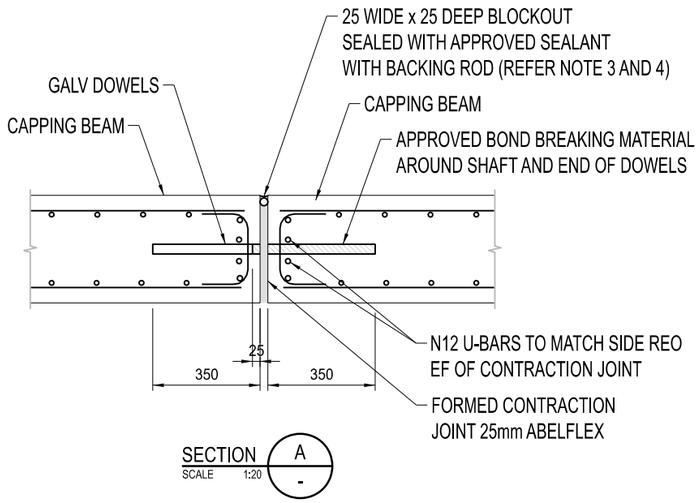
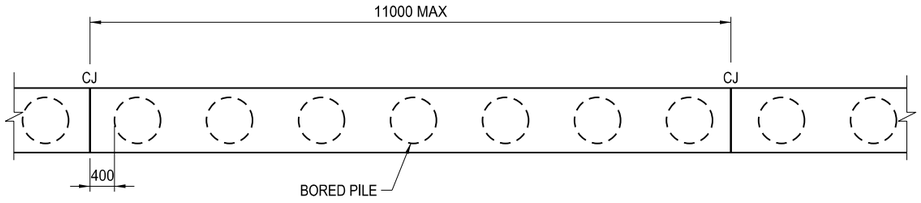


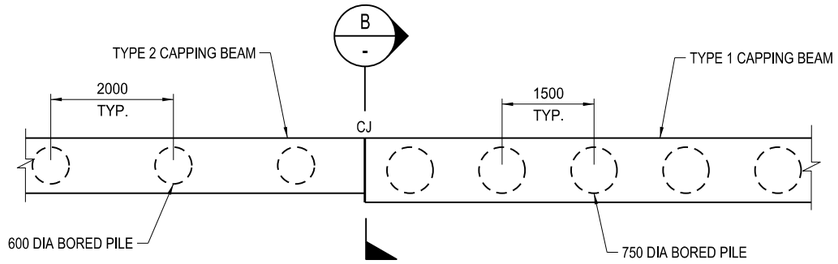
TYPICAL SECTION AT CONTRACTION JOINT (CJ)- TYPE 1 CAPPING BEAM
SCALE 1:20



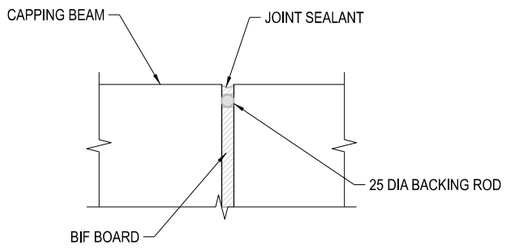
CONTRACTION JOINT (CJ) IN CAPPING BEAM



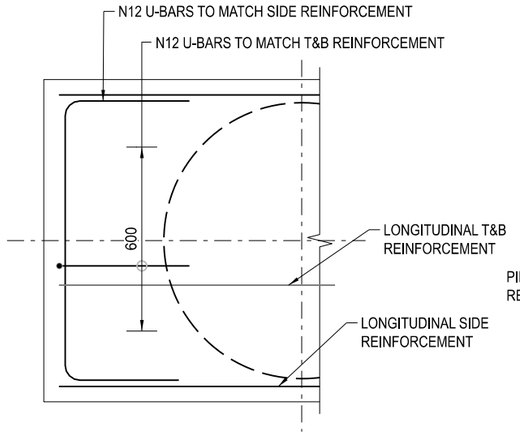
INDICATIVE CONTRACTION JOINT (CJ) PLAN
SCALE 1:100



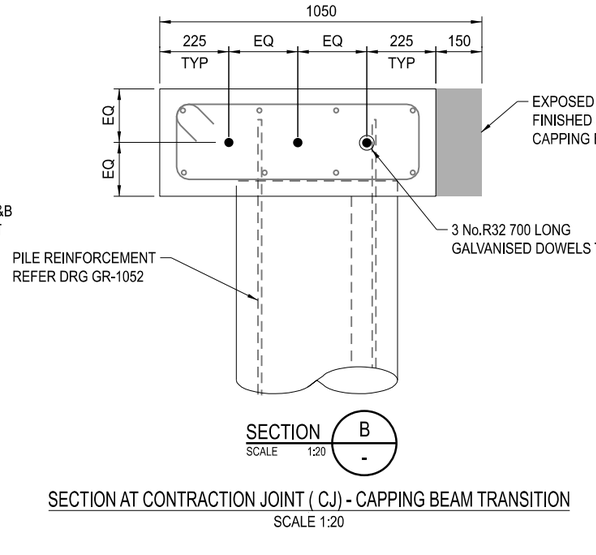
CAPPING BEAM TRANSITION PLAN
SCALE 1:100



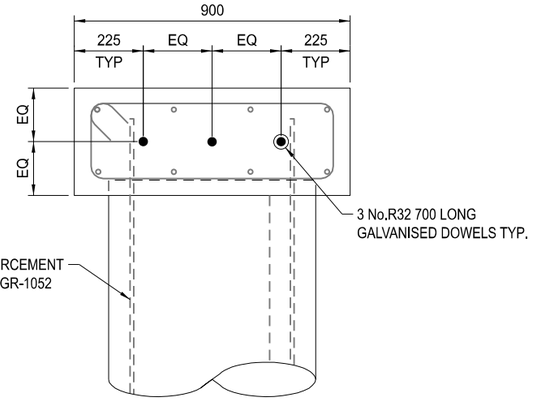
GROOVE & SEALANT DETAIL
SCALE 1:5



PLAN - CAPPING BEAM END DETAIL
N.T.S.
PILE CAPE SIZE VARIES



SECTION AT CONTRACTION JOINT (CJ) - CAPPING BEAM TRANSITION
SCALE 1:20

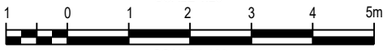


TYPICAL SECTION AT CONTRACTION JOINT (CJ)- TYPE 2 CAPPING BEAM
SCALE 1:20

NOTES

1. FOR INDICATIVE CONTRACTION JOINT LOCATION REFER DRG GR-1036&1037
2. AN APPROVED NEOPRENE COMPRESSION SEAL CONFORMING TO ASTM D2628 MAY BE USED INSTEAD OF FIELD MOULDED SEALANT AND BACKING ROD.
3. BACKING ROD SHALL BE MADE OF POLYTHELENE FOAM OR APPROVED EQUIVALENT. ALTERNATE MATERIAL AND SHAPE SUBJECT TO PRIOR APPROVAL.
4. CARE TO BE TAKEN TO ENSURE THAT GALVANISED DOWEL BARS ARE NOT TO CONTACT WITH REINFORCEMENT.
5. FOR CONCRETE AND STEEL GRADE REFER DRG GR-1052

SCALE 1:20



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Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
PILE CAPPING BEAM - SHEET 2

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

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JARUNEE R.	D.MACPHIE
Checked By	Ind. Review
H.NELSON	M.RAMACHANDRAN
Approved	Approval Date
M.BUNNEY	

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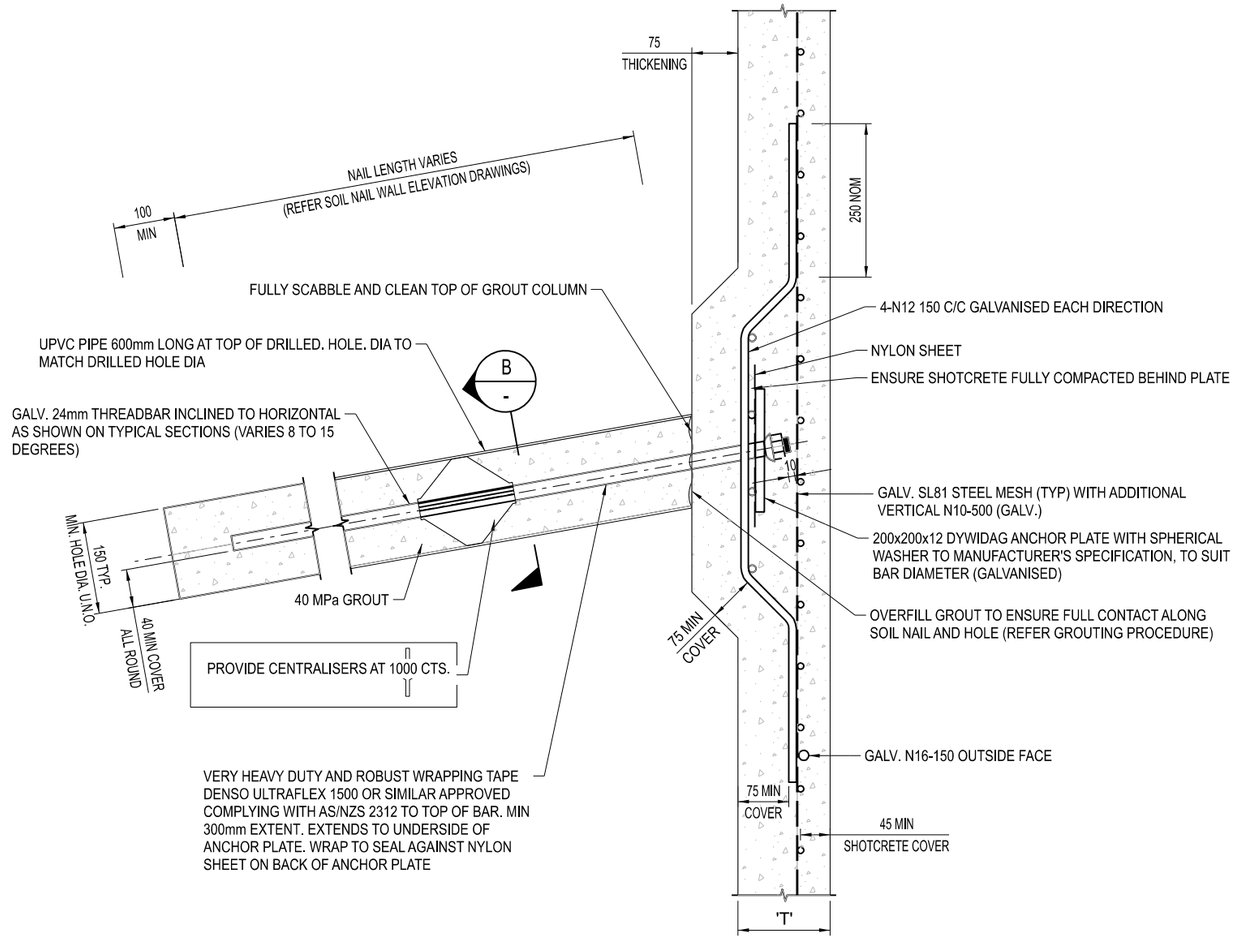
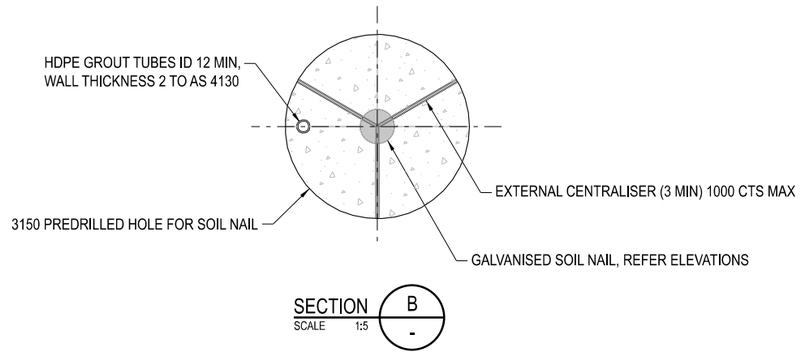


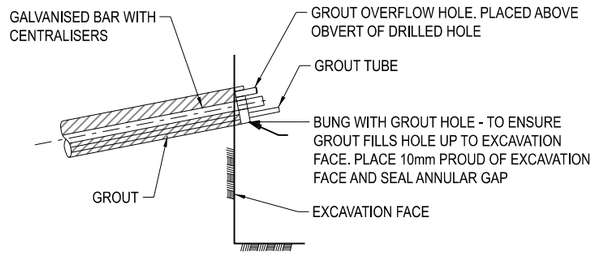
SOIL NAIL DETAIL WITH BEARING PLATE

SCALE 1:10

REINFORCEMENT SHOWN FOR 150 THICK WALL

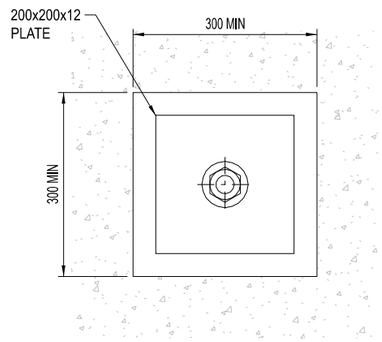


SECTION B - SCALE 1:5



TYPICAL SOIL NAIL GOUTING PROCEDURE DETAIL

N.T.S.



BLOCKOUT DETAIL FOR PRODUCTION TEST NAILS

SCALE 1:10

NOTES

1. FOR SOIL NAIL WALL NOTES REFER TO GENERAL NOTES
2. STRIP DRAIN NOT SHOWN FOR CLARITY AND TO BE PLACED CENTRALLY BETWEEN NAILS
3. FOR CONCRETE AND STEEL GRADE REFER DRG GR-1052
4. ADJUST BLOCKOUT DIMENSIONS TO SUIT JACK FOR LOAD TESTING OF NAILS
5. SCABBLE EDGES OF BLOCKOUT AND FILL WITH CONCRETE AFTER TESTING

SHOTCRETE WALL SCHEDULE		
LOCATION	'T' MIN	MESH REQUIREMENT
BETWEEN PILES AND SLOPES	150	SINGLE LAYER GALVANISED SL81 + N16-150 HORIZONTAL + N10-500 VERTICAL

50 0 50 100 150 200 250mm
SCALE 1:5

100 0 100 200 300 400 500mm
SCALE 1:10

FINAL DESIGN

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Consultant: aurecon

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RAILWAY TRACK AND CIVIL
GEELONG
DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
SOIL NAIL AND FACING DETAILS - SHEET 1

Up Location	Down Location	Datum
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PUBLIC TRANSPORT VICTORIA PT

Drawn By: JARUNEE R.	Designed By: D.MACPHIE
Checked By: H.NELSON	Ind. Review: M.RAMACHANDRAN
Approved: M.BUNNEY	Approval Date:
File Name:	
Sheet No.: 01 of 01	
In Serv.	
Scale: AS SHOWN	Sheet Size: A3
Drawing Number: GEE_C1332	Revision: A

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15/03/2024 9:19:25 AM

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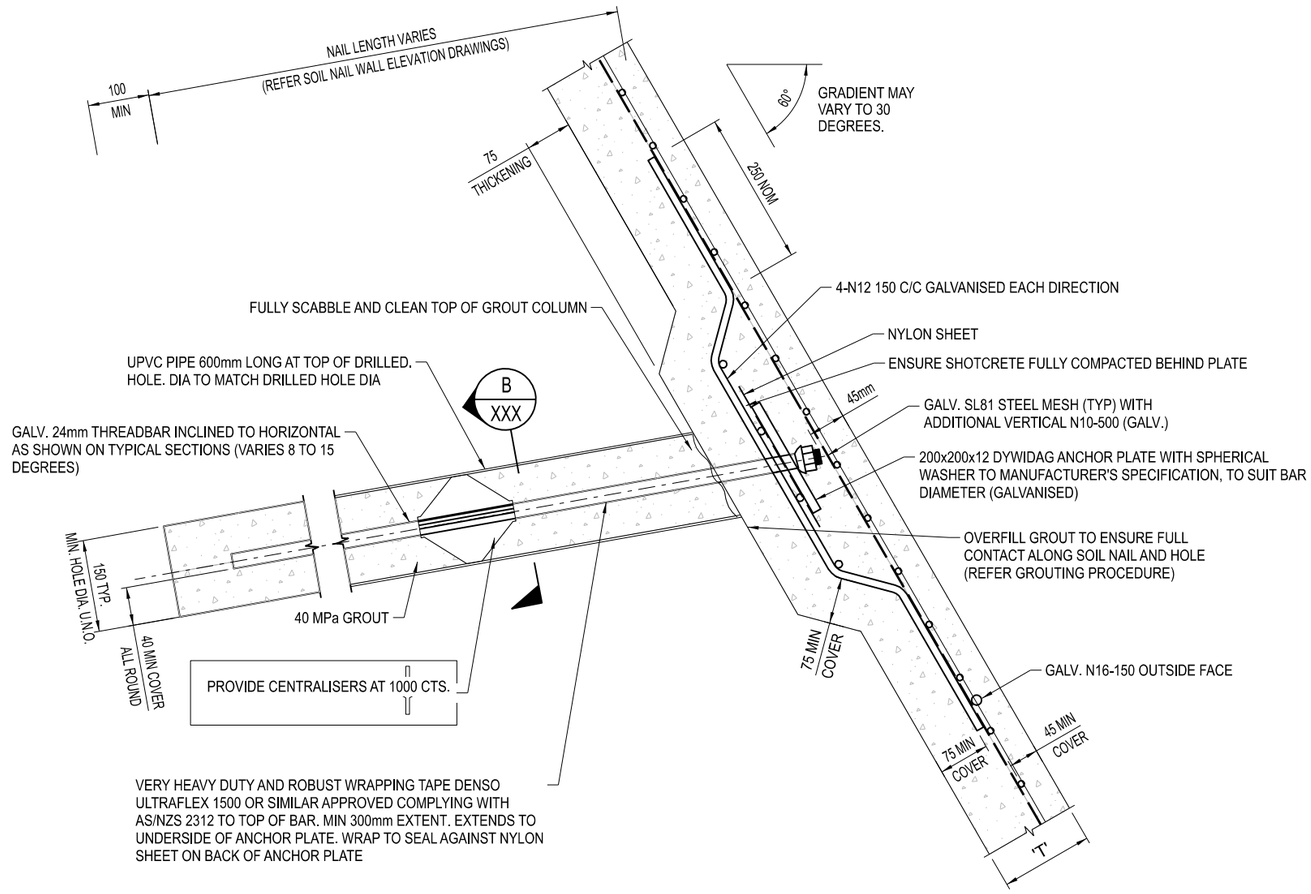

SOIL NAIL DETAIL WITH BEARING PLATE

SCALE 1:10

REINFORCEMENT SHOWN FOR 150 THICK WALL, REFER TO TABLE FOR OTHER WALL THICKNESSES

NOTES

1. REFER TO GENERAL NOTES, PLAN LAYOUT, ELEVATION AND SECTION DRAWINGS.
2. FOR CONCRETE AND STEEL GRADE REFER DRG GR-1052

100 0 100 200 300 400 500mm

SCALE 1:10

FINAL DESIGN

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Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
SOIL NAIL AND FACING DETAILS - SHEET 2

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

File Name

Sheet No. 01 of 01

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Scale AS SHOWN | Sheet Size A3

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JARUNEE R.	D.MACPHIE
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H.NELSON	M.RAMACHANDRAN
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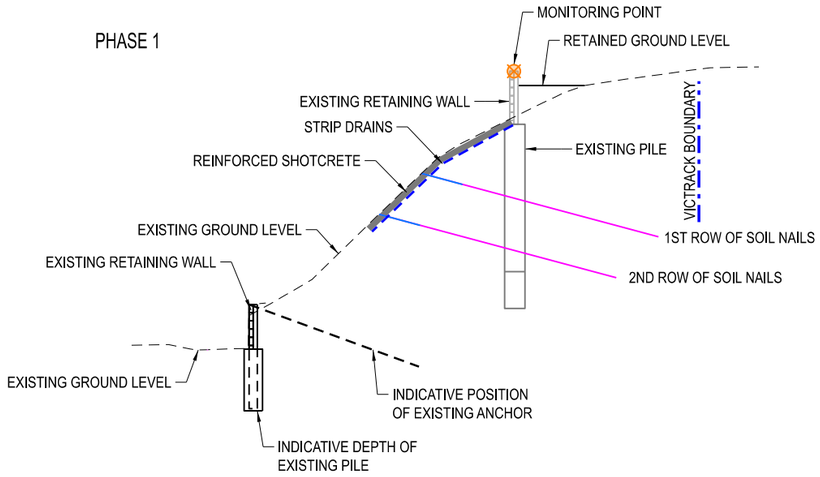
Certified By:

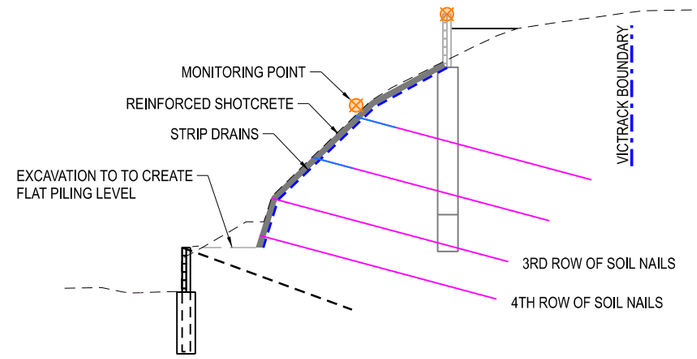
PHASE 1



1. INSTALL INSTRUMENTATION AND MONITORING ON EXISTING CREST WALL
2. CLEAR VEGETATION ON SLOPE FACE IN PROPOSED SHOTCRETING ZONE *.
3. INSTALL FIRST TWO ROWS OF SOIL NAILS
4. CONSTRUCT STRIP DRAINS AND REINFORCED SHOTCRETE.

* GEOTECHNICAL ENGINEER SHALL INSPECT THE SLOPE AFTER VEGATATION REMOVAL TO BEST ASSESS THE SLOPE STABILITY AND GROUND TYPES.

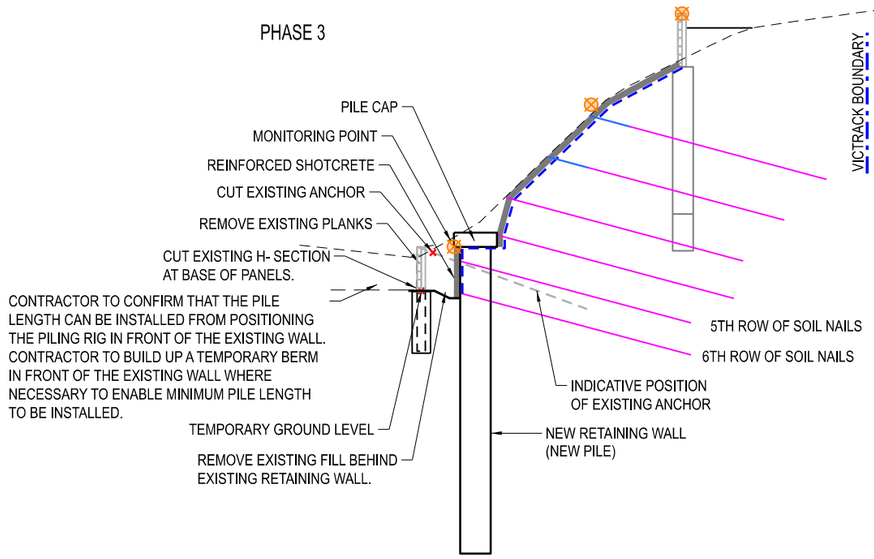
PHASE 2



1. EXCAVATE TO 3RD SOIL NAIL ROW *
2. INSTALL 3RD SOIL NAIL ROW
3. EXCAVATE TO 4TH SOIL NAIL ROW
4. INSTALL 4TH SOIL NAIL ROW
5. CONSTRUCT STRIP DRAINS AND REINFORCED SHOTCRETE
6. INSTALL INSTRUMENTATION AND MONITORING ON SLOPE FACE.

* GEOTECHNICAL ENGINEER SHALL INSPECT THE SLOPE TO CONFIRM THE TEMPORARY STABILITY AT EVERY STAGE OF THE EXCAVTION.

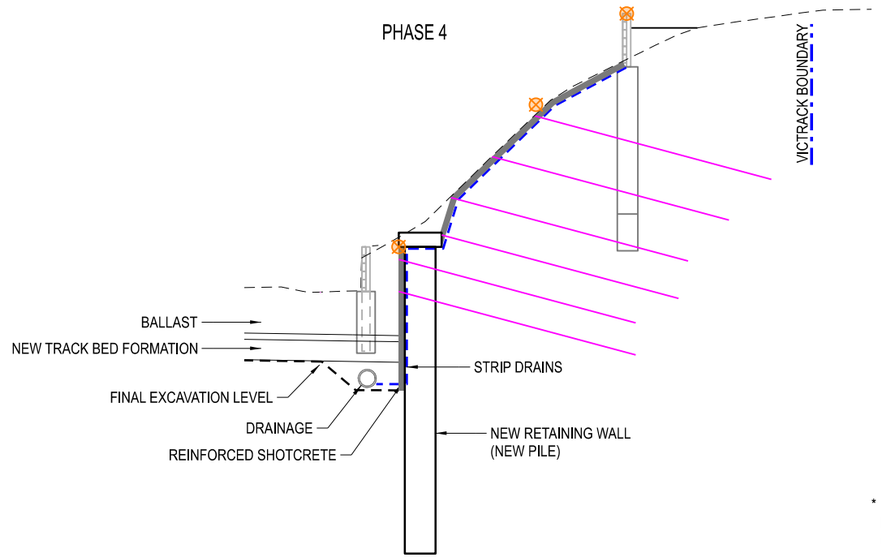
PHASE 3



1. INSTALL NEW PILE AND INSTALL PILE CAP.
2. INSTALL INSTRUMENTATION AND MONITORING POINTS ON PILE.
2. CUT EXISTING ANCHOR
3. REMOVE EXISTING PLANKS AND BACKFILL BETWEEN EXISTING PILE AND NEW PILE AND CUT EXISTING UC SOLDIER PILE.
4. INSTALL 5TH AND 6TH SOIL NAILS BETWEEN NEW PILES.
5. CONSTRUCT STRIP DRAINS AND REINFORCED SHOTCRETE ON NEW WALL FACE.
6. IT IS ANTICIPATED THAT SCHEME WILL BE LEFT FOR UP TO 18 MONTHS IN THIS CONDITION.

FINAL DESIGN

PHASE 4



* EXCAVATION SHALL NOT PROCEED IN FRONT OF PILES UNTIL THE PILES HAVE REACHED A 20MPa CONCRETE STRENGTH.

1. EXCAVATE TO FINAL EXCAVATION LEVEL *
2. CUT OR REMOVE EXISTING PILE
3. CONSTRUCT STRIP DRAINS AND REINFORCED SHOTCRETE ON WALL FACE
4. INSTALL DRAINAGE AND NEW TRACKBED FORMATION
5. CONSTRUCT BALLAST.

"THIS PHASE (STEPS 1 TO 4) IS REQUIRED TO BE COMPLETED OVER A MAXIMUM PERIOD OF 2MONTHS FOR ALL WALLS, TO CONTROL WALL DEFLECTIONS AND STABILITY AS PER THE DESIGN REQUIREMENTS. CONTRACTOR TO SEQUENCE WORK ACCORDINGLY INVOLVING DISCRETE BAY LENGTHS."

NOTES

1. ANTICIPATED CONSTRUCTION SEQUENCE SHOWN FOR WEST CUT AT CH.72,900.

Revised By	In Serv	Rev.	Date	Description	Designed	Checked	Ind. Review	Approved
		A	15/03/24	FINAL DESIGN	D.M.	H.N.	M.R.	M.B.

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15/03/2024

Consultant: aurecon

Franchisee / Lessee: V/Line

RAILWAY TRACK AND CIVIL

GEELONG

DJILLONG TUNNEL REHABILITATION
GEOTECHNICAL DESIGN
CONSTRUCTION SEQUENCE

Up Location	Down Location	Datum
East. North. ID#	East. North. ID#	MGA Z55

PUBLIC TRANSPORT VICTORIA PT

File Name

Sheet No. 01 of 01

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JARUNEE R.	D.MACPHIE
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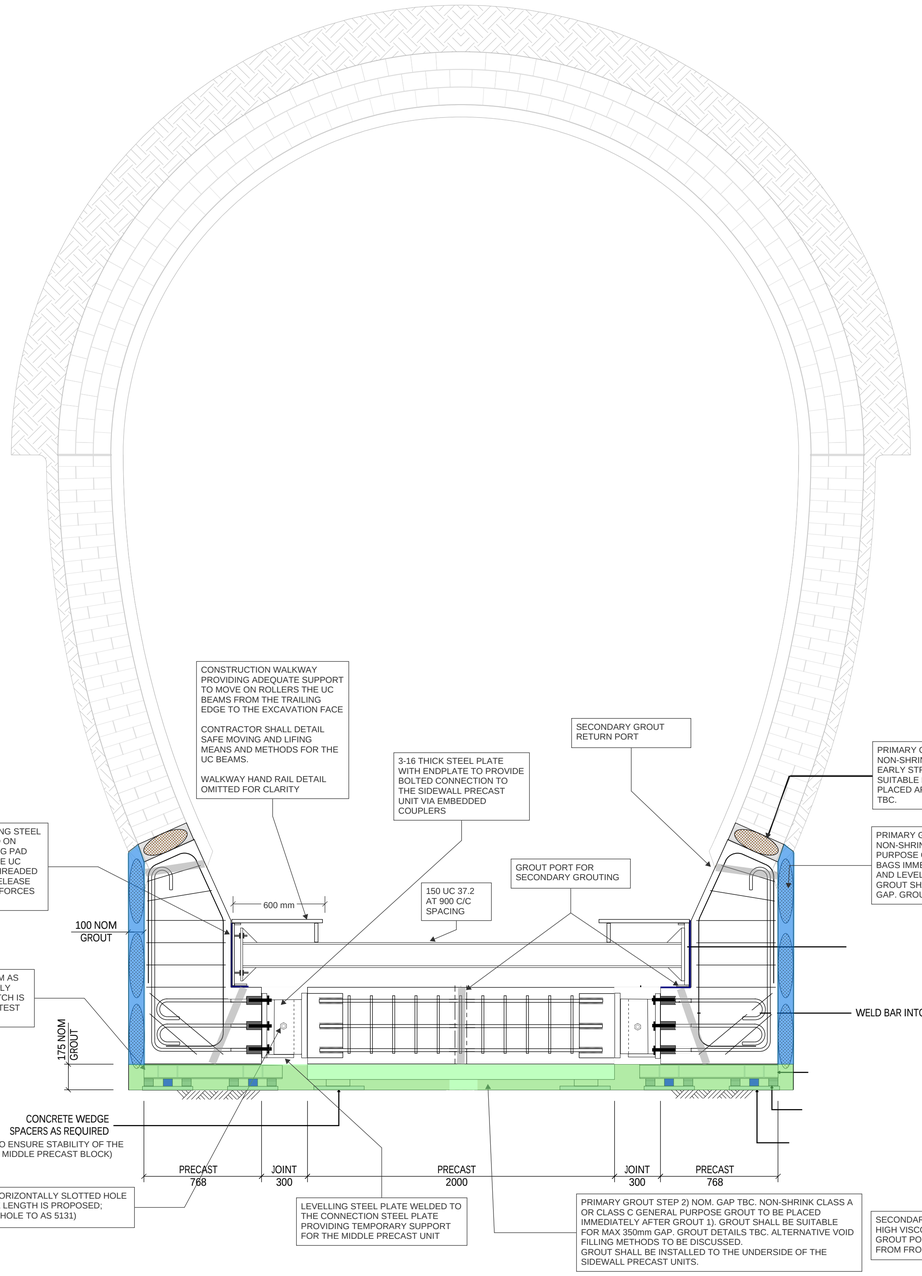
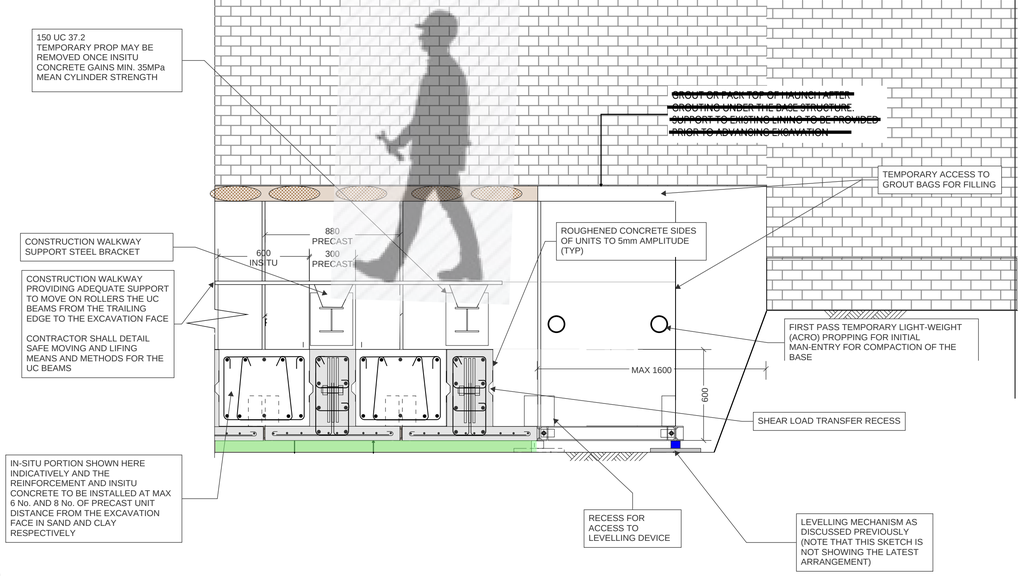
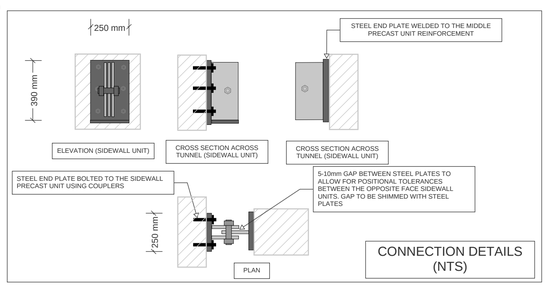
PC UNIT INSTALLATION SEQUENCE
1. COMMENCE EXCAVATION PROVIDED CONTRACTORS PERMIT TO EXCAVATE PROCESS FOLLOWED AND MITIGATION MEASURES AS REQUIRED ARE INSTALLED.
2. INSTALL SIDEWALL UNITS AND INSTALL FIRST PASS TEMPORARY PROPPING. ASSESS EXCAVATION FOR STABILITY PRIOR TO WORKFORCE PERSONNEL ENTERING TRENCH. IF REQUIRED INSTALL TEMPORARY GROUND SUPPORT BETWEEN THE LEADING EDGE OF THE PRECAST UNIT AND THE EXCAVATION FACE.
3. COMPACT INVERT AND LEVEL SIDEWALL UNITS
4. REMOVE ACRO PROPPING AND LIFT THE MIDDLE PRECAST UNIT IN PLACE. NOTE - NO WORKFORCE PERSONNEL IS PERMITTED TO ENTER EXAVATION OR ONTO PRCAST UNITS WITHOUT PROPPING SUITABLY INSTALLED.
5. INSTALL ONE 150 UC 37.2 PROP CENTRALLY PLACED OVER JUST LAID PRECAST UNITS. EXCAVATION IS SAFE FOR MAN ENTRY.
6. LEVEL CENTRE PRECAST UNIT, ADJUST PLACEMENT OF THE UNITS AND ASSEMBLE THE BOLTED CONNECTIONS BETWEEN THE PRECAST UNITS.
7. COMMENCE NEXT EXCAVATION AND INSTALL PRIMARY GROUT AS SHOWN ON THE SKETCH. MIN. GROUT STRENGTH REQUIREMENTS TBC.
8. CONCURRENTLY INSTALL AND FIX REINFORCEMENT CAGES FOR INSITU POUR AND POUR CONCRETE. MAX. DISTANCE FROM EXCAVATION FACE IS AS SHOWN BELOW.



GEELONG TUNNEL INVERT CONCEPT PRECAST WITH STEEL SPLICE
1:20



TUNNEL ELEVATION DURING CONSTRUCTION
1:20



PINNED PRECAST UNIT CONNECTION OPTION
28th MARCH 2024
Rev A

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