



## Application for Project Change

Northern Link Road Tunnel Project

October 2010





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*Dedicated to a better Brisbane*

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## Executive Summary

### 1 Overview

The Northern Link Road Tunnel (**NLRT**) project was proposed by Brisbane City Council (**Council**) as a motorway-standard link between the Centenary Motorway at Toowong and the Inner City Bypass (**ICB**) at Kelvin Grove/ Herston to cater for cross-city trips and alleviate traffic congestion in the Brisbane central city area. The NLRT project is part of Council's TransApex plan, to create a system of motorway-standard link roads to divert cross city traffic away from the Central Business District. The NLRT is consistent with Council's Transport Plan for Brisbane 2006-2026, which provides strategies and actions around the public transport services and infrastructure needed for a sustainable future.

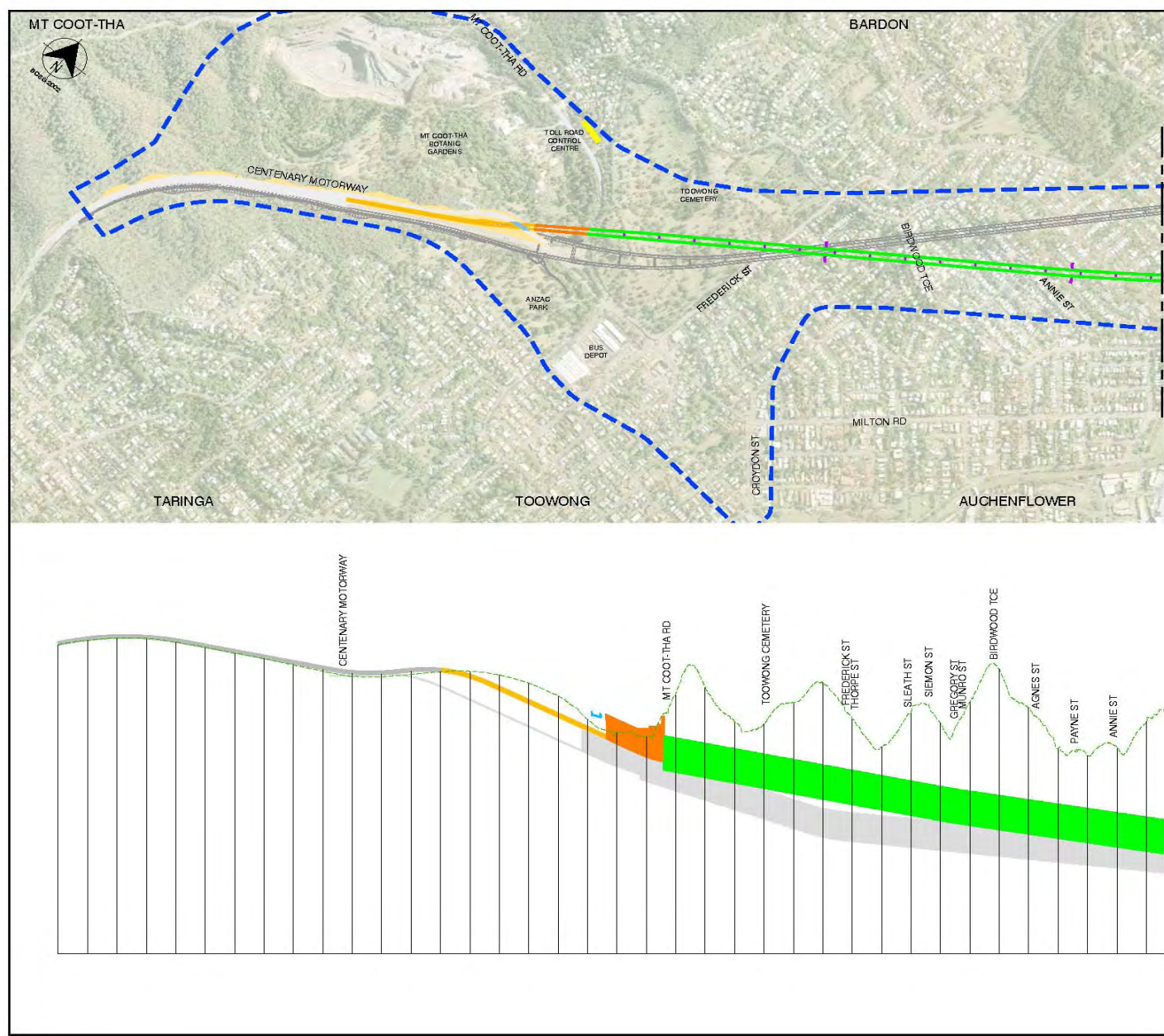
The NLRT Project would be approximately 5km in length and would consist of two carriageways constructed mostly in parallel tunnels, each of two lanes, passing beneath the inner western and northern suburbs. The NLRT Project would be operated by Brisbane City Council, through its agent Transcity, as a tolled road. The project would include fire and life safety measures, ventilation plant and equipment, communications and traffic monitoring equipment, maintenance facilities and equipment, and tollroad management facilities and equipment.

The NLRT is progressing through development from the detailed feasibility phase, in which a business case, reference design and environmental impact statement (**EIS**) were prepared, to the procurement phase, in which tenders for delivery were called. The EIS for NLRT was evaluated by the Coordinator-General in accordance with the *State Development and Public Works Organisation Act 1971*. The Coordinator-General recommended that the Northern Link Project as described in detail in the Environmental Impact Statement and the Supplementary Report (**Reference Design**) may proceed, subject to the conditions contained in Appendix 1 of the Coordinator-General's Report dated April 2010.

Since the Coordinator-General's Report was issued, Brisbane City Council has selected the Transcity Consortium (**Transcity**) to design, construct, maintain and operate for 10 years the NLRT project. Transcity is a consortium of BMD Constructions Pty Ltd. as Main Contractor supported by international sub contractors Acciona Infrastructures Pty Ltd (Acciona) and Ghella Pty Ltd (Ghella).. The Transcity proposal (**Changed Project**) includes changes to the Northern Link Project and the Project delivery arrangements. The tendered design, or Changed Project, would be substantially the same as the Reference Design, and would remain consistent with the project objectives. The Northern Link Project continues to be a motorway link connecting the Centenary Motorway at Toowong in the west, with the Inner City Bypass (**ICB**) at Kelvin Grove/ Herston in the east, constructed mostly in tunnels beneath the inner western suburbs of Brisbane.

**Figure 1** shows the general alignment of the Changed Project in comparison with the Reference Design.

A summary of the proposed changes and the reasons for those changes follow.



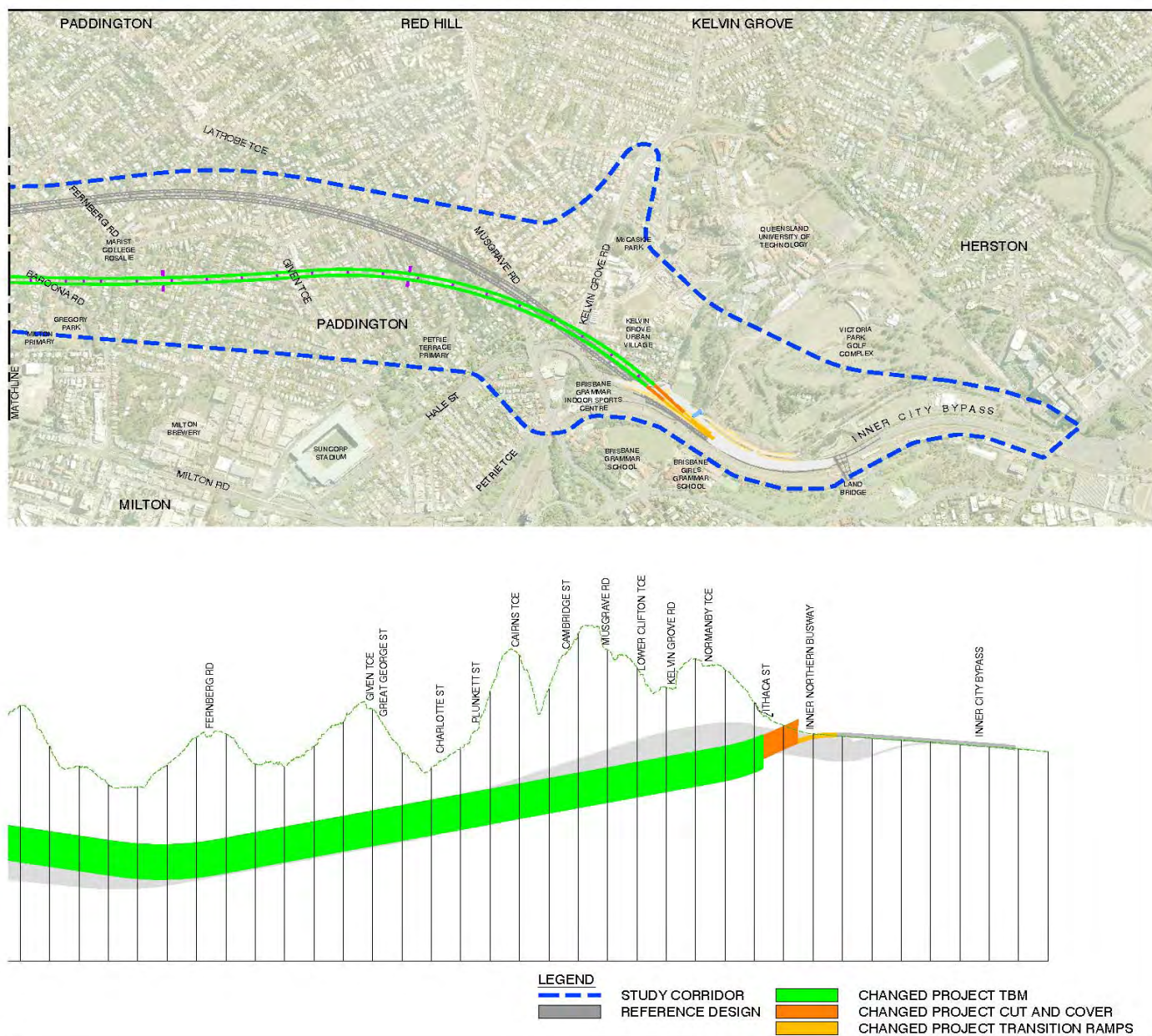


Figure 1: General Alignment– Changed Project

### Changes to the main alignment:

- Horizontal Alignment – the main alignment between the connections would differ from the Reference Project by commencing at the western side of Mt Coot-tha Road approximately 100m north of the Reference Design alignment. The main alignment would then pass under the Toowong Cemetery, in a straighter route up to 300m south of the Reference Design to connect with the ICB on the southern side of Normanby Terrace. The connection would be near to the location indicated for the Reference Design. The proposed change in the main alignment would provide a more direct route between the connections. There would be a reduction in the number of properties affected by acquisition of volumetric title;
- Vertical Alignment - The vertical alignment of the main alignment for the Changed Project would be shallower for most of the route apart from the section from Carins Terrace east. This is due to the change in the horizontal alignment and ground surface levels at those locations and design changes to optimise tunnel gradients;
- Flatter or 'easier' grades within the main tunnels in the Changed Project, compared to the Reference Design, would provide for more efficient flows for all traffic, but especially for heavy commercial traffic. There would be consequential reductions in emissions and a safer, more reliable traffic flow;
- Volumetric Title Requirements - 334 properties would be affected by the Changed Project where the Reference Design identified approximately 374. Of these, 269 would be newly affected, including 6 Council owned parcels, and 65 of these would continue to be affected as they would be with the Reference Design. There may be minor changes to the number of affected properties during detailed design;
- There are some minor changes to surface land requirements for Council and State land as a result of changes in alignment, but there remain no requirements for the surface acquisition of privately owned land.

### Changes to the Western Connections:

- The key differences in the Changed Project compared with the Reference Design at the western connections would be the realignment of the eastbound lanes of the Centenary Motorway to the north. This change would accommodate the location of the entry and exit portals to the NLRT tunnels in the centre of the motorway corridor.
- The changes in location of the western connections would enable construction works, including the launch of the TBMs for the driven tunnel construction, to occur off-line from traffic on Centenary Motorway. The construction of the surface works, such as the realigned eastbound lanes of the Centenary Motorway would also occur off-line, requiring only a single traffic switch to the ultimate alignment on completion of that package of works.
- The changed connection would also avoid construction through Mt Coot-tha Road and the roundabout, consolidating the construction area and simplifying construction traffic management and provides improved grades for the associated cut and cover and transition structures to the Centenary Motorway.
- Compared with the Reference Design, the Changed Project would provide a shorter merge from the Mt Coot-tha roundabout traffic to the outbound traffic from the NLRT onto the Centenary Motorway. The merge would still comply with agreed design standards.
- With the realignment of the Centenary Motorway eastbound lanes, and the positioning of the NLRT entry and exit portals in the centre of the motorway corridor, the critical support infrastructure, such as the ventilation station and ventilation outlet, and the water and power utility area, would move further west, in to the rising ground adjacent to the Botanic Gardens.
- The western ventilation station would be fully buried immediately north of the infrastructure utility area. The above ground ventilation outlet would be relocated approximately 43 metres north-west of the location proposed in the Reference Design. The ventilation station would be buried to mitigate its visual impact and to enable its inclusion in the future expansion area of Botanic Gardens.
- As a consequence of the changes to the western connections, and the relocation of the ventilation station and infrastructure utility area, the Tollroad Control Centre (TCC) would be located to a different site situated on the corner of Richer Street and Mt Coot-tha Road. Access would be provided

off Mt Coot-tha Road. This avoids the impact the TCC in the Reference Design would have had on the Botanic Gardens and would avoid the requirement for direct access to the Centenary Motorway.

### Changes to the Eastern Connections:

- As with the western connection, the key difference between the Changed Project and the Reference Design would be the rearrangement of the connections, such that the eastbound lanes of the ICB would move to the north to accommodate the central location for the entry and exit portals of the NLRT Project.
- The realignment of the eastbound lanes on the ICB would involve a small increase in the land required over the Brisbane Grammar School playing fields, as well as the construction of a new span beneath the Inner Northern Busway.
- Similar benefits would include a reduction in disruptions to traffic flows on the ICB during construction and more efficient connections and grades between the Changed Project and the ICB.
- The eastbound exit portal would be located 60m further east nearer to the Inner Northern Busway (INB) overpass. The westbound entry portal would be located 300m further west in line with Victoria Park Road. The tunnel portals would be located together in the centre of the ICB corridor. This arrangement creates a widened median within the ICB and enables the westbound cut and cover to be significantly reduced and would also reduce the impact on ICB traffic during construction;
- The transition ramps between the NLRT portals and the ICB would be together in the centre of the ICB and extend from generally in line with the Brisbane Girls Grammar School to the tunnel portals between Victoria Park Road and the INB overpass. Apart from the construction benefits, the proposed change would create better sight lines for merge and diverge conditions.
- The location of the eastern ventilation station and ventilation outlet would be unchanged from that proposed in the Reference Design. Access to the eastern ventilation station would be from the eastbound carriageway of the ICB.

### The changes to the project delivery arrangements include:

- The delivery program would expand from 45 months to 49 months, commencing in late 2010 to December 2014;
- The Changed Project provides for both tunnels to be lined with pre-cast, reinforced, concrete rings installed by the TBM, providing enhanced ground support and preventing the inflow of groundwater. Underground cross passages and substation sites would remain 'drained' and consequently would allow groundwater to enter the tunnels. Overall, the inflow of groundwater to the Changed Project tunnels would be at a lower rate than estimated for the Reference Design which proposed cast in-situ concrete lining.
- The TBMs would be assembled at the western worksite in the Botanic Gardens in the excavated cut and cover tunnel and transition areas during surface working hours (6.30am – 6.30pm Monday to Saturday). After assembly of the main component of each TBM, an acoustic-lined workshed would be erected over and beside the TBM launch-box to facilitate continuous underground operations;
- An increase to the construction area on the northern side of the Centenary Motorway within the Botanic Gardens, would remove the requirement for any surface road and tunnel construction area on the southern side of the motorway. This change also would avoid road construction impacting on the Anzac Park wetland and the existing bicycle path along the Centenary Motorway.
- Construction staging strategies to mitigate the potential impacts on traffic flows on the Centenary Motorway and Mt Coot-tha Road during construction. The initial construction activities would be carried out off the Centenary Motorway and behind construction barriers.
- Temporary construction workforce parking areas would be established in Anzac Park for up to 300 vehicles, without any loss of significant trees in the park, and with access from Dean Street only.
- Minor changes to the spoil haulage volumes because of the increase in size of the TBMs from 12m in diameter to 12.4m in diameter and to changed excavation requirements and quantities.
- The majority of spoil at the western worksite would be transported to the Mount Coot-tha Quarry by conveyor and would be used for quarry rehabilitation, with approximately 10% transported by truck to a placement site located at Rudd Street, Oxley or other approved locations.

- The spoil conveyor alignment has been changed to avoid the public areas and the plantings within the Botanic Gardens. The spoil conveyor would be enclosed to achieve noise and dust criteria.
- Spoil from the eastern worksite would be transported to a placement site adjacent to the Brisbane Airport at Pinkenba or other approved locations.

## 2 Application for Project Change

Before the Changed Project can proceed, the Coordinator-General will be asked, by way of this application from the Brisbane City Council, whether a further evaluation of the proposed changes to the design and construction of the NLRT is required, and if so, whether the Changed Project would require further consultation and a period of public notification. The Coordinator-General will also be requested to consider what changes to the existing conditions, or additional conditions, would be required to allow the Changed Project to proceed. These requests will also be made in accordance with the *State Development and Public Works Organisation Act 1971*.

This application for Project Change is consistent with the approach taken with other major infrastructure projects and is essential to the project development process in that it allows the proponent (Council) to encourage and deliver the benefits of innovation in design, construction and delivery from a competitive market.

## 3 Project Changes – Main Alignment

### 3.1 Design Changes and Effects

The key changes in the design of the main alignment, compared with the Reference Design, would be:

- the realignment of the main tunnels generally to the east and south, to take a shorter, more direct route between the two connections; and
- the realignment of the main tunnels so that they would lie generally closer to the surface than those proposed for the Reference Design, again to provide a more direct link and to provide easier traffic conditions for heavy vehicles leaving the tunnels in either direction.

As a consequence of these proposed refinements, the Changed Project would lie closer to the surface beneath low points in the Toowong Cemetery and in other low points along the route, such as Barooka Road Rosalie, and Charlotte Street Paddington. Another consequence of the changes in the main alignments would be that some different properties to those above the Reference Design, would be affected by volumetric acquisition of land, and potentially, by construction effects such as regenerated noise and vibration.

There would be no material adverse effects on these new properties affected by volumetric acquisition during the operation phase of the NLRT.

The Changed Project would still carry the same or similar traffic flows as forecast for the Reference Project. Consequently, there would be no significant change in related, consequential effects on traffic noise and ambient air quality. There would be some network benefits as a consequence of the changed connections to the Centenary Motorway and the ICB.

While 334 properties would be affected by the Reference Design, 328 properties would be affected by the Changed Project, There would be 65 properties affected by both the Reference Design and the Changed Project. Of the properties affected by the Changed Project, 6 would be Council-owned or controlled properties. There may be some minor changes to these numbers during detailed design.

### 3.2 Construction Changes and Effects

The key change in the construction of the main alignments would be the use of double-shielded TBMs which install pre-cast, segmented, concrete lining as they progress along the route. The benefits of this change include a greatly reduced risk of ground settlement during tunnel construction, and a greatly reduced potential for groundwater inflow during both the construction phase and subsequent period of tunnel operations.

The Reference Design proposed to construct each tunnel with TBMs but would follow with a cast in-situ concrete lining for structural support and groundwater resistance. Some ground settlements were predicted in the EIS for this method. Similarly, some groundwater inflow was predicted to the main tunnels. Neither the settlement nor the groundwater inflow predictions were considered to be of such significance as to warrant a different method of construction or extra-ordinary mitigation measures. The rate of inflow is estimated to reduce from 4l/sec for the Reference Design to less than 3l/sec for the Changed Project.

As with the Reference Design, the Changed Project would be constructed with drained cross-passages. That is, groundwater would possibly enter the tunnel system via the cross-passages and would require collection and treatment prior to release.

The change in construction would require the delivery of pre-cast concrete segments to the western worksite in time to meet the requirements of continuous TBM operation. It is noted that the TBMs for the Reference Design also were proposed to operate on a continuous basis. With either project, TBM operations would incorporate a maintenance period of up to 4 hours each day on average.

## 4 Project Changes – Western Connection

### 4.1 Design Changes and Effects

The key design changes embodied in the Changed Project at the western connection relate to the location of the NLRT entry and exit portals in the centre of the Centenary Motorway corridor, and the consequential realignment of the eastbound lanes of the Centenary Motorway to the north before they swing back to connect with Mt Coot-tha Road at the roundabout.

There would be related changes to the merge / diverge arrangements for the ramps to the NLRT portals and for the eastbound lanes of the Centenary Motorway. The merge/diverges with the Centenary Motorway would be further west than proposed in the Reference Design to accommodate the central location for the entry / exit portals. There would be no changes to the westbound lanes of the Centenary Motorway.

The changed connection arrangements would still be able to accommodate any future widening of the Centenary Motorway, to three lanes in each direction, that might be planned by DTMR.

Off-line, there would be changes in the location of project infrastructure including:

- the TCC would move from the location in the western worksite proposed in the Reference Design to a site situated opposite the entrance to the Mt Coot-tha Botanic Gardens on Mt Coot-tha Road;
- the ventilation station and ventilation outlet would move approximately 43m to the west of the site proposed in the Reference Design. The ventilation station would be completely buried and its roof landscaped and incorporated into an expansion of the Botanic Gardens. There would be no change in the minimum height of the ventilation outlet;

- project utilities such as groundwater treatment and power supply would be located in the western worksite area, as proposed in the Reference Design.

The design changes for the Changed Project would result in more efficient and more 'legible' connections between the Centenary Motorway and the NLRT, without impacting on the potential for future capacity development on the motorway. Similarly, the proposed design changes would not prejudice a possible future northern motorway (Inner Orbital) connection with the Centenary Motorway, as indicated might be required in the *South East Queensland Infrastructure Plan and Programme 2010 - 2031* (SEQIPP).

The detailed changes in road geometry proposed in the Changed Project, such as the changes in gradient and merge arrangements are anticipated to be acceptable to the DTMR.

The proposed design changes for the connection with the Centenary Motorway would achieve acceptable performance in the event of a major traffic incident on the Centenary Motorway. The visual impact of the central connections, and the realignment of the eastbound lanes on the Centenary Motorway, would be similar to or lower than that anticipated for the Reference Design, because of the reduction in exposed infrastructure and the retention of the outbound lanes on their present alignment.

The proposed change in location of the ventilation station and ventilation outlet would be expected to result in the same air quality outcomes as the Reference Design. The Changed Project for the NLRT would not lead to adverse air quality outcomes, when compared with the Reference Project.

The design and siting of the ventilation outlet for the Changed Project would mitigate the potential visual impact of the facility from most viewpoints. As with the Reference Design, the ventilation outlet would remain visible and evident for outbound traffic.

## 4.2 Construction Changes and Effects

The key changes in construction method for the Changed Project relate mostly to:

- the different method of and location for assembling and launching the TBMs;
- the delivery, storage and handling of pre-cast concrete segments for the tunnel rings;
- the proposal to re-use some spoil for construction of the road invert in each of the tunnels, after tunnel boring has been completed;
- the different configuration of the western worksite, including an increase in the area required for the worksite;
- different access arrangements, to include access for light vehicles off Mt Coot-tha Road just west of the roundabout;
- the conveyor route to the quarry has changed;
- the proposal to deliver spoil into the Mt Coot-tha quarry on a continuous basis, with spreading and compaction activities being limited to the quarry standard operational hours;
- the proposal to provide construction workforce car parking from a temporary car park in Anzac Park, adjacent to the existing pedestrian and cycle bridge over the Centenary Motorway.

### TBM assembly and launching

The two TBMs would be delivered in parts and assembled in the incomplete, cut and cover troughs leading down to the portals for the driven tunnel sections, just south of Mt Coot-tha Road.

The assembly would take place as day time surface works with acoustic screening provided by the cut and cover troughs. The troughs would remain open for the duration of the assembly to allow the operation of the large, overhead cranes required to lift large, heavy components into place. Once the TBMs have been assembled and launched, a portal shed would be constructed above the launch box to

accommodate a large gantry crane and the laydown and handling area for the pre-cast concrete segments.

The portal shed would remain in place for the remainder of the tunnel construction period including civil fit-out but not during the commissioning phase of the project works.

The pre-cast segments would be delivered to the western worksite by truck via the Centenary Motorway. The segments are likely to be manufactured at a plant in the western industrial corridor (eg Wacol or similar). Two truck loads would be required for each of the 4,300 rings estimated for the two main tunnels.

### **Spoil handling and placement**

The spoil conveyor from the worksite into the quarry would follow a different alignment to that proposed in the Reference Design. The changed alignment would be further to the west, following earthworks for the realignment of the Centenary Motorway and to avoid public areas and plantings within the Botanic Gardens.

For the Changed Project, spoil would be taken from each of the tunnels by enclosed conveyor to an acoustic-lined spoil shed situated at the western end of the worksite. The spoil would be transferred, within this shed, from the TBM-fed conveyor to the main external spoil conveyor to the Mt Coot-tha quarry. Spoil would be released onto the quarry floor for subsequent spreading and compaction. The spoil conveyor would operate on a continuous basis, providing the noise goals for night-time works are achieved. In the event of breakdown of the conveyor, there will be capacity to stockpile two full days production of TBM spoil in the spoil shed. Any stockpiled material would then be removed with conventional loader/excavator and trucking operations.

Approximately 932,000m<sup>3</sup> of spoil would be delivered to the quarry with the Changed Project, compared with 973,000m<sup>3</sup> for the Reference Design. Approximately 303,000m<sup>3</sup> would be transported from the construction area and worksite by truck compared to approximately 265,000m<sup>3</sup> for the Reference Design. Approximately half of this amount would be TBM spoil that cannot be accommodated within the quarry. The Reference Design identified an approved placement site for western construction spoil at Swanbank while the Changed Project has identified an approved site in Rudd Street, Oxley or at alternative approved sites in accordance with the Coordinator-General's conditions. The haulage task would involve 4 – 5 trucks per hour for 12 months, but may be much higher (35 trucks per hour) should the spoil conveyor be out of operation.

### **Configuration of western worksite**

The western worksite for the Changed Report would be larger (6ha) than that proposed for the Reference Project (4ha), due to the rearrangement of the western connections, the intention to construct the eastbound lanes for the new Centenary Motorway alignment off-line and the supports required for the TBM launch box in a location further north than proposed in the Reference Design.

Access from the Centenary Motorway would remain unchanged as a left-in, left-out arrangement. However an additional access for light vehicles would be provided from Mt Coot-tha Road.

The reconfigured western worksite, the changed alignment for the spoil conveyor and the realignment of the eastbound lanes of the Centenary Motorway would result in the loss of some vegetation mapped under the *Vegetation Management Act 1999*. Some of this vegetation also is recognised in mapping by the Council under its Natural Assets Local Law. Generally, this impacted vegetation is of 'least concern' or regulated regrowth according to the mapping. Approvals and permits to clear are required under the

*Nature Conservation Act 1992, the Vegetation Management Act 1999 and the Natural Assets Local Law 2003.*

Most of the fauna species in the area affected by the changes to the western worksite, and the realignment of the Centenary Motorway eastbound lanes are mobile and unlikely to be adversely affected by the proposed works. Normal fauna spotting and relocation activities would be undertaken in conjunction with clearing operations and in accordance with the approvals.

### **Temporary Workforce Car Parking**

The Changed Project would provide construction workforce car parking in a temporary car park in Anzac Park. This temporary car park would provide up to 300 spaces, with access to the worksite via the pedestrian and cycle bridge over the Centenary Motorway. The temporary car park would not remove any significant trees or require the relocation of any active park use facilities. Access to the park for local people would be maintained at both Dean Street and Wool Street, whereas workers' access would be restricted to access from Dean Street.

The car parking area on Sir Samuel Griffiths Drive proposed in the Reference Design would be retained to service the project office staff and visitors' centre proposed to be established in the former Freers potato chip factory site.

## **5 Tollroad Control Centre**

### **5.1 Design and Siting and Effects**

The Changed Project proposes to locate the tollroad control centre (TCC) on land off Mt Coot-tha Road, and presently used for overflow car parking for the Mt Coot-tha Botanic Gardens. A site accessed from the Centenary Motorway as proposed in the Reference Design within the rehabilitated worksite would not be feasible as it would require access through the Botanic Gardens. The proposed site has direct access off Mt Coot-tha Road.

The TCC would incorporate the support workshops for tunnel equipment maintenance and spare parts storage, incident control room, traffic control room and office space for administration. A motor vehicle workshop would not be included in the TCC and vehicle maintenance would not be undertaken at the TCC. All data collected by the in-tunnel monitoring systems would be processed and all the services controlled from this location.

The TCC for the Changed Project also would contain the control room which would be a 24 hour, seven days per week operation with at least two on-duty operators at any time while other functions such as office administration and equipment maintenance would generally take place during 6:30am to 6:30pm Monday to Friday.

The TCC would include a training and incident room, office space for the operations and maintenance contractor staff as well as Council and emergency services personnel, a computer and communications equipment room, a plant room, two meeting rooms, workshop space for the maintenance of tunnel equipment, tunnel spare parts store, toilets, showers, change rooms, a reception area and a lunch room. A secure hardstand area will provide parking for incident management vehicles and replacement equipment layby and manoeuvring. Driveway access to and from the TCC would be provided from Mt Coot-tha Road. On-site parking for approximately 30 vehicles would be provided in the TCC site, including 2 disabled spaces.

Obtaining water for the tunnel wash down operations, and installation of the pressure booster for use by the fire brigade would not be undertaken at the proposed location for the TCC as was proposed in the Reference Design. Equipment maintenance would include the servicing of a range of tunnel equipment including, for example, electronic monitoring equipment, pumps and fans.

The TCC building would be approximately 90m in length, and approximately 10m in height. The height of the building would be mitigated by siting it on a bench to be excavated into the rising ground towards the northern boundary of the site. The building would not be obtrusive in the views available for the dwellings higher up the same slope. The length of the building would be mitigated by a range of architectural variations and treatments to the facade. Combined with the setback from Mt Coot-tha Road, the building would change but not impact adversely on the visual amenity of the setting. The topography and proposed landscaping of the TCC site would provide an effective mitigation for this change.

There are no heritage values attaching to the proposed TCC site. Similarly, there is no mapped remnant vegetation that would require an approval under the *Vegetation Management Act 1999*. However, the clearing of vegetation on the land would require an approval under the *Natural Assets Local Law 2003*.

Use of the land for the TCC would constitute a use for road purposes, and consequently, would be exempt from assessment under City Plan. The assessment would be conducted through this Application for Project Change, as a State controlled process. A building approval will be required from a building certifier.

The land is classified mostly as parkland with a smaller section covering most of the bitumen carparking areas used as overflow for the Botanic Gardens as unclassified land being the old Mt-Coot-tha road reserve. Having regard to the setting of the TCC adjacent to the Botanic Gardens and the Toowong Cemetery, the loss of less than 1 ha of green space is not considered to be significant.

## 5.2 Traffic

Traffic flows during operation of the TCC, based on preliminary designs and experience with other facilities of similar size, are anticipated to average 20 vehicle trips per hour in the peak, and 80 vehicle trips per day. The majority of these would be cars for workers within the TCC, with some being incident management vehicles and trucks for the movement of tunnel maintenance parts. Traffic flows to and from Mt Coot-tha Road would have no adverse effect on overall traffic levels.

Some residents currently use land along the rear of the TCC site off Ada Street to access the rear of properties in Ada Street and Horrocks Street. This area is designated "Parkland" under the current planning scheme. While all residential properties can be accessed from their road reserve boundary, either from Ada Street or Horrocks Street, consideration will be given during detailed design to retaining and formalising this rear access for local residents,

## 5.3 Construction

The construction of the TCC is currently programmed to commence in mid 2012, with building works taking approximately one year. Works would continue at the TCC once constructed for activities such as fitout, commissioning and testing. Full operation of the TCC would commence once the tollroad is opened.

## **6 Project Changes – Eastern Connection**

### **6.1 Design Changes and Effects**

The eastbound lanes on the ICB would be realigned to the north, to accommodate centrally-located entry and exit portals for the NLRT main tunnels. The entry portal (westbound) to the NLRT would be situated approximately 300m further to the west, while the exit portal for the eastbound NLRT lanes would be situated approximately 60m further east.

There would be consequential changes to the road geometry for the tie-ins with the ICB in each direction, and there would be some changes in local road geometry to accommodate the realignment of the eastbound ICB lanes. The connection of Victoria Park Road with the ICB would be reconfigured but would still provide the left-in, left-out access as presently exists.

There would be changes to the INB to allow an additional span to be constructed beneath it for the realigned eastbound ICB lanes. The merges with the ICB, eastbound, would extend further east to the land bridge.

The existing pedestrian bridge over the ICB from the Brisbane Grammar School (BGS) would be extended to maintain connectivity with the BGS playing fields and the Victoria Park pedestrian and cycle path.

The design changes would require a slightly larger area of the BGS playing fields than would be required for the Reference Project. Current indications are that this additional permanent area required would be less than 1,000 square metres. The easterly extension of the ICB merges for the eastbound lanes would also require a larger area from the Victoria Park golf course. As with the Reference Design, the ventilation outlet and ventilation station for the Changed Project would be situated in Victoria Park golf course land. The locations are the same.

The changed connections with the ICB would not be affected by flooding events in the Brisbane River. However, stormwater drainage works in the vicinity of the eastern connections would be required to convey drainage waters and local flood flows beyond the connections and beyond the playing fields. The impact on the playing fields would be an increase of approximately 20mm on peak flood levels for a 100year ARI event.

The changed traffic connections with the ICB would operate much the same and would deliver similar levels of service to those anticipated for the Reference Design. Safe traffic operations would be achieved through the implementation of appropriate geometric design standards.

### **6.2 Construction Changes and Effects**

With the extended connections for the realignment of the eastbound ICB lanes, the work area for the Changed Project would be larger than that anticipated for the Reference Project. The worksite would include part of the BGS playing fields and extend beneath the Inner Northern Busway to the ICB land bridge.

A worksite would be established in the area to be occupied by the ventilation station, with access to be provided by a left-in, left-out arrangement. A temporary access along the Victoria Park cycle path would be relied upon to connect this worksite with the nearby temporary construction workforce car parking.

As with the Reference Project, the ICB land south of Normanby Terrace would be required for construction including the removal of the TBMs.

The proposed realignment of the eastbound ICB lanes would allow construction to occur off-line, with a single traffic switch required then to direct eastbound traffic to the ultimate ICB alignment. Construction of the entry and exit portals would also be constructed off-line with only a single traffic switch required to commence operations of the NLRT project.

For the duration of the construction period, the Victoria Park pedestrian and cycle path would be realigned to the north of the worksite and would connect back to Victoria Park Road and to the existing pedestrian bridge over the ICB.

The quantity of spoil to be removed from the eastern worksite has increased for the Changed Project but remains a comparatively smaller quantity of spoil, compared with the western worksite. Most of this spoil would be generated by the construction of the central portals, the realignment of the eastbound ICB lanes and works through and beneath the INB. For the Changed Project, spoil would be taken to a site at Eagle Farm Road, Pinkenba or other sites approved in accordance with the Coordinator-General's conditions.

## **7 Relationship with other projects**

As with the Reference Design, the Changed Project would interact with a number of other projects, including:

- Centenary Motorway;
- future 'Inner Orbital' Road;
- Moggill Road Interchange; and
- Inner Northern Busway.

### **7.1 Centenary Motorway**

The Changed Project would satisfy the requirement of the Coordinator-General's conditions (Schedule 3, condition 26(a)) that the connection and 'tie in' of the NLRT project to the Centenary Motorway would be designed, constructed and operated so that it does not limit the ability for possible future widening of the Centenary Motorway to six 'through lanes' – 3 lanes each way. The design objective for the tie-in and connection is that the extension of the Centenary Motorway past the NLRT portals must be achieved without any impact on structures forming part of the NLRT project.

### **7.2 Future 'Inner Orbital' Road**

The Coordinator-General's conditions (Schedule 3, condition 26(b)) requires that the connection and 'tie in' of the NLRT project to the Centenary Motorway is to be designed and constructed to ensure that:

- operation of the project shall not compromise the ability for a future connection of Centenary Motorway with an 'Inner Orbital' tunnel;
- operation of the project should not compromise the ability for future operation of the 'Inner Orbital' tunnel and the Centenary Motorway as a continuous motorway route (that is, maintaining the speed environment) with traffic flow priority on Centenary Motorway directed to the continuous route;
- the Northern Link connection excavation works are not to be below the existing motorway surface levels west of a line drawn between the two points (E46987.038, N157425.253) and (E47071.605, N157283.886).

The proposed configuration of the western connection for the Changed Project would not compromise the ability for a future connection of Centenary Motorway with an 'Inner Orbital' tunnel. There would be no excavation works for the Changed Project to the west of the line identified in the existing condition.

### **7.3 Moggill Road Interchange**

The Reference Design would lead to increase traffic volumes through the signalised intersections at the Centenary Motorway ramps at Moggill Road by approximately 5% and 13% in the AM and PM peaks respectively in 2014 compared to the scenario without NLRT.

The forecast daily traffic increase on Moggill Road between Indooroopilly and the Centenary Motorway would be 3% in 2014 and 4% in 2026. With these predicted increases, the Moggill Road connections could be managed satisfactorily with signal co-ordination in early years post NLRT opening.

Ultimately, upgrades to the interchange configuration at Moggill Road would be required in association with the future upgrading of the Centenary Motorway in the 2010 to 2031 time-frame identified in the Southeast Queensland Infrastructure Plan and Program and/or in association with any future 'Inner Orbital' connection with the Centenary Motorway.

To mitigate the potential for impacts in relation to the Moggill Road – Centenary Motorway Interchange, the Coordinator-General's conditions (Schedule 3, condition 27) requires Council to design and upgrade the interchange to mitigate traffic impacts resulting from the operation of the NLRT.

The Changed Project would not change this situation at the Moggill Road intersection, such that the conditions for the Reference Design, including the implementation of the Interface Agreement between Council and DTMR, remain relevant and necessary.

### **7.4 Inner Northern Busway**

The Reference Design made an allowance for a possible future opportunity to deliver a busway-type link for future cross-town bus services between key trip generators in the western and northern suburbs to travel via the NLRT and the Northern Busway or other surface routes. The Changed project would not preclude such a connection.

# 1 Introduction

## 1.1 Background

The western part of Greater Brisbane has become the third largest economic generator area after the Central Business District and the Australia Trade Coast precinct (including the Port Of Brisbane). There is a growing need to link these residential and economic growth centres and Northern Link will fill a fundamental gap in the motorway network.

The Northern Link Road Tunnel (**NLRT**) project was proposed by the Brisbane City Council (**Council**) to be an approximately 5km long toll cross-city tunnel linking the Centenary Motorway at Toowong in the west of Brisbane with the Inner City Bypass and Kelvin Grove/ Herston to the north of Brisbane. The NLRT project is the fourth of five crucial projects to be delivered in Brisbane City Council's TransApex plan, to improve cross city travel in Brisbane's inner and middle suburbs by creating a formal ring road system to divert cross city traffic away from the Central Business District. It also meets the strategic objectives of Council's Transport Plan for Brisbane 2006-2026, which provides strategies and actions around the public transport services and infrastructure needed for a sustainable future.

The project was assessed by the State Government as a Significant Project pursuant to the process described in Part 4 of the *State Development Public Works Organisation Act 1971* (SDPWO Act). Council prepared a Reference Design for the NLRT project and then in October 2008 published an Environmental Impact Statement (EIS) based on the Reference Design that assessed the project's potential impacts and mitigation measures to respond to those impacts. Council, and the State Government, undertook broad consultation on the Reference Design and EIS. In response to concerns raised in submissions made on the EIS Council removed intermediate access points to the tunnels from the Reference Design and in June 2009 published a Supplementary Report to address these changes and other issues raised in EIS submissions.

In April 2010, the Coordinator-General issued an evaluation report<sup>1</sup> (**Coordinator-General's Report**) recommending that the NLRT project, as described in detail in the EIS<sup>2</sup> and the Supplementary Report<sup>3</sup>, may proceed, subject to the conditions contained in Appendix 1 of the Co-ordinator General's Report.

The Coordinator-General's Report also noted that the detailed design process may result in amendments to the Reference Design which would be likely to require a Coordinator-General's change report under the process afforded by Division 3A Part 4 of the SDPWO Act.

The project that was evaluated in the Coordinator-General's Report is referred to throughout this application as the Reference Design.

### 1.1.1 Implementation of NLRT Project

Following a competitive tender process, Council engaged the Transcity consortium (**Transcity**) to design, construct, maintain and operate for 10 years the NLRT project. Transcity consists of BMD Constructions

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<sup>1</sup> in accordance with Part 4, Division 3, section 35(3) of the *State Development and Public Works Organisation Act 1971* (SDPWO Act)

<sup>2</sup> Northern Link Environmental Impact Statement dated September 2008

<sup>3</sup> Northern Link Environmental Impact Statement Supplementary Report dated June 2009

Pty Ltd. as the Main Contractor supported by international sub contractors Acciona Infrastructures Pty Ltd (Acciona) and Ghella Pty Ltd (Ghella). BMD Constructions is a Brisbane-based construction company operating in the provision of infrastructure and its parent company, BMD Holdings, is one of the largest privately owned companies in Australia. Acciona is a multidisciplinary company listed on the Madrid Stock Exchange and working in over 30 countries. Ghella is owned by Ghella S.p.A. who are a privately owned Italian construction contractor with over 60% of their work in tunnelling in a wide range of countries.

The accepted tender is generally consistent with the Reference Design and would accord with the approval and conditions provided in the Coordinator-General's Report. Changes proposed to the Reference Design and project delivery would provide an improved outcome for Council and the people of Brisbane.

The Project objectives remain unchanged except as noted for the timing of the project delivery. They are:

- to improve east-west cross-city movement of people and freight;
- to address deficiencies in the national freight network to improve freight distribution in and around Brisbane;
- to provide opportunities for additional public transport capacity;
- to protect and, where possible, enhance the environment;
- to assist development of a sustainable urban environment for inner-western suburbs;
- to deliver value-for-money over whole of project life; and
- to deliver Northern Link by December 2014 (was previously June 2014).

The Changed Project would optimise the configuration of the NLRT project with a range of benefits to meet these objectives. However, the delivery program would expand from 45 months to 49 months, commencing in late 2010 with delivery by December 2014, subject to detailed design and approval. The essential features of the Project remain unchanged.

### **1.1.2 Project Benefits**

Peak employment during the construction phase of the Project would be approximately 1,000 people. The NLRT project is expected to deliver \$10.5 billion in economic benefits from travel time, vehicle operating costs and road safety savings and environmental benefits. Benefits expected from the implementation of the NLRT project include:

- connecting the Western Growth Corridor to the Brisbane Airport and Australia Trade Coast, thereby supporting economic development;
- reducing congestion on surface roads such as Milton Road and Coronation Drive by up to 14 per cent in 2026, and reduce through-traffic on a number of local streets;
- completing the missing link in the motorway network between the Centenary Motorway and the Inner City Bypass (ICB), allowing motorists to avoid seven sets of traffic lights;
- reducing travel times by up to 66 per cent by 2026 between the Centenary Bridge and the Inner City Bypass; and
- providing opportunities for improved public transport outcomes by freeing up capacity on the surface road network (eg removing 38,000 vehicles per day for cross-city trips).

### **1.1.3 Application for Project Change**

This application for project change identifies the design and delivery changes proposed to the NLRT project relative to the Reference Design, and requests evaluation by the Coordinator-General of the project changes. The project presented in this application is referred to as the Changed Project.

The Changed Project is described briefly below, with a more detailed description of the changes relative to the Reference Design in Chapter 2 and an assessment of the effects of those changes in Chapters 3 to 6. Chapter 7 discusses the relationship of NLRT with other projects, while Chapter 8 provides the conclusions to be drawn from this assessment.

The process for evaluating the project changes is set out in section 1.2 and further approvals for the project that may be required are discussed in section 1.3. The consultation process is summarised in section 1.4. An overview of the Changed Project including design and delivery changes and reasons for the proposed changes are presented in chapter 2. The effects of the proposed changes to the Reference Design are described in chapters 3, 4, 5, and 6, together with any further mitigation measures required in addition to those contained with the Coordinator-General's Report. The relationship of the NLRT with other projects is set out in chapter 7. Conclusions and recommendations including proposed changes to the conditions in Appendix 1 of the Coordinator-General's Report are set out in Chapter 8.

### **1.1.4 Summary of proposed changes to Reference Design**

The Changed Project is similar to the Reference Design but includes design changes, such as the configuration of surface road network connections, the alignment of the main tunnels, location of tunnel portals and supporting infrastructure, and different property access requirements.

The Changed Project also revises the way in which the Project would be delivered, including changes to the layout and access/egress arrangements with construction worksites, minor changes to spoil management and the improved provision for temporary off-street construction workforce car parking.

### **1.1.5 Design Changes**

The Changed Project includes changes to the tunnel horizontal and vertical alignment from the Reference Design, realigning the western portals northwards so that they connect with the centre lanes of the Centenary Motorway, straightening the tunnel alignment, and re-positioning the eastern portals to enable Northern Link to merge within the centre lanes of the Inner City Bypass. The changed alignment is still located within the Northern Link study corridor identified in the Terms of Reference for the Environmental Impact Statement (EIS).

The changed alignment at each of the connections would be accompanied by realignment, off-line, of the eastbound lanes for both the Centenary Motorway and the ICB. Construction would progress off-line to allow a switch in traffic to the new motorway and ICB alignments, to undertake the portal constructions in the centre of each corridor.

The changed arrangements provide a straighter and more direct connection between the Centenary Motorway and the ICB and will involve much less disruption to traffic during construction than the Reference Design.

The Changed Project design has flatter grades within the main tunnels compared to the Reference Design, making for more efficient movement of traffic through the tunnels, especially heavier commercial vehicles, reducing emissions and providing a safer, more reliable traffic flow.

At the western connection, the realignment of the eastbound lanes on the Centenary Motorway would occur off-line on the northern side. Compared to the Reference Design the Changed Project provides simpler construction traffic management – the westbound Centenary Motorway lanes and the Mt Coot-tha Road roundabout at Toowong would be unaffected during construction (with the exception of longitudinal drainage works which would be constructed behind barriers in the final stages of construction), with important benefits for Brisbane motorists. There would be no impact on known future upgrading requirements for the Centenary Motorway due to the changes. Road traffic noise sources would be located further away from residential properties to the south than in the Reference Design and noise barriers, including earth berms will reduce noise impacts within the Mt Coot-tha Botanic Gardens. The Changed Project's urban design features are an improvement to the Reference Design and will facilitate the future extension of the Botanic Gardens into the area adjacent to the motorway.

The Changed Project includes the relocation of the Tollroad Control Centre (TCC) from the possible location identified in the Reference Design within the future extension of the Botanic Gardens to a location opposite the gardens entry gate off Mt Coot-tha Road. This location provides public road access which is restricted from the Botanic Gardens site and would also remove the infrastructure from the visual catchment of the gardens. The land opposite the gardens gate provides suitable ground levels for the building to be dug into the slope and to retain a vegetated buffer to the residential boundary to the north.

The proposed design changes for the ICB connections would require the realignment of the eastbound lanes to the north, to accommodate the central location of the exit and entry portals to the main tunnels of the Changed Project. At the same time, the Changed Project would reduce the extent of the ICB cut and cover works required. This change would reduce the duration of construction works and associated impacts at that location.

The proposed changes to the alignment of the main tunnels would result in some minor changes to surface land requirements for Council and State land, but there remain no requirements for the surface acquisition of privately owned land. Volumetric title requirements for the main tunnels below surface properties would change in location, and there would be a reduction in the number of properties affected by volumetric requirements. There remains no anticipated impact on future development opportunities above the changed alignment of the tunnels at the depths proposed.

Consultation with directly affected property owners commenced as soon as the Changed Project was publicly announced and Council is likely to commence the acquisition of volumetric lots within the next six months under the *Acquisition of Land Act 1967*.

### 1.1.6 Construction Changes

There are few changes in construction method proposed with the Changed Project. The key change is to install waterproof lining in the main tunnels, by way of pre-cast, segmented rings applied by a tunnel boring machine (TBM). Apart from reducing the potential for groundwater inflow, the adopting of this different method would also reduce any possible risks associated with traversing possibly softer ground along the main tunnel alignment.

Spoil management would be similar to the Reference Design, with the majority of tunnel spoil material being placed in the Mt Coot-tha quarry. However, the arrangements at the Mt Coot-tha quarry now make provision for the placement of tunnel spoil in an exhausted area of the quarry to facilitate the eventual rehabilitation of the quarry rather than for re-use, and also separate from the normal quarry operations. The conveyor transporting spoil material to the quarry will operate on a continuous basis as identified in the Reference Design, subject to complying with the requirements of the Coordinator-General's Report.

## 1.2 Project Change Process

Under the terms of Division 3A of the SDPWO Act, Council can apply to the Coordinator-General to assess a proposed change to the project or a condition of the project and to evaluate the environmental effects of the proposed change, its effects on the project and any other related matters. The application must:

- describe the proposed change and its effects on the project;
- state reasons for the proposed change; and
- include enough information about the proposed change and its effects on the project to allow the Coordinator-General to make the evaluation.

After receiving the application, the Coordinator-General may:

- refer details of the proposed change, its effects on the project or any other related matter to anyone the Coordinator-General considers may be able to give comments or information to help the making of the evaluation.
- ask the proponent for further information about the proposed change, its effects on the project or any other related matter.
- require the proponent to publicly notify the proposed change and its effects on the project, in a way decided by the Coordinator-General.

In making the evaluation, the Coordinator-General must consider each of the following:

- the nature of the proposed change and its effects on the project;
- the project as currently evaluated under the Coordinator-General's Report for the EIS for the project;
- the environmental effects of the proposed change and its effects on the project;
- if public notification was required, all properly made submissions about the proposed change and its effects on the project;
- the submissions made to the EIS to the extent that it is relevant to the proposed change and its effect on the project.

The Coordinator-General may refer the proposed changes to anyone to seek input on the changes, and within this, may decide to publicly notify the change request for comment. Submissions made will be among materials the Coordinator-General uses to inform his decision on the changes. The Coordinator-General must prepare a report (a Coordinator-General's Change Report) that makes an evaluation and may make recommendations, amend any conditions, impose conditions or refuse to allow the proposed change<sup>4</sup>.

After completing the Coordinator-General's Change Report, the Coordinator-General must:

- give a copy of it to the proponent; and
- publicly notify the report.

To the extent that there is any inconsistency between the Coordinator-General's Report and the Change Report, the Change Report prevails.

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<sup>4</sup> in accordance with Part 4, Division 3A, section 35I of the SDPWO Act

### 1.3 Approvals for the Project

The approvals required for the Project are described in Chapter 4 of the EIS (Section 4.6) and also Section 3.4 of the Supplementary Report. The range of approvals required for the Changed Project are largely the same as those required for the Reference Design. As for the Reference Design, approval may be required under the Natural Assets Local Law of Brisbane City Council for clearing of vegetation. Recommended changes or amendments to the Coordinator-General's conditions contained in Appendix 1 of the Coordinator General's Report, including amendments to the stated conditions for Sustainable Planning Act 2009 (SPA) approvals, are proposed in Section 8 of this application.

### 1.4 Consultation

Extensive public information and consultation was undertaken throughout the EIS process for the Reference Design. In support of the application for project change, the proponent is facilitating a range of targeted government agency briefings and community engagement on the Changed Project, both before and during any notification period required by the Coordinator-General and in addition to any formal notification required by the Coordinator-General.

Consultation on the Changed Project commenced from the moment the Transcity tender was announced on 20 September 2010 and included:

- Updating the Council project website ([www.northernlinkeis.com.au](http://www.northernlinkeis.com.au)) with the Changed Project concept design drawings;
- Issuing media releases to advise of the Changed Project decision;
- Provision of information to Council's call centre on the Changed Project;
- Establishment and manning of 1800 phones to assist with public enquires on the Changed Project;
- Receipt of and responding to email and written correspondence from the public;
- Direct communication with property owners who would be directly affected by the Changed Project by either a full or partial acquisition of their land or a volumetric acquisition to provide separate tenure for the underground tunnels and associated infrastructure.
- Letters delivered by Council to:
  - Newly affected property owners under the Changed Project tunnel alignment;
  - Property owners previously affected under the EIS Reference Design who are still affected under the Changed Project tunnel alignment;
  - Property owners previously affected under the Reference Design who are no longer affected under the Changed Project tunnel alignment;
- visits to directly-affected property owners and residents;
- meetings with directly affected property owners;
- establishment of a visitor information centre from Monday 4 October. The location of the visitor information centre is 160 Edward Street, Brisbane

Upcoming consultation activities include:

- a series of community and Government Agency information sessions for interested parties to view details of and discuss the proposed changes with project staff;
- Letters will be mailed to each of the affected property owners advising of the release of the Change Report.
- Letters will be mailed to community members who have registered interest in receiving information about the Changed Project.

- Distribution of a community newsletter to the Northern Link study corridor and the wider catchment area for the project (Timing: first week of November)
- Staging information sessions for members of the community. Information sessions will be advertised in daily and suburban newspapers. Information sessions will be held at Milton State School on the following dates:
  - Saturday 6 November 2010
  - Wednesday 10 November 2010
- Information including maps and drawings of the proposed changes to the project will be available on the EIS website ([www.northernlinkeis.com.au](http://www.northernlinkeis.com.au))
- Static display locations will be advertised in the daily newspapers and will be set up with the following materials:
  - A3 poster announcing the Change Report
  - Two copies of the Change Report
  - Two copies of project maps and urban design drawings
  - CD of the Change Report

Display locations are:

- Libraries:
  - Toowong Library – Toowong Village Shopping Centre, 9 Sherwood Road, Toowong
  - Indooroopilly Library – Level 4, Indooroopilly Shopping Centre, 318 Moggill Road, Indooroopilly
  - Mt Coot-tha Library – Administration Building, Mt Coot-tha Botanic Gardens, Mt Coot-tha Road, Toowong
  - Grange Library – 79 Evelyn Street, Grange
  - Brisbane Square Library – Brisbane Square, 266 George Street, Brisbane
  - Ashgrove Library – 87 Amarina Avenue, Ashgrove
- Ward offices:
  - Toowong Ward Office – 50 High Street, Toowong
  - Central Ward Office – Shop 11, 31 Duncan Street, Fortitude Valley
  - Walter Taylor Ward Office – Level 4, Indooroopilly Shopping Centre, 318 Moggill Road, Indooroopilly
- State and Federal Electorate offices:
  - Mt Coot-tha State Electorate Office – 76 MacGregor Terrace, Bardon
  - Brisbane Central State Electorate Office – Unit 2, Hill House, 541 Boundary Street, Spring Hill
  - Brisbane Federal Electorate Office – Shop 1, 209 Days Road, Grange
  - Ryan Federal Election Office – 31 Station Road Indooroopilly

Any person may make a submission to the Coordinator-General about the proposed changes to the project during the period of public notification. Submissions to the Coordinator-General must:

- be made within the submission period;
- be in writing and signed by each person making the submission;
- state the name and the address of each person making the submission; and
- state the grounds for the submission, and the facts and circumstances relied upon in support of those grounds;

Submissions can be made via:

Email: [northernlink@dip.qld.gov.au](mailto:northernlink@dip.qld.gov.au)

Or

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## 2 Overview of Changed Project

A graphic comparison between the Reference Design and the Changed Project is shown in the Figures identified in **Table 2-1**.

**Table 2-1: Design comparison figures**

Design Element	Reference Design	Changed Project
Tunnel Horizontal Alignment	Figure 2-1	Figure 2-2
Tunnel Vertical Alignment	Figure 2-3	Figure 2-4
Western Connection – Tunnel Portals	Figure 2-5	Figure 2-6
Western Connection – Centenary Motorway Connection	Figure 2-7	Figure 2-8
Western Connection – Urban and Landscape Design	Figure 2-9	Figure 2-10
Western Connection – Western Worksite	Figure 2-11	Figure 2-12
Eastern Connection – Tunnel Portals	Figure 2-13	Figure 2-14
Eastern Connection – Urban and Landscape Design	Figure 2-15	Figure 2-16

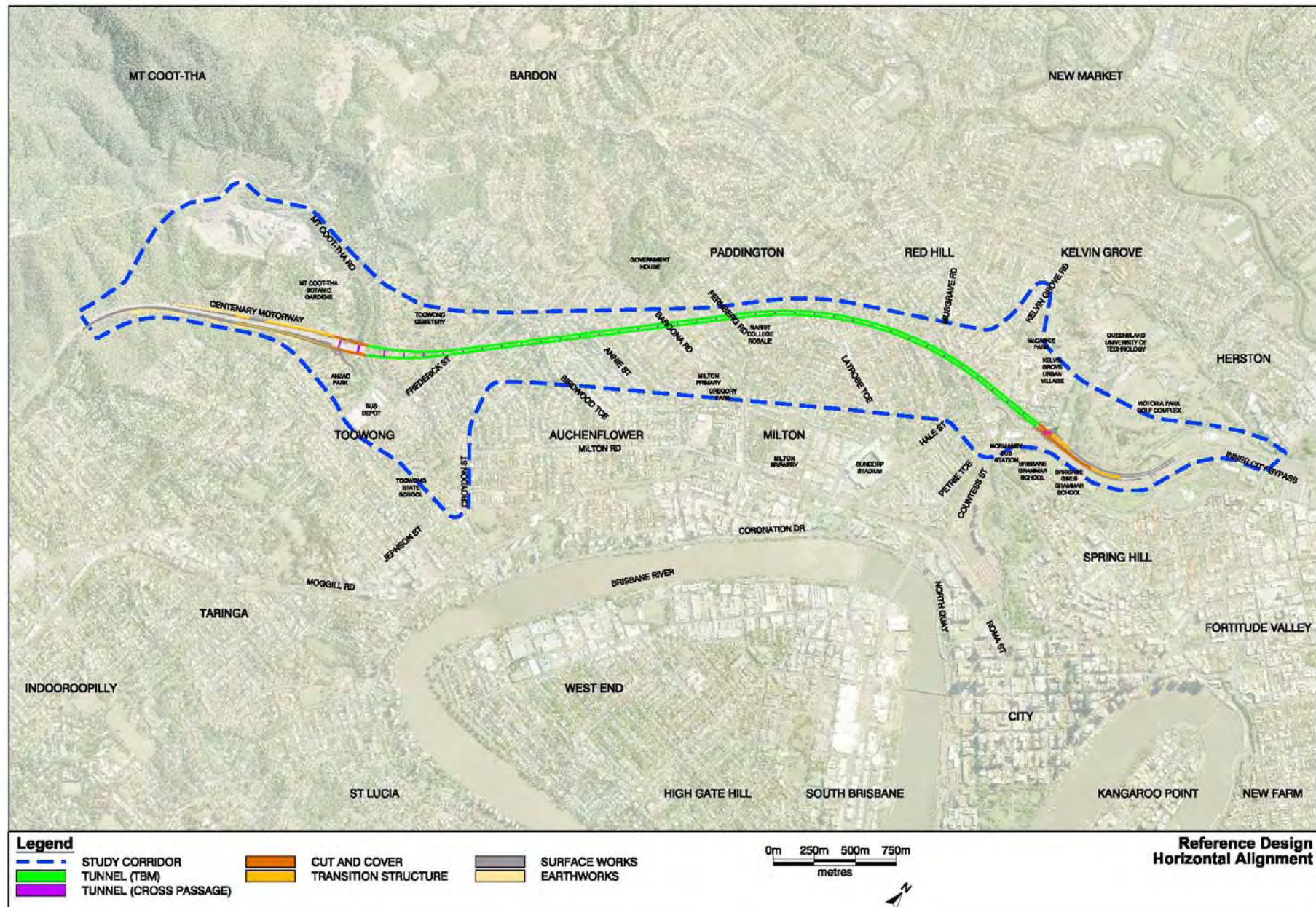


Figure 2-1: Reference Design Horizontal Alignment

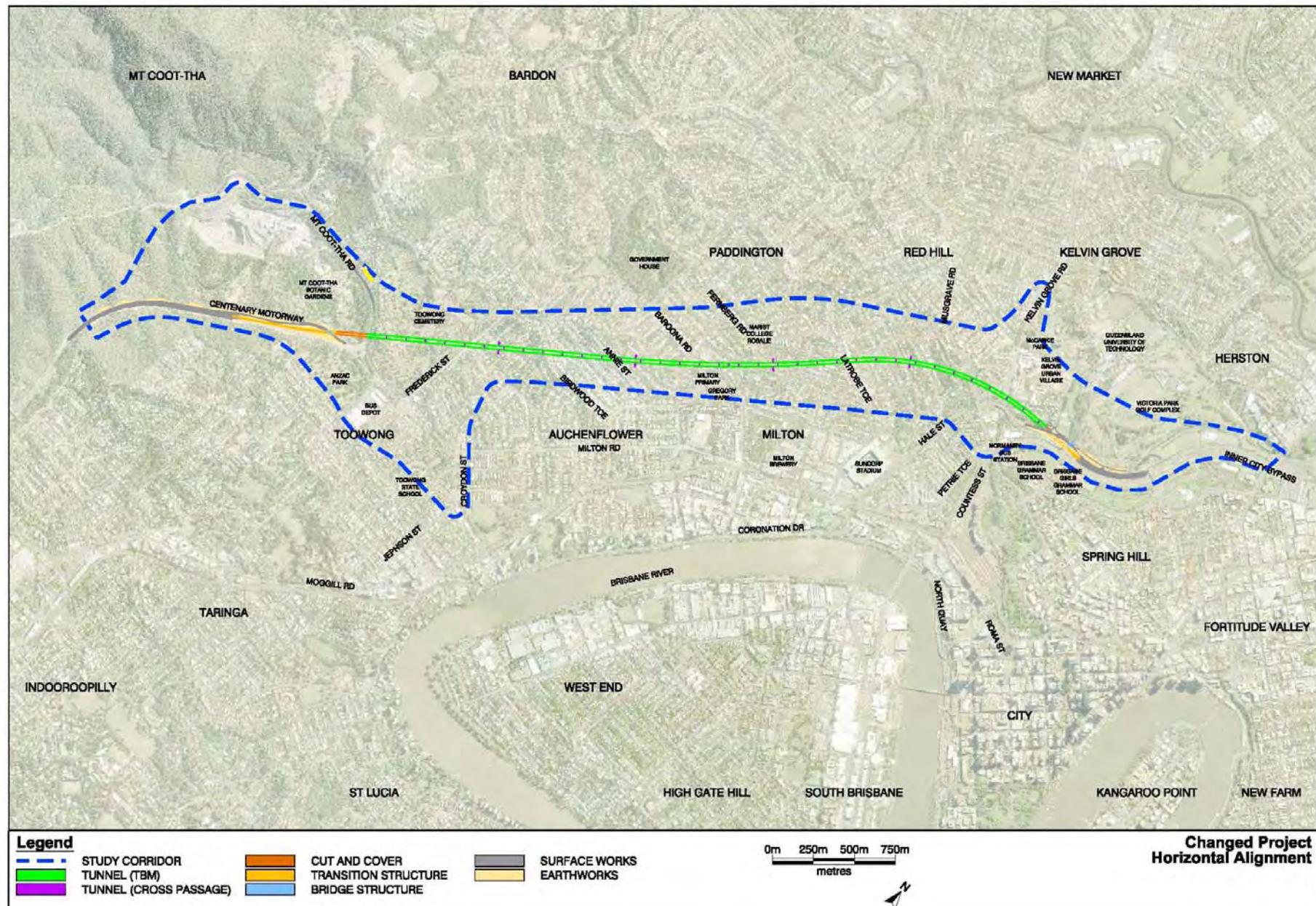


Figure 2-2: Changed Project Horizontal Alignment

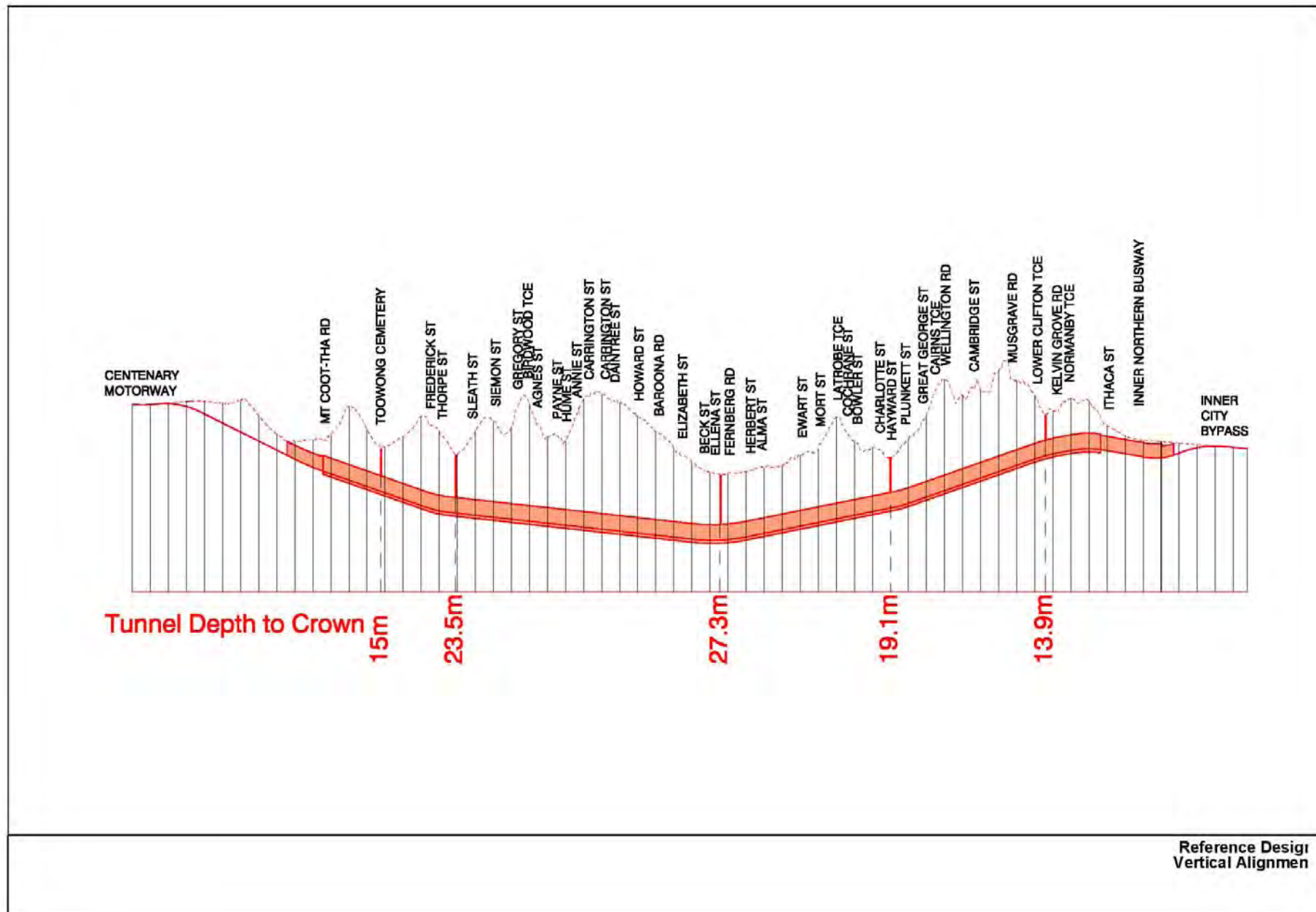


Figure 2-3: Reference Design Vertical Alignment

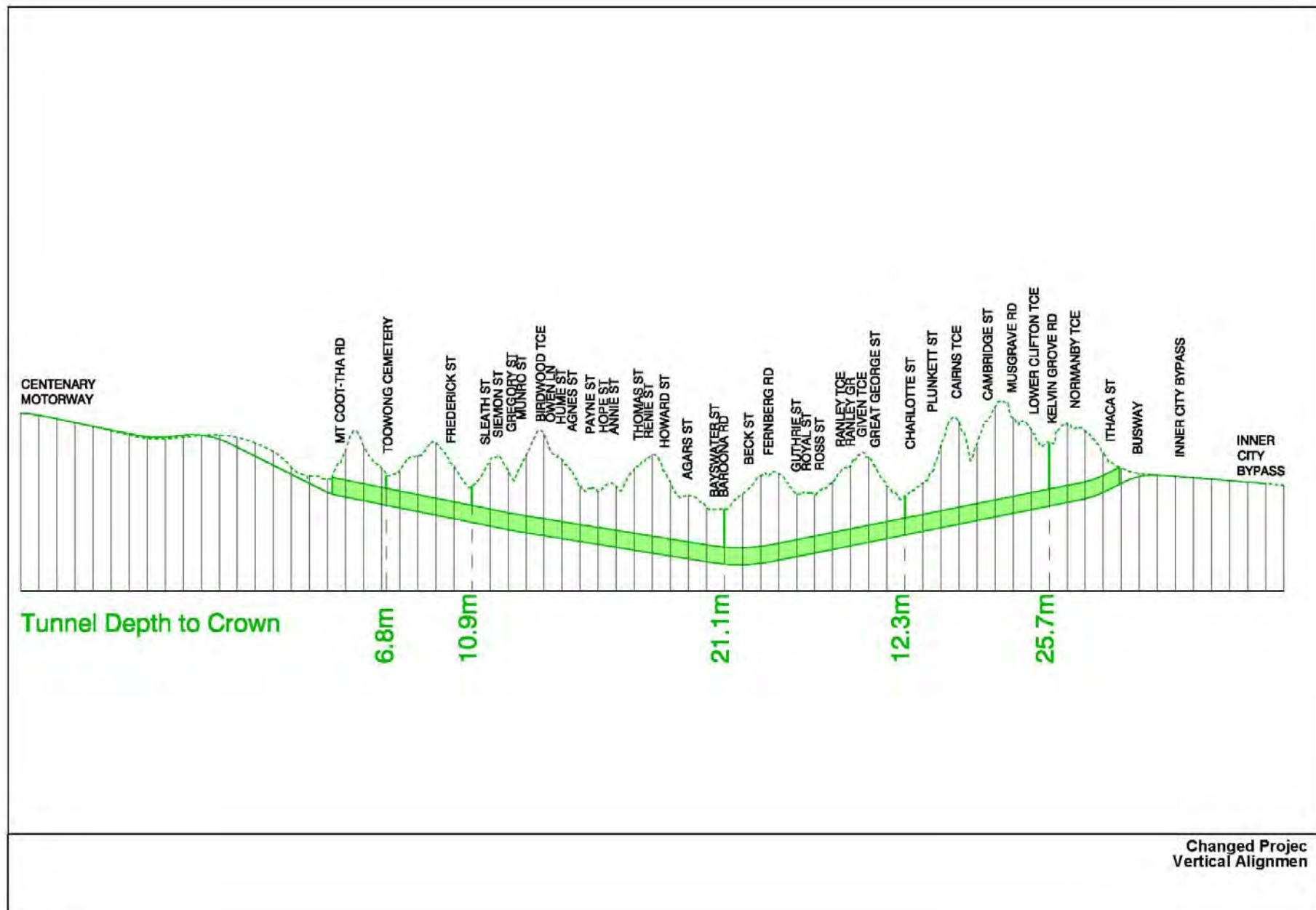


Figure 2-4: Changed Project Vertical Alignment

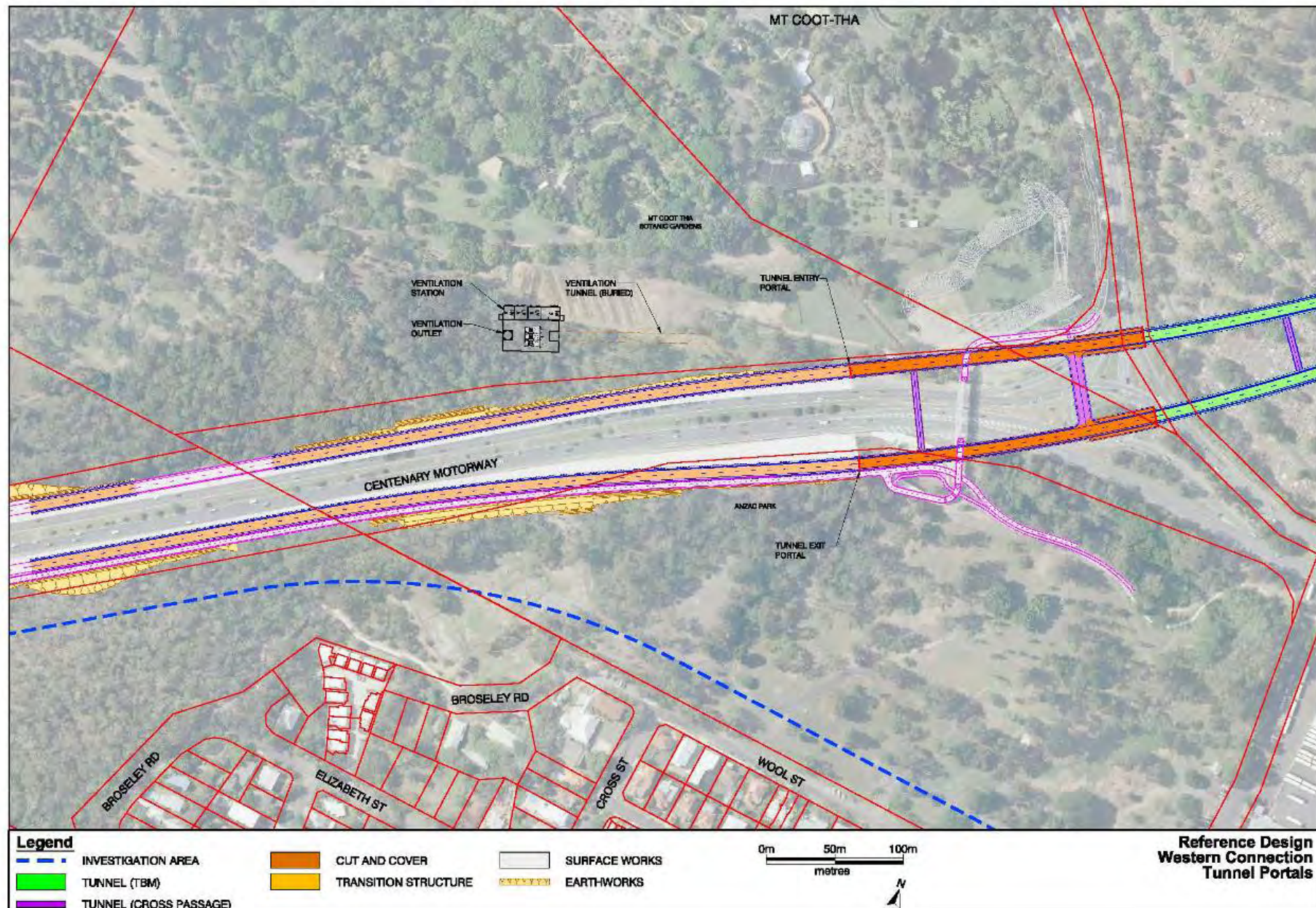


Figure 2-5: Reference Design Western Connection – Tunnel Portals

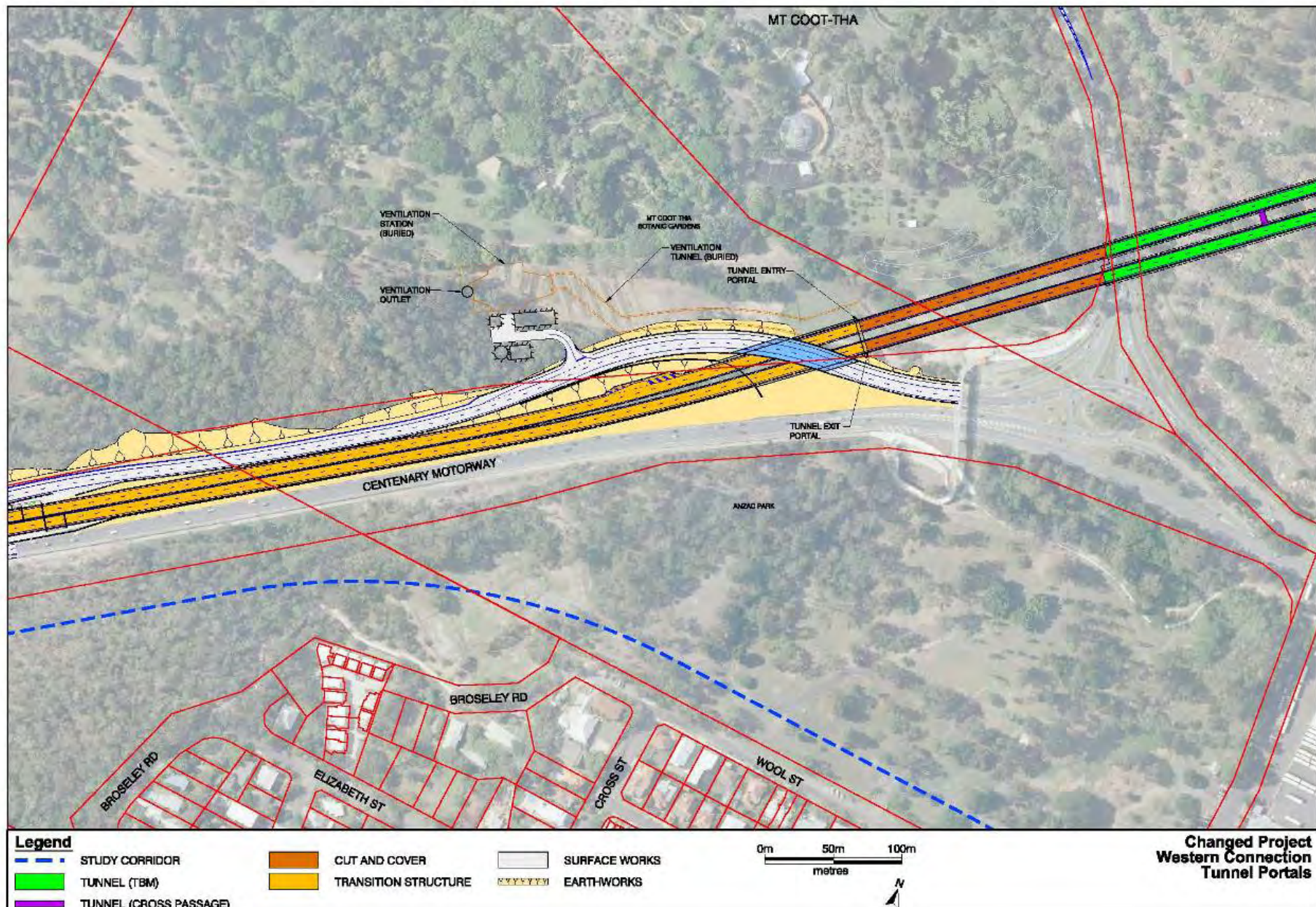


Figure 2-6: Changed Project Western Connection – Tunnel Portals

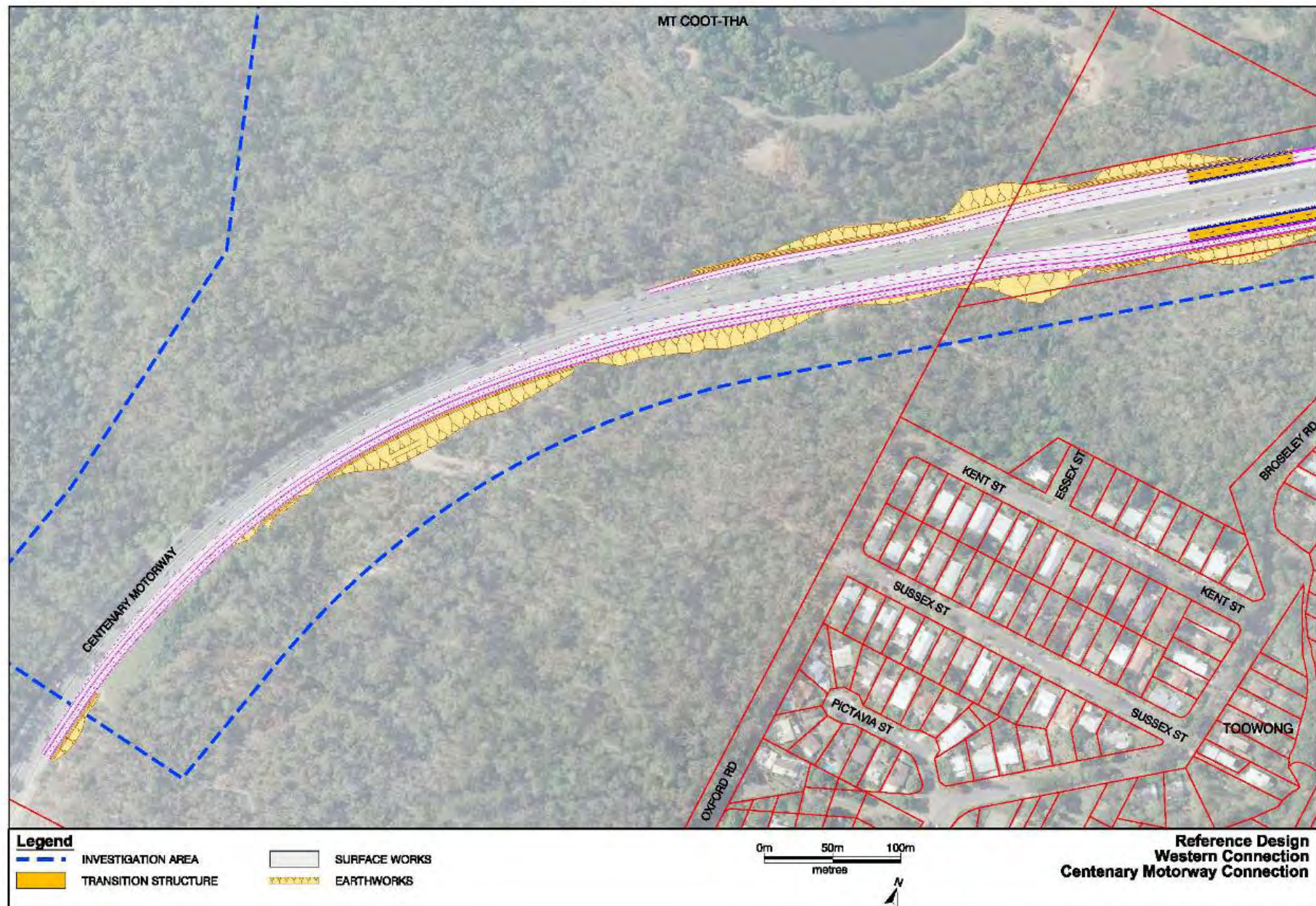


Figure 2-7: Reference Design Western Connection – Centenary Motorway connection



Figure 2-8: Changed Project Western Connection – Centenary Motorway connection

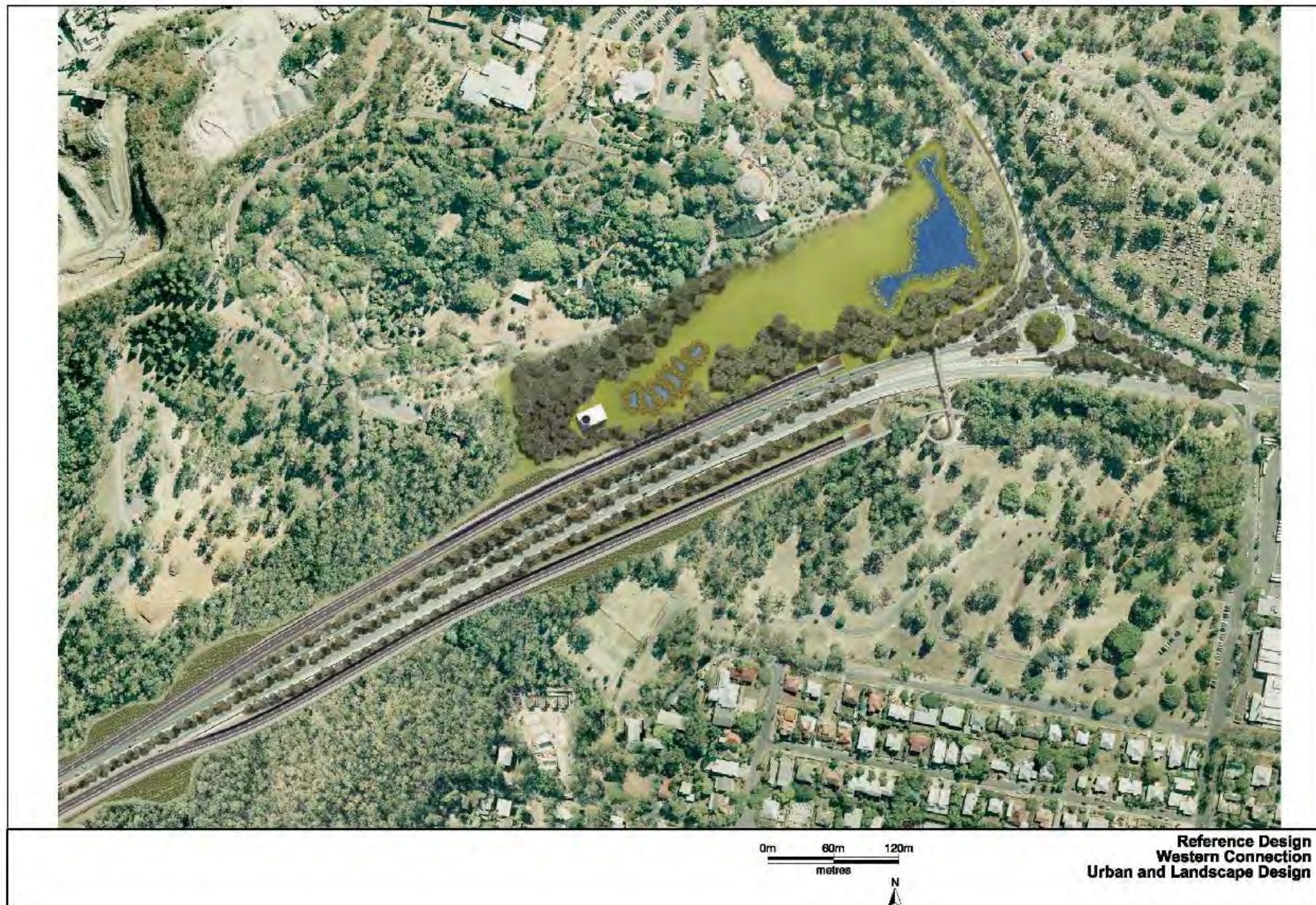


Figure 2-9: Reference Design Western Connection – Urban and Landscape Design

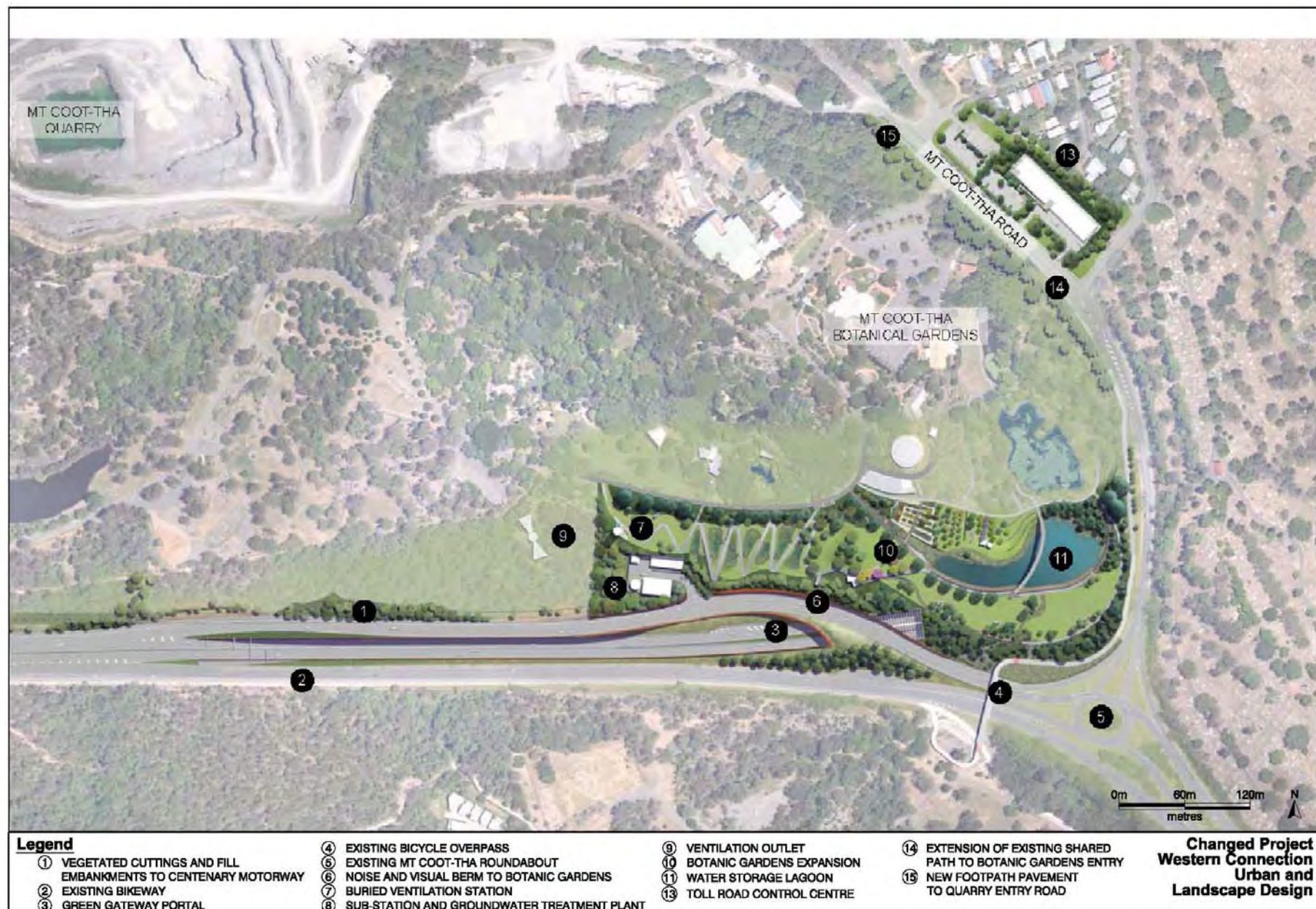


Figure 2-10: Changed Project Western Connection – Urban and Landscape Design

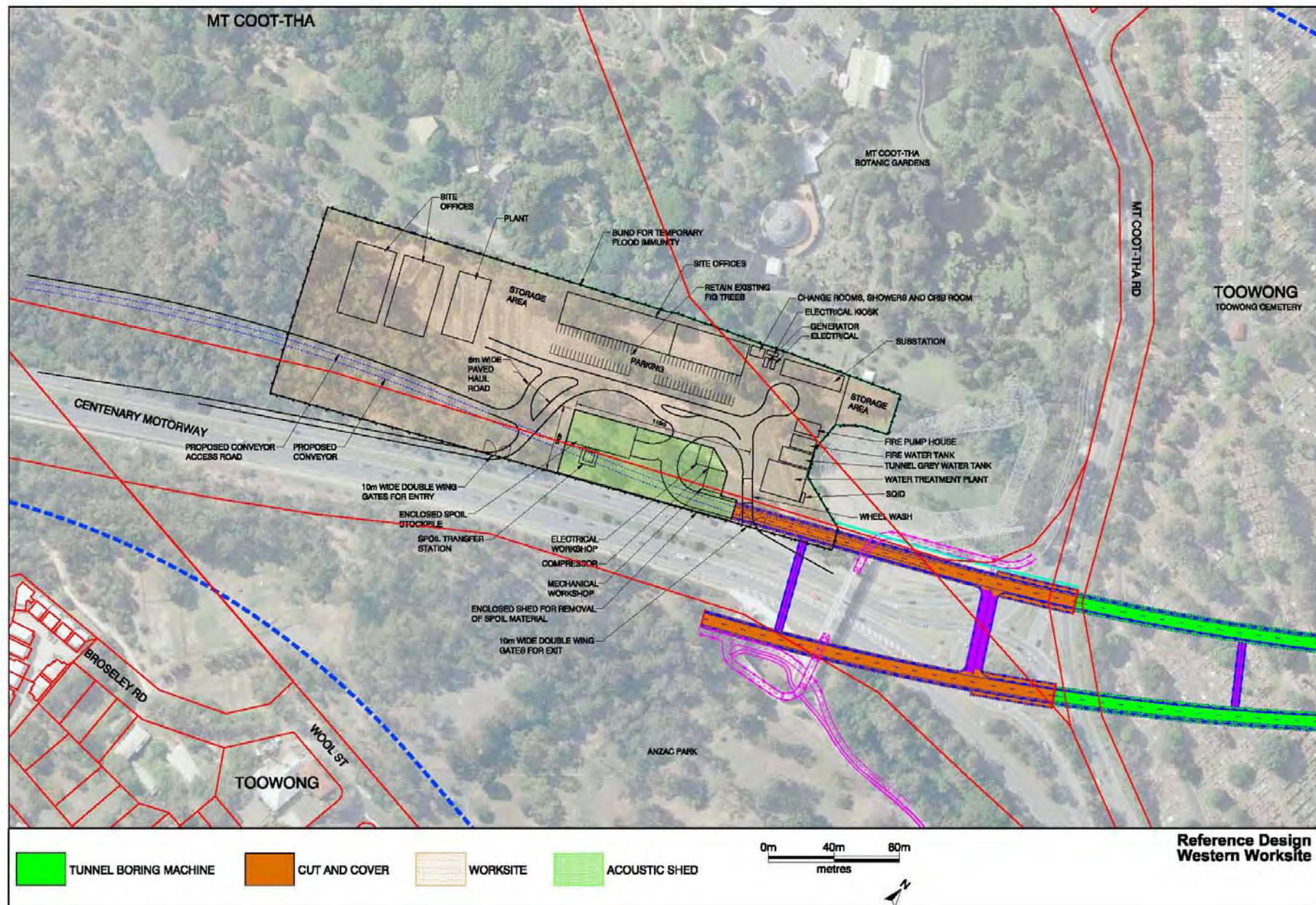


Figure 2-11: Reference Design – Western Worksite

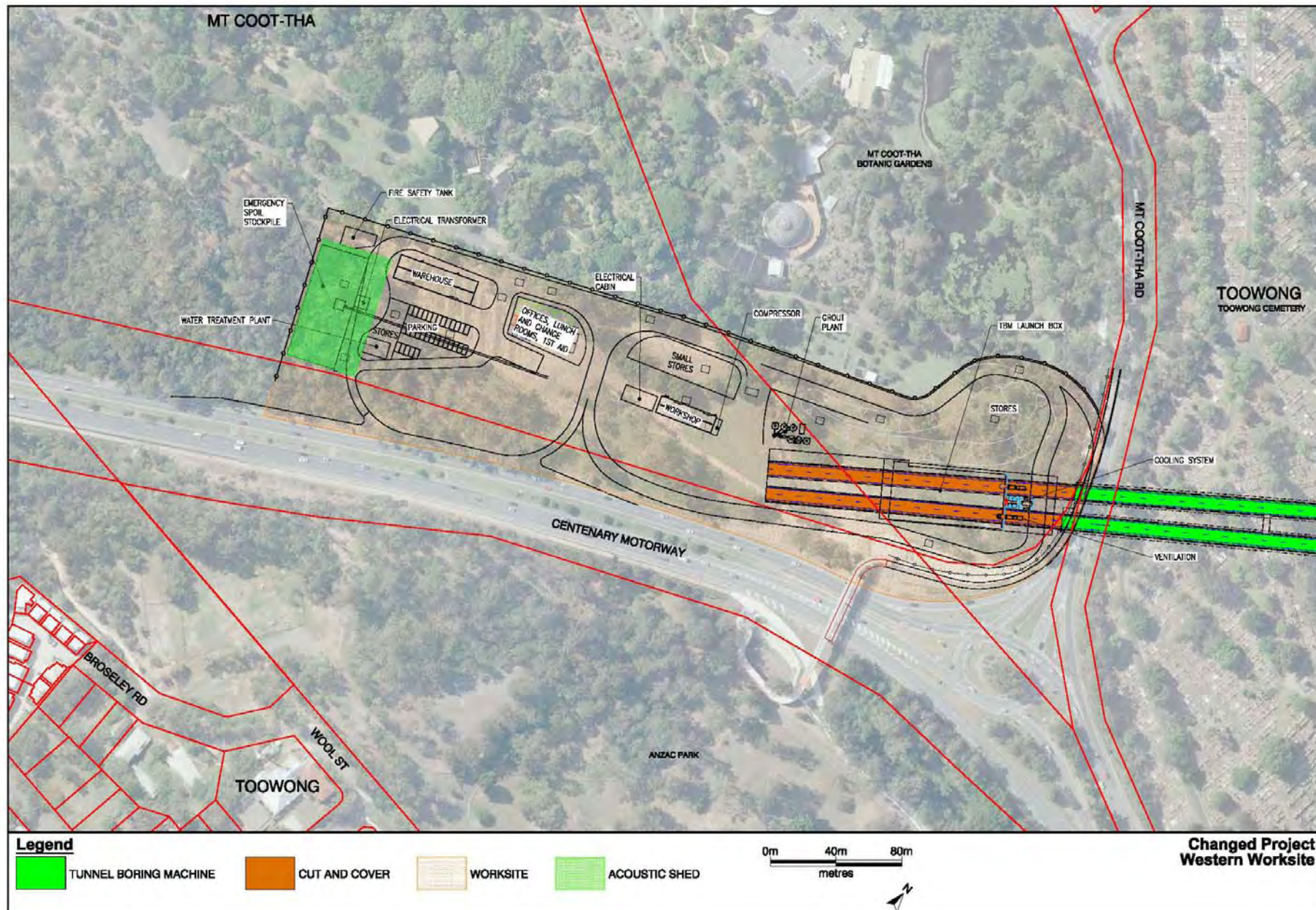


Figure 2-12: Changed Project – Western Worksite

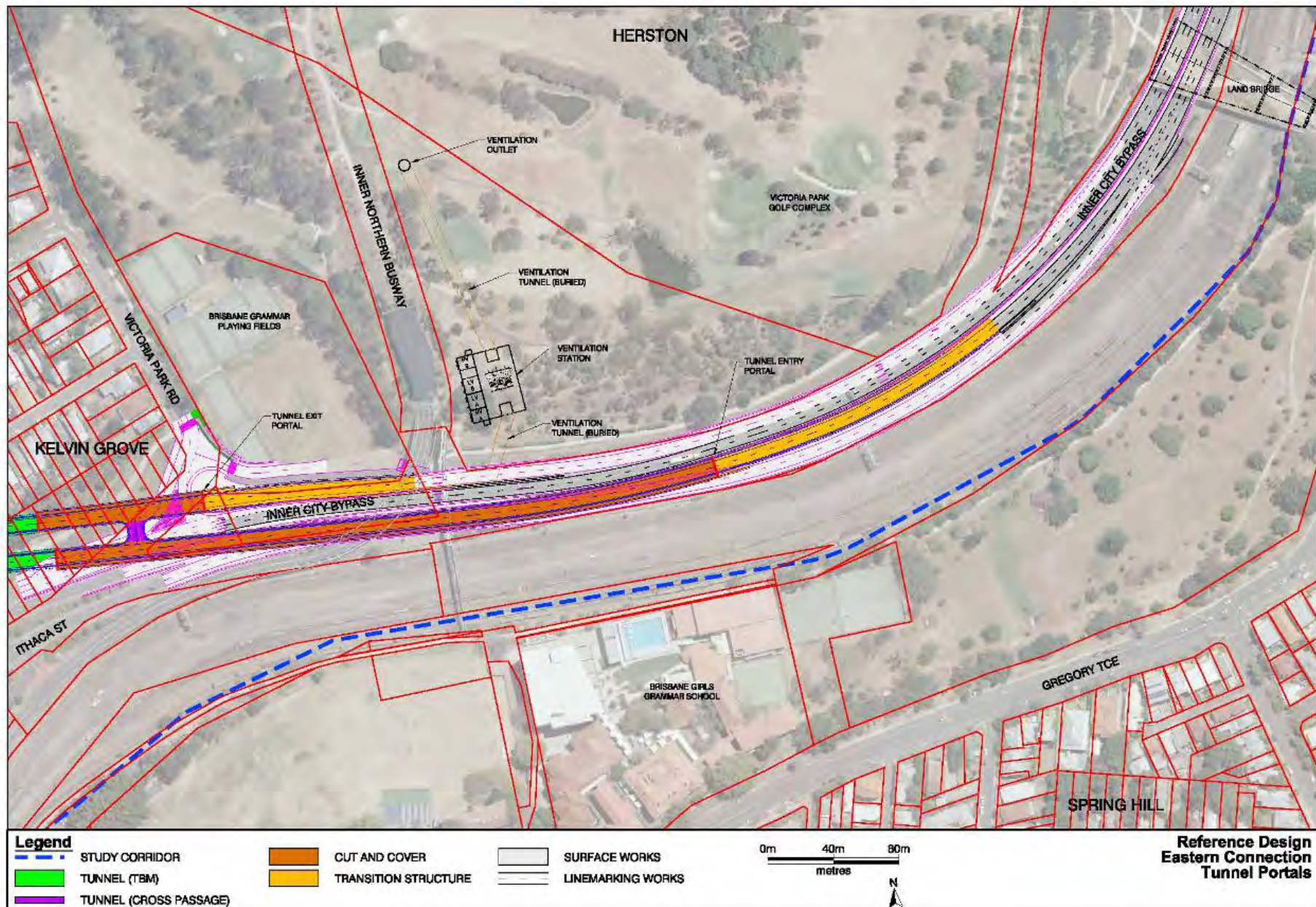


Figure 2-13: Reference Design Eastern Connection – Tunnel Portals

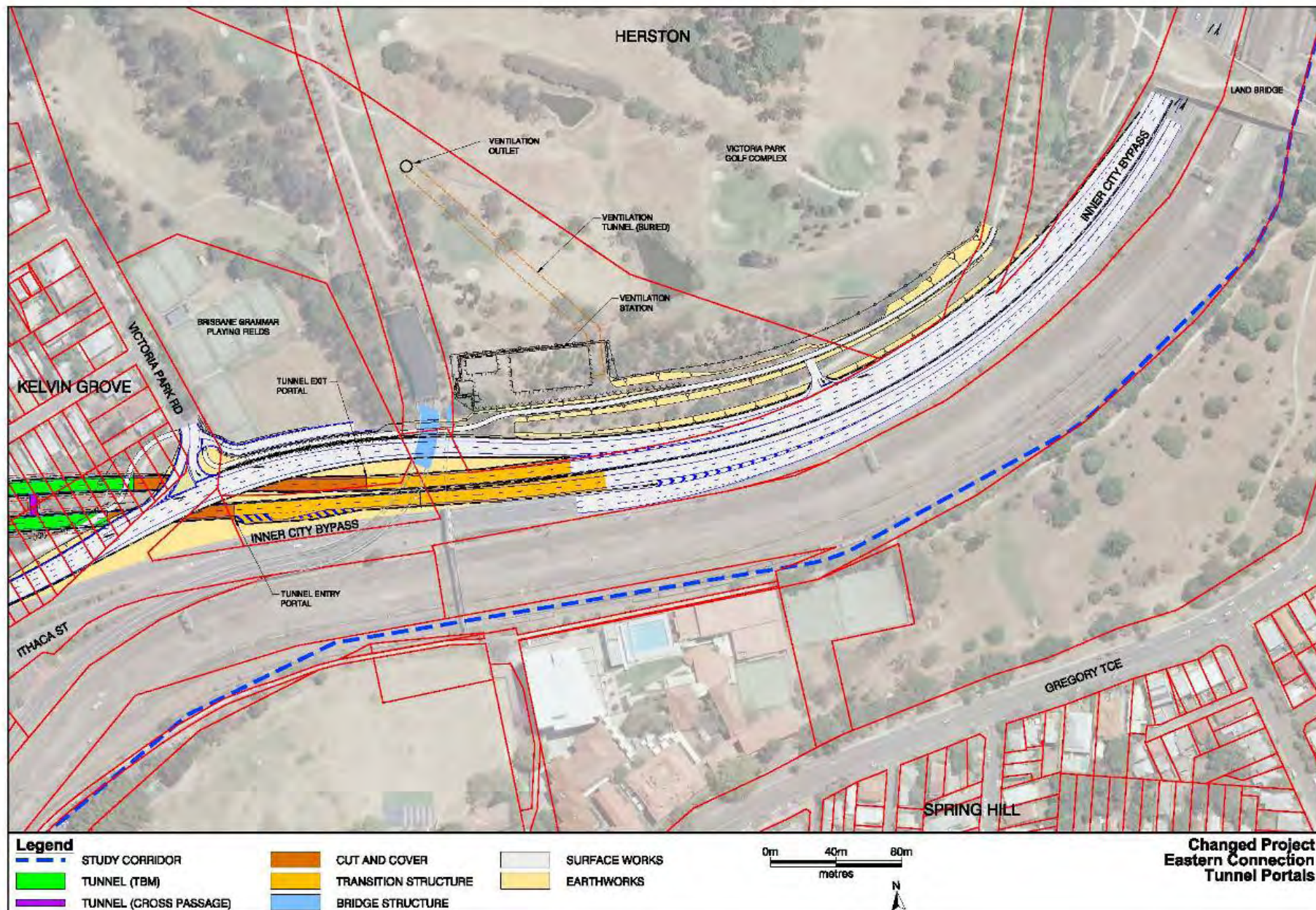


Figure 2-14: Changed Project Eastern Connection – Tunnel Portals

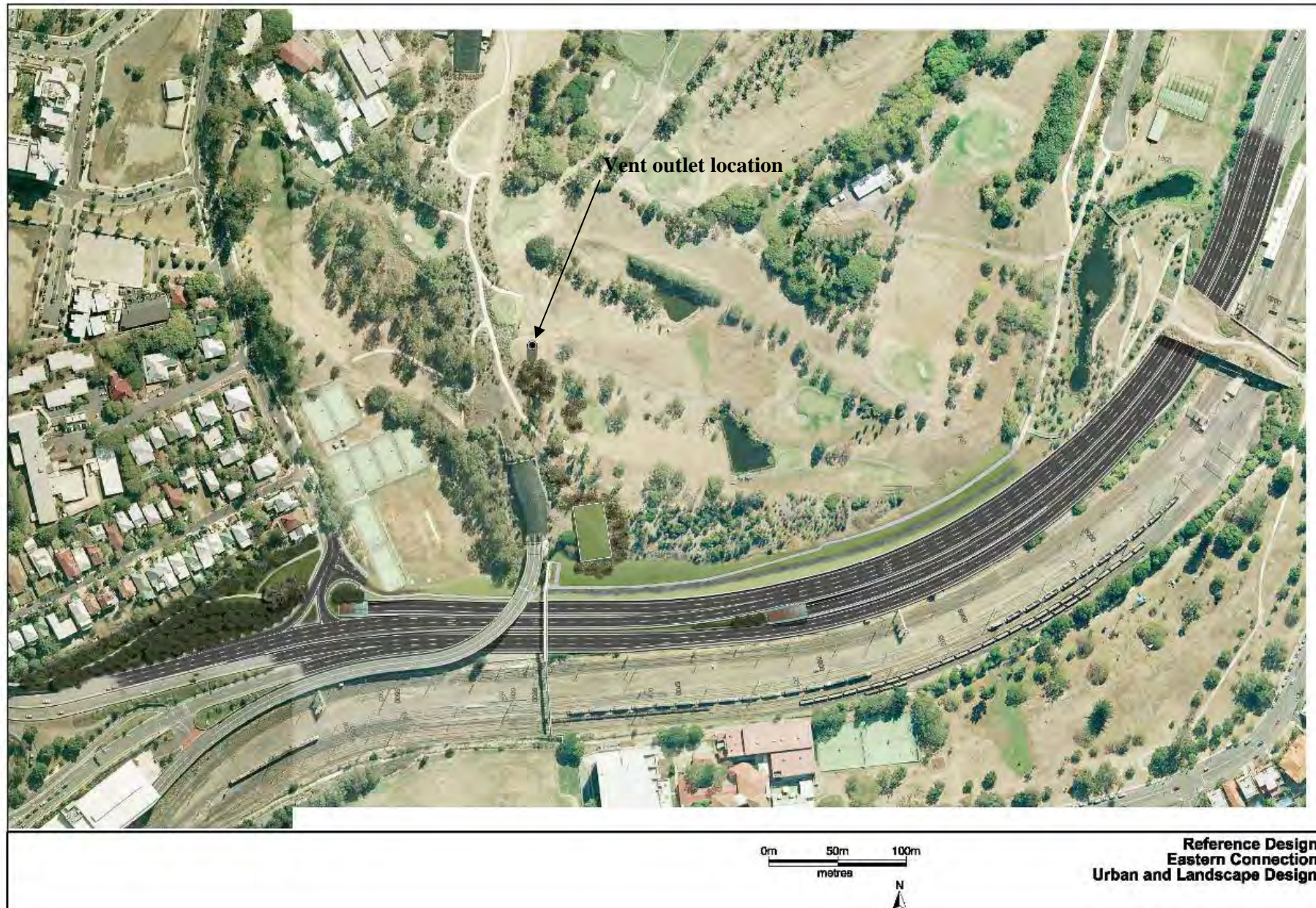


Figure 2-15: Reference Design Eastern Connection – Urban and Landscape Design

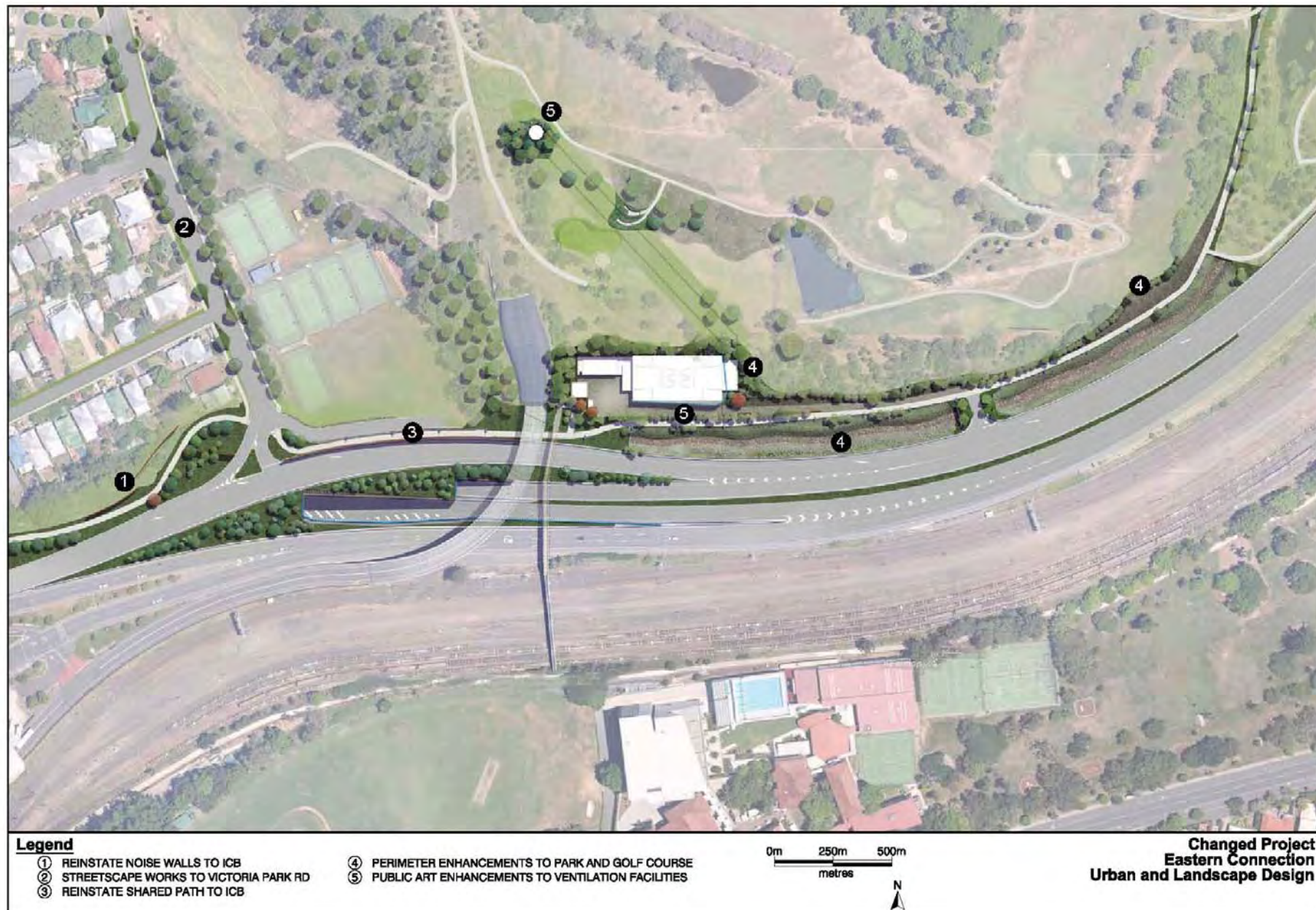


Figure 2-16: Changed Project Eastern Connection – Urban and Landscape Design

## 2.1 General Arrangement

### 2.1.1 Reference Design

The Reference Design for the NLRT would connect the Centenary Motorway at Toowong with the Inner City Bypass at Kelvin Grove/ Herston. The NLRT would comprise two separate, parallel road tunnels of uniform cross-section, each with two lane carriageways. Both tunnels would have openings (portals) to the surface on the Centenary Motorway just west of the Mt Coot-tha Road roundabout at Toowong, and on the Inner City Bypass (ICB), near its junction with Victoria Park Road at Kelvin Grove / Herston.

The overall project presented in the Reference Design would be approximately 7 kilometres in length, including surface connections. The eastbound tunnel (northern) is approximately 4.6 kilometres long and the westbound tunnel is approximately 4.9 kilometres long. The two tunnels would be at least 10 metres apart and connected by cross passages every 120 metres along their length. The excavation of the two tunnels would be by tunnel boring machine (TBM) commencing from the western end with spoil carried by conveyor to the Mount Coot-tha Quarry for processing.

The alignment of the Reference Design progressed from the western connection to the eastern connection in a wide arc west of the former Marist College, Rosalie and then deep beneath St Brigid's Church, Red Hill. This alignment was proposed based on the original EIS tunnel ramp connections, which were subsequently removed during the Supplementary Report. However, the horizontal alignment was not modified during the Supplementary Report. The alignment also follows the assumed geotechnical conditions associated with the high ground conditions in Toowong, Rosalie and Red Hill.

### Changed Project

The Changed Project would retain the general features of the Reference Design in that it would connect the Centenary Motorway at Toowong and with the ICB at Kelvin Grove/ Herston. The Changed Project also would consist of two parallel road tunnels, each with a uniform cross-section comprising containing two lanes.

The overall length of the Changed Project remains approximately 7km. The length of the westbound tunnel would be shorter by about 400m due largely to the reduction of cut and cover required. Similar to the Reference Design, the tunnels for the Changed Project would be aligned in parallel approximately 10m apart and connected by cross passages at the same distance along the length of the tunnels (120m).

The Changed Project would connect with the Centenary Motorway by way of centrally-located portals to the east and west-bound tunnels and associated transition structures. Similarly, the Changed Project would connect with the ICB via centrally-located portals and associated transition structures. For both connections, the existing motorway lanes would be realigned to accommodate the central connection location.

The Changed Project would be up to 60m north of the Reference Design at the driven tunnel portals at the eastern edge of the Botanic Gardens. The alignment continues approximately 100m north of the Reference Design underneath the Mt Coot-tha Cemetery until crossing the Reference Design alignment just to the east of Frederick Street, between Thorpe and Sleath Streets, Auchenflower. The alignment continues south of the Reference Design to the north of Gregory Park at Baroona Road and approximately 350m south of the Reference Design in the area of Guthrie Street, Paddington. The alignment rejoins the Reference Design alignment near Kelvin Grove Road, with the driven tunnel

finishing south of Normanby Terrace to the west of Victoria Park Road. The vertical alignment is generally shallower than the Reference Design, except at the eastern end north of Cairns Terrace, Paddington.

The tunnel ventilation system would be similar to the Reference Design with a longitudinal ceiling smoke duct and ventilation outlets at each end of the Changed Project. Both western and eastern ventilation stations would be located in the general localities as proposed in the Reference Design.

The western ventilation station would be buried underground in a location immediately north of the Reference Design location. The ventilation outlet for this ventilation station would be above ground on the western side of the buried ventilation station and approximately 43m north-west of the outlet location identified in the Reference Design. Maintenance access to the western ventilation station and associated infrastructure would be agreed with DTMR during detailed design. The eastern ventilation station would be cut into the side of the hill and the ventilation outlet would be situated in the same location as proposed for the Reference Design. Controlled access would be provided to and from the eastbound ICB.

The Tollroad Control Centre (TCC) for the Changed Project would be located on the northern side of Mt Coot-tha Road opposite the entrance to the Mt Coot-tha Botanic Gardens, whereas the Reference Design indicated a possible location for the TCC within the western worksite off the Centenary Motorway.

A summary of the design changes to the Reference Design, including references to relevant Reference Design drawings and Changed Project concept design drawings are identified in **Table 2-2**. The Reference Design drawings are available from the EIS Supplementary Report Volume 2: Project Design set of drawings available from the Northern Link Project Website and the Changed Project drawings referenced in **Table 2-2** are provided in this application following the table. **Table 2-2** also identifies the reason for each of the identified changes described in the table.

**Table 2-2: Design Changes**

Design Element	Description of the Reference Design (RD)	Description of the proposed Change	Reason(s) for Change
<b>TBM Tunnel Alignment</b>			
Horizontal Alignment	From south-west corner of Toowong Cemetery in an arc along the northern section of the Study Area to surface on the southern side of Normanby Terrace residences west of Victoria Park Road.  Refer to <b>Figure 2-1</b> above and Supplementary Report Volume 2 Planning Layout Drawings <sup>1</sup> .	From the western side of Mt Coot-tha Road and 100m north of the RD alignment under the Toowong Cemetery in a straighter alignment through the centre of the Study corridor up to 300m south of the RD alignment to land on the southern side of Normanby Terrace residences.  Refer <b>Figure 2-17 to Figure 2-20</b>	Enables both TBMs to be launched off-line within the construction worksite and outside of existing traffic areas.  Avoids construction through Mt Coot-tha Road and the roundabout. Provides improved grades for the associated cut and cover and transition structures to the Centenary Motorway.  Provides a more direct alignment while maintaining suitable geology with some reduction in TBM length (westbound TBM -60m and eastbound TBM – 30m) and private property volumetric requirements.
Vertical Alignment (Depth)	The RD ranged in vertical alignment depths under the surface between some 11m	The changed vertical alignment of the tunnels under private properties	Consequence of the amended horizontal geometry and ground surface heights.

Design Element	Description of the Reference Design (RD)	Description of the proposed Change	Reason(s) for Change
	and 66m  Refer to <b>Figure 2-3</b> above and Supplementary Report Volume 2 Longitudinal sections	varies between approximately 10-50m and would be generally shallower than the Reference Design, although the section between Cairns Terrace and the ICB would be deeper.  Refer <b>Figure 2-4</b> and <b>Figure 2-21</b> to <b>Figure 2-28</b> .	Also due to design changes to optimise tunnel gradients.
Volumetric Title Requirements	374 parcels of land identified as affected in Supplementary EIS.  Refer to Section 3.3.2 of the Supplementary Report.	334 property holdings are affected by the Changed Project. Some 269 of these are newly affected (including 6 Council owned parcels) and 65 of these continue to remain affected as identified in the Reference Design. There may be some minor changes to these numbers as a result of detailed design and survey.	Newly identified properties are required due to the revised horizontal alignment design and further design development of tunnel infrastructure including volumetric buffer requirements (1.5m surrounding the underground structures) as well as the concept design for cross passages and underground sub-stations.
Tunnel and cross passage configuration	The Reference Design proposed undrained or sealed cut and cover tunnels with a drained or unsealed driven TBM tunnel and drained cross passages and substations. Groundwater inflow to the tunnel was estimated at 4 litres per second.  Refer to Supplementary Report Volume 2 Typical Cross Sections <sup>3</sup>	The Changed Project has chosen to seal both the tunnels to prevent the inflow of groundwater. The TBM tunnels would be fully sealed with pre-cast tunnel segment rings and grouting. Underground cross passages and substation sites would remain drained and as a source of groundwater entry into the tunnels but less than that estimated for the Reference Design (ie approx 3 litres per second).  Refer to <b>Figure 2-29</b> to <b>Figure 2-30</b>	Development of more efficient construction methodology using pre-cast tunnel rings to line the tunnel in one process as the tunnel is being constructed.
<b>Western Surface Connections</b>			
TBM portal locations	The TBM portals are separated some 50m apart, with the northern entry portal located at the corner of Mt Coot-tha Road and the roundabout adjacent to the Toowong Cemetery and the southern exit portal located in line with the middle of the roundabout adjacent to the cemetery.  Refer to <b>Figure 2-5</b> and Supplementary Report Volume 2 Planning Layouts <sup>1</sup>	The TBM portals are located together some 60m north of the northern Reference Design portal and some 100m north of the southern Reference Design portal on the western side of Mt Coot-tha Road within the western worksite  Refer to <b>Figure 2-6</b> and <b>Figure 2-31</b>	Enables both TBMs to be launched off-line within the construction worksite and outside of existing traffic, avoiding construction through Mt Coot-tha Road and the roundabout.  Provides improved grades for the associated cut and cover and transition structures to the Centenary Motorway.  Provides for the tunnel cut and cover portals to be together consolidating the construction area and also simplifying construction traffic management

Design Element	Description of the Reference Design (RD)	Description of the proposed Change	Reason(s) for Change
Cut and Cover tunnels and tunnel entry and exit portal locations	<p>The cut and cover tunnel portals being the entry and exit portals to and from the tunnels, are located either side of the Centenary Motorway, west of the Mt Coot-tha roundabout. These portals are 60m apart on either side of the Centenary Motorway. The northern entry cut and cover tunnel is approximately 215m in length along the northern side of the Centenary Motorway. The southern exit cut and cover tunnel is 220m along the southern area of the Centenary Motorway within Anzac Park. Further cut and cover cross passages are constructed between the tunnels through the Centenary Motorway and a larger second cross passage through the roundabout and the off ramp to Mt Coot- tha Road.</p> <p>Refer to <b>Figure 2-5</b> and Supplementary Report Planning Volume 2 Planning Layouts</p>	<p>The cut and cover tunnel portals for the Changed Project are located together north of the Centenary Motorway and approximately 40m north of the northern Reference Design portal and some 175 west of Mt Coot-tha Road. The cut and cover tunnels are generally 10m apart and some 30-40m shorter than the Reference Design tunnels. The cut and cover areas would be replanted and returned for public use to the Botanic Gardens apart from a 10m to 50m section of semi covered transition structure west of the tunnel portal within the gardens area.</p> <p>Refer to <b>Figure 2-6</b> and <b>Figure 2-31</b></p>	<p>Consolidates the construction area north of the Mt Coot-tha roundabout avoiding cut and cover construction through Mt Coot-tha Road and the roundabout simplifying construction traffic management.</p> <p>Also retains sensitive areas of Anzac Park and the existing pedestrian and cycle bridge across the Centenary Motorway.</p>
Tunnel entry and exit transition ramps to the Centenary Motorway	<p>An approximately 500m tunnel entry ramp with maximum downgrades of 7% and a 610m tunnel exit ramp with maximum upgrades of 5% are located on the outside of the Centenary Motorway.</p> <p>Refer to <b>Figure 2-5</b> and Supplementary Report Volume 2 Planning Layouts<sup>1</sup></p>	<p>The Changed Project entry and exit transition ramps are located together on the inside of the Centenary Motorway. These ramps are longer than the Reference Design (the entry by 145m and the exit by 40m) with generally maximum grades of 5%.</p> <p>Refer to <b>Figure 2-6</b> and <b>Figure 2-17</b></p>	<p>Consultation with DTMR indicates some benefit in making the CM-NLRT route the primary traffic and freight route by connecting from the inside lanes of the Centenary Motorway.</p> <p>Also provides a safer route for approved on-road cyclists using the Centenary Motorway outside lanes.</p>
Realignment of the Centenary Motorway inbound lanes to the north	<p>No design changes to the inbound lanes of the Centenary Motorway.</p> <p>Refer to <b>Figure 2-5</b> and Supplementary Report Volume 2 Planning Layouts<sup>1</sup></p>	<p>The inbound lanes of the Centenary Motorway would be realigned to the north. The inbound lanes, including the earthwork for the future widening would be constructed off-line followed by a single switch of traffic onto the new lanes.</p> <p>Refer to <b>Figure 2-6</b> and <b>Figure 2-17</b></p>	<p>To provide a single construction area and space for the centre connection of the Northern Link within the median of the Centenary Motorway.</p>
Centenary Motorway merge and diverge	<p>The Reference Design provides for a merge from the tunnel to the Centenary motorway of approximately 800m and for a diverge from</p>	<p>The Changed Project provides for a merge from the Mt Coot-tha roundabout traffic to the exit traffic from the tunnel onto the Centenary</p>	<p>The shorter merge (150m) is due to the commencement of the merge being further west than the Reference Design due to the difference in</p>

Design Element	Description of the Reference Design (RD)	Description of the proposed Change	Reason(s) for Change
locations	the Motorway to the tunnel of approximately 175m  Refer to drawing <b>Figure 2-7</b> and Supplementary Report Volume 2 Planning Layouts <sup>1</sup>	Motorway of approximately 650m and a diverge of approximately 375m.  Refer to <b>Figure 2-8</b> and <b>Figure 2-17</b>	vertical geometry. The longer (200m) diverge is due to the improved geometry and to comply with agreed design standards.
Western ventilation and infrastructure maintenance access.	Ventilation station and associated facilities partially buried into the higher ground at the western end of the western worksite. Access not defined.  Refer to <b>Figure 2-5</b> and Supplementary Report Volume 2 Ventilation Site Plans <sup>4</sup>	Ventilation station fully buried. The ventilation outlet has moved approximately 43 metres north west, which is further away from the nearest residence. A water and power utility area would remain cut into the higher ground with final access arrangements to be approved by DTMR. No change to the minimum height of the ventilation outlet.  Refer to <b>Figure 2-31</b> and <b>Figure 2-38</b>	There is no change to ventilation outlet minimum level. The reason for the decision to fully bury the ventilation station was to further reduce visual impact from within the Botanic Gardens. The change in the location of the ventilation outlet is as a result of the burying of the ventilation station in order to mitigate visual impact.
Tollroad Control Centre (TCC) location	The TCC would be situated adjacent to the Centenary Motorway within the rehabilitated worksite area with access off the Centenary Motorway.  Refer to EIS Volume 1 Part 4 Section 4.4.1	The TCC would be located on the corner of Richer Street and Mt Coot-tha Road with access off Mt Coot-tha Road.  Refer to <b>Figure 2-33</b> to <b>Figure 2-36</b>	The Reference Design proposed site would have impacted on the Botanic Gardens, whereas the Changed Project location would avoid further above ground infrastructure and traffic within this significant public area.
<b>Eastern Surface Connections</b>			
TBM portal locations	TBM portals located south of the residences along Normanby Terrace Refer to <b>Figure 2-13</b> and Supplementary Report Volume 2 Planning Layouts <sup>1</sup>	Changed Project has similar TBM portal locations although the eastbound TBM portal has moved approximately 60m east and the westbound TBM portal has moved approximately 30m east. Both being further distant from the majority of residences along Normanby Terrace.  Refer to <b>Figure 2-14</b> and <b>Figure 2-37</b>	Provides for better capacity for TBM extraction using machinery above tunnel alignment. Reference Design eastbound tunnel portal was very close to existing residences.
Cut and Cover tunnels and tunnel entry and exit portal locations	Westbound entry portal located in line with the eastern side of the Brisbane Girls Grammar School with cut and cover approximately 406m long through the westbound lanes of the ICB Eastbound exit portal located in line with Victoria Park Road some 100 m east of the TBM portal	Westbound entry portal located 300m further west in line with Victoria Park Road. Eastbound exit portal located 60m east to the western side of the INB overpass. Tunnel portals located together and within the centre of the ICB  Refer to <b>Figure 2-14</b> and <b>Figure 2-37</b>	Significantly reduces the impact of the works on ICB traffic during construction by some 330m of cut and cover through the westbound lanes of the ICB

Design Element	Description of the Reference Design (RD)	Description of the proposed Change	Reason(s) for Change
	Refer to <b>Figure 2-13</b> and Supplementary Report Volume 2 Planning Layouts		
Tunnel entry and exit transition ramps to the ICB	<p>Eastbound transition exit ramp from Victoria Park Road portal to the INB Busway. Westbound transition entry ramp from the eastern side of the Brisbane Girls Grammar School (BGGs) for approximately 190m</p> <p>Refer to <b>Figure 2-13</b> and Supplementary Report Volume 2 Planning Layouts<sup>1</sup></p>	<p>The transition ramps for the Changed Project have also been brought together from a position in line with the middle of BGGs to the tunnel portals between Victoria Park Road and the INB overpass.</p> <p>Refer to <b>Figure 2-14</b> and <b>Figure 2-37</b></p>	Due to changes in the positions of the cut and cover tunnels due to the realignment of the ICB in order to create off-line construction conditions with significantly reduced traffic impacts and also better sight lines for merge and diverge conditions.
Realignment of the ICB outbound lanes to the north	ICB eastbound maintains similar alignment to existing.	<p>ICB realigned approximately 40m through the lower section of the Brisbane Grammar playing fields and beneath an additional INB bridge span</p> <p>Refer to <b>Figure 2-14</b> and <b>Figure 2-37</b></p>	<p>The ICB realignment to the north provides additional median space within which to construct the Northern Link Connection off-line - ie no requirement to relocate and replace the westbound lanes of the ICB to construct the extensive cut and cover tunnel entry.</p> <p>Will significantly reduce construction conflicts with the operation of the westbound lanes of the ICB.</p>
ICB merge and diverge locations	<p>The Reference Design eastbound merge length was approximately 375m to an area some 50m west of the landbridge. Due to the extensive cut and cover tunnel with the Reference Design the westbound diverge length was restricted to some 90m.</p> <p>Refer drawings <b>Figure 2-13</b> and Supplementary Report Volume 2 Planning Layouts<sup>1</sup></p>	<p>The Changed Project merge length is some 410m which extends the merge to the landbridge. The Changed Project's diverge length into the relocated tunnel portal is approximately 240m and provides better sight distances to motorists compared to the Reference Design.</p> <p>Refer to <b>Figure 2-14</b> and <b>Figure 2-37</b></p>	An additional benefit resulting from the change to portal locations
Eastern ventilation and other infrastructure and maintenance access.	<p>Location to the east of the INB with no urban design or access identified.</p> <p>Refer to <b>Figure 2-13</b> and Supplementary Report Volume 2 Ventilation Site Plans<sup>4</sup></p>	<p>Urban design developed and controlled access identified off the eastbound carriageway of the ICB</p> <p>Refer to <b>Figure 2-37</b> and <b>Figure 2-39</b></p>	<p>No change to the general location.</p> <p>Further development of the project design to identify urban design and maintenance access.</p>

<sup>1</sup> Northern Link EIS Supplementary Report Volume 2: Project Design, June 2009 – Drawing EIS-PL-00 to EIS-PL-10

<sup>2</sup> Northern Link EIS Supplementary Report Volume 2: Project Design, June 2009 – Drawings EIS-LS-01 to EIS-LS-04

<sup>3</sup> Northern Link EIS Supplementary Report Volume 2: Project Design, June 2009 – Drawings EIS-TX-01 to EIS-TX-03

<sup>4</sup> Northern Link EIS Supplementary Report Volume 2: Project Design, June 2009 – Drawing EIS-VS-00 to EIS-VS-02

(The above drawings can be viewed at <http://www.northernlinkeis.com.au/EISDocuments.html#1>)

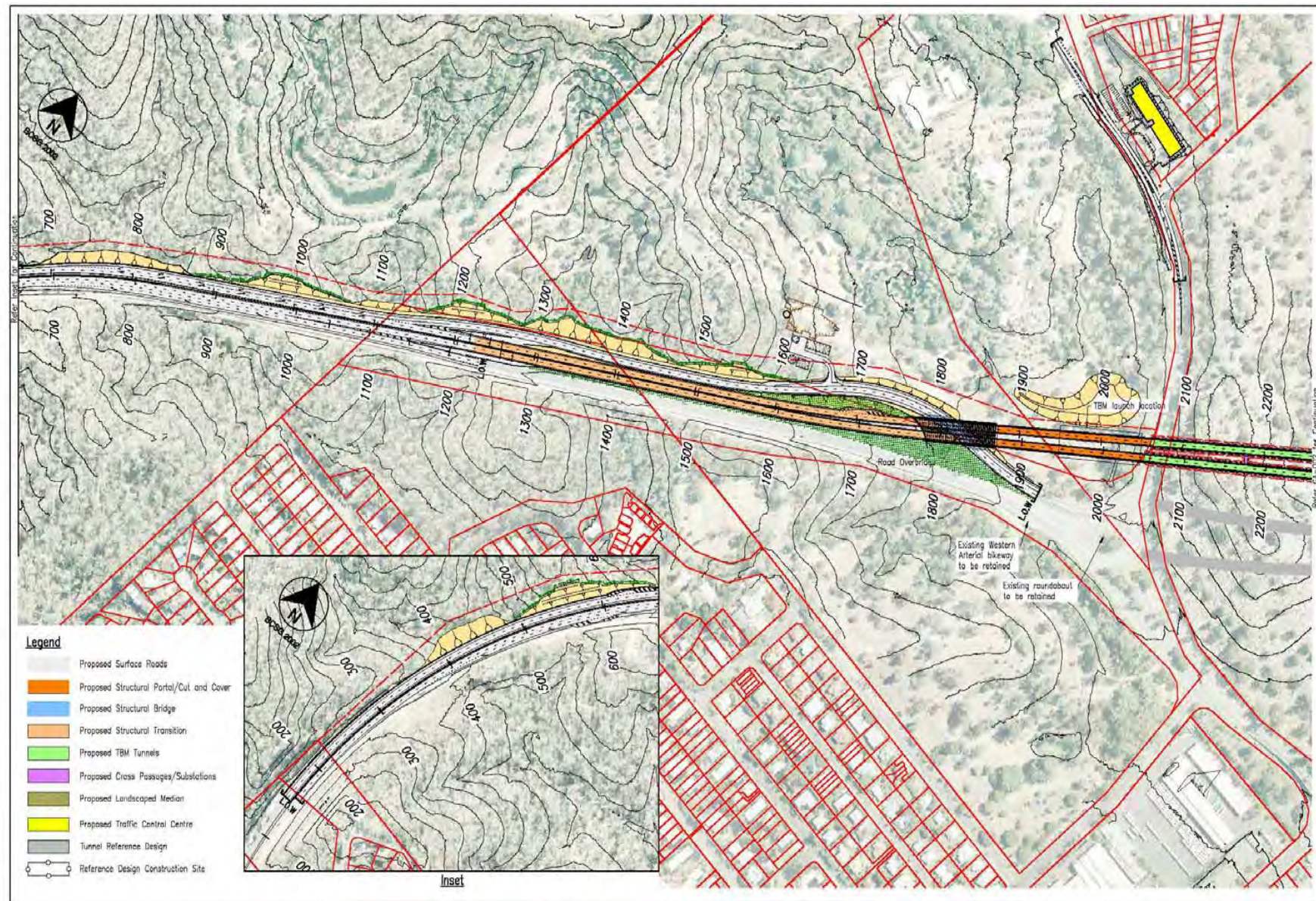


Figure 2-17: Changed Project alignment – Centenary Motorway Connection

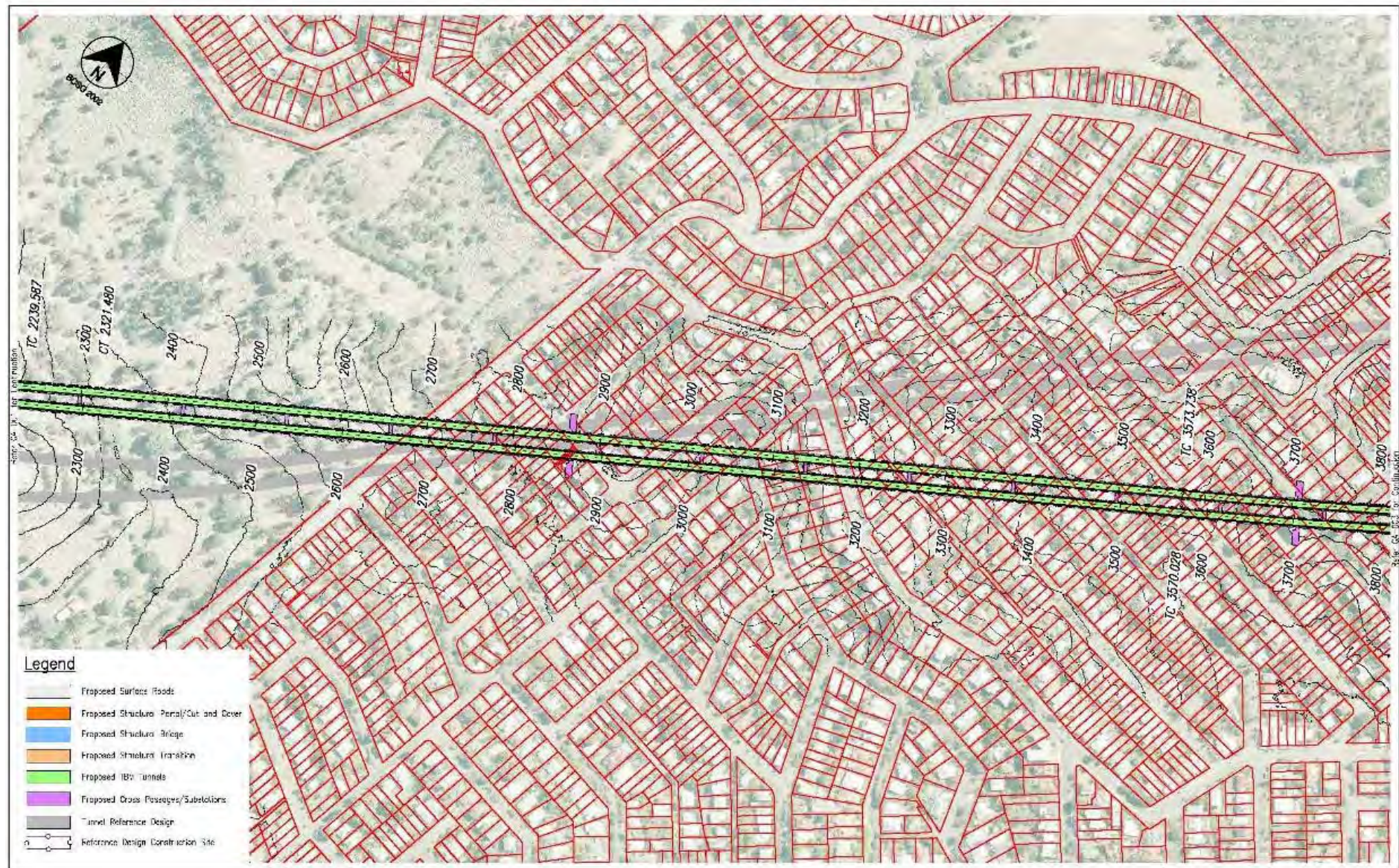


Figure 2-18: Changed Project alignment – Toowong Cemetery to Thomas Street

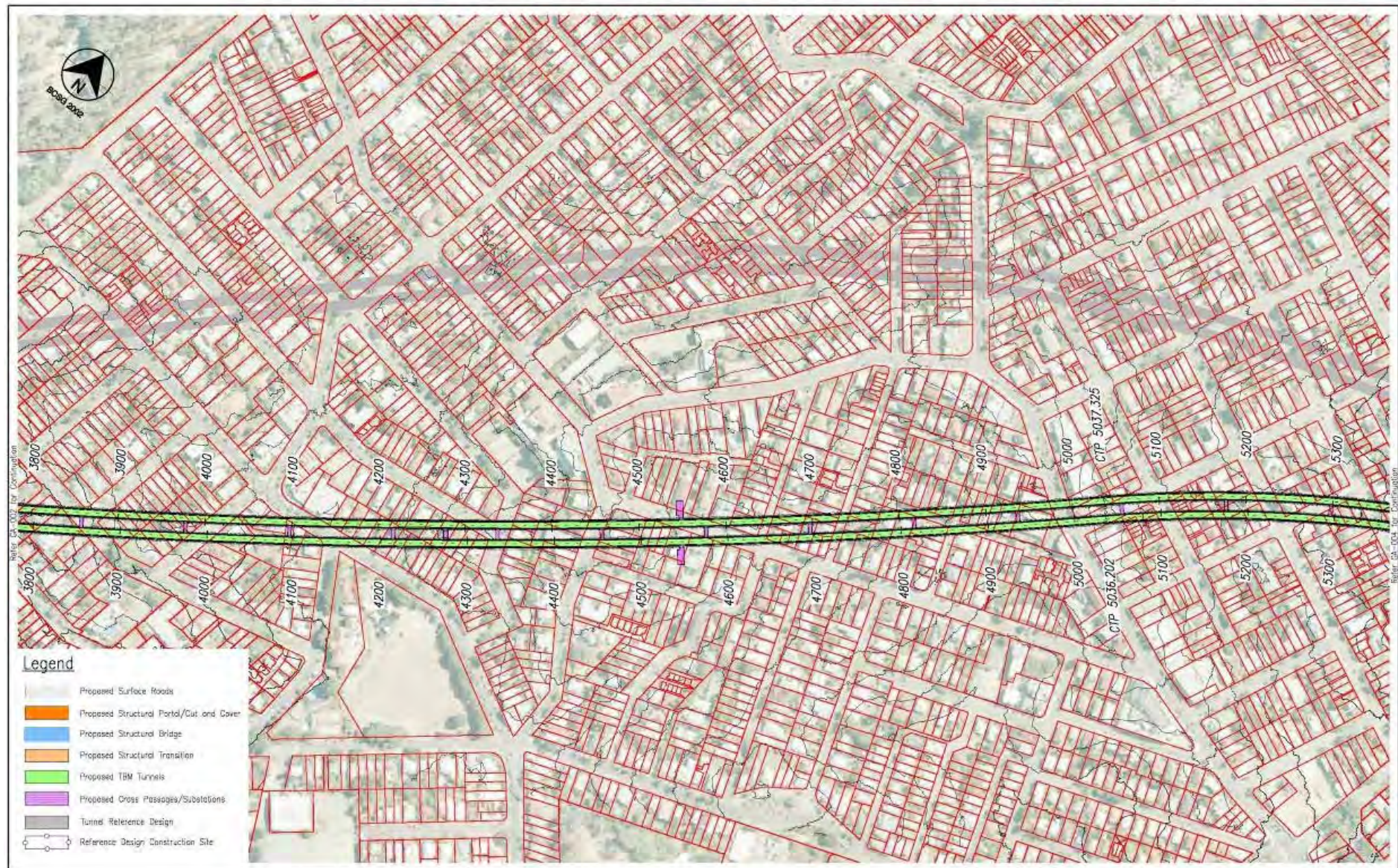


Figure 2-19: Changed Project alignment – Thomas Street to Plunkett Street

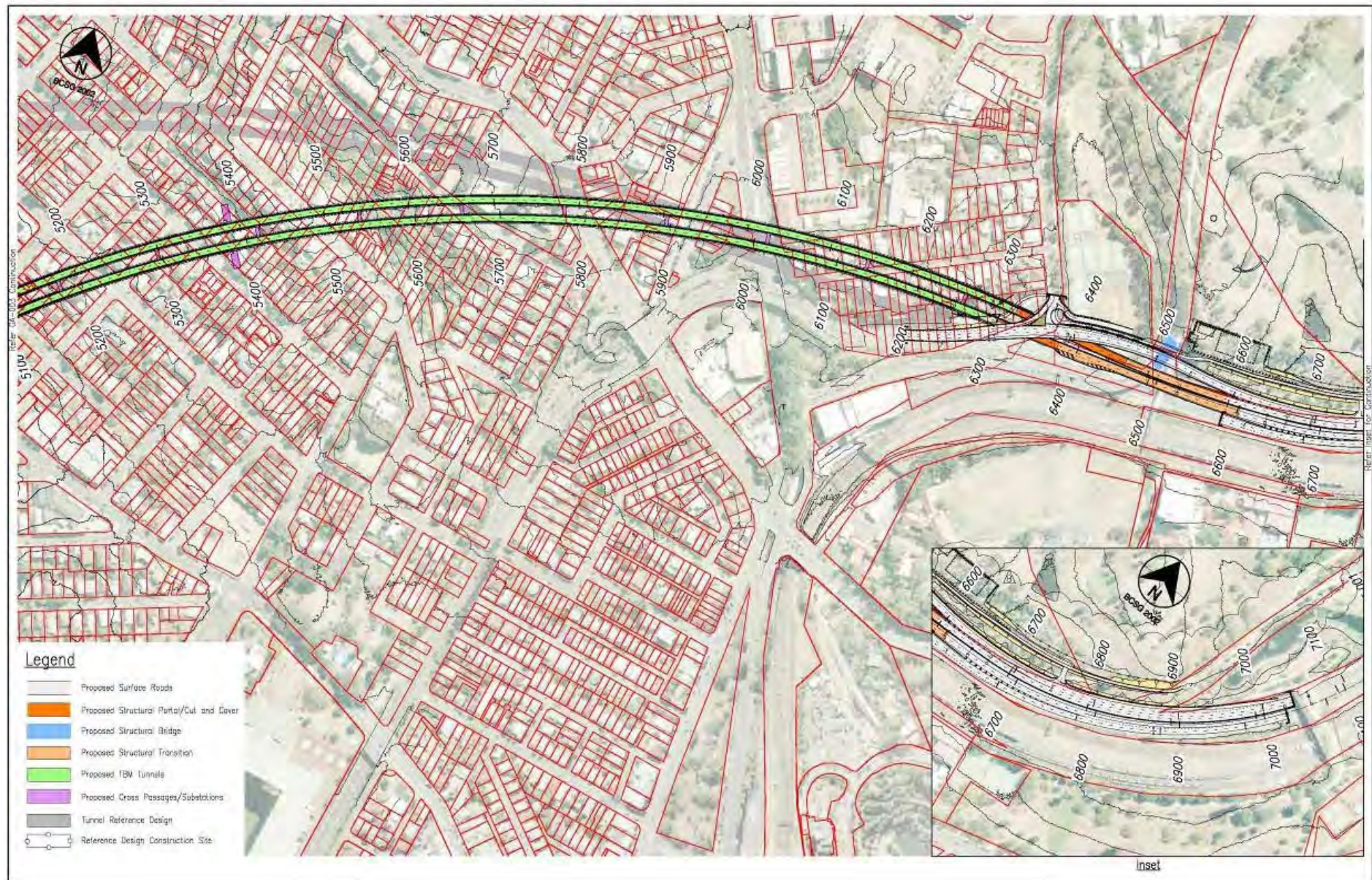


Figure 2-20: Changed Project Alignment – ICB Connection



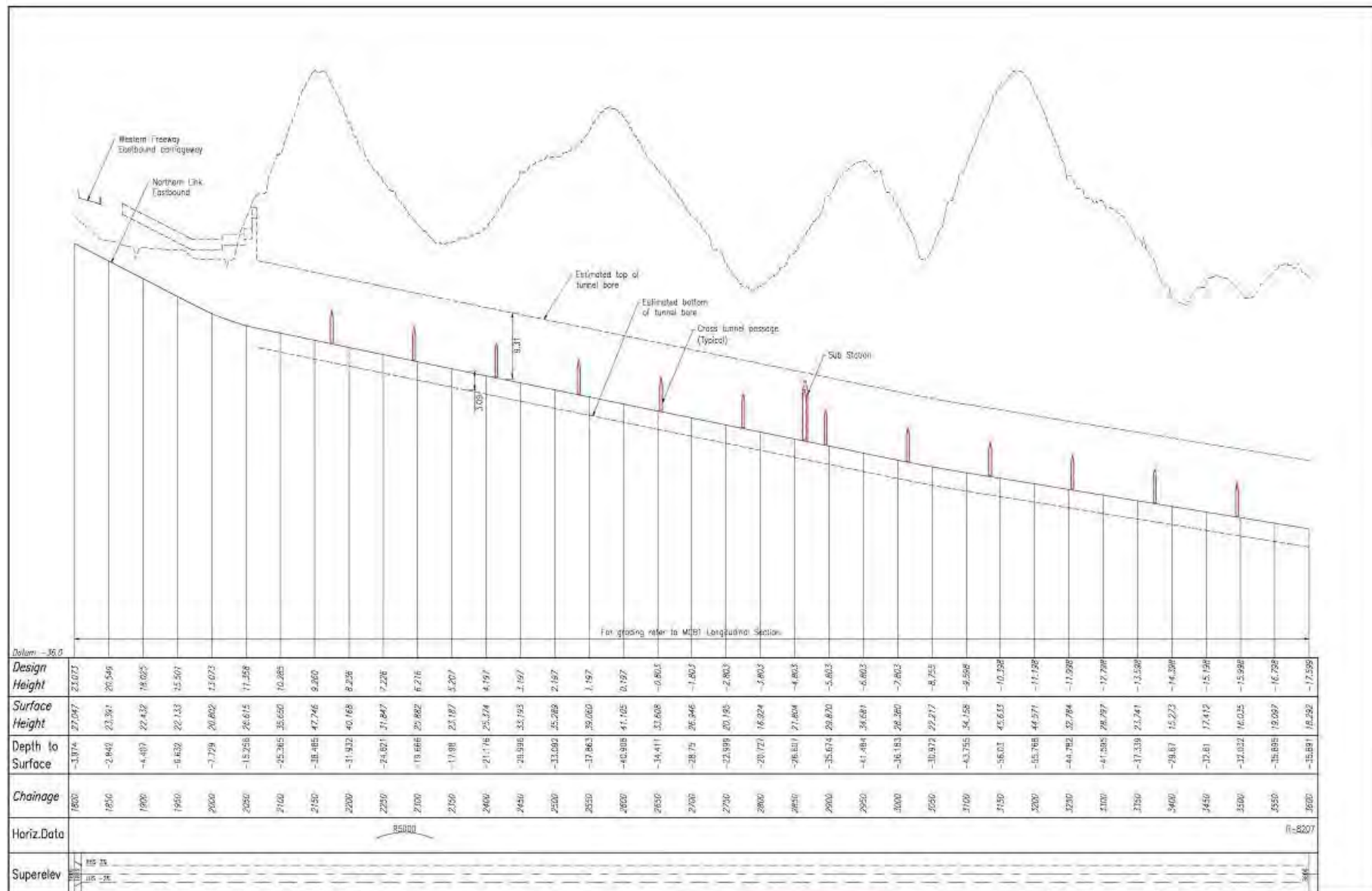


Figure 2-22: Eastbound tunnel vertical alignment – Toowong Cemetery to Thomas Street

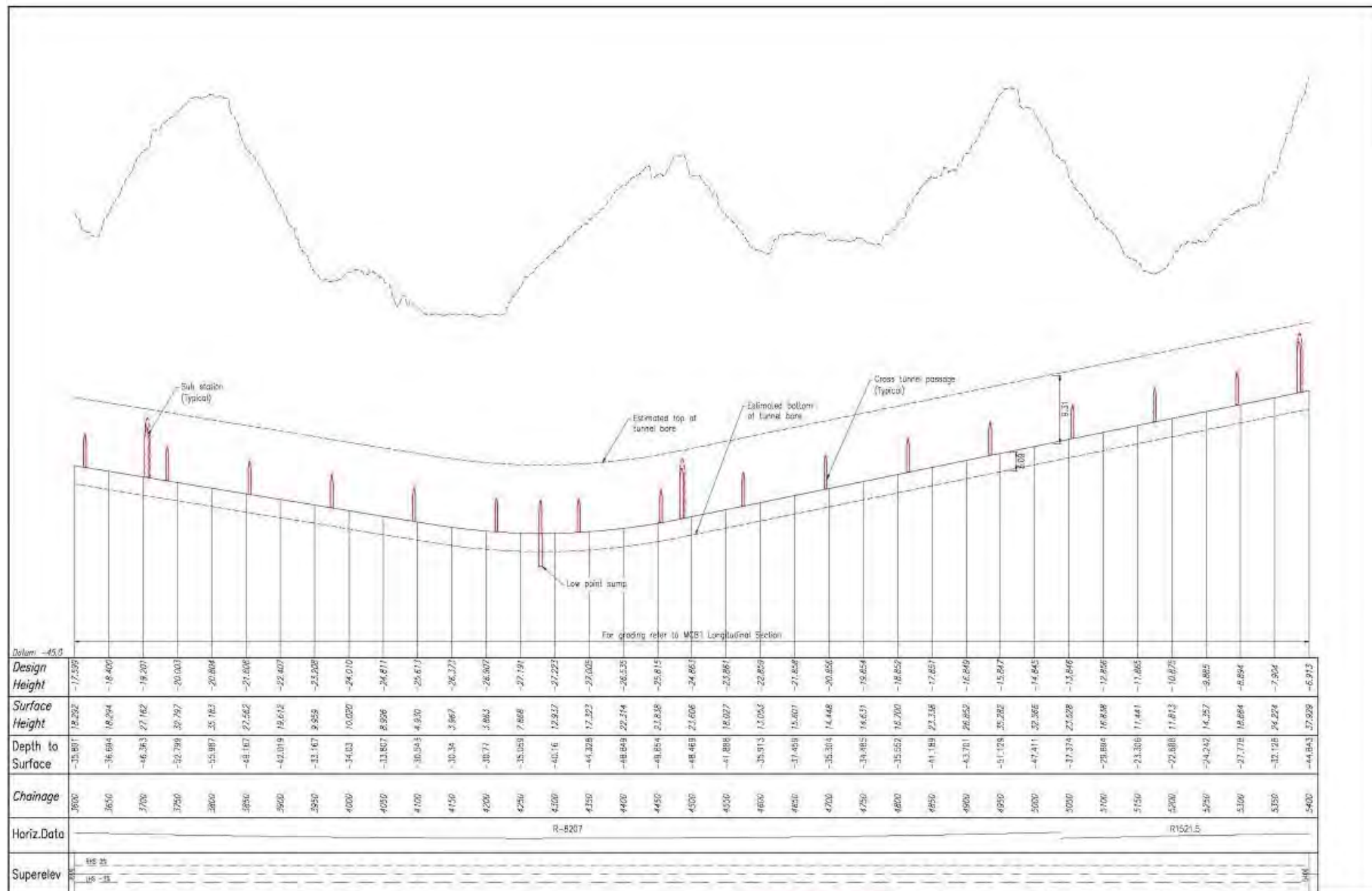


Figure 2-23: Eastbound tunnel vertical alignment – Thomas Street to Plunkett Street

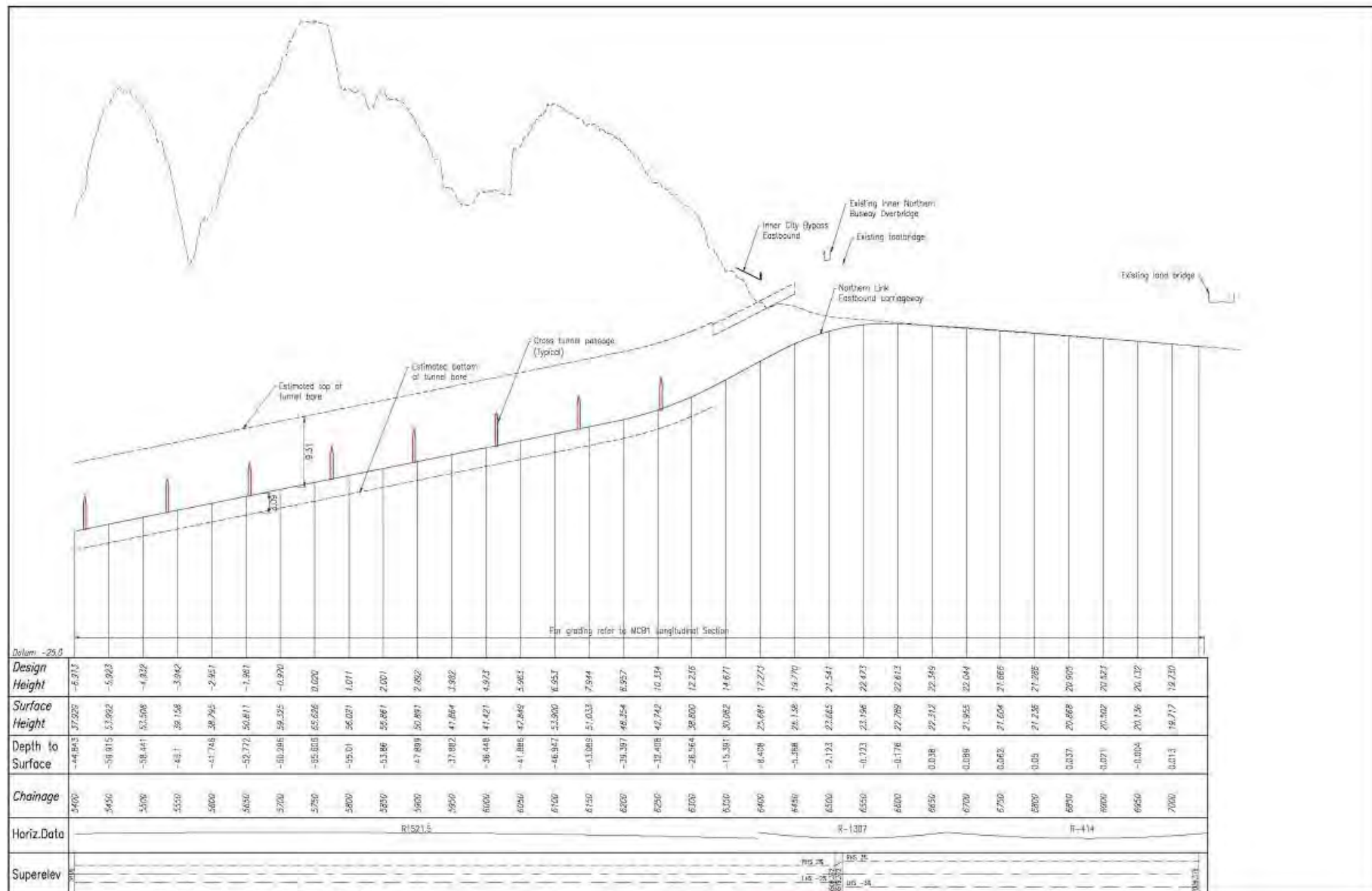


Figure 2-24: Eastbound tunnel vertical alignment –ICB Connection

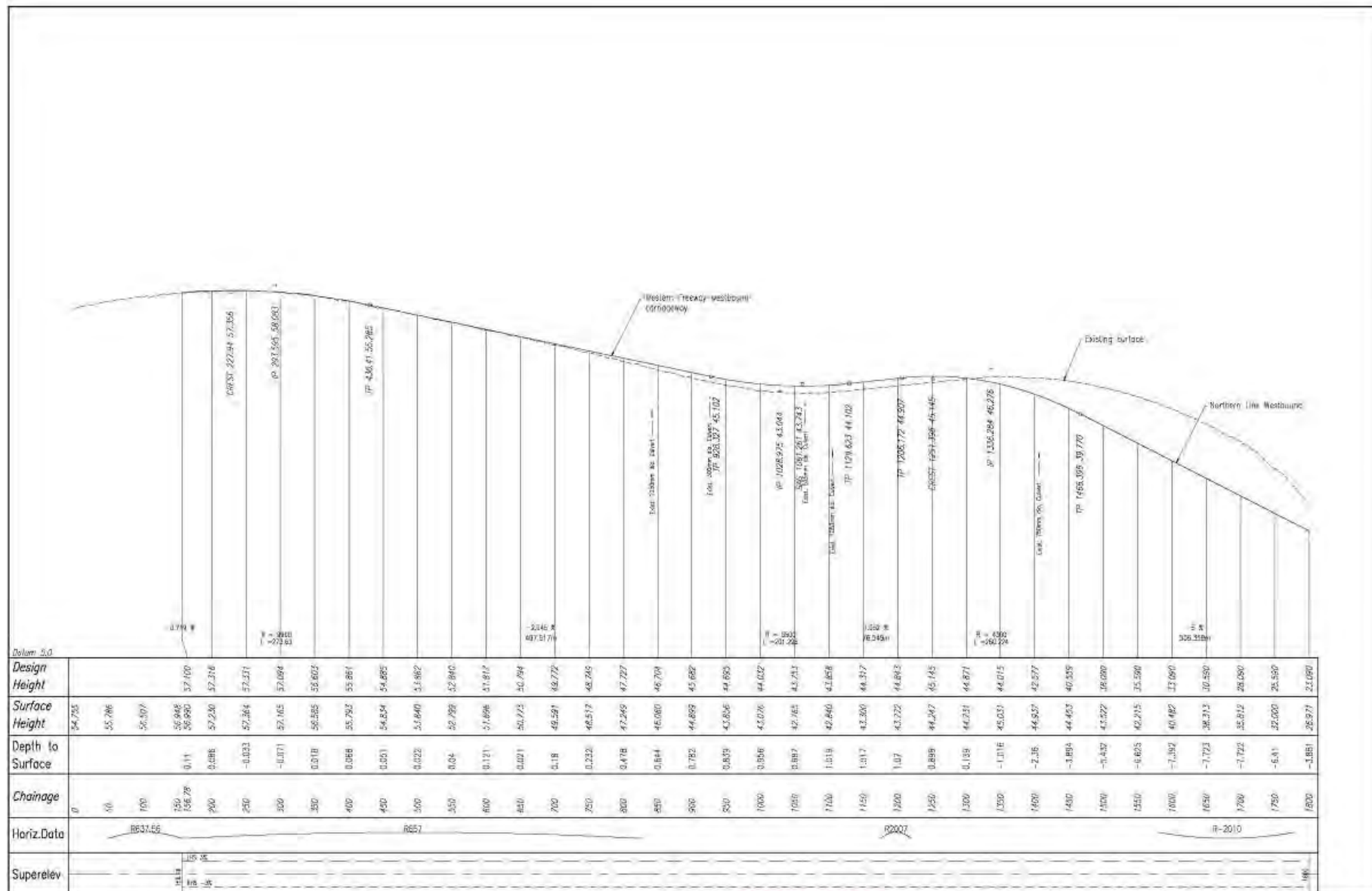


Figure 2-25: Westbound tunnel vertical alignment – Centenary Motorway Connection

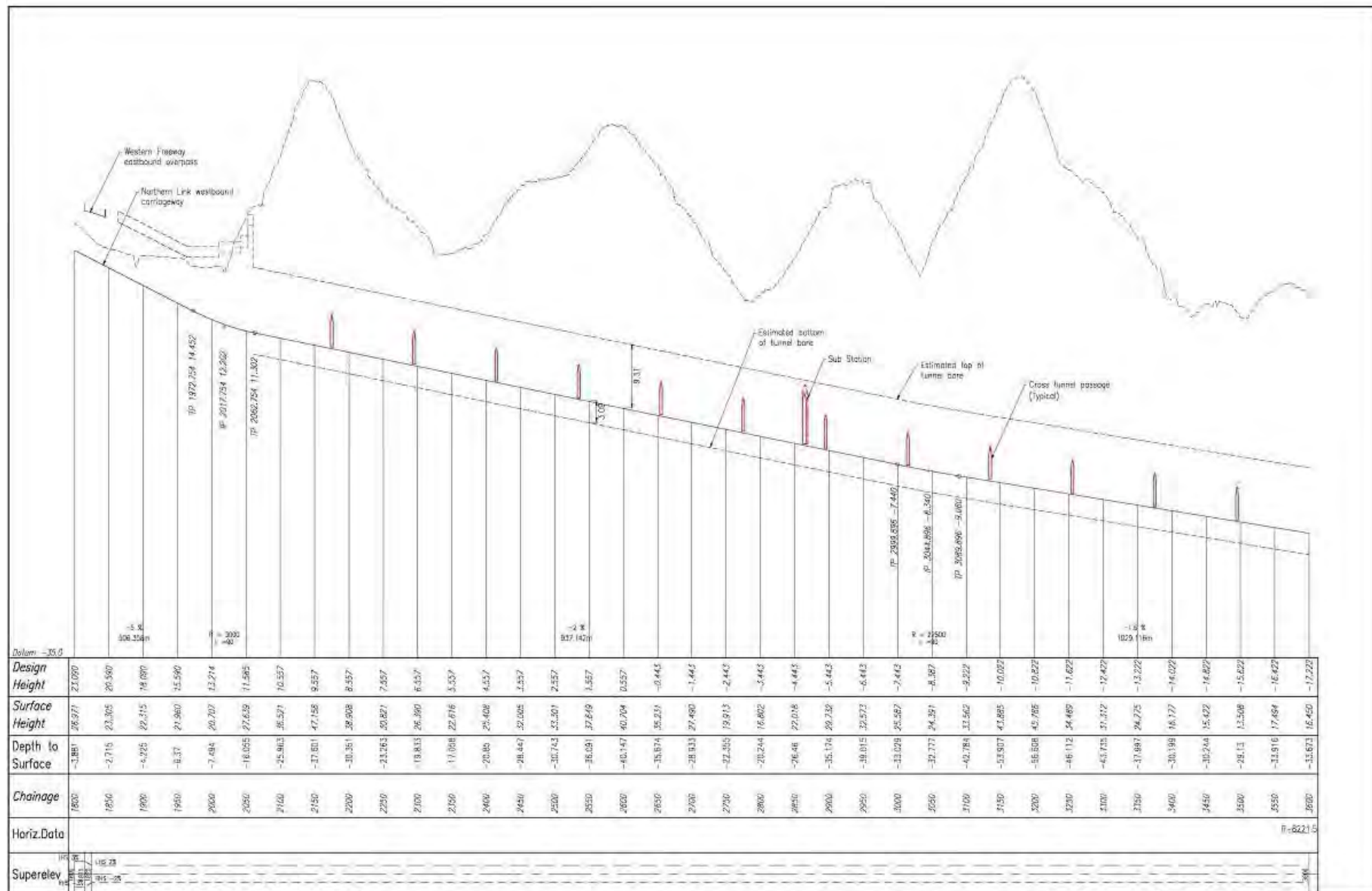


Figure 2-26: Westbound tunnel vertical alignment – Toowong Cemetery to Thomas Street

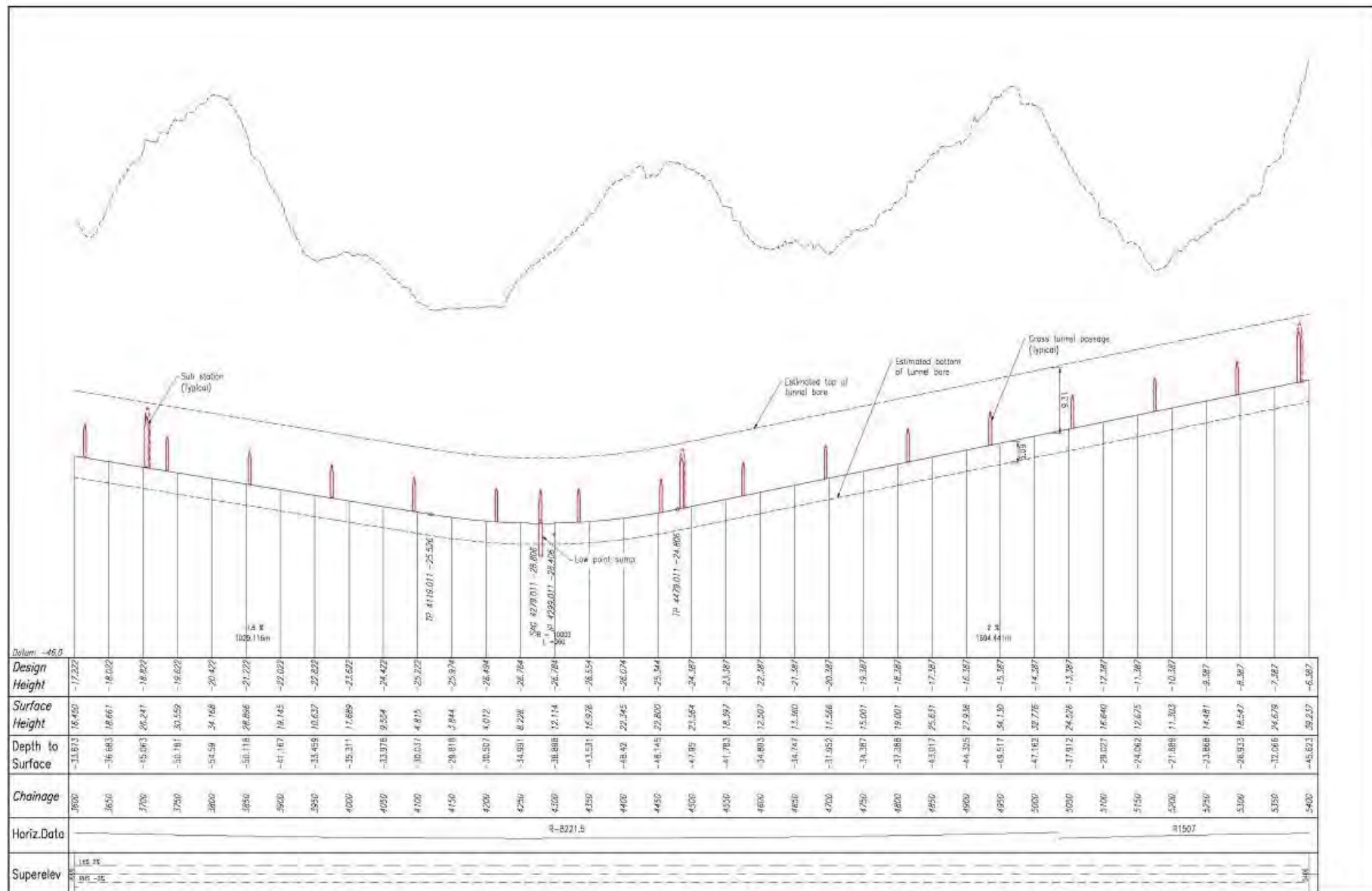


Figure 2-27: Westbound tunnel vertical alignment – Thomas Street to Plunkett Street

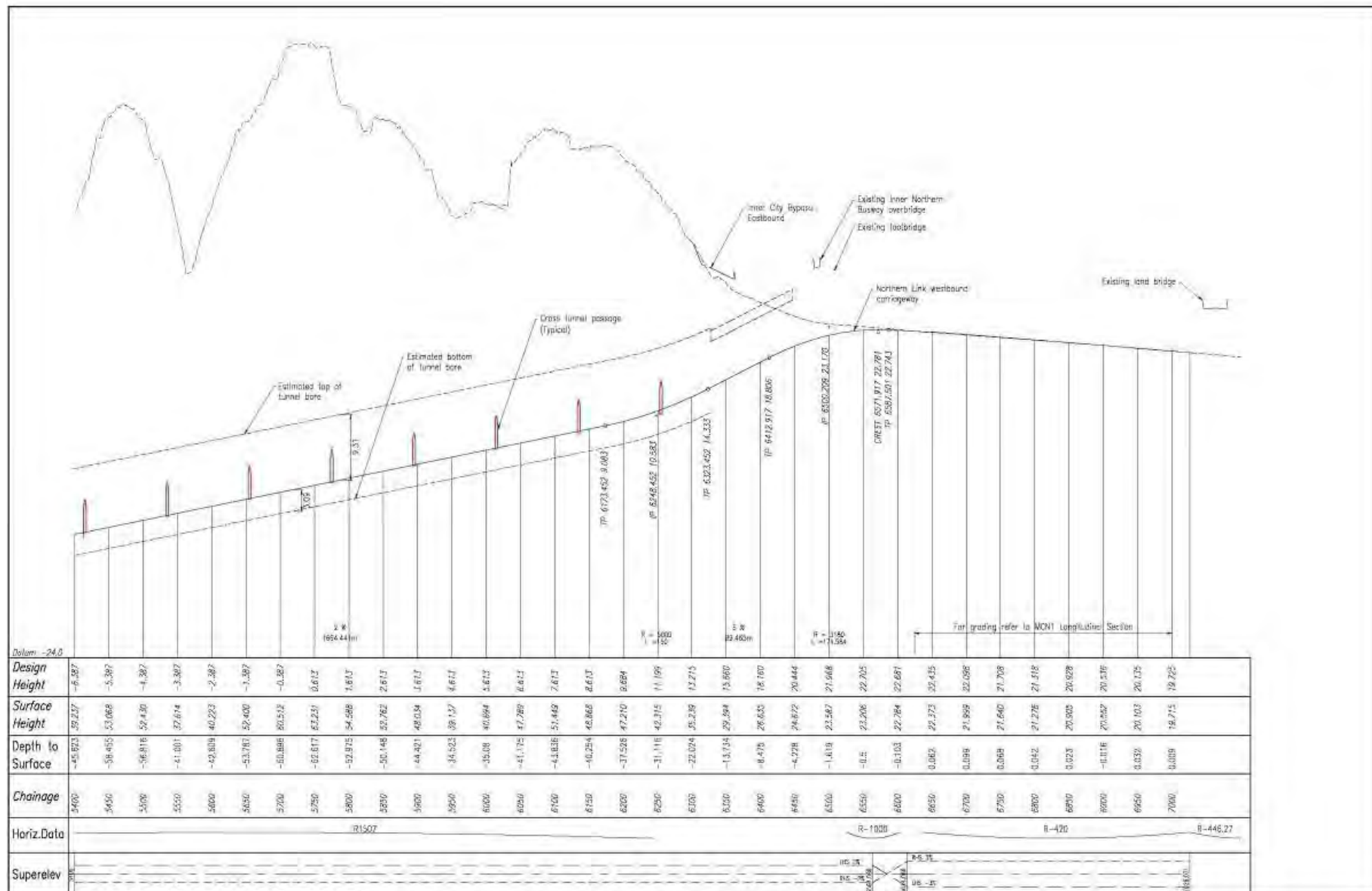


Figure 2-28: Westbound tunnel vertical alignment –ICB Connection

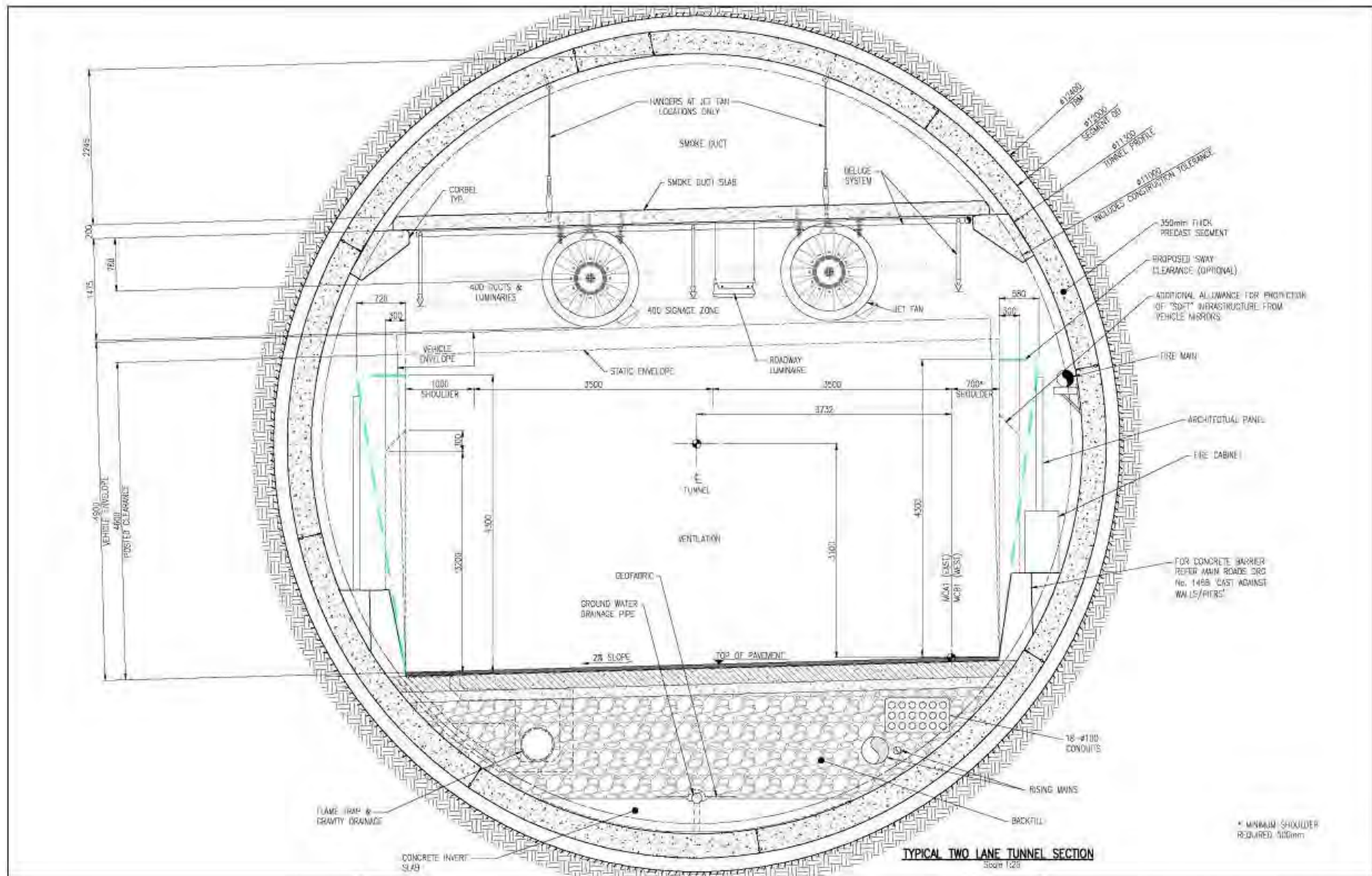


Figure 2-29: Tunnel profile cross section

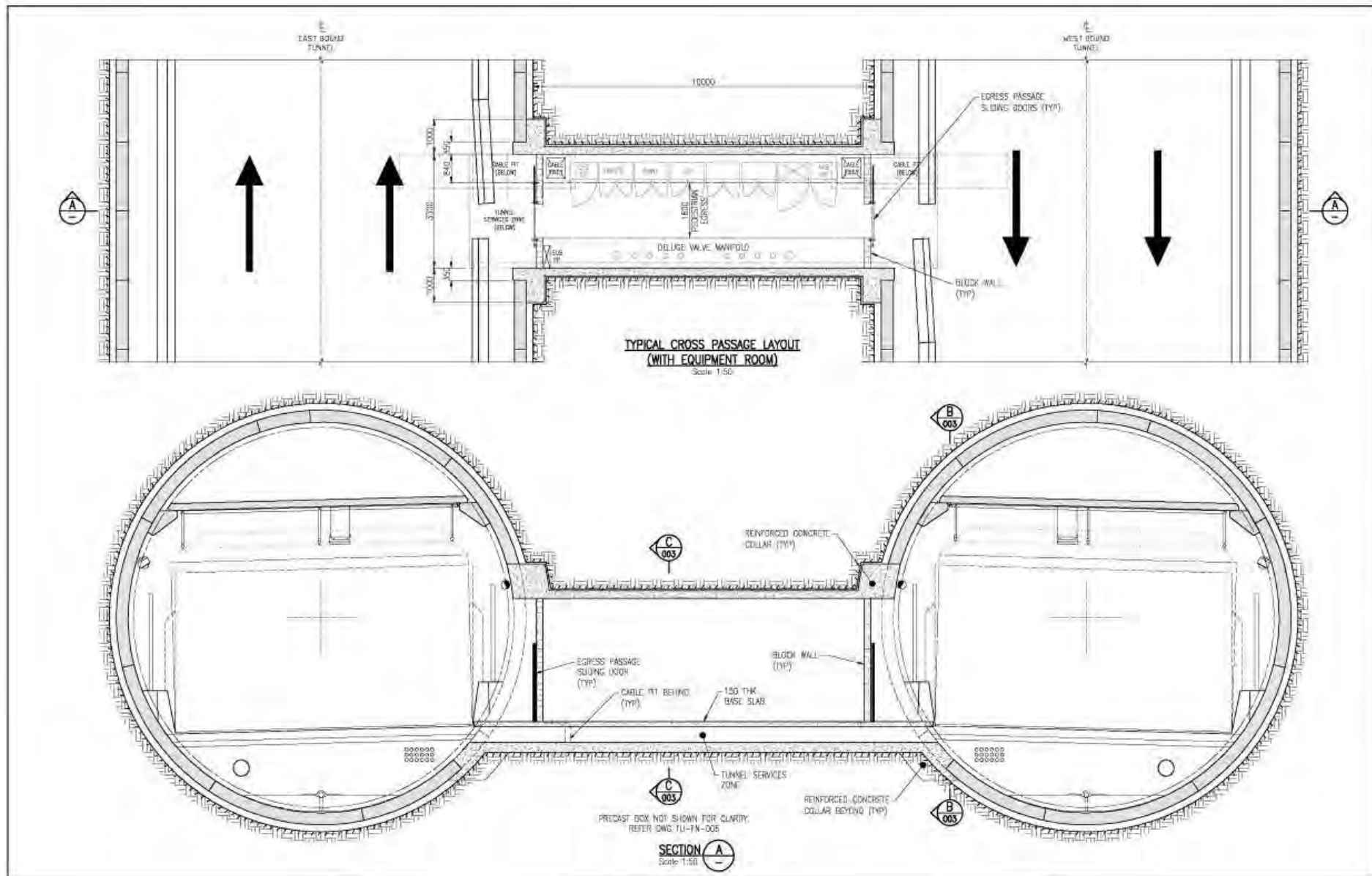


Figure 2-30: Typical cross passage – Plan and Elevation

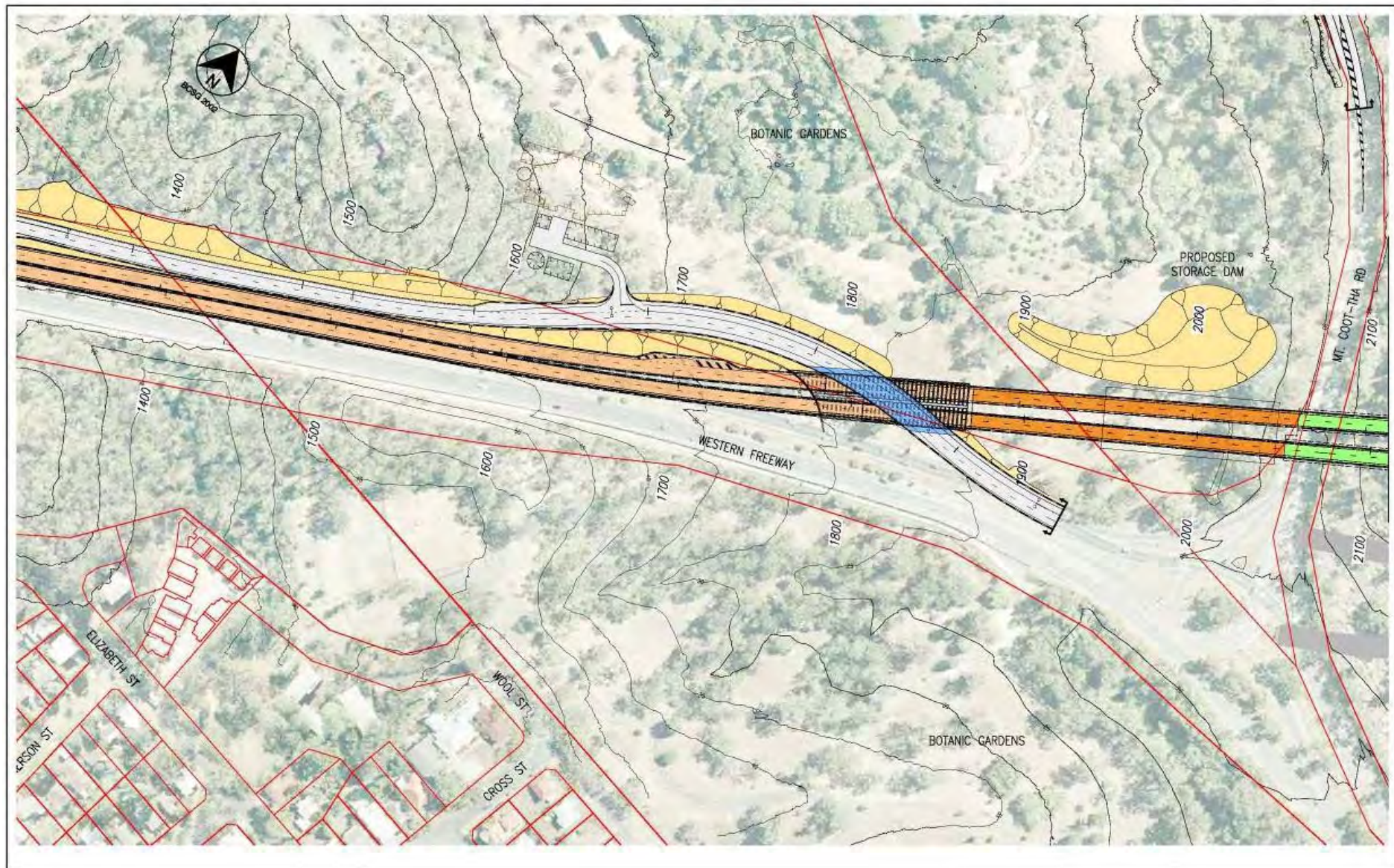


Figure 2-31: Changed Project – Western connection overview



Figure 2-32: Tollroad Control Centre – Proposed Site



Figure 2-33: Tollroad Control Centre – Landscape master plan



Figure 2-34: Tollroad Control Centre – Artist impression view north



Figure 2-35: Tollroad Control Centre – Artist impression view east

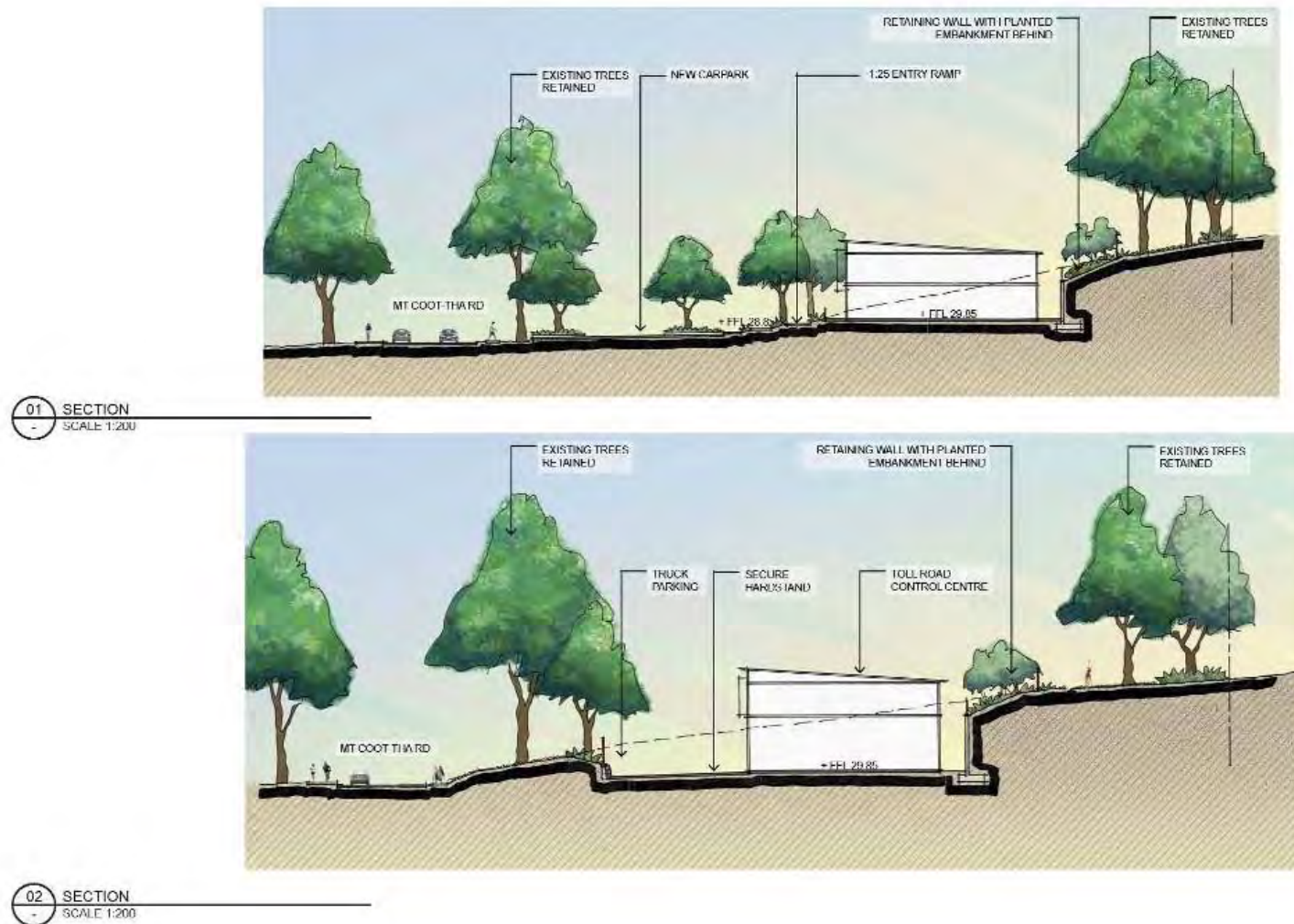


Figure 2-36: Tollroad Control Centre – Cross section

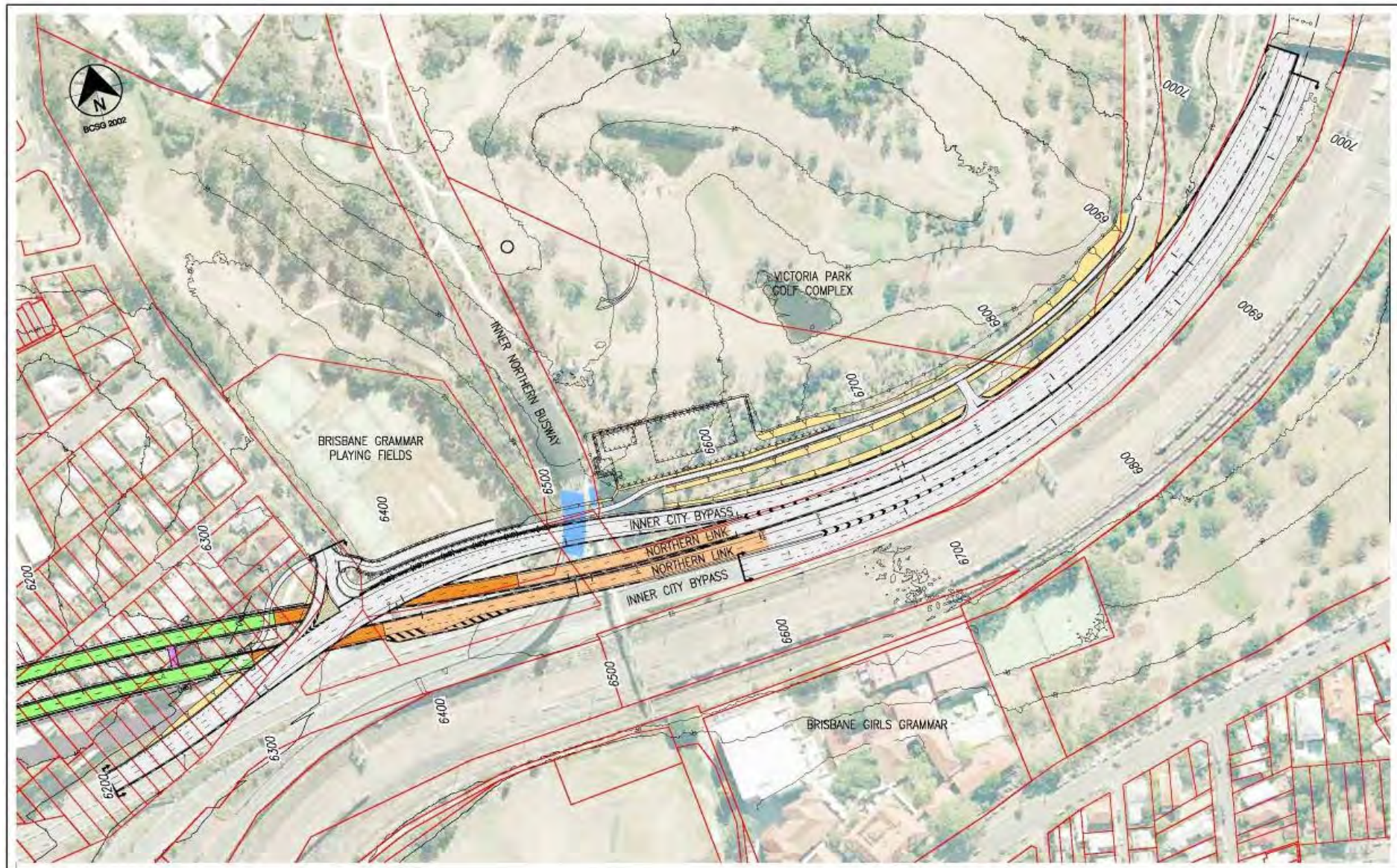


Figure 2-37: Changed Project – Eastern connection overview



Figure 2-38: Western ventilation station and outlet



Figure 2-39: Eastern ventilation station and outlet

## 2.2 Main Alignment

### 2.2.1 Design Changes – Main Alignment

The alignment of the main tunnels in the Changed Project would be straighter than for the Reference Project. This change would provide a more direct route between the Centenary Motorway and the ICB. This alignment would be generally shallower than the Reference Design, particularly for the western half of the route due to the local topography above the changed alignment and flatter tunnel gradients. These flatter gradients would provide greater efficiencies for traffic use and tunnel operations, such as safety and ventilation.

The horizontal alignment would be up to 60m north of the Reference Design at the tunnel portals at the eastern edge of the Botanic Gardens and up to 100m north of the Reference Design underneath the Mt Coot-tha Cemetery until meeting the Reference Design alignment just to the east of Frederick Street, between Thorpe and Sleath Streets, Auchenflower. The alignment would then be located south of the Reference Design passing just to the north of Gregory Park at Baroona Road, Rosalie and 350m south of the Reference Design in the area of Guthrie Street, Paddington and joining the Reference Design location near Kelvin Grove Road, Kelvin Grove with the driven tunnel finishing south of Normanby Terrace and to the west of Victoria Park Road, Herston.

The vertical alignment would be generally shallower and flatter than the Reference Design although the eastern area from Cairns Terrace, Red Hill to the ICB is deeper than the Reference Design as shown in **Table 2-3** below.

**Table 2-3: Approximate depth from existing surface to crown of the tunnels**

Location	Reference Design		Changed Project	
	Eastbound Tunnel Depth (m)	Westbound Tunnel Depth (m)	Eastbound Tunnel Depth (m)	Westbound Tunnel Depth (m)
Western Driven (TBM) Tunnel Portal	11	9	9	8
Toowong Cemetery	15	16	9 to 33	8 to 31
Frederick Street (near its intersection with Thorpe Street), Toowong	36	33	19	18
Birdwood Terrace at its intersection with Gregory Street), Auchenflower The equivalent Changed Project location is Birdwood Terrace between Hume Street and Gregory Street, Auchenflower	58	58	49	49
Carrington St at its intersection with Daintree Street, Paddington The equivalent Changed Project location is Thomas Street west of Renie Street, Auchenflower	60	66	39	38
Baroona Road (between Howard and McNab Streets), Paddington The equivalent Changed Project location is Howard Street near its intersection with Bass St, Paddington	50	48	40	37
Beck Street (west of its intersection with Nash Street), Paddington The equivalent Changed Project location is Baroona Road near its intersection with Bayswater Road, Paddington	30	30	21	21

Location	Reference Design		Changed Project	
	Eastbound Tunnel Depth (m)	Westbound Tunnel Depth (m)	Eastbound Tunnel Depth (m)	Westbound Tunnel Depth (m)
Fernberg Road (east of its intersection with Ellena Street) Paddington The equivalent Changed Project location is Fernberg Road to the south of Guthrie Street, Paddington	29	29	41	39
Latrobe Terrace, north of its intersection with Cochrane Street, Paddington The equivalent Changed Project location is Given Terrace near its intersection with Great George St, Paddington	48	48	40	38
Hayward Street (between Plunket and Charlotte Streets), Paddington The equivalent Changed Project location is Charlotte Street between Great George St and Martha St, Paddington	20	20	16	14
Cairns Terrace at its intersection with Great George Street, Red Hill The equivalent Changed Project location is Cairns Terrace between Great George Street and Dowse Street, Red Hill	43	47	52	49
St Brigid's Church on Musgrave Road, Red Hill	48	48	51	51
Kelvin Grove Road (north of the ICB) Kelvin Grove	16	15	27	25
Eastern Driven (TBM) Portal, Kelvin Grove	9	8	10.5	12.5

Table source – Northern Link EIS Supplementary Report Sept 2009 – Table 3-1.

There remains the need for volumetric acquisitions of property where the Changed Project passes beneath as shown in **Table 2-4** below.

**Table 2-4: Changes to volumetric property requirements**

	Volumetric	
	Reference Design	Changed Project
<b>Private</b>	374	328
<b>State</b>	NIL	NIL
<b>Council</b>	NIL	6

There are 334 properties currently identified as being affected by the need for the acquisition of a volumetric (subsurface) title for the Changed Project. Of these, 269 would be newly affected, including 6 Council-owned parcels, with a further 65 properties affected by the Changed Project as they would be by the Reference Design. Subject to detailed design and detailed property survey, there may be some further minor changes to the location and numbers of volumetric property requirements.

The changes in volumetric property requirements are brought about through the design changes in the main alignment together with further design investigations. Such investigations include the provision of a 1.5m buffer around the perimeter of each tunnel to accommodate tunnel supports and other contingencies for volumetric land tenure, as well as the inclusion of underground cross passages and substations.

### 2.2.2 Delivery Changes – Main Alignment

Generally, the construction method for the two main tunnels would be substantially the same as the Reference Design. The main difference in the delivery modes for the Reference Project and the Changed Project relates to the proposed lining of the main tunnels to prevent the inflow of groundwater and to provide enhanced structural support. The linings would be provided by continuous installation of pre-cast concrete segments made off-site during the construction phase. The Reference Project proposed a drained tunnel construction by TBMs with cast in-situ concrete lining. The drained cross passages would remain as proposed in the Reference Design, with cast in-situ concrete lining.

This change in delivery mode would require regular delivery of pre-cast concrete segments to the western worksite, where they would be stored, or laid down, pending their application by the TBMs. The transport task and effects of this proposed change are discussed in section 3.3.1 of this Application.

As with the Reference Project, the construction of the Changed Project would entail launching two TBMs from the western worksite adjacent to the Botanic Gardens. The TBMs would be extracted from the proposed cut and cover areas south of Normanby Terrace as proposed in the Reference Design.

The management systems for the tunnel's operation, including mechanical, electrical and ventilation systems and fire and life safety systems remain as described for the Reference Design.

## 2.3 Western Connection

### 2.3.1 Design Changes – Western Connection

#### Tunnel portals

The Changed Project connects with the Centenary Motorway in the west via portals located in the centre of the motorway, whereas the Reference Design proposed connections and portals on either side of the motorway. With the associated realignment of the Centenary Motorway through lanes to Mt Coot-tha Road, the portals for the Changed Project would be immediately west of Mt Coot-tha Road approximately 60m to 100m north of those proposed in the Reference Design.

The portals for the Changed Project would connect with the Centenary Motorway by cut and cover tunnel sections located approximately 185m west of Mt Coot-tha Road, similar to the Reference Design connection. However the Changed Project connections would be adjacent to each other rather than on either side of the Centenary Motorway as proposed for the Reference Design. This enables all cut and cover work for the launching of the TBMs to be off-line from the existing live traffic lanes of the motorway and within the western worksite.

There would be several advantages in this arrangement over the Reference Design including:

- no tunnel or road construction through Anzac Park, Toowong;
- no construction within the west-bound lanes of the Centenary Motorway;
- maintaining access to the existing cycleway and the pedestrian and cycle bridge structure over the Centenary Motorway;

- the removal of proposed cut and cover construction through Mt Coot-tha Road and the Mt-Coot-tha roundabout; and
- improved traffic management and pedestrian and cycle access during construction.

The tunnel infrastructure within the Botanic Gardens for the Changed Project would be covered and landscaped consistent with the possible future expansion of the Botanic Gardens.

There would be a length of semi-enclosed transition structure up to approximately 50m within the future extension area of the Botanic Gardens where the realigned inbound lanes of the motorway would cross the lanes of the Changed Project. The realigned Centenary Motorway and associated cross-over of the tunnel transition access would be located at-grade and would not intrude on views from public areas within the Gardens.

### **Motorway surface connection**

The ramps proposed to connect with the Centenary Motorway inbound would extend for some 650m or approximately 40m further than the Reference Design but within the centre of the Centenary Motorway. The inbound lanes of the Centenary Motorway would be realigned to the north of their current position to accommodate the central portals.

The realigned inbound lanes would come back over the tunnel connection to rejoin the motorway to the west of the Mt Coot-tha roundabout.

For the Changed Project, the eastbound diverge from the Centenary Motorway to the Mt Coot-tha roundabout would be approximately 375m in length, compared with the diverge length of 175m in the Reference Design. This would improve traffic arrangements further and would comply with relevant design standards.

The westbound merge from the Mt Coot-tha roundabout to the Centenary Motorway would be approximately 650m in length for the Changed Project compared with the Reference Design merge length of approximately 800m. The commencement of the merge for the Changed Project would be further west than the Reference Design due to the differences in vertical geometry.

Any potential future widening of the Centenary Motorway to three lanes each way by DTMR could still be accommodated with the Changed Project. However, any such widening, if required, would be on the outside of the motorway, rather than within the existing median area as proposed in the Reference Design.

The vertical alignment or gradient of the tunnels and transitions to the surface have also changed, improving exit speeds particularly for heavy commercial vehicles. The length of downgrade into the tunnels with gradients greater than 3% has also been reduced by almost half from 1200m for the Reference Design to 650m for the Changed Project with an associated potential for improved vehicle safety on tunnel entry.

### **Tollroad Control Centre (TCC)**

The Reference Design proposed that the TCC be located adjacent to the Centenary Motorway within the rehabilitated worksite area. The TCC for the Changed Project would be located at the corner of Richer Street and Mt Coot-tha Road adjacent to the existing Botanic Gardens overflow car park (refer **Figure 2-33 to Figure 2-36**). The Reference Design proposed site would have impacted on the Botanic Gardens, whereas the Changed Project location would avoid further above ground infrastructure and

traffic within this significant public area.. The DTMR has raised concerns about unrestricted access from the Centenary Motorway which would then have required public road access through the Botanic Gardens.

### Ventilation Station and Outlet

The ventilation station for the Changed Project would be buried next to the supporting surface infrastructure (eg sub-station, groundwater treatment, water storage). The supporting surface infrastructure would be above ground but constructed in a cutting in a similar location to that identified in the Reference Design and it would be infrequently serviced by left-in, left-out access from the Centenary Motorway. DTMR will be further consulted during the detailed design for this infrequent access.

The ventilation outlet is proposed to be situated above the western end of the buried ventilation station about 43m to the west of the site proposed in the Reference Design. The ventilation outlet would be at least 20m high and reach an elevation of at least 67m (AHD), consistent and complying with the Coordinator-General's conditions. There would be no change to the minimum height of the ventilation outlet.

The architectural treatment of the ventilation outlet for the Changed Project would ensure its assimilation into the landscape of the Botanic Gardens and the rising terrain to the west, towards Mt Coot-tha. The roof of the ventilation station would be landscaped to provide a functional pedestrian connection across the structure between the existing Gardens and areas to be rehabilitated and reinstated as Gardens space.

### Property requirement

No private properties would be required for the Changed Project's surface works at the western connection, consistent with the Reference Design. Two additional State-owned properties would be required. One is at the far western end of the Centenary Motorway and the other is the site required for the proposed Tollroad Control Centre. There would be an additional parcel of freehold land owned by the Council, adjacent to the State land at the far western end shown in **Table 2-5** below.

**Table 2-5: Western surface property access requirements**

	Western Surface	
	Reference Design	Changed Project
Private	NIL	NIL
State	1	3
Council	4	5

### 2.3.2 Delivery Changes – Western Connection

The Changed Project provides a further refinement of the method proposed in the Reference Design for the western worksite as shown on the stage 1 layout (**Figure 2-40**) and the stage 2 and 3 layout (**Figure 2-41**).

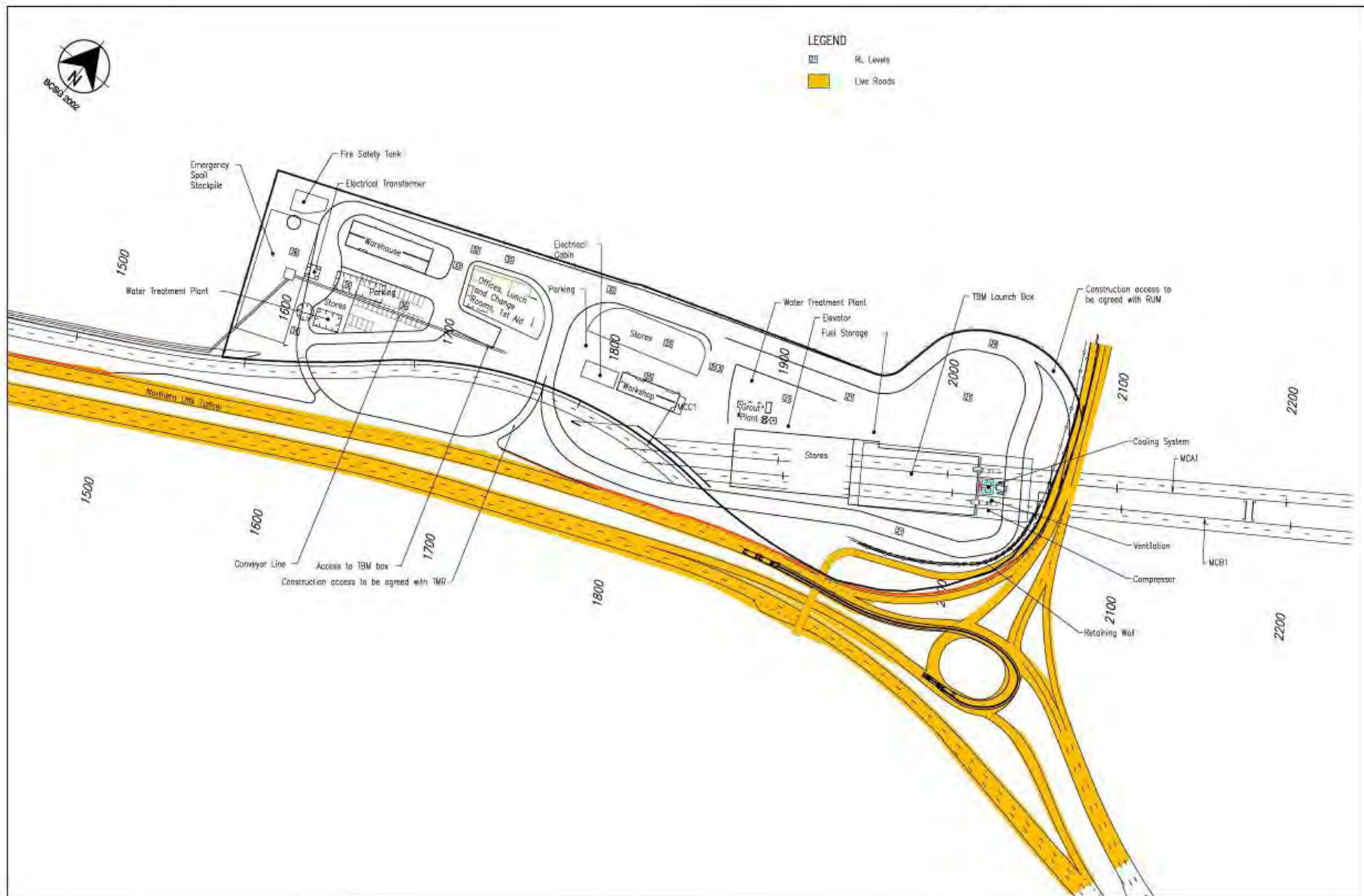


Figure 2-40: Western worksite – Stage 1 layout



### **Delivery Mode – Reference Design**

The Reference Design western worksite would be located on Council owned land on the northern side of the Centenary Motorway, adjacent to the Mt Coot-tha Botanic Gardens. The worksite would be used primarily for the launch and operation of the TBMs and would be approximately 4 hectares in area.

An enclosed, acoustic-lined shed approximately 110m long by 40m wide would sit over and to the west of the tunnel entry portal. This work shed would mitigate the anticipated effects of the removal and handling of spoil from the TBMs to the external conveyor to the Mt Coot-tha Quarry.

The spoil from the southern (westbound) tunnel would be re- routed through an enlarged cross passage to the northern (eastbound) tunnel and then to the shed at the entry portal. The worksite also would provide access to and from the adjacent Centenary Motorway. Other more general aspects of the worksite included some car parking, site offices, general plant, storage, and water and flood protection.

The worksite did not include construction areas required for the cut and cover tunnels and the associated cross passages through areas of Anzac Park, the pedestrian and cycle bridge, the Centenary Motorway, the roundabout and through Mt Coot-tha Road.

The Reference Project identified that to avoid workforce parking on local streets, project parking areas would be established either in the overflow car park across Mt Coot-tha Road from the entrance to the Mt Coot-tha Botanic Gardens or in areas along Sir Samuel Griffith Drive between Mt Coot-tha Road and Simpsons Road. Shuttle buses would be provided to transport workers between the parking areas and the worksites.

The Coordinator-General specified in the imposed conditions of approval for the Project (18j) that:

- The construction workforce must not park in local streets
- A dedicated and adequate construction workforce off-street parking area must be provided
- All construction workforce vehicles must be directed to project construction workforce car parks
- To avoid construction workforce car parking in local streets, shuttle transport between construction workforce car parks distant from a construction area must be provided for the duration of the period the construction area is in use

### **Delivery Mode – Changed Project**

The Changed Project worksite would be in the same location but larger than that proposed for the Reference Design. The proposed worksite would now include an additional area to the east allowing for both areas of the cut and cover tunnel construction up to the western edge of Mt Coot-tha Road. The site extension is approximately 2.1 hectares and is also Council owned land. This additional area was identified in the Reference Design as the area required for the future water storage required by the Botanic Gardens.

The enlarged worksite for the Changed Project would include the future water storage and landscape feature as well as areas for constructing and launching of the TBMs, areas for the storage and handling of the precast tunnel segments and a grout batching plant.

The western and northern boundary, along the existing fence line, remains the same as the Reference Design.

Each of the TBMs would be assembled in the excavated cut and cover tunnel and transition areas during surface working hours (6.30am – 6.30pm Monday to Saturday) only.

After assembly of the main component of each TBM, an acoustic-lined workshed would be erected over and beside the TBM launch-box to facilitate the continuous underground operations by mitigating the potential noise and light impacts of segment handling and general TBM operations. The segments would be stored, pending installation, inside the shed. The pre-cast tunnel segments would be lifted by a gantry crane onto special vehicles for transport to the TBM. They would be used to line the tunnels immediately after excavation by the TBM. The Changed Project would require approximately 4,300 rings for the tunnel lining.

An enclosed conveyor from the tunnel portal (operating on a continuous basis) will transport spoil to an acoustically-lined spoil handling shed located at the western end of the site, from which the spoil material will be further transported by enclosed conveyor to the Mt Coot-tha Quarry.

The tunnel spoil material will arrive at the quarry at an approximate elevation of RL 94m and will be deposited into the designated quarry stockpile area.

The conveyor and transfer stations would be designed and operated to not affect the continued operation of the quarry and the delivery of spoil into the quarry would be managed to mitigate any adverse impacts in accordance with conditions as set out by the Coordinator-General, including:

- the environmental objectives and the performance criteria for noise (Schedule 3, condition 22 Table 10 of the Coordinator-General's conditions); and
- the environmental objectives and the performance criteria for air quality (Schedule 3, condition 20 of the Coordinator-General's conditions).

The spreading and compaction of the spoil material within the designated quarry stockpile area will be carried out during regular quarry operating hours (7am – 5pm Monday to Friday), in accordance with the existing quarry development permit.

Temporary access to the worksite would be from the Centenary Motorway generally as proposed in the Reference Design. A further temporary entry and exit for lighter construction vehicles requiring on-site parking and access to site offices is proposed for the Changed Project in the north-east corner of the site to and from Mt Coot-tha Road.

The Changed Project generally would comply with the Coordinator-General's conditions with regards to workforce car parking. The Changed Project would provide an additional dedicated temporary off-street construction workforce parking area for up to 300 vehicles within Anzac Park, with connection via the pedestrian/cycle bridge over the Centenary Motorway.

## 2.4 Eastern Connection

### 2.4.1 Design Changes – Eastern Connection

#### Tunnel Portals

With the Changed Project, the eastern connections would be located centrally in the ICB corridor, with the ICB through lanes being realigned to the outside of the project ramps. This would be a similar approach to that taken for the western connection, with the eastbound lanes of the ICB being realigned to the north and outside the central NLRT project entry and exit portals.

Consequently, the entry and exit portals for the Changed Project would be relocated to the north, with the ICB east-bound lanes realigned to pass over and to the outside of the project connections. The portals would be situated close together within an extended landscaped median, in the centre of the ICB between

Victoria Park Road and the Inner Northern Busway (INB). These arrangements would reduce the length of cut and cover works along the westbound lanes of the ICB and would improve traffic management during the construction of the ICB connection.

The portal for the eastbound driven tunnel would be approximately 60m east of the Reference Design position and the cut and cover portal would be approximately 100m further east to a position some 20m west of the INB. Overall the cut and cover tunnel for the eastbound connection would increase by approximately 40m over the Reference Design in order to accommodate the realignment of the outbound lanes of the ICB.

The ICB eastbound lanes would be realigned up to approximately 30m to the north, requiring further land, approximately 1,000m<sup>2</sup> in addition to the 3,000m<sup>2</sup> required by the Reference Design, within the BGS playing fields area. A new bridge span is proposed on the northern side of the existing INB bridge and also for the existing pedestrian bridge, to allow for the northern re-alignment of the ICB to pass below both structures. The traffic management of the ICB eastbound would require one primary traffic switch over the cut and cover section of the central portals south of Normanby Terrace.

The westbound entry portal would be approximately 300m further west and the driven tunnel section would commence approximately 30m further east. The total length of cut and cover section proposed in the Reference Design would be reduced by approximately 330m and would be situated mostly to the west of the Brisbane Girls Grammar School. The westbound ICB lanes would no longer be required for construction of the cut and cover section of the Reference Design, removing the potential for construction under inbound city traffic flows.

### **ICB surface connection**

The connections for the Changed Project would both be located in the centre of the realigned ICB whereas with the Reference Design, only the westbound entrance ramp was situated in the centre of the ICB.

For the Reference Design, the eastbound merge length was approximately 375m to a point some 50m west of the existing landbridge. In comparison, the merge length for the Changed Project would be some 410m which extends the merge to the landbridge.

The Changed Project would continue to give priority to the ICB westbound traffic lanes however the diverge into the tunnel would occur further to the west, with the tunnel portal located in line with Victoria Park Road. With the extensive cut and cover tunnel for the Reference Design, the westbound diverge length was restricted to some 90m. In comparison, the diverge length into the relocated tunnel portal for the Changed Project would be approximately 240m.

The realigned eastbound lanes of the ICB would provide controlled maintenance access to the project's eastern ventilation station which like the Reference Design is located on the eastern side of the INB.

The vertical alignment or gradient of the tunnels and transitions to the surface have also changed, marginally improving exit speeds, particularly for heavy commercial vehicles and with the associated potential for improved vehicle safety on tunnel entry.

## Supporting Infrastructure

The eastern ventilation station would be cut into the side of the hill in the general location of the Reference Design with the ventilation outlet located as identified in the Reference Design and controlled access to and from the eastbound ICB.

## Property requirement

The Changed Project will require a larger area of the playing fields occupied by the Brisbane Grammar School. No acquisition of private property on the surface would be required for the Changed Project's surface works consistent with the Reference Design.

Access would be required to two additional State owned properties during construction. One is north of the playing fields where access is required to relocate the pedestrian path around the north of the construction sites as shown on **Figure 2-46**. Access to additional State land also would be required for the INB construction works where this was not proposed in the Reference Design.

There would be two fewer lots of Council owned properties required as the two previously acquired from the Brisbane Grammar School for the ICB are now counted as one and the lots below Normanby Terrace were previously counted as two lots and are now counted as one land holding owned by Council. Overall changes to land access requirements for the eastern surface works are shown in **Table 2-6** below.

**Table 2-6: Eastern surface property access requirements**

	Eastern Surface	
	Reference Design	Changed Project
Private*	NIL	NIL
State	4	6
Council	4	2

\* Does not include Brisbane Grammar School playing fields – see discussion above

### 2.4.2 Delivery Changes – Eastern Connection

The eastern worksites required for the Changed Project are substantially the same as those required for the Reference Project. The worksites for the Changed Project include:

- the widened cut and cover areas between the ICB and Normanby Terrace to extract the TBMs as proposed in the Reference Design;
- road and drainage construction within the southern area of the Brisbane Grammar School playing fields;
- excavation through the northern abutment of the INB overpass; and
- a construction worksite east of the INB for the tunnel ventilation station and associated works.

As with the Reference Design, tunnel construction works at the ICB would involve road reconfiguration. The TBMs would be disassembled and removed within the cut and cover tunnel sections north of the ICB following completion of the tunnel drives from the western worksite in Toowong.

The Changed Project would require a construction area on the northern side of the ICB whereas the Reference Design proposed that all work be undertaken within the cut and cover and transition ramps for the project connections. The proposed realignment of the ICB eastbound lanes on the northern side of

the ICB, through a new widened section of the Inner Northern Busway overpass, would allow the ICB connections to be constructed without affecting the westbound ICB lanes.

The extent of the westbound cut and cover tunnel construction is significantly shortened by some 300m. Consequently, only one traffic movement switch is required for the eastbound ICB lanes following completion of the off-line realignment of the ICB to the north, on the outside of the tunnel connection.

The Changed Project worksites would include the following:

- the TBM portal and cut and cover area below Normanby Terrace required to extract the TBMs as proposed in the Reference Design (**Figure 2-44**);
- an enlarged area of the Brisbane Grammar School playing fields required to realign Victoria Park Road over the completed cut and cover works, realign the ICB eastbound lanes and also realign the major drainage channel north of the ICB (**Figure 2-42** and **Figure 2-43**);
- the construction through the northern abutment of the INB to provide the additional bridge span for the realigned ICB lanes, drainage and final shared path alignment (**Figure 2-42** and **Figure 2-43**);
- as with the Reference Design, the area to the east of the INB required for the construction of the ventilation station and associated infrastructure; and
- as with the Reference Design, an area in Victoria Park required for site facilities including construction car parking, offices and utility areas (**Figure 2-42** and **Figure 2-43**).

The Changed Project also identifies the temporary realignment routes and tie-ins for the shared pedestrian and cycle paths around and through the construction area. As identified in the Reference Design the existing footbridge across the ICB to the Brisbane Girls Grammar School would be retained although the Changed Project will need to extend the footbridge over the realigned ICB lanes and tie into the realigned footpath around the northern side of the construction areas (**Figure 2-45** and **Figure 2-46**).

In terms of construction workforce parking, the Reference Project would provide dedicated temporary construction workforce parking facilities at the eastern end of Victoria Park between Gilchrist Avenue and the ICB. The Changed Project would provide temporary construction car parking in an area between Gilchrist Avenue and the ICB as identified in the Reference Project and an additional area for temporary off-street car parking spaces within the construction area accessed from Victoria Park Road and the ICB.

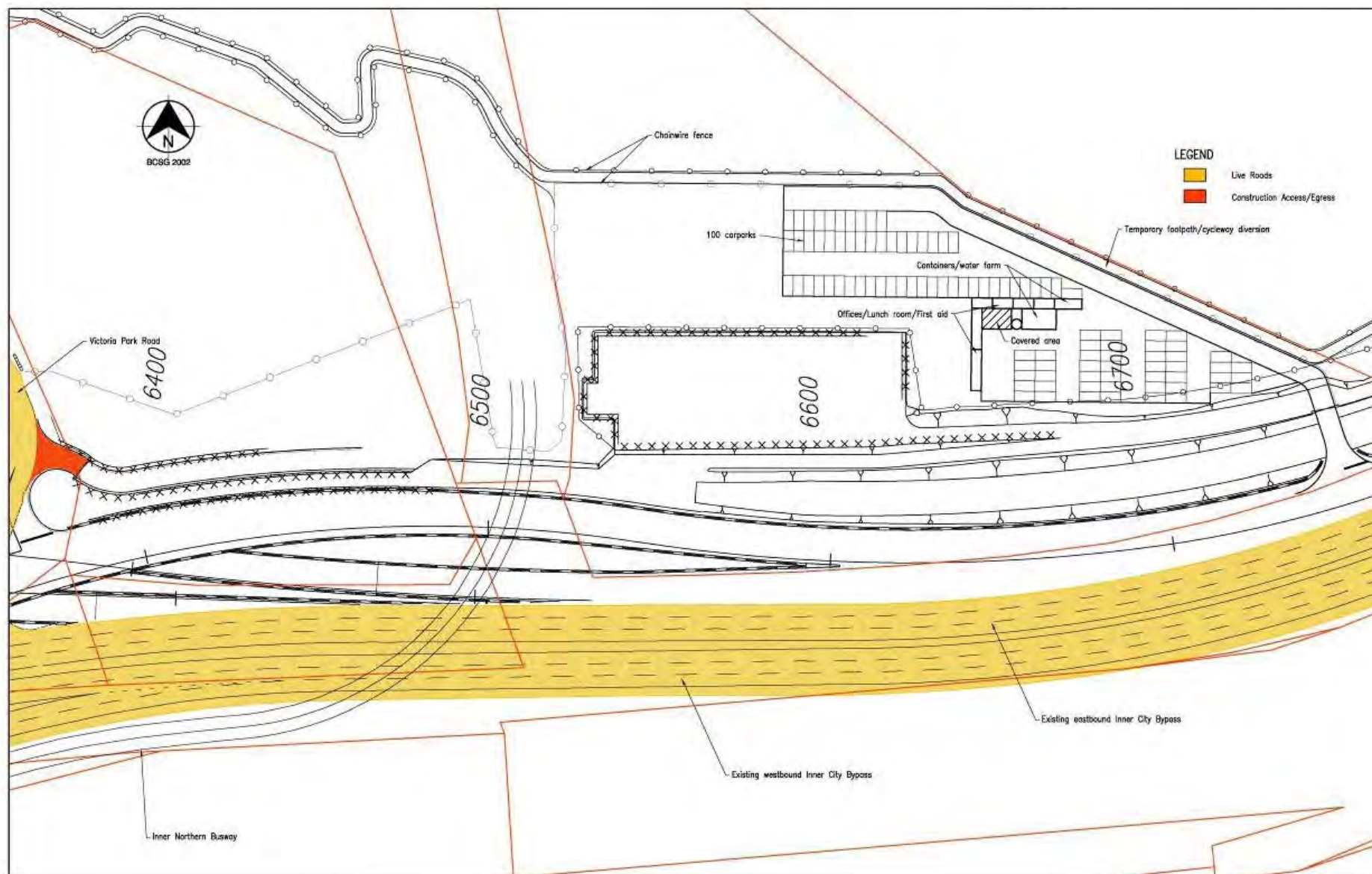


Figure 2-42: Eastern worksite – Stage 1, 2 & 3 layout

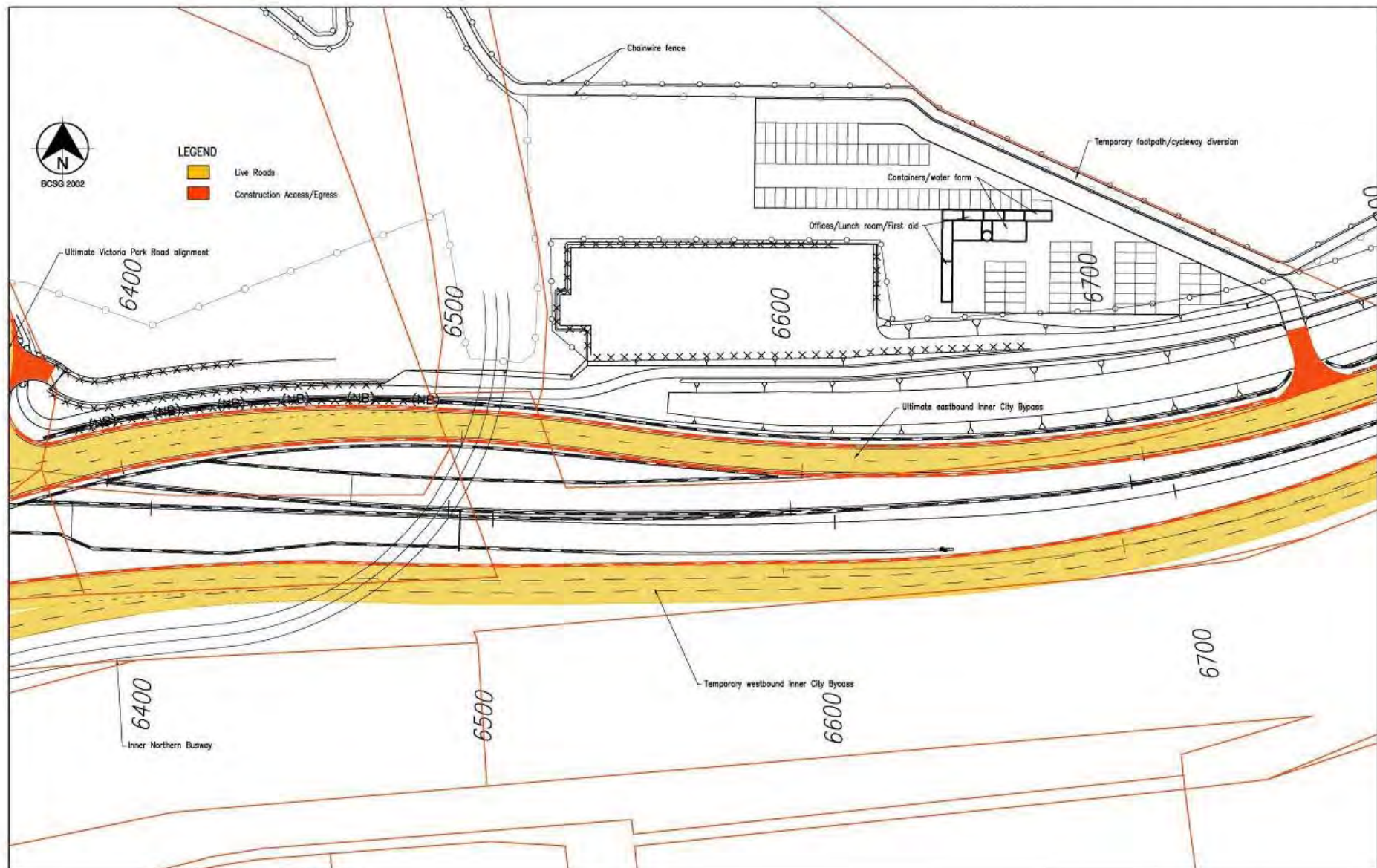


Figure 2-43: Eastern worksite – Stage 4 layout



Figure 2-44: Construction Sequencing – TBM Extraction Site

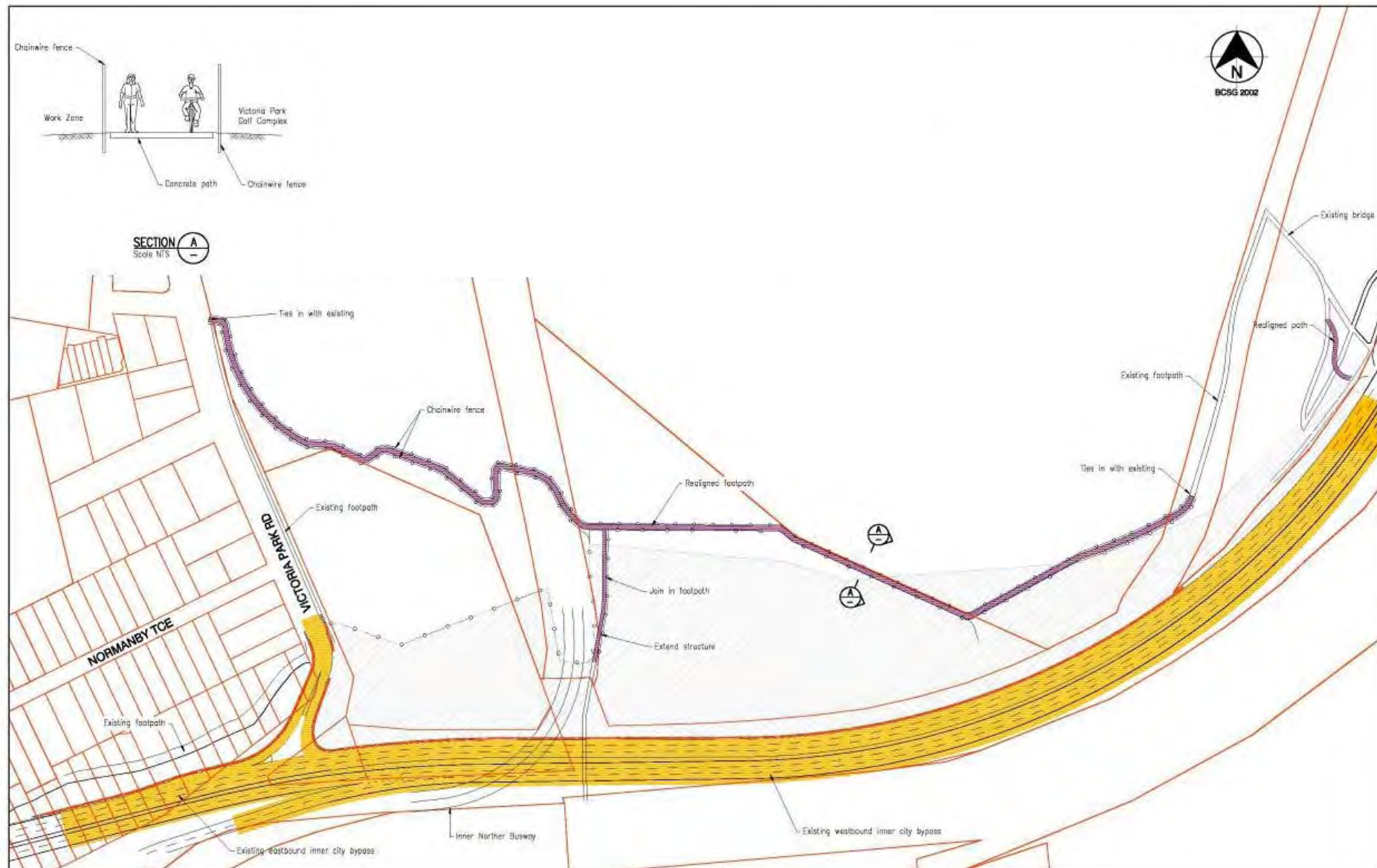


Figure 2-45: Pedestrian & Cyclist Provisions Stage 1 – Eastern Connection

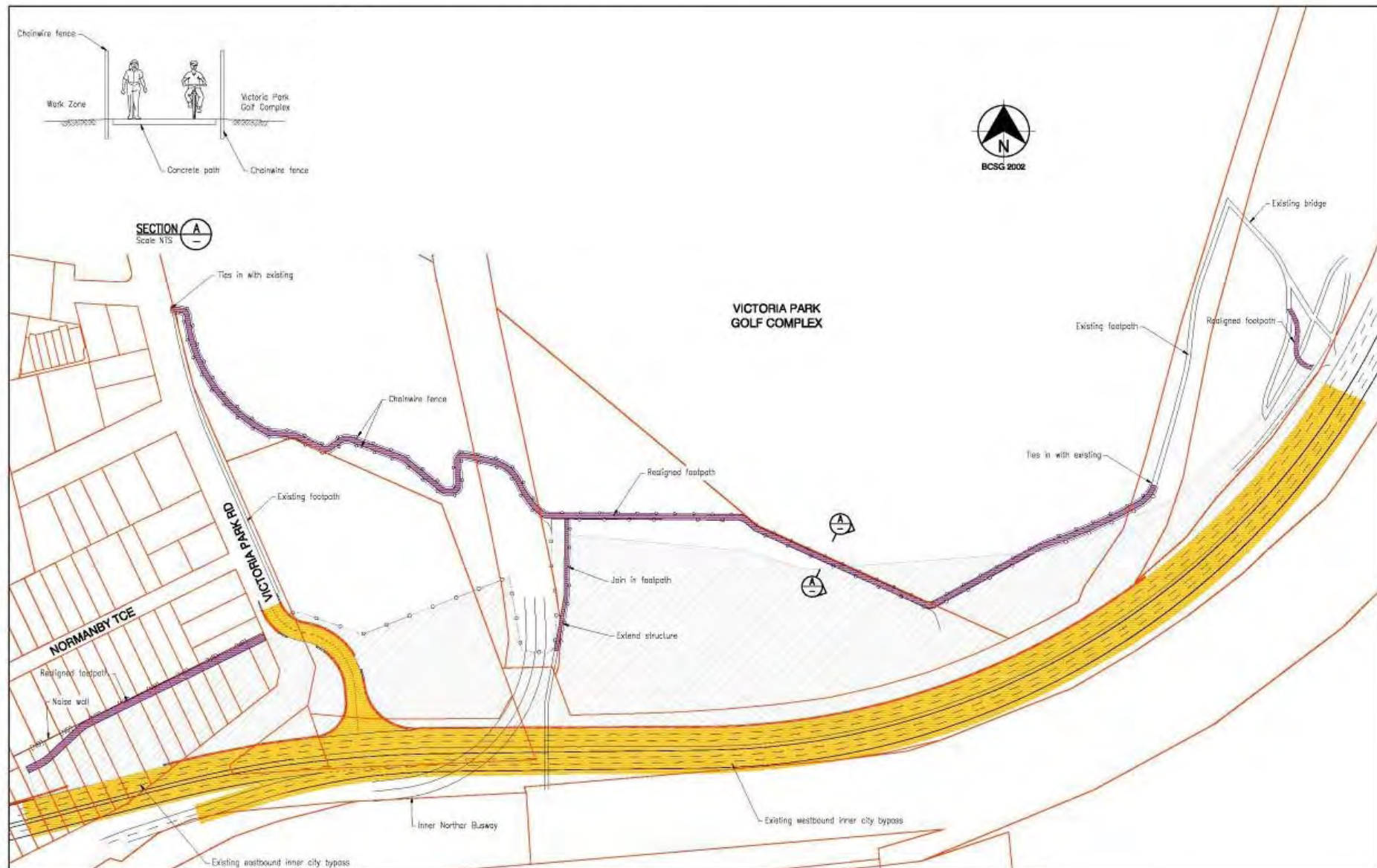


Figure 2-46: Pedestrian & Cyclist Provisions Stage 2, 3 & 4 – Eastern Connection

## 2.5 Spoil handling, haulage and placement

The Changed Project proposes some changes in regards to spoil haulage arrangements compared to the Reference Design. These changes include:

- minor increase (less than 1%) to spoil volumes (summarised in **Table 2-7**) and changes to placement areas from both western worksites and eastern worksites;
- changed location of the proposed western spoil handling shed and its use for both conveyor transfer and truck haulage access;
- changes to the alignment of the spoil conveyor from the western worksite to the Mt Coot-tha quarry. The conveyor alignment for the Changed Project would exit the western worksite and follow an alignment along the earthworks for the widening of the Centenary Motorway for approximately 630m. At this point the conveyor alignment would proceed towards the quarry around the western side of the Botanic Gardens as shown on **Figure 2-47**; and
- changes to the management and use of spoil placed within the Mt Coot-tha quarry.

The estimated quantities of spoil to be removed from the Changed Project from both the tunnel construction, including the cut and cover tunnels, and the surface works are generally consistent with the estimates provided for the Reference Design, however some additional truck movements will be required. These estimates are provided in **Table 2-7** along with estimated truck haulage requirements and durations.

**Table 2-7: Total spoil quantity estimates and haulage requirements**

Worksites and Construction Areas	Conveyor to Mt Coot-tha Quarry (Bank m3)		Truck Haulage West (Bank m3)			Truck Haulage East (Bank m3)		Total Estimate Spoil Quantity and Truck Haulage Movements (Bank m3)	
	Ref Design (TBM)	Changed Project (TBM)	Ref Design	Changed Project	Changed Project (TBM)	Ref Design	Changed Project	Ref Design	Changed Project
Western and Centenary Motorway	973,000 <sup>1</sup>	932,000 <sup>1</sup>	265,000	151,300 <sup>2</sup>	151,700 <sup>3</sup>	NIL	NIL	1,238,000	1,235,000
Eastern and ICB	NIL	NIL	NIL	NIL	NIL	25,000	40,500	25,000	40,500
<b>Total Spoil</b>	<b>973,000</b>	<b>932,000<sup>1</sup></b>	<b>265,000</b>	<b>303,000</b>		<b>25,000</b>	<b>40,500<sup>4</sup></b>	<b>1,263,000</b>	<b>1,275,500</b>
Truck Haulage Movements	NIL	NIL	20,400	11,600 <sup>2</sup>	11,700 <sup>3</sup>	2000	3100	<b>22,400</b>	<b>26,400</b>
Duration of Works (months)	14	12	14	12	14	23	15		
Average No of Truck Loads per day	NIL	NIL	58	37	50	3	8		
Average No of truck loads per hour <sup>5</sup>	NIL	NIL	6	4	5	0.3	0.8		

### Table Notes

1. Spoil from the TBMs via conveyor to the Western Worksite Spoil Handling Shed and then by conveyor into the quarry.
2. Lower due to Changed Project not having the deep transition cuts and extensive cut and cover of the Reference Design

3. Excess spoil from the driven TBM tunnel construction would be handled within the acoustic shed at the western end of the site and hauled out along the approved routes between the hours stipulated in the Coordinator-General's conditions Schedule 3 condition 16 and between 6.30am Monday to 6:30 pm Saturday with allowances to avoid peak hours.
4. Includes spoil estimates associated with the buried vent outlet duct and the partial burial of the ventilation station not accounted for in the Reference Design.
5. Normal truck haulage (Surface Works) is based on standard construction hours (6.30am to 6.30 pm Monday to Saturday).

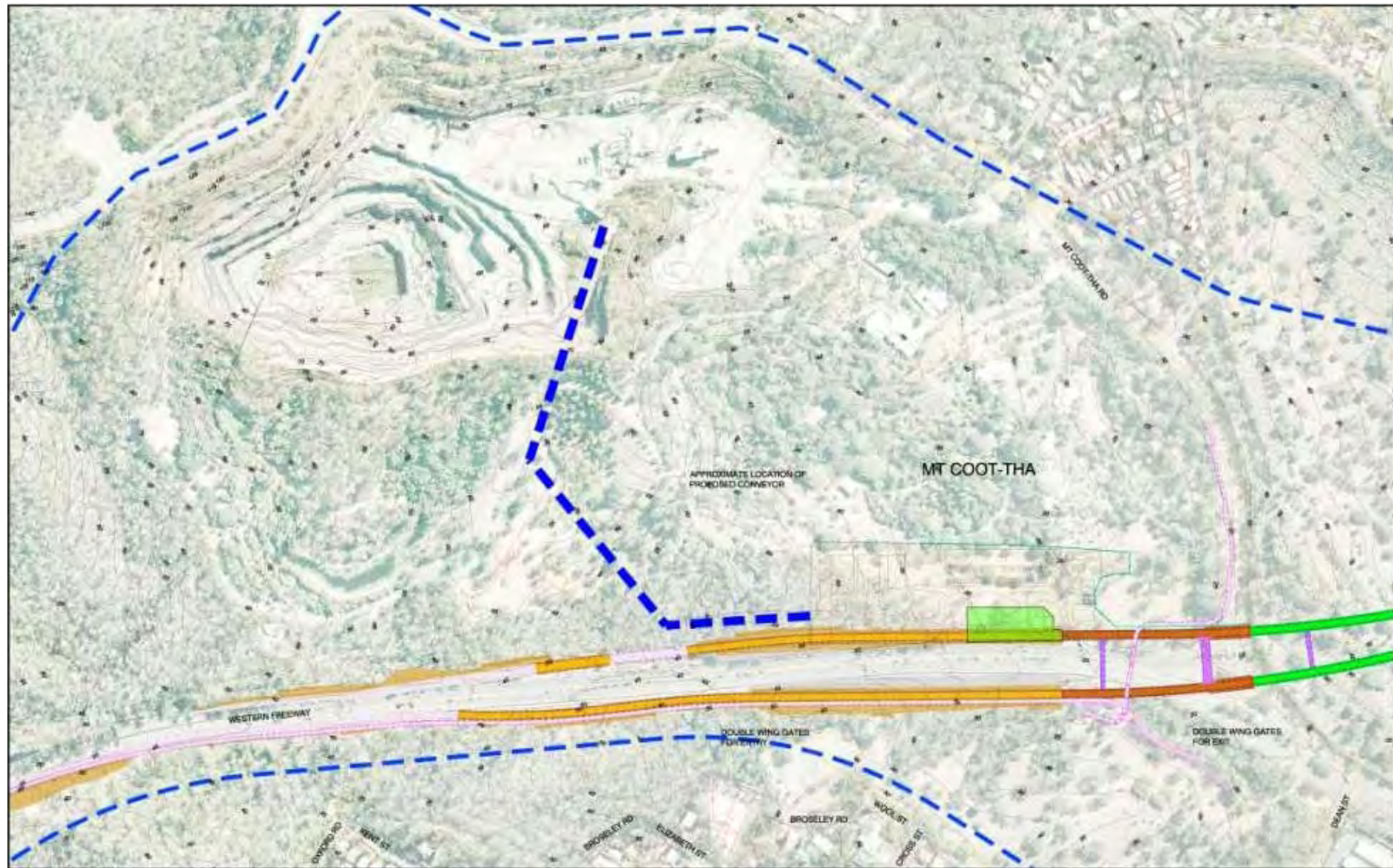


Figure 2-47: Reference Design - Spoil conveyor route

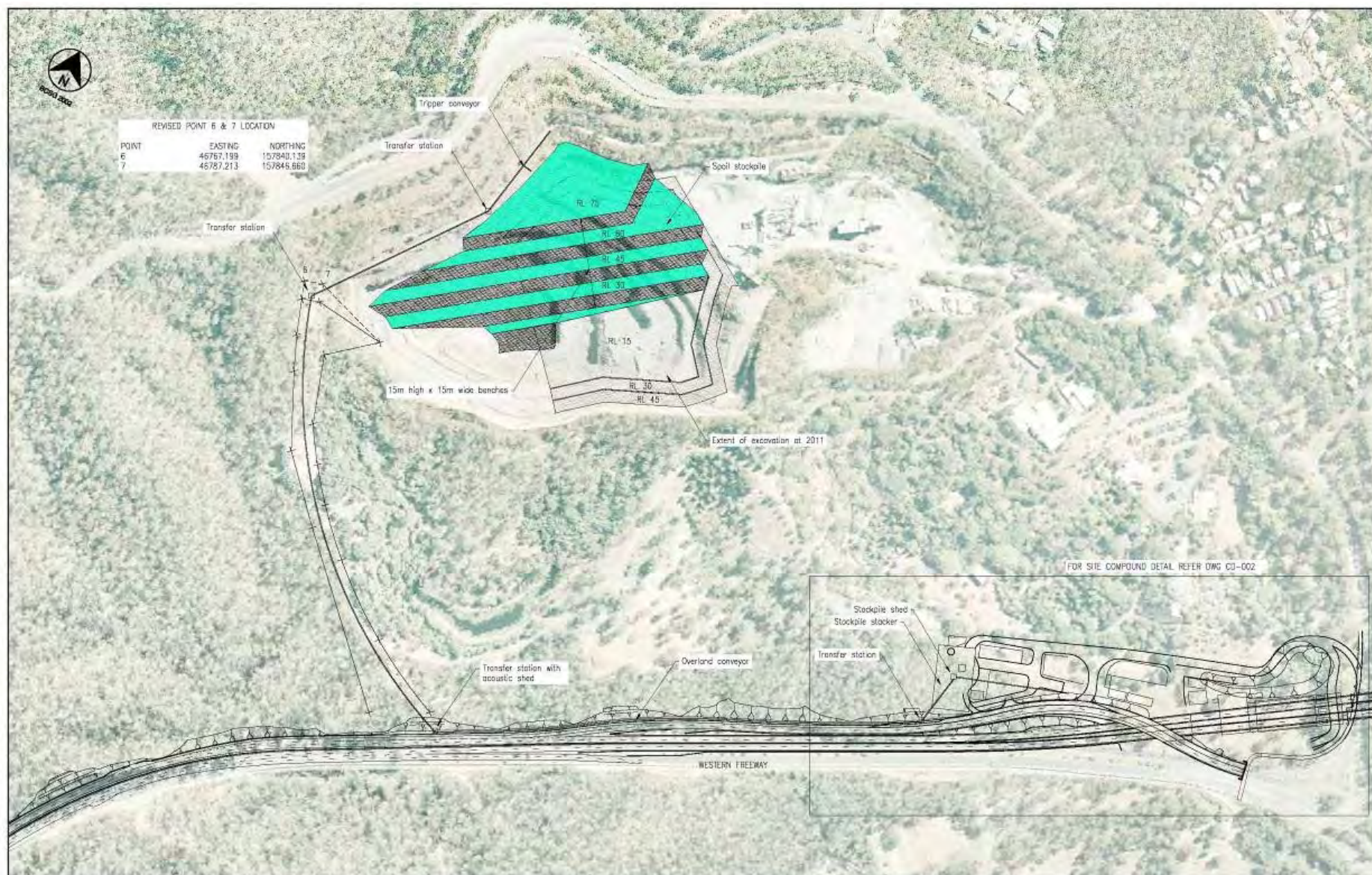


Figure 2-48: Change Project – Spoil conveyor route and stockpile design

Overall, the Changed Project would produce an additional approximately 12,500 bank cubic metres (bcm) of spoil material. This is made up from,

- marginally less spoil material (41,000 bcm) being conveyed into the quarry than from the Reference Project,
- marginally more spoil material (38,000 bcm) being hauled by trucks to the western spoil placement site,
- more spoil from the eastern worksite (15,500 bcm) being hauled by trucks to the eastern spoil placement site

The TBM material for the Changed Project which cannot be accommodated within the quarry placement area (approximately 10% of the tunnel spoil or 151,700 bcm) will need to be trucked to the western spoil placement area. This task would require approximately 11,700 truck movements.

Under normal operations the excess tunnel spoil material will be progressively transported off site west along the Centenary Motorway to the spoil site. Should the spoil conveyor be out of operation and the stockpile facility start to reach capacity, all the tunnel spoil would need to be removed by road transport. Approximately 450 truck loads per day at an approximate average rate of 35 trucks per hour would be required to take the material to the western spoil placement site in these circumstances.

There is an estimated reduction of spoil of some 115,000bcm from the western cut and cover, transition structures and surface works due largely to the shallower transition structures within the Centenary Motorway. There is an additional 15,000bcm from the eastern worksites from the additional cuttings required for the realignment of the ICB and the ventilation station and outlet tunnel.

The conveyor route to the quarry has changed as shown on **Figure 2-48**. The length of the conveyor for the Changed Project would be approximately 1,500m or approximately 500m longer than that for the Reference Design. The first 630m of the conveyor alignment from the workshop would be within the earthworks required for the future third lane on the realigned Centenary Motorway. This land is required for the future road widening by DTMR and would be returned as landscaped and stabilised road earthworks. Approximately 550m of the conveyor alignment would pass between the Centenary Motorway through the Mt Coot-tha Forest along the western boundary of the Botanic Gardens, to the quarry. For the Reference Project, this alignment was initially through Council owned land within the Botanic Gardens and then also through State owned land identified as the Mt Coot-tha Forest, but used for the Botanic Gardens and also the Mt Coot-tha Quarry. The proposed alignment was amended by Council to specifically avoid the public areas and established plantings within the Gardens.

The preferred placement sites have changed from Swanbank in the west to an approved landfill site at Rudd Street, Oxley and from Port of Brisbane in the east to future Australia Trade Coast development land at Pinkenba. Other suitable locations may be identified during the course of the project and would be subject to complying with the Coordinator-General's conditions (refer Schedule 3, Condition 16).

The road haulage of all spoil from the western worksite and associated construction areas would be on an approved route to the west using the Centenary Motorway and then the Ipswich Motorway to Oxley. The road haulage of all spoil from the eastern worksite and associated construction areas would be on an approved route to the east using the ICB and Kingsford Smith Drive to Pinkenba. All surface spoil from surface and cut and cover excavations for the Changed Project will be handled between the hours of 6:30am to 6:30pm, Monday to Saturday. Excess spoil from the driven tunnel construction would be handled within the acoustic shed at the western end of the site and hauled out along the approved routes between the hours stipulated in the Coordinator-General's conditions (refer Schedule 3, condition 16).

Placement of spoil within the Mt Coot-tha Quarry would also change. It is no longer proposed to use the material from the TBM to replace the further extraction of material at the quarry for the duration of the project as identified in the Reference Design as reported in the Coordinator-General's Report. For the Changed project, there would be no processing of the TBM spoil through the existing quarry facility and there would be no transport of spoil generated by the Changed Project from the quarry. Spoil from the Changed Project to the quarry would be placed within an identified area of the quarry no longer required as a source of quarrying material. The proposed placement would be part of the future rehabilitation of the quarry and would off-set future transport of material that would be required for back-filling and quarry rehabilitation.

The Mt Coot-tha Quarry will continue to operate under the existing Development Permit issued by DERM. The conveyor transporting spoil material into the quarry will operate on a continuous basis while the spreading and compacting of the tunnel spoil material within the quarry will be carried out under the existing quarry operating hours of Monday to Friday 7am to 5pm. This use of the conveyor and the quarry will avoid impacts on the adjacent road network. If this method of spoil disposal was not available all tunnel spoil would have to be hauled off site west along the Centenary Motorway to Oxley or another approved spoil location. This would require traffic movements of up to 35 trucks per hour 6.30am Monday to 6.30pm Saturday, which would require changes to the existing Coordinator-General's conditions in regards to allowable truck types and frequency of use.

### 3 Project Changes to Main Alignment

#### 3.1 Changes to Design – Main Alignment

The principal change to the Reference Design is the proposed realignment of the main tunnels between the connections with the Centenary Motorway and the ICB. The main tunnel alignments would be straighter and shallower to create a more direct, safer and more efficient motorway-standard link between the Centenary Motorway and the ICB. These changed alignments are shown in **Figure 2-1** and **Figure 2-2**.

The horizontal alignment would be up to 60m north of where the Reference Design alignment would be at the eastern edge of the Botanic Gardens. The changed alignment would be approximately 100m north of the Reference Design alignment through the Toowong Cemetery and would converge with the Reference Design alignment just to the east of Frederick Street, between Thorpe and Sleath Street, Auchenflower. Further on, the changed alignment would then pass south of the Reference Design alignment by approximately 300m in the vicinity of Gregory Park at Baroona Road. The main tunnels would emerge to the south of Normanby Terrace and Victoria Park Road, as would the Reference Design.

The vertical alignment of the Changed Project generally would be shallower than the Reference Design alignment, particularly in the western section beneath the cemetery and areas of Auchenflower. However, the alignment is deeper than the Reference Design alignment on the eastern side of Paddington and Red Hill.

#### 3.2 Changes to Delivery – Main Alignment

The excavation of the two mainline tunnels by tunnel boring machines (TBMs) is, consistent with the approach proposed for the Reference Design. For both the Reference Project and the Changed Project, the TBMs would be launched from the main worksite, in the west and adjacent to the Mt Coot-tha Botanic Gardens. Similarly, the TBMs would be removed at the Normanby Terrace cut and cover section with both the Reference Design and the Changed Project.

The Reference Project proposed a drained tunnel construction by TBMs with in-situ concrete lining installed. Unlike the Reference Design approach, the Changed Project proposes to waterproof the main tunnels with installation of continuous, segmented, pre-cast concrete rings with associated grouting behind the segments. The excavated diameter of each of the main tunnels would increase from a nominal 12m with the Reference Design to 12.4m diameter for the Change Project.

The cross passages would be constructed by a combination of mechanical excavation and selected drill and blast, following the construction of the main driven tunnels. The cross passages would remain drained with in-situ lining as proposed in the Reference Design. As with the Reference Design, the cross-passages would be constructed at approximately 120m intervals. There would be up to ten underground substations (4 in each driven tunnel and 1 at each end within the cut and cover tunnels) to support the Changed Project with final power supply arrangements to be determined during detailed design.

The Changed Project entails the delivery and handling of pre-cast concrete ring segments used to line the tunnels. Each complete tunnel ring would consist of nine pre-cast segments. These segments would be cast at an off-site facility and be transported to the western worksite by delivery vehicles over approximately 14 months. Each ring would require two truckloads of segments. Approximately 4,300 rings would be required for the tunnel linings, generating 8,600 return trips for their delivery.

The segments would be stored on the site and lifted by a gantry crane into the cut and cover trough for transportation to the head of the TBM.

### 3.3 Effects of Project Changes – Main Alignment

#### 3.3.1 Traffic and Transport

The tunnel configuration for the Changed Project would be generally unchanged from the Reference Design, consisting of two separate, parallel road tunnels each with two lane carriageways and shoulders. The traffic flows through the Changed Project would be substantially the same as those estimated for the Reference Design.

The flatter vertical alignment of the Changed Project compared to the Reference Design offers improvements in traffic flow and safety. As a result of the reduced lengths of 5% maximum upgrade and the reduced climbing distances, traffic modelling indicates that heavy vehicle speeds could be maintained closer to the general traffic speed. This would reduce the demand for lane changing and consequential disruption to traffic flow, providing an improvement in safety and vehicle operating efficiency.

Compared to the Reference Design, the Changed Project has shorter distances of roadway with descending grades steeper than 3%, again reducing the demand for lane changing and assisting in the maintenance of vehicle speeds (due to less braking) with resulting safety benefits.

#### 3.3.2 Geology and Soils

As with the Reference Design, the Changed Project would encounter a wide range of ground conditions during its construction. The following **Table 3-1** provides a comparison of the ground conditions that would be encountered by the Changed Design alignment and the Reference Design alignment, both horizontally and vertically.

**Table 3-1: Comparison of Changed Project alignment versus Reference Design alignment**

Reference Design	Changed Project	Comments
<b>Mt Coot-tha Rd</b> Tunnel alignment commenced at Mt Coot-tha Road, just to the north of the Mt Coot-tha Rd roundabout. Each mainline tunnel was horizontally separated approximately 60-70m to enable the proposed connections to the Centenary Motorway to occur.	<b>Mt Coot-tha Rd</b> Tunnel alignment commences further to the north up Mt Coot-tha Road. Mainline tunnels horizontally separated approximately 10m. Tunnels approximately 8m deep beneath Mt Coot-tha Rd.	<b>Mt Coot-tha Rd</b> Ground conditions are expected to consist of extremely weathered to distinctly weathered, very low to low strength material in the tunnel crown (roof), improving with depth to slightly weathered, high strength in the tunnel side walls and floor. Roadheader tunnels of this span and depth (cover to the crown of the tunnel) in these ground conditions with forward pre-support and immediate ground support have been undertaken throughout Brisbane previously with minimal impact on the existing surface infrastructure.
<b>Toowong Cemetery</b> Two mainline tunnels come closer together horizontally beneath the Toowong Cemetery, to be approximately 10-15m horizontally separated by Frederick St.	<b>Toowong Cemetery</b> Mainline tunnels remain horizontally separated by approximately 10m beneath the Toowong Cemetery, however tunnel alignment is further north compared with the Reference Design.	<b>Toowong Cemetery</b> Ground conditions are expected to consist of extremely weathered to distinctly weathered, very low to medium strength material in the tunnel crown (roof) in the shallow area, improving with depth to fresh, very high strength in the deeper areas of the tunnel alignment.

Reference Design	Changed Project	Comments
The vertical depth beneath the Toowong Cemetery varied between approximately 15m to 40m.	The vertical depth beneath the Toowong Cemetery varies between approximately 8m to 32m.	
<b>Frederick St to Baroona Rd (Fernberg Road)</b> Horizontal alignment remains to the north of the study corridor. Mainline tunnels remain horizontally separated by approximately 10m. Depth varies between approximately 24m to 68m. The depth (18m) beneath the alluvial channel in the Baroona/Fernberg Rd with tunnel expected to be located in slightly weathered to fresh, high strength rock at this location.	<b>Frederick St to Baroona Rd</b> Mainline tunnels remain horizontally separated by approximately 10m, however tunnel alignment is further south compared with the Reference Design.  The vertical depth in this area varies between approximately 10m to 55m. 13m depth beneath the alluvial channel in Baroona Rd with tunnel expected to be located in slightly weathered to fresh, high strength rock at this location.	<b>Frederick St to Baroona Rd</b> The majority of this section is expected to be located within slightly weathered to fresh, high to very high strength rock, which is essentially the same as the Reference Design through this section, hence no additional requirement for TBM excavation and support.  Whilst depth beneath the alluvial channel for the Changed Project is slightly less, the anticipated ground conditions above and within the tunnel area are expected to be similar, consisting of competent, high strength rock. The proposed TBM excavation and support will be able to appropriately excavate and support these ground conditions similar to that proposed in the Reference Design.
<b>Baroona Rd to Plunkett St</b> Horizontal alignment remains to the north of the study corridor (due to old EIS with ramps alignment as discussed above). Mainline tunnels remain horizontally separated by approximately 10m. Depth varies between 18m and 26m. 18m depth beneath Hayward St with tunnel expected to be located in slightly weathered to fresh, high to very high strength rock.	<b>Baroona Rd to Plunkett St</b> Mainline tunnels remain horizontally separated by approximately 10m, however tunnel alignment is further south compared with the Reference Design. Based on the regional geological maps, the Changed Project comes within 70-80m (in plan) of an alluvial channel near the southern end of Charlotte Street.  Vertical depth varies between 12m and 45m. 12m depth beneath Charlotte St with tunnel expected to be located in slightly weathered, medium to high strength rock or better.	<b>Baroona Rd to Plunkett St</b> The majority of this section is expected to be located within slightly weathered to fresh, high to very high strength rock, which is essentially the same as the Reference Design geology through this section, hence no additional impact for TBM excavation and support.  Whilst depth beneath Charlotte St for the Changed Project is slightly less (to improve operational efficiency of the tunnel), the anticipated ground conditions above and within the tunnel area are expected to be appropriate, consisting of competent, medium to high strength rock. The proposed TBM excavation and support will be able to excavate and support these ground conditions similar to that proposed in the Reference Design.
<b>Plunkett St to Inner City Bypass</b> Horizontal alignment heads southwards back towards to the Inner City Bypass. Mainline tunnels remain horizontally separated by approximately 10m. Depth varies between 11m and 52m. 11m depth at the driven tunnel portal with ground conditions expected to be distinctly weathered to	<b>Plunkett St to Inner City Bypass</b> Horizontal alignment remains south of Reference Design alignment until Musgrave Rd where the Changed Project horizontal alignment coincides with the Reference Design alignment up to the Inner City Bypass connection. Depth varies between 11m and 60m. 11m depth at the driven	<b>Plunkett St to Inner City Bypass</b> The majority of this section is expected to be located within slightly weathered to fresh, high to very high strength rock, which is essentially the same as the Reference Design geology through this section, hence no additional impact for the TBM excavation and support.  Changed Project intercepts the possible Normanby Fault at approximately the same location as the Reference Design, thus no additional impact for the TBM excavation and support.

Reference Design	Changed Project	Comments
slightly weathered, medium to high strength rock.	tunnel portal with ground conditions expected to be distinctly weathered to slightly weathered, medium to high strength rock.	

The Changed Project would engage two TBMs for excavation and lining each of the tunnels between the surface connections. Pre-cast concrete segments would be erected in a ring within the TBM shield in the excavated tunnel to form both the temporary (immediate) and permanent support system. The completed ring would provide structural tunnel support, minimising impacts of ground movement surrounding each tunnel.

This approach to tunnel excavation and support would allow for a wide range of ground conditions from extremely weathered, low to very low strength rock, up to fresh (weathered), very high strength rock to be encountered with low risk, while mitigating impacts such as settlement and groundwater drawdown.

The Changed Project would undertake additional geotechnical investigation works along the Changed Project alignment, prior to the completion of the detailed design phase. These works will include the following:

- up to 30 geotechnical boreholes drilled to depths of up to 30m, to be positioned in areas where limited existing information is currently present in the geological/geotechnical models;
- in-situ pressuremeter and dilatometer testing in soils where direct measurement of at-rest earth pressure is relevant to the design (at the eastern and western approaches);
- piezocone (CPTu) penetration testing, for the purpose of providing more accurate data on strength and variability of the alluvial and residual soils; and
- seismic velocity surveys at the eastern and western approaches, for the purpose of providing validation of rippability estimates and rock surface profiles.

## Settlement

### Types of Settlement

Settlement resulting from tunnel excavation/construction activities may arise due to the following effects:

- Elastic ground settlements caused by the excavation of the tunnel.
- Consolidation settlements caused by groundwater drawdown into the tunnel.

As was the case with the EIS/Reference Design, the Changed Project will make an assessment of the settlement impacts from both of the above effects.

The elastic settlement assessment for the Reference Design was based on experience and judgement of similar large diameter TBMs in hard rock. As no large diameter TBMs had been excavated in Brisbane geology at the time of the Reference Design, key input parameter assumptions had to be made based on similar large diameter TBMs in similar hard rock conditions in order to estimate the Reference Design elastic settlement impacts.

Since the Reference Design, the CLEM7 tunnel has been excavated with two large diameter TBMs through Brisbane geology. Throughout the excavation and support of the CLEM7 tunnels, settlement monitoring at the surface above the excavating TBMs was undertaken. The NL project has used this

settlement monitoring data to better calibrate the key input parameter assumptions for the assessment of the elastic settlement induced impacts associated with excavating two large diameter TBMs. In order to compare the difference between the Reference Design and the Changed Project, the theory's used for estimating the elastic settlement in the Reference Design and the Changed Project have been the same, noting however that the key input assumptions have been modified based on the actual elastic settlement data obtained from CLEM7.

The estimates of elastic settlement at the surface for the Reference Design were generally less than 5mm for the majority of the Reference Design alignment. There were some isolated locations which were greater than this general 5mm settlement including in the vicinity of Mt Coot-tha Road, Toowong Cemetery and the Inner City Bypass

Estimates for elastic settlement at the surface for the Changed Project are comparable to those of the Reference Design, with less than 5mm predicted for the majority of the new alignment. As with the Reference Design, there are isolated areas with the potential for settlement greater than 5mm as for the Reference Design, however the magnitudes of these potential settlements are lower for the Changed Project.

### 3.3.3 Hydrology (groundwater)

The Changed Project would be constructed as an undrained or waterproof system of road tunnels into which the average rate of inflow for groundwater would be less than 3L/sec. This compares with the estimated inflow rate for the Reference Design of 4L/sec which was proposed as a drained tunnel system. Neither rate of flow is considered significant, such that both rates of inflow would be considered to be 'dry' tunnels.

The Coordinator-General's conditions pertaining to groundwater management remain relevant and appropriate for managing the potential effects of the Changed Project

As with the Reference Design, groundwater that was admitted to the Changed Project tunnels would be collected and treated if necessary to required standards before being released. Any required approvals will be obtained.

Settlement induced by groundwater drawdown for the Reference Design was assessed in the EIS and found generally to be of no consequence in terms of property effects and groundwater-dependent ecosystems. For example, settlement for properties above much of the tunnel alignment for the Reference Design was assessed to fall within the lowest range of 0 – 10mm. With a much lower inflow rate, the Changed Project would have even less effect on properties due to groundwater induced settlement. Further discussion on the settlement induced by groundwater drawdown (consolidation settlement) is discussed in section 3.3.2.

The Reference Design potentially would lead to the following groundwater impacts:

- drawdown effects over a 50 year period located in an area up to 800m from the driven tunnel;
- approximately 4L/s inflow;
- low risk of effect on existing bore users,
- low risk of settlement due to groundwater drawdown,
- low risk of saline water infiltration from the Brisbane River,
- negligible risk of encountering acid sulphate soils,

- potential risk of impacts to groundwater dependant ecosystems, however the risk is mitigated by the likely occurrence of clay between the alluvium and the fractured rock aquifer, and
- potential risk of contaminant movement from isolated (and as yet unknown) contaminated properties.

The proposed change in the horizontal alignment would move the NLRT towards Milton Road, and towards the Brisbane River. While there may be some hydrogeological connection with the Brisbane River with local aquifers in some locations along the changed alignment, the risk of groundwater entering the tunnels is very low due to the nature of their construction (ie segmental lining and grouting).

The shallower vertical alignment would also reduce the hydrogeological risks by reducing the zone of potential lateral groundwater drawdown.

The lined cut and cover tunnels at the western end are the same as the Reference Design and would restrict groundwater movement into the tunnel system. Similarly, the lined cut and cover tunnels at the eastern end of the Changed Project would limit groundwater inflow from the alluvium beds adjacent to Victoria Park Road.

The proposed changes in design would reduce the risk of groundwater inflow to the tunnels even further than predicted in the EIS/Supplementary Report in respect of the Reference Design.

Nevertheless, the Coordinator-General's requirement for a full detailed investigation to inform detailed design must be maintained to address potential risks arising from the movement of contaminated groundwater and groundwater-dependent ecosystems.

### 3.3.4 Air Quality and Greenhouse Gases

The air quality implications of the Changed Project design and operational features are the same as the Reference Design. As a result, the current Coordinator-General's conditions remain appropriate.

The tunnel ventilation system is similar to the Reference Design with a longitudinal air flow aided by jet fans in the ceiling and a ventilation station and outlet linked with the exit portal of each tunnel. The traffic flows through each of the main tunnels would be the same as forecast for the Reference Project, resulting in the same motor vehicle emissions passing through the ventilation system. The modelling presented in relation to air quality effects for the Reference Project remain relevant for the Changed Project.

The flatter vertical alignment of the Changed Project compared to the Reference Design would result in reduced climbing distances and a reduction in the length of 5% maximum climbing grade. As a result there would be improvements in traffic safety and reductions in motor vehicle emissions within the Changed Project tunnels compared with the Reference Design. These changes would result in some improvement to the air quality in each tunnel and the receiving environment (ambient air quality), and would also result in reduced greenhouse gas emissions. Greenhouse gas emissions must be calculated in accordance with the Coordinator-General's condition 2 of Schedule 3, Appendix 1.

### 3.3.5 Noise and Vibration

As a consequence of the change in the main tunnel alignment, there is the potential for noise and vibration impacts arising from construction activities to manifest in different locations to those notified during the EIS process for the Reference Design. However, the Coordinator-General's conditions for managing the noise and vibration effects of tunnel construction remain relevant and appropriate.

The design changes may give rise to noise and vibration impacts in different locations due to changes in the vertical and horizontal alignments for the driven tunnel (TBM) section. Compared with the Reference Design, the vertical alignment of the Changed Project is generally shallower as follows:

- the main tunnels would be less than 15 metres underground around parts of the Toowong Cemetery and east of Frederick Street, Toowong; and
- the main tunnels would be less than 20 metres underground near Charlotte Street, Paddington.

The potential impacts from the proposed design change would vary according to the depth of construction relative to the undulating terrain on the surface and include:

- regenerated noise; and
- vibration.

### Construction Regenerated Noise

Whereas refined data for vibration has been collected from the CLEM7 project since preparation of the Northern Link EIS, no such refined data is available for regenerated noise for that project. Consequently, there has been no refinement of the regenerated noise predictions which may be lower based on the lower vibration levels experienced during the CLEM7 construction.

It will be important to collect data early on actual regenerated noise to guide further predictions and mitigation implementation.

The predictions for regenerated noise from tunnel construction take into account the following factors:

- the slant distance between the tunnel crown and a sensitive location for each individual property;
- the ground elevation at each property derived from the existing topography digital terrain model; and
- the source emission data.

The currently predicted regenerated noise for tunnel construction for the whole of the Changed Project, relative to the Reference Design and the environmental objectives adopted in the Coordinator-General's evaluation, is presented in **Table 3-2**. These predictions will be further refined during detailed design.

**Table 3-2: Changed Project - Regenerated Noise Predictions**

Predicted Regenerated Noise Level (Leq) greater than the night time regenerated noise objectives (35(dB(A)))	Number of Potentially Affected Properties		
	Reference Design	Changed Project	Additional to the Reference Design
>40 dBA	208	270	62
35 - 40 dBA	226	253	27
<b>Total</b>	434	523	89

The shallower tunnel alignment of the Changed Project may result in more properties being exposed to regenerated noise levels than would be for the Reference Design. Current modelling suggests that there could be an additional 89 properties that exceed the night-time regenerated noise objective of 35 dBA Leq during the night (10pm to 6:30am). These predictions will be refined during detailed design and as a result of monitoring during construction. These properties would be in addition to the 434 residences identified in the Supplementary Report. There are approximately 11,500 residential properties within the study corridor for the NLRT project.

Based on a planned progress rate of 100m/week for the TBM, current modelling indicates that some residential properties close to the tunnel alignment may experience noise levels in excess of 35 dBA Leq for between 7 and 10 days during the excavation of each tunnel. Following the submissions received on the EIS about noise, the Coordinator-General conditions set out mitigations required. These conditions remain appropriate for the Changed Project.

### Construction Vibration

The indicative ground vibration levels predicted for the Reference Design and reported in the EIS were based on the use of 12m diameter TBMs in hard rock, referenced against a comparable project, the Dublin Port Tunnel Project<sup>5</sup>. Since then TBMs of approximately 12m in diameter have been employed in Brisbane for the construction of the CLEM7 tunnel through hard rock. Useful and relevant data from construction of the CLEM7 project has been adopted as the more relevant local data for TBM vibration modelling and predictions.

**Table 3-3** outlines Reference Design vibration source emission values and also more relevant CLEM7 emission values. These predictions will be further refined during detailed design.

**Table 3-3: TBM Vibration Source Emission Data**

Slant Distance from Source	EIS Predicted PPV (mm/s) <sup>1</sup>	CLEM7 Predicted PPV (mm/s) <sup>2</sup>	Difference (mm/s)
5 m	35	2.7	-32.3
10 m	10	1.6	-8.4
20 m	3	0.9	-2.1
30 m	1.5	0.7	-0.8
40 m	0.8	0.5	-0.3
50 m	0.5	0.4	-0.1

Table Notes

<sup>1</sup>. As reported in Table 27 of the Northern Link EIS Technical Report 9A Construction Noise and Vibration

<sup>2</sup>. Based on the data set of measured levels of the CLEM7 TBM

**Table 3-3** shows that the CLEM7 vibration data is lower than the EIS data at all distances, particularly at shallow distances where the decrease in vibration emission is significant. It is noted that submissions to the EIS raised issues regarding vibration caused by roadwork near houses. The EIS vibration predictions were higher than for the Changed Project. With the revised vibration predictions below, and with implementation of the Coordinator-General's conditions, vibration impacts from the construction works are anticipated to be further reduced by the Changed Project.

**Table 3-4** shows that the shallower tunnel alignment of the Changed Project is off-set by the lower vibration source data resulting in 161 fewer properties predicted to exceed the night-time guide for vibration levels for human comfort of 0.5mm/s.

<sup>3</sup> Sound pressure is related to vibration velocity as  $20 \times \log_{10}(V)$ , in the ground, vibration velocity varies with distance-1.5 as an approximation across a range of rock conditions. (The exponent can typically vary from -0.5 to -2.5) depending on the particular rock conditions.) Combining these, the sound pressure is related to distance as  $-30 \times \log_{10}(\text{distance})$ .

**Table 3-4: Changed Project – Vibration Predictions**

Predicted Vibration Levels Greater than the Guide value for sleep disturbance (0.5mm/s)	Number of Affected Properties		
	Reference Design	Changed Project)	Additional to the Reference Design
> 10 mm/s	0	0	0
5 – 10 mm/s	0	0	0
2 – 5 mm/s	37	0	-37
1 - 2 mm/s	63	0	-63
0.5 - 1 mm/s	145	84	-61
<b>Total</b>	<b>245</b>	<b>84</b>	<b>-161</b>

### Operational Noise and Vibration

No noise or vibration operational impacts with traffic travelling underground through the tunnels following the opening of the tunnels to road traffic are predicted for the change in tunnel alignment proposed for the Changed Project.

#### 3.3.6 Planning and Land Use

While no additional privately-owned land would be acquired to accommodate the Changed Project for surface works, the proposed change in alignment of the main tunnels would affect different properties through the acquisition of volumetric title. As identified in **Table 2-4**, there would be approximately 334 properties affected by acquisition of a volumetric title for the tunnels and associated underground infrastructure. Of these, 269 would be newly affected, including 6 Council owned parcels, and a further 65 properties would remain affected as with the Reference Design.

There may be some small variations to these numbers during detailed design development, in which case further consultation with those people affected would be required. All property owners potentially affected by the Changed Project have been contacted and will be kept informed as the project progresses.

The owners of properties potentially affected by volumetric acquisition for the Changed Project have been notified of their changed status. On completion of the final detailed design, Council will negotiate with landowners regarding compensation, and the acquisitions will be finalised in accordance with the provisions of the Acquisition of Land Act 1967, and other regular property transaction protocols.

There are two locations within the Ithaca Local Plan area where, due to topography, the main tunnels would be shallowest beneath Baroona Road, Rosalie where it is intersected by Bayswater Road (21m), and at Charlotte Street, Paddington between Great George and Martha Streets (14m).

The former location in the locality bounded by Baroona Road, Elizabeth Street, Carrington Street and Howard Street, is referred to under the Ithaca Local Plan as the Rosalie Village Special Area. It is partially designated as a local convenience centre, and is surrounded by low-medium density residential development and the near-by Milton State School. The latter is in a low-density character residential area characterised by the typically steep, undulating terrain of Paddington and Red Hill, and as such the depth of cover increases sharply in each direction along the tunnel alignment.

The future use of these areas, for their designated purposes, would not be affected by the Changed Project.

### 3.3.7 Cultural Heritage

The EIS documented the cultural heritage values of the Toowong Cemetery and the sensitivities of that place to the potential effects of underground construction, particularly in places of shallow cover above the main tunnels. The EIS, and the Coordinator-General's evaluation, identified the need for specific studies to recommend ways to protect the heritage values of Toowong Cemetery during construction of the NLRT project. Such studies were to precede the commencement of works beneath the cemetery.

As with the Reference Project, the Changed Project would pass beneath the Toowong Cemetery. The changed alignment has moved to the north along Mt Coot-tha Road. The eastbound tunnel has moved approximately 100m north and the westbound tunnel approximately 200m north. The vertical alignment is also shallower, with less cover in some places between the crown of the tunnels and the surface than the Reference Design. The change to the alignment has however removed the tunnels from the area below the Governor Blackall Memorial and the steeply sloping terraces that include elaborate headstones such as Trooper Cobb's Grave. The density of burial sites, monuments and headstones in the changed alignment is lower than the elevated and sloping areas of the Reference Design alignment.

The Coordinator-General's evaluation and conditions for continuous vibration for heritage listed places establishes a guide value of 2 mm/sec peak particle velocity to achieve minimal risk of cosmetic damage (refer Schedule 3, condition 22, Table 14, Coordinator-General's report). The conditions remain relevant and appropriate for the Changed Project.

Modelling of ground vibration due to TBM works beneath Toowong Cemetery indicated that for the Reference Design alignment using the same source emission data reported in the EIS:

- there would be possible exceedances of the vibration goal of 2mm/sec PPV in the vicinity of 13th Avenue (the low drainage line through the cemetery) and Boundary Road (adjacent to Mt Coot-tha Road) within the cemetery. These areas coincide with the low points and shallow cover, which generally have a lower density of burial sites, monuments and headstones than other places in the cemetery;
- vibration would possibly reach levels of 1 – 2 mm/sec PPV on the surface, following the construction path between Boundary Road and 1st Avenue within the cemetery.

More recent source emission data<sup>6</sup> has been derived from monitoring of underground construction works on the CLEM7 road tunnel project. This data suggests that the EIS data was overly conservative such that vibration impacts were predicted to be greater than might actually be experienced. Modelling of ground vibration due to TBM works for the Changed Project alignment, and using the CLEM7 source emission data beneath Toowong Cemetery indicates that:

- vibration would possibly reach levels of 1 – 2 mm/sec PPV in a small area either side of the low point drainage line and adjacent to 8th Avenue;
- vibration would possibly range from 0.35mm/sec to 1.0mm/sec PPV along the tunnel alignment beneath the cemetery.

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<sup>6</sup>Council commissioned independent measurements of the TBM and roadheader driven tunnelling throughout the construction of the CLEM7 tunnel (and after preparing the Northern Link EIS). The data collected during these measurements is considered relevant to the further evaluation of the Changed Project vibration impacts as it is based on the first driven tunnelling vibration data collected for a TBM in Brisbane. The TBMs used/proposed for both tunnels (CLEM7 and Northern Link) are of a similar 12 metre diameter and it is expected that the rock strength along the Northern Link alignment (uniaxial compression strength up to around 100 MPa) will be similar to the rock encountered for the CLEM7 tunnel.

It is noted that submissions on the EIS raised issues with the vibration effects and duration of vibration effects at Toowong Cemetery. The revised vibration data and detailed mitigation measures for the Changed Project and the existing Coordinator-General's conditions appropriately address and mitigate potential vibration effects at the Cemetery.

To date the geotechnical investigations in Toowong Cemetery have been commensurate with the requirements of a detailed feasibility study. The modelling undertaken for this Application for Project Change identifies and confirms the need for additional investigations to identify and mitigate the potential risks to the heritage values of the place arising from TBM construction, particular under the low points in the cemetery.

These additional investigations, particularly within the low cover area of the Toowong Cemetery, would be undertaken only within areas where appropriate, to ensure that impacts on existing monuments within the Cemetery are adequately addressed and mitigated. This may require techniques such as inclined borehole investigations, non-destructive surveys to detect possible underground artefacts prior to undertaking further geotechnical works, or other non-intrusive geotechnical investigations techniques.

The Changed Project would not affect the Queensland Heritage registered site of "Baroona" at 90 Howard Street Paddington as would the Reference Design. Ground vibration from underground tunnel construction (TBM) associated with the Changed Project would have the potential to affect two other sites directly above the tunnels with volumetric title requirements. These are properties are registered as "Boondah" at 50 Howard Street, Auchanflower and "Cross Terrace" at 50 Cairns Street, Paddington.

Development on a State Heritage Place must comply with Schedule 1 of the Coordinator-General's conditions.

An amendment to the Coordinator-General's conditions is requested to Schedule 1 condition 2(b) of the conditions to remove reference to 'Baroona' and include as "Boondah" at 50 Howard Street, Auchanflower and "Cross Terrace" at 50 Cairns Street, Paddington as additional places that will require specific Cultural Heritage Management Plans prior to any construction work commencing.

## 4 Project Changes to Western Connection

### 4.1 Changes to Project Design – Western Connection

The key changes arising from the Changed Project in the vicinity of the western connection relate to the:

- location of the tunnel portals to an area north of those proposed for the Reference Design;
- location of the tunnel entry and exits and the related relocation of entry and exits transition ramps to the inside of the Centenary Motorway;
- realignment of the Centenary Motorway east-bound lanes to the north and east to accommodate the changed connections with the motorway, resulting in an increased encroachment upon the Mt Coot-tha Botanic Gardens; and
- relocation of the Tollroad Control Centre (TCC) from a position adjacent to the southern boundary of the Botanic Gardens to a site situated opposite the entrance.

The Coordinator-General's report observed that the construction of road tunnels is often simpler and less costly if portals are located on the inside of major feeder roads and that, subject to further assessment, there was potential merit in an inner-portal final design option at the western end.

In response to this observation, the Changed Project proposes relocating the portals, with the entry and exit transition ramps to be placed together in a central location on the inside of the existing Centenary Motorway lanes. The traffic effects are discussed below in Section 4.3.1. The central transitions to and from each tunnel would be of similar length to the Reference Design.

To accommodate this change in portal location, the eastbound lanes of the Centenary Motorway would be realigned to swing outside and to the north of the existing lanes before swinging back to connect with Mt Coot-tha Road at the roundabout. All surface road widening works for the east-bound lanes would occur on the northern side of the existing Centenary Motorway.

The alignment of the westbound lanes of the Centenary Motorway would be unaffected by the relocation of the portals for the Changed Project. The westbound merge arrangements of the Changed Project with the Centenary Motorway would be shorter than the merge for the Reference Design by about 150m.

Traffic management for the realignment of the Centenary Motorway eastbound lanes would require only one primary traffic switch. The existing Mt Coot-tha roundabout and the adjacent existing pedestrian/cycle bridge structure also both remain unaffected by the Changed Project.

The western ventilation station would be buried underground in a location immediately north of the Reference Design location. The ventilation outlet for this ventilation station would be above ground on the western side of the buried ventilation station and approximately 43 \m north-west of the outlet location identified in the Reference Design. The ventilation outlet would be at least as high as the Reference Design outlet which must be at least to RL 67m or 20m above the land surface.

The Reference Design, at the western connection, provided for the reinstatement of the area between the Botanic Gardens and the western connection of Northern Link with the Centenary Motorway. The reinstatement works were to be conducted in consultation with the Botanic Gardens management. The Changed Project would also be compatible with requirements for the Botanic Gardens management and future expansion, including a water feature and recreational space adjoining the existing gardens complex.

## 4.2 Changes to Delivery – Western Connection

### 4.2.1 Worksite Layout and Construction Areas

As with the Reference Design, the Changed Project would entail a major construction site and construction activity at the western connection (Toowong).

The Changed Project would adopt construction staging strategies to mitigate the potential impacts on traffic flows on the Centenary Motorway and Mt Coot-tha Road during construction. The initial construction activities will be carried out off the Centenary Motorway and behind construction barriers.

**Figure 4-1, Figure 4-2 and Figure 4-3** below show the three main construction stages for the delivery of the western connections with the Changed Project. The larger area indicates the location of the western worksite at the intersection of Mt Coot-tha Road and the Centenary Motorway.

#### Stage 1 – Worksite arrangements

**Figure 4-1**, identifies stage 1, being the establishment of the construction areas and western worksite (blue) to the north of the Centenary Motorway. Construction access and egress (red) would be established off the Centenary Motorway and also off Mt Coot-tha Road, north of the roundabout. The construction of the realigned eastbound lanes of the Centenary Motorway would be off-line with the existing road network unaffected (yellow), apart from access requirements to and from the worksite. Stage 1 would be approximately 26 months in duration and include:

- site establishment, land clearing and earthworks to the north of the Centenary Motorway and within the western worksite;
- establishment of the western worksite facilities and equipment;
- construction of the ultimate eastbound carriageway;
- cut and cover and portal construction including the TBM assembly area and launch box, within the excavations for the cut and cover tunnels;
- daytime assembly of the TBMs in the uncovered, 'cut and cover' and transition excavations and subsequent erection of the TBM sheds;
- the completion of the TBM tunnelling.

#### Stage 2 – Worksite arrangements

**Figure 4-2** identifies stage 2 which would be of approximately 14 months duration and includes:

- the traffic switch to the realigned eastbound lanes of the Centenary Motorway (yellow);
- the construction of the east and westbound transition ramps and tie-ins within the newly created central median to the surface road network (blue);
- completion of the cut and cover (green); and
- construction of the western ventilation station.

#### Stage 3 – Worksite arrangements

**Figure 4-3** identifies Stage 3 of the delivery of the western connection which would be of approximately 4 months duration and include:

- completion of the ramps and tie-ins to the surface motorway;
- construction drainage work off the existing westbound Centenary Motorway;
- completion of the tunnel fit-out; and
- site demobilisation and urban design and landscape works.

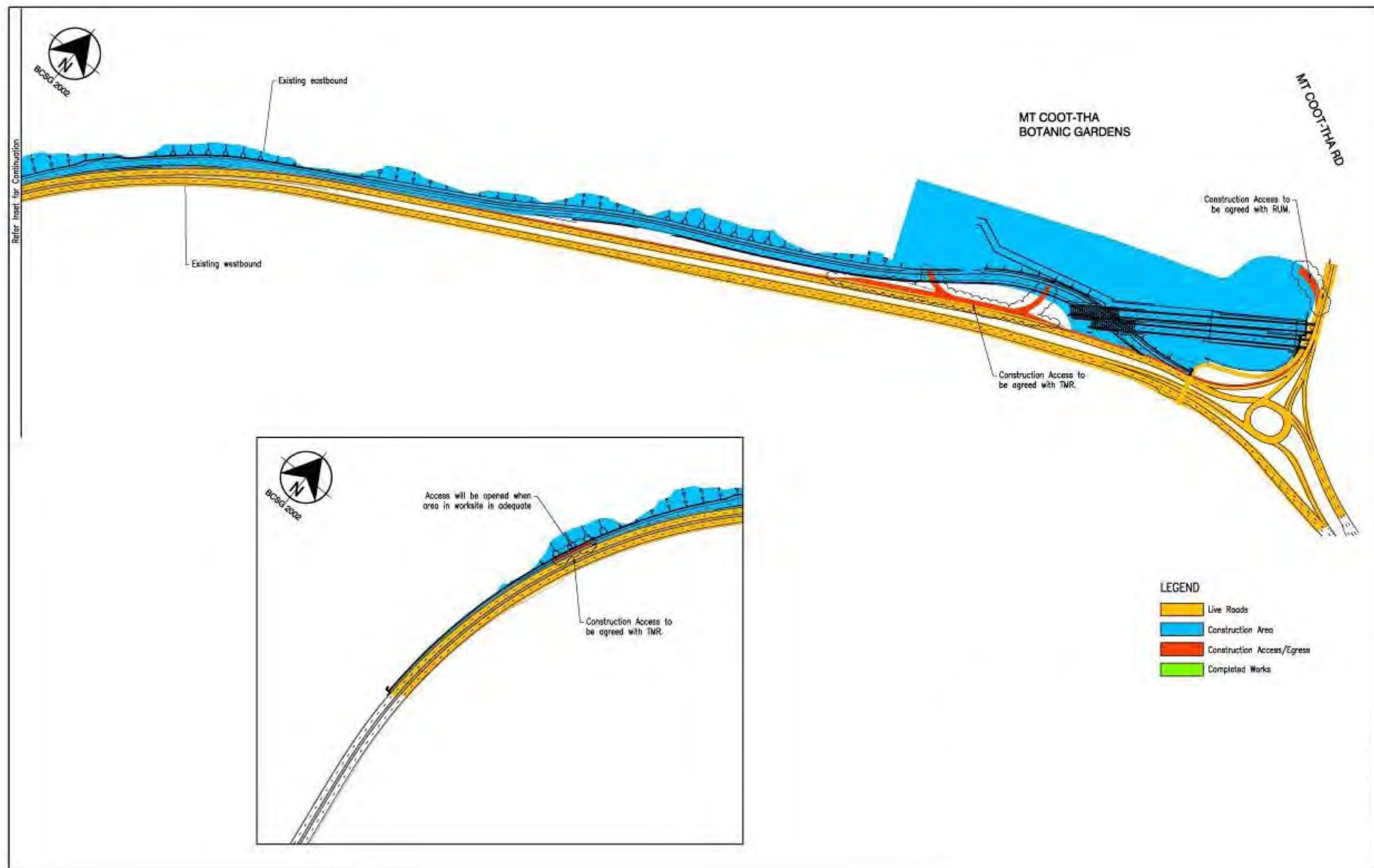


Figure 4-1: Stage 1 construction sequencing – Western connection



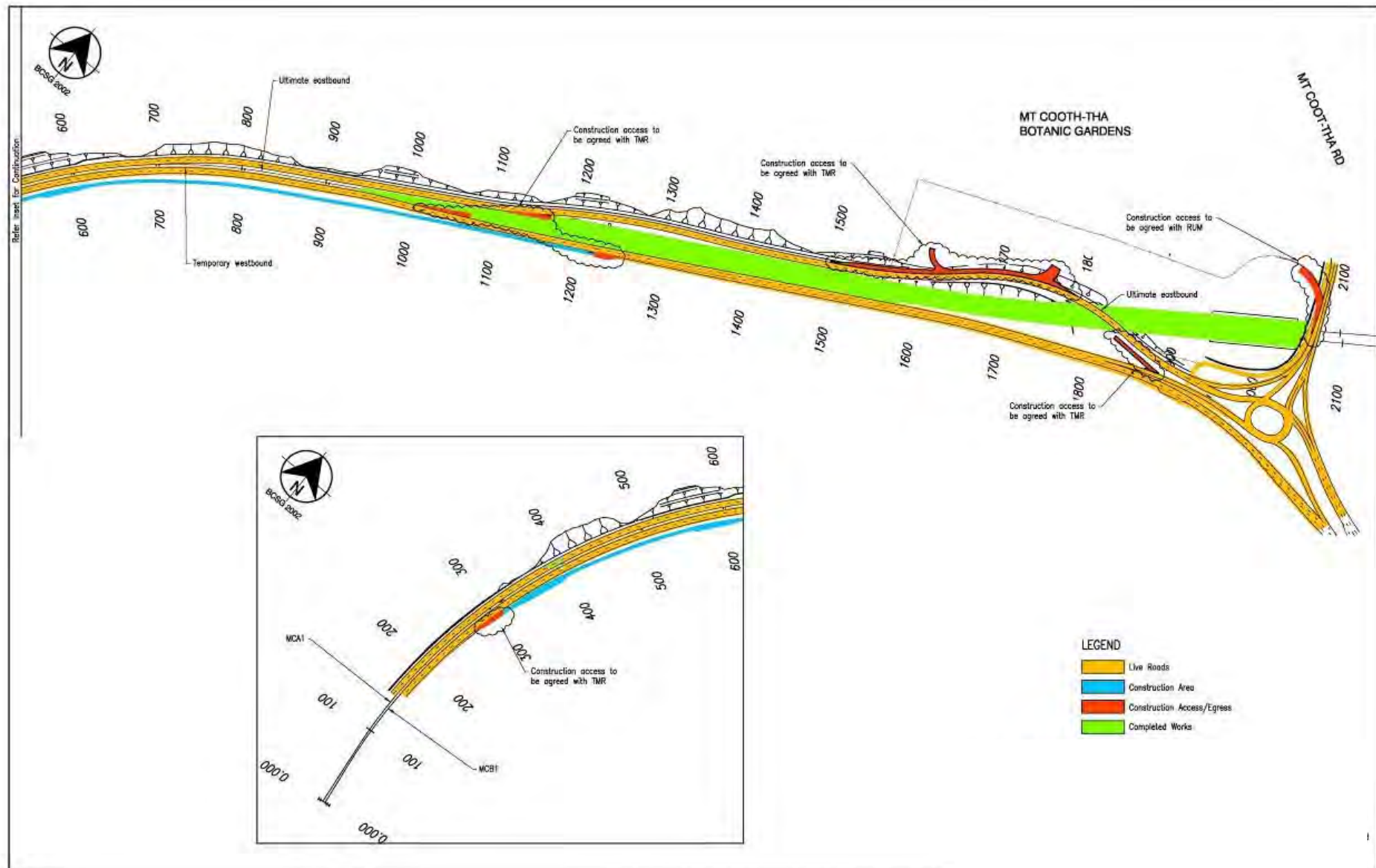


Figure 4-3: Stage 3 construction sequencing – Western connection

The general layout of the western worksite is shown on **Figure 2-40** during Stage 1 and **Figure 2-41** during Stage 2 following the switch of traffic onto the new eastbound lanes of the Centenary Motorway.

The Changed Project would increase the area of the worksite from approximately 4 hectares to 6 hectares by including the area to the west of Mt Coot-tha Road. This area includes the TBM tunnel portals and TBM launch chambers within a large open section of the cut and cover excavations, storage areas either side of the launch chambers for the unloading and handling of pre-cast tunnel ring segments and additional site access for light vehicles from Mt Coot-tha Road.

Temporary access and egress for heavy vehicles would be off the eastbound lanes of the Centenary Motorway with an additional temporary access for light vehicles off Mt Coot-tha Road.

Temporary construction on-site parking would be provided with those parking areas becoming available during successive stages. As construction progresses, access to the work zone between the realigned eastbound and existing westbound carriageways of the Centenary Motorway would be provided as left-in entries or left-out exits to the westbound carriageway, with a left-in entry to this area from the eastbound lanes added in later stages.

Subject to the Coordinator-General conditions, all surface construction work would be undertaken during standard construction hours between 6.30am to 6.30pm (Monday to Saturday) and at no time on Sundays and public holidays.

The workshops and stores on the construction site would be acoustically lined to mitigate construction noise. Early construction of a noise barrier, up to 6m high, would also be undertaken along the northern boundary of the construction site to mitigate noise impacts to the adjacent Mt Coot-tha Botanic Gardens.

The TBMs would be assembled in the cut and cover transitions during the standard construction hours (Monday to Saturday 6.30am – 6.30pm). After assembly of the main components of each TBM an acoustic-lined work shed would be erected over and beside the TBM launch-box to facilitate the continuous underground operations by mitigating the potential noise and light pollution impacts of segment handling and general TBM operations.

The segments would be stored, pending installation, inside the shed. The pre-cast tunnel segments would be lifted by a gantry crane onto special vehicles for transport to the TBM. They would be used to line the tunnels immediately after excavation by the TBM from within the TBM shield. The Changed Project would require 4,300 rings for the tunnel lining.

The tunnel ventilation system during construction includes the installation of two ventilation fans with sound attenuators located above the two edges of the fans. A noise enclosure would be provided to mitigate construction ventilation noise.

During Stage 1 and the TBM construction, an acoustic workshed for spoil handling would be provided on the western end of the worksite. This workshed would transfer spoil from the in-tunnel conveyors to the external quarry conveyor. The in-tunnel conveyor between the TBM tunnel and the spoil handling workshed would be enclosed for noise attenuation and dust control. From the transfer station, a single conveyor will transport the material to the Mt Coot-tha Quarry. The external conveyor will be fully enclosed along its length between the worksite shed and the quarry.

The workshed would have capacity of approximately 16,000m<sup>3</sup> or two full days of TBM operation to store spoil for transport off site in the event of the conveyor being out of operation.

The second stage of construction would continue within the worksite for tunnel fit out and also within the transition structures and tie-in areas within the centre of the Centenary Motorway following completion of the tunnel construction and routing of eastbound traffic onto the realigned Centenary Motorway. Some tie-in works would need to be constructed during lane closures and night works. The pedestrian and cycle bridge structure would be retained with access maintained during construction. Some minor realignment of the shared path would be required on the northern side of the bridge to accommodate the worksite adjacent to Mt Coot-tha Road. This work would be conducted off-line or at night under relevant approvals in order to minimise disruption to local pedestrian and cycle access.

Compared to the Reference Project, the Changed Project provides for minimal disruption to pedestrian and cycle access to the Botanical Gardens and Toowong Cemetery, addressing concerns raised in some submissions to the EIS.

#### 4.2.2 Workforce Car Parking

The Reference Design included dedicated temporary construction workforce parking areas at the western end in the overflow car park across Mt Coot-tha Road from the entrance to the Mt Coot-tha Botanic Gardens or in areas along Sir Samuel Griffith Drive between Mt Coot-tha Road and Simpsons Road, or any combination of more than one of these sites where required to avoid workforce parking on local streets. Shuttle buses would be provided to transport workers between the parking areas and the worksites.

For the Changed Project the overflow car park on Mt Coot-tha Road would no longer be used for temporary construction workforce parking as identified in the EIS but would include workforce construction parking only for the construction of the TCC. The proposed changed use of this site for the TCC is addressed in Section 5 of this application.

#### Construction project office and visitor centre

For the Changed Project a site along Sir Samuel Griffith Drive between Mt Coot-tha Road and Simpsons Road has been identified to establish the construction project office and visitor centre with temporary parking for office staff and visitors during the construction of the project between 2011 and 2014. This arrangement is shown on **Figure 4-4**, subject to detailed design. The land contains the ex-Freers chip factory building on Lot 1 RP76740 at 95 Sir Samuel Griffith Drive, Bardon as well as the vacant land parcels either side of the existing building.

If required, additional staff parking requirements may be provided at this location, No construction activities would originate from the construction project office once it is established and the site would not be used during night shift construction activities.

A public visitor information centre would be established with associated car parking at the construction project office site. Development approval for the construction project office would be sought, where required in accordance with the *Sustainable Planning Act 2009* and City Plan.

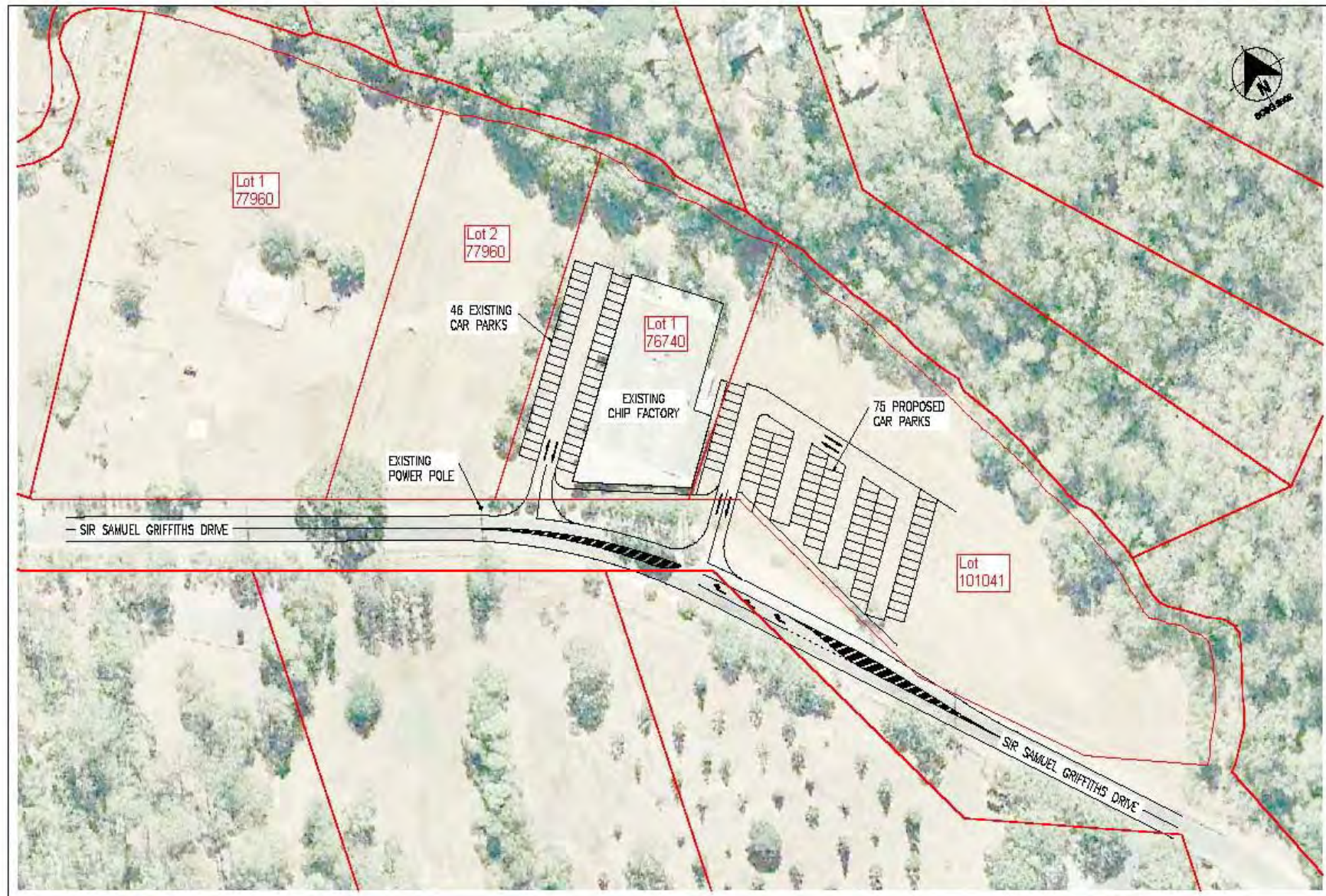


Figure 4-4: Proposed construction project office at 95 Sir Samuel Griffith Drive

### Construction car parking at Anzac Park

A temporary construction workforce parking area for up to 300 vehicles would be provided in Anzac Park, as shown in **Figure 4-5**. This has been included to satisfy the Coordinator-General's condition with regards adequate off-street construction workforce parking to ensure the construction workforce does not park on surrounding local streets. This additional temporary construction parking site would be located in the northern part of Anzac Park, adjacent to the recently-constructed pedestrian and cycle bridge and behind a topographic ridge which would visually separate the site from Wool Street.

Access to the workforce parking for construction workers would be limited to and from Dean Street, with no access for construction workers from Wool Street. From this temporary parking area, construction workers could walk between the car park and the western worksite using the existing pedestrian/cycle bridge over the Centenary Motorway.

The construction workforce would also be encouraged to use public transport, linking the western worksite to the Toowong train station and nearby bus stops. Shuttle buses and prepaid public transport tickets would be provided to the construction workforce to reduce construction-related traffic and parking demand.

The temporary construction workforce parking area would be securely fenced at all times and would be only available for access and use by the construction workforce. Upon completion of the works, this section of Anzac Park will be reinstated in line with Council, stakeholder and community requirements.

The Coordinator-General's condition 22 remains relevant to the mitigation of the potential effects of construction workers parking. An addition to this condition is recommended in Section 8 to manage potential car park noise.

The proposed temporary construction workforce car park in Anzac Park would be approximately 80m from the nearest residences in Wool Street. Most of the temporary construction workforce car park along the existing bicycle path would be approximately 200m from the nearest residences along Wool Street.

Protocols and procedures for all construction personnel in interacting with the community will be established and implemented through ongoing workforce induction, training and an agreed code of conduct or code of behaviour to be adhered to by all personnel while on any construction site associated with the Changed Project.

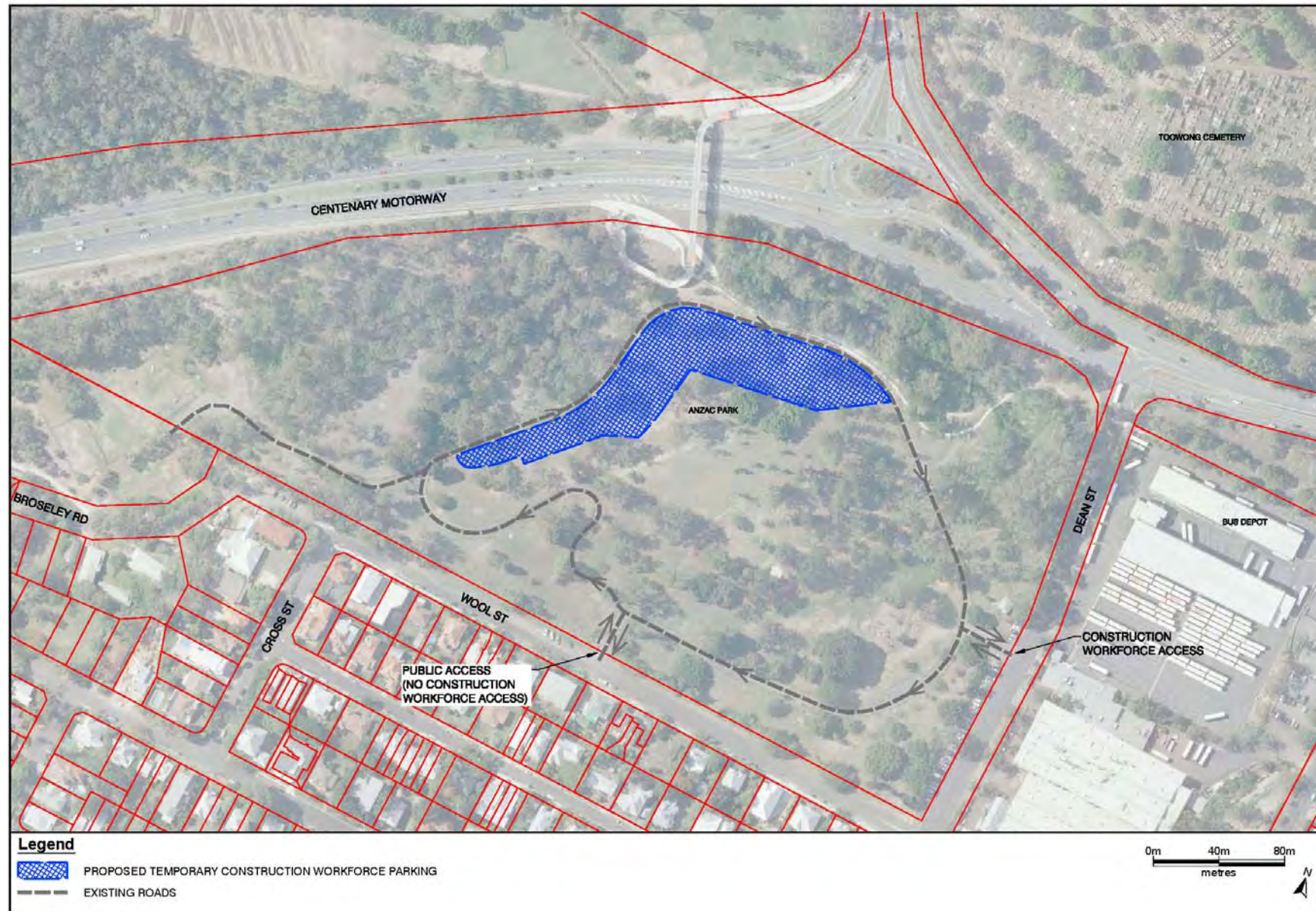


Figure 4-5: Proposed temporary workforce construction parking – Anzac Park

### 4.2.3 Spoil Handling, Haulage and Placement – Western Worksite

#### Spoil Handling

Spoil handling arrangements from the western worksite for the Changed Project and for the Reference Design are summarised in **Table 4-1**.

**Table 4-1: Summary of change in spoil handling (bank cubic metres) – western worksite**

Criterion	Reference Design	Changed Project	Change (%)
Total spoil (Bank m3)	1,238,000	1,235,000	-0.25%
Spoil via conveyor to Mt Coot-tha Quarry (Bank m3)	973,000	932,000	-4.2%
Disposal site (for spoil not disposed of in Mt Coot-tha Quarry)	Swanbank	Rudd Street, Oxley (or other location as approved)	
Haulage route	Centenary Motorway – Ipswich Motorway – Cunningham Highway – Swanbank Road	Centenary Motorway – Ipswich Motorway – Ipswich Mwy Service Road – Douglas Street – Rudd Street (or other location as approved)	
Spoil by truck (Bank m3)	265,000	303,000	14.3%
Haulage hours	6:30am Monday to 6:30pm Saturday,	Standard construction hours: 6:30am to 6:30pm Monday to Saturday TBM spoil (in case conveyor is out of operation): 6:30am Monday to 6.30pm Saturday	
Ave. haulage per hour (trucks in each direction)	6 for 14 months	14 months; 5 for excess TBM spoil 35 for TBM spoil when conveyor is out of operation	

The Changed Project would provide a spoil conveyor between the western worksite and the Mt Coot-tha quarry, as did the Reference Design. The conveyor would follow an alignment adjacent to the realigned Centenary Motorway and around the western edge of the Botanic Gardens.

The surface and cut and cover spoil as well as the TBM spoil that cannot be placed within the quarry would be transported by truck (303,000bcm) to an approved site located at Rudd Street, Oxley or other approved locations. The haulage task to Rudd Street would require approximately 4-5 trucks per hour. The proposed haul route would be via Centenary Motorway, Ipswich Motorway, Ipswich Motorway Service Road, Douglas Street and Rudd Street. Other approved spoil sites may be used subject to the approval of Construction Traffic Management Plans and Coordinator-General's Conditions Schedule 3 Section 16. The haulage hours for the Changed Project address the concerns raised in submissions to the EIS regarding noise impacts for residents.

Should the spoil conveyor be out of operation and the emergency stockpile facility within the spoil shed start to reach capacity, all the tunnel spoil would need to be removed by road transport. Approximately 450 truck loads per day at an approximate average rate of 35 trucks per hour would be required to take the material to the western spoil placement site in these circumstances. This operation, if required, would be carried out between 6.30am Monday to 6.30pm Saturday.

## Spoil Conveyor

In relation to the Reference Design, the Coordinator-General, on page 16 of Coordinator-General's report stated that:

*The majority of spoil excavated by the TBMs will travel by conveyor from each TBM, existing at the western tunnel portals to a transfer station located within the western worksite. From the transfer station, a single conveyor will transport the material to the Mount Coot-tha Quarry. The conveyor will be fully enclosed along its length between the worksite shed and the quarry. All stockpiling, truck and conveyor loading activities at the western worksite will be undertaken entirely within worksite shed or within the tunnel excavation area.*

The above described arrangements relating to the Reference Design would be maintained for the Changed Project.

Condition 18c of the Coordinator-General's report provides for the operation of the conveyor to transport spoil from the tunnel boring machine into the Mt Coot-tha Quarry, provided the relevant noise limits in Condition 22 can be met.

The spoil conveyor would operate from the TBM portal shed through to the spoil handling shed and transfer station and then on to the quarry. Spoil would be delivered by conveyor into the quarry on a continuous basis to support the operation of both TBMs, while achieving the required noise conditions.

## Spoil Placement

For the Changed Project, the spoil would be spread and compacted within an allocated area of the quarry to facilitate the eventual rehabilitation of the quarry. This is different to the Reference Design. The placement of spoil would not affect the continued operation of the quarry.

Spoil placement within the quarry, being the distribution, spreading and compaction of conveyor spoil from the project works, would be controlled in accordance with the existing quarry development permit.

The existing quarry development permit remains appropriate for the operations within the quarry. It is proposed that for delivery of spoil into the quarry, the following further Coordinator-General's conditions would apply:

*Conveyor spoil delivery into the quarry must be managed to mitigate any adverse environmental impacts including:*

- *Spoil may be delivered by conveyor into the quarry providing the environmental objectives and the performance criteria for noise (Schedule 3, condition 22 of the Coordinator-General's conditions) and air quality (Schedule 3, condition 20 of the Coordinator-General's conditions) are met at adjacent residential properties.*

These proposed and existing Coordinator-General conditions will ensure that concerns raised in submissions to the EIS regarding amenity impacts of the conveyor and spoil placement operation at the quarry will continue to be appropriately managed.

Noise monitoring and dust deposition monitoring would be implemented to confirm that spoil placement activities meet the Coordinator-General's conditions. The noise monitoring station would be in place two months prior to the commencement of conveyor operations and would continue until either completion of Northern Link spoil placement at the quarry or sooner if the Coordinator-General is satisfied that noise emissions for spoil placement at the quarry are not causing residential impacts.

## 4.3 Effects of Project Changes – Western Connection

### 4.3.1 Traffic and Transport

The key changes to the Reference Design entail the realignment of the Centenary Motorway eastbound lanes to accommodate central portals for the NLRT project. The alignment of the westbound Centenary Motorway lanes and the Mt Coot-tha roundabout would be unchanged.

There would be no impact on future, known upgrading requirements to the Centenary Motorway and the local road network. The Changed Project would be compatible with future widening of the Centenary Motorway, and would accommodate a connection with a possible future Inner Orbital. Similarly, the Changed Project would not affect the design of the mitigation works for the Moggill Road ramps.

The road layouts for the Changed Project would provide for easy way finding for motorists, with clear choices between the NLRT and the surface roads via the Centenary Motorway.

DTMR has indicated acceptance for the Changed Project of a design speed of 70km/h (posted at 60 km/h) downstream of the exit to Northern Link on the Centenary Motorway eastbound, but that a transition in design speeds from 90km/h on the mainline to 70km/h on the realigned eastbound Centenary Motorway would be required. With some minor adjustments to the length of merges and line marking, the western connections are equivalent to or better than that proposed in the Reference Design, and in principle satisfy DTMR requirements.

The location of the portals and connecting lanes at the western end of Northern Link reinforces the Centenary Motorway – Northern Link route as the primary traffic and freight route, with Milton Road becoming a secondary route. The central portal location reinforces this transport benefit.

The central portals arrangement for the western connection of the Changed Project would:

- allow the Centenary Motorway merge and diverge areas to operate safely and efficiently;
- allow traffic to enter the tunnels even with traffic queues associated with both the Mt Coot-tha roundabout and the Toowong roundabout; and
- allow traffic to access Milton Road, even with an incident in either of the tunnels.

### Performance of merge and diverge arrangements

Micro-simulation modelling (Paramics) demonstrates the performance of the merge and diverge arrangements for the Changed Project at the western connection. This is the same approach used to assess the performance of the Reference Design in the EIS Supplementary Report (June 2009).

The results of this analysis, with the Reference Design performance results from the EIS Supplementary Report for comparison, are shown in **Table 4-2**. The Changed Project would provide similar performance to the Reference Design in the western connection area, with the same forecast levels of service throughout. The merge and diverge arrangements would operate with satisfactory levels of service.

The required geometric design standards for sight distance and manoeuvring space provide for safe traffic operations. Line-marking arrangements in the merge and diverge areas would be developed during detailed design in consultation with DTMR.

**Table 4-2: Comparison of western connection performance results (2014)**

Road Network Element	Reference Design				Changed Project			
	Eastbound		Westbound		Eastbound		Westbound	
	Av Speed <sup>(2)</sup>	LoS <sup>(3)</sup>	Av Speed <sup>(2)</sup>	LoS <sup>(3)</sup>	Av Speed <sup>(2)</sup>	LoS <sup>(3)</sup>	Av Speed <sup>(2)</sup>	LoS <sup>(3)</sup>
<b>AM Peak</b>								
Northern Link Tunnel	80	A	80	A	80	A	80	A
Centenary Motorway east of tunnel portal (towards Mt Coot-tha Road)	80	A	70	B	78	A	73	A
Centenary Motorway at Northern Link diverge zone	70	B	-	-	72	B	-	-
Centenary Motorway at Northern Link merge zone	-	-	67	B	-	-	65	B
<b>PM Peak</b>								
Northern Link Tunnel	80	A	80	A	80	A	80	A
Centenary Motorway east of tunnel portal (towards Mt Coot-tha Road)	80	A	66	B	79	A	64	B
Centenary Motorway at Northern Link diverge zone	75	B	-	-	72	B	-	-
Centenary Motorway at Northern Link merge zone	-	-	52	C	-	-	50	C

- Table Notes:
1. Data extracted from Paramics micro-simulation modelling using input 2 hour peak demands from cordon matrix prepared using Northern Link Traffic Model run TR\_2014\_257. No peak spreading applied.
  2. Average Speed = average speed on link during the middle hour of the peak two hour micro-simulation period.
  3. Level of service (LoS) is an index of the operational performance of traffic on a road when accommodating various traffic volumes under different operating conditions. The indicative level of service has been calculated based upon ratio between actual speed and free-flow speed, using Figure 5.12 of the Road Planning and Design Manual (Queensland Department of Main Roads, 2005). Level of service ranges from A (highest) to F (lowest performance).

### Effect of design changes on adjacent road network

The Reference Design is expected to reduce traffic demands at both the Mt Coot-tha roundabout and the Toowong roundabout, and also on Milton Road. The forecast volumes at these intersections would remain the same with the Changed Project as with the Reference Design. The intersection performance analysis presented in the EIS Supplementary Report would still apply.

Key performance measures for these two intersections with NLRT in place, drawn from the SIDRA prepared for the EIS Supplementary Report, are presented in **Table 4-3**. The 95th percentile queue on the western approach to the Mt Coot-tha roundabout would be less than 100 metres in both morning and evening peak periods in both 2014 and 2026, while the eastbound queue at the Toowong roundabout would be less than 120 metres.

As the available queuing space for eastbound traffic between these roundabouts exceeds 350m, the Mt Coot-tha roundabout would not be expected to be affected by downstream blocking effects. The queue on the eastbound Centenary Motorway back towards the Northern Link portals would be determined by the Mt Coot-tha roundabout alone, giving a 95th percentile length of under 100m.

The Changed Project would provide a clear distance of approximately 900m between the Mt Coot-tha roundabout and the NLRT diverge. The Mt Coot-tha roundabout and the Toowong roundabout are not expected to have any impact on traffic entering NLRT up to and including 2026.

**Table 4-3: Performance of Toowong Roundabouts (SIDRA analysis)**

Intersection and Approach	Peak	Degree of Saturation	Delay (s)	Level of Service	95% back of queue (m)
<b>Mt Coot-tha Road Roundabout - 2014</b>					
Overall Intersection	AM	0.84	13	B	98
	PM	0.71	9	A	65
Western Approach	AM	0.81	7	A	98
	PM	0.71	7	A	65
<b>Mt Coot-tha Road Roundabout – 2026</b>					
Overall Intersection	AM	0.89	14	B	95
	PM	0.92	16	B	104
Western Approach	AM	0.81	7	A	93
	PM	0.77	8	A	82
<b>Frederick Street Roundabout – 2014</b>					
Overall Intersection	AM	0.80	10	A	88
	PM	0.91	11	B	152
Western Approach	AM	0.80	10	A	88
	PM	0.68	7	A	63
<b>Frederick Street Roundabout – 2026</b>					
Overall Intersection	AM	0.86	11	B	115
	PM	0.95	16	B	192
Western Approach	AM	0.86	12	B	115
	PM	0.77	10	A	85

Table Note: 1. Demands from Northern Link Traffic Model runs TR\_2014\_257 and TR\_2026\_257

### Effect of a major incident on Centenary Motorway

The normal operation of the Changed Project would not lead to adverse interaction between diverging Centenary Motorway traffic and potential queuing on the NLRT carriageways, as shown by the micro-simulation analysis described above.

As with the Reference Design, a major incident in the NLRT project would have the potential to produce substantial queues on the eastbound carriageway and in some circumstances the Centenary Motorway would be affected if this is not managed. However, in the event of a major incident, a Major Incident

Management Plan would be implemented by the operator to ensure continued operation of the Centenary Motorway and access to Milton Road through the Mt Coot-tha roundabout.

Incident Management Plans would be finalised during detailed design with stakeholder comments incorporated to ensure confidence in the effectiveness of the plans.

### **Ventilation station access**

For the Changed Project, like the Reference Design, the western ventilation station would be located on the northern side of the Centenary Motorway, approximately 400m west of Mt Coot-tha Road.

Access for maintenance and inspection for the ventilation station and associated supporting infrastructure would be provided from the eastbound carriageway of the Centenary Motorway. A deceleration lane would be provided to allow vehicles to enter the site safely and without affecting motorway traffic. The access width would allow an entering vehicle to pass a vehicle waiting to turn out of the site. This arrangement has been generally approved by DTMR with final details to be developed in detailed design and further consultation with DTMR.

### **Anzac Park Temporary Construction Workforce Parking**

Access to the construction parking area would be via the internal Anzac Park private road, which connects to both Dean Street and Wool Street. Dean Street would be the specified access point due to its proximity to the major road network. Current traffic volumes on Dean Street are low, and the road width is sufficient to allow right turning vehicles to be overtaken, so the increase in usage of this access point is not expected to significantly affect the street's operation. The land use opposite the Dean Street entry and exit access is not residential and is used for the bus depot.

Access routes to the construction workforce carpark would primarily be via the Centenary Motorway and the two Toowong roundabouts, although this proposal would also allow alternative routes from the south and south-east. Although right turns into and out of the northern end of Dean Street are restricted to buses only, the nearby roundabouts facilitate U-turns. The impact of construction traffic on these intersections is likely to be reduced by the timing of construction shifts, which are typically earlier than the commuter peaks.

The Construction Traffic Management Plans (CTMPs), to be prepared for the Changed Project during detailed design, would include examination of the impacts of construction related parking in Anzac Park and identification of suitable mitigation and management measures.

### **Pedestrian and cyclist arrangements**

The Changed Project would provide for the same pedestrian and cyclist connectivity around the western connections as the Reference Design, including the extension of the existing pathway along Mt Coot-tha Road to the Botanical Gardens entrance near Ada Street. Further east, the pedestrian/cycle crossings of Dean Street and Miskin Street would be enhanced, with a larger median island on Dean Street and a kerb build-out on the eastern side of Miskin Street improving cyclists' safety.

As a result of the central portal locations, the Changed Project would not require cyclists travelling along the Centenary Motorway to or from the Mt Coot-tha Road roundabout to cross motorway lanes. The configuration of the Changed Project would support continued use of the Centenary Motorway by group and sport cyclists, consistent with DTMR's current arrangement with Bicycle Queensland. Use of the

Centenary Motorway by cyclists should be re-considered by DTMR as recommended in the Coordinator-General's report.

Additionally the Changed Project would help alleviate construction impacts in the following ways:

- no impact on the DTMR Centenary Motorway pedestrian and cyclist bridge structure during or after construction;
- full connectivity provided for the pathway to Mt Coot-tha Road from the overpass during construction with realignment work conducted offline where appropriate and night works to tie into existing infrastructure to minimise any impacts;
- maintaining access in relation to the Centenary Motorway bikeway to the south; and
- no impacts on Mt Coot-tha Road roundabout or on the southern side of Centenary Motorway.

### **Effects of delivery on the road network**

The Changed Project would minimise the potential impact of construction on road users in the western connection area, with no significant or long-term impacts on the westbound lanes on the Centenary Motorway and no works on the Mt Coot-tha roundabout. The existing number of lanes and traffic capacity would be maintained throughout the construction period.

A draft Construction Traffic Management Plan is proposed for construction of the Centenary Motorway connection to Northern Link, with only one major traffic switch for existing motorway traffic.

The early works would involve construction off-line of the proposed eastbound Centenary Motorway alignment to avoid direct impact on present traffic flows. The off-line works would extend from the diverge away from the Changed Project to the tie-in with the Mt Coot-tha roundabout. A section of the transition structure and Centenary Motorway underpass would also be built during this stage.

Eastbound traffic on the Centenary Motorway would be switched to the new alignment to enable the construction of the second stage. This will be a permanent arrangement and would occur after about 26 months of work. Short-term night works would be required for this switch. Traffic operations on Mt Coot-tha Road, Mt Coot-tha roundabout and the approaches to the roundabout would be unaffected during this stage.

No traffic switches would be required for westbound traffic on the Centenary Motorway. Some disruption, and work under traffic should be anticipated, when the westbound merge from Northern Link is constructed. Some drainage works would be required, with little effect on traffic capacity, in the vicinity of the westbound lanes towards the completion of the construction programme at the western connections.

No capacity reductions through the area are expected with the existing westbound Centenary Motorway retaining all its lanes and the realigned eastbound carriageway having two lanes throughout construction.

### **Centenary Motorway Worksite Access and Egress**

The proposed temporary access from the Centenary Motorway to the worksite would satisfy DTMR standards in accordance with Chapter 13 of the Road Planning and Design Manual. The temporary access would enable a heavy vehicle to enter and exit the construction site. It is intended that this access is only for use by heavy vehicles. A light vehicle access is provided off Mt Coot-tha Road.

The length of the acceleration lane and taper is in excess of 145m which should be adequate for a heavy vehicle to reach 60km/hr at the merge with the motorway. The downgrade is greater than 4% in this location.

A vehicle weave analysis is required during the preparation of the Construction Traffic Management Plan to ensure that vehicles from the worksite can adequately change lanes to enable a U-turn to occur at the Mt Coot-tha Road roundabout for vehicles heading westbound on the motorway.

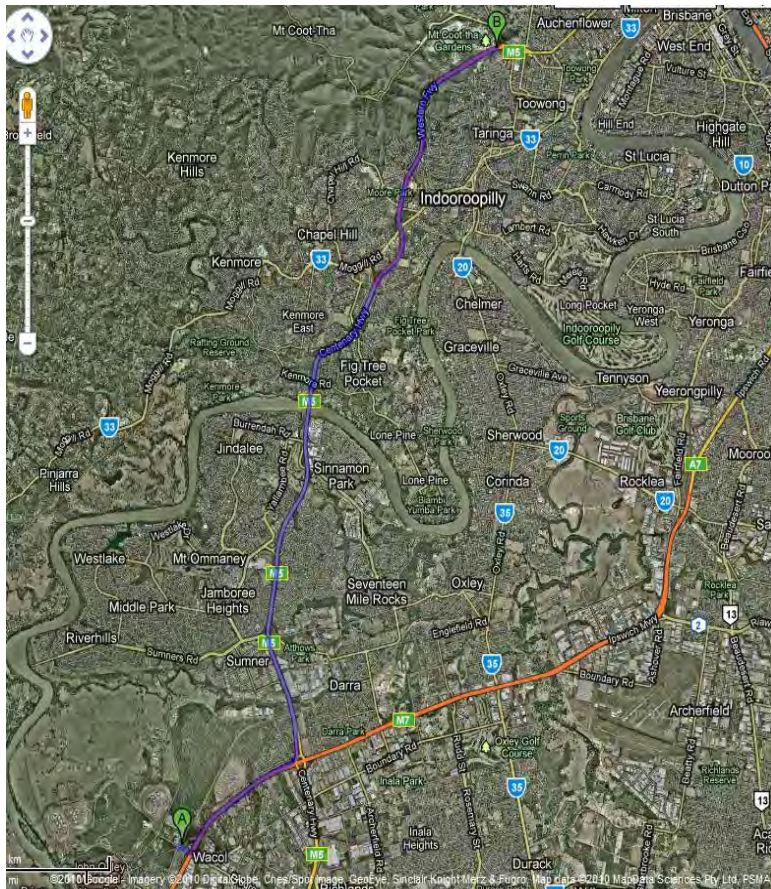
Heavy vehicle movements entering and exiting the worksite will be restricted to out of traffic peak periods on the motorway.

The additional access on Mt Coot-tha Road, just north of the roundabout, would be subject to a Construction Traffic Management Plan and EMP Sub-Plan with associated mitigation measures with the objective to not materially affect traffic conditions on this route, or affect the amenity of the residential areas further north. Sight distance, turning radii and traffic control measures to ensure safe operation of this entry, considering both the shared pathway along the site boundary and traffic from the roundabout slip lane, would be resolved during detailed design.

### **Tunnel Ring Pre-cast Segment Delivery**

The precast segments would be made at an off-site facility at Wacol and transported to the western worksite by road over approximately a 14 month period. A full ring would be transported to the western worksite in two loads. During peak production, there would be approximately 16 rings (32 loads) per 24 hour period transported to the worksite.

To minimise the effect on traffic and the community, a fleet of 4 trucks would operate 16 hours a day 7 days a week between the Wacol site and the western worksite. The delivery of the tunnel precast segments entering and exiting the western worksite will be at an average volume of 4 truck loads per hour (4 trucks in and 4 trucks out). **Figure 4-6** shows the nominated route for the delivery routes for the precast tunnel segment vehicles.



**Figure 4-6: Nominated pre-cast segment route**

## Grout and Other Material Deliveries

Delivery of grout and sand for the grout plant for the western worksite would involve approximately 5 truck and trailers of sand per day and 1 semi-trailer load of grout per day.

During surface construction works approximately 5 truck deliveries of materials would arrive at the western work site per hour. The traffic management plans would direct light vehicle (only) movements to the site via Mt Coot-tha Road whilst strictly retaining access/egress for larger construction vehicles via the Centenary Motorway in accordance with the Coordinator-General's conditions. This would minimise traffic impacts on both local and Centenary Motorway traffic.

## Deliveries of Tunnel Backfill

Following the construction of the raw TBM tunnels an amount of back-filling is required to create the required surface level for the road pavement. The quantity of back-filling required for the Changed Project is estimated at approximately 95,000 bank cubic metres which would be approximately 20% less than would have been required for the Reference Design. Over a 7 month period following the construction of the TBM tunnels this amounts to approximately 4 truck loads per hour over a 24 hour period excluding peak hour times.

For the Changed Project the material to be utilised for backfill of the tunnel may also be material removed by the TBMs during the tunnel excavation activities and unable to be placed in the quarry. This surplus

material will be transported off site by road truck to a designated fill site in the western corridor for reprocessing and returned to site for the tunnel backfill operation.

### 4.3.2 Hydrology

#### Flooding (Operational)

Flooding characteristics relevant to the western connection were assessed as part of the Northern Link Reference Design and described in Technical Report No. 6 Flooding (SKM-CW JV, May 2008). That report assessed the potential for the Western Connection to be affected by regional Brisbane River flooding. Flood levels for the 1 in 10,000 AEP and Probable Maximum Flood (PMF) were assessed as being well below the terrain levels at the Western Connection (Mt Coot-tha roundabout) from regional Brisbane River flooding. This remains the case for the Changed Project.

Local catchment flood levels essentially would be unchanged in relation to the Western Connection. Two local drainage paths flow through the Botanical Gardens to a pond at a low point in the Gardens immediately upstream of the Centenary Motorway, before flowing through pipes under the Motorway to the natural water course running west-east in Anzac Park. The capacity of the pond storage area would be increased as with both the Changed Project and for the Reference Project.

As part of the Reference Design, flood immunity for the western portal would be provided by a combination of flood protection walls, use of the storage volume available in the ponding area within the Botanical Gardens and extension of the existing drainage pipe under the Centenary Motorway. Modelled upstream flood impacts in the 1 in 100 AEP flood event were generally less than 100mm and located within the existing ponds and water features of the Botanical Gardens.

The Changed Project would include the flood protection wall and the proposed water storage but does not include any changes to the existing pipe under the Centenary Motorway. The Changed Project would involve the following enhancements to the Reference Design case:

- construction of three (3) outlet pipes from the enhanced water storage dam;
- construction of an additional storm water pipe under the Centenary Motorway adjacent to the existing pipe if required during detailed design;
- provision of an overland flow path over the top of the tunnels at the western portal; and
- a change in the location of the wall of the new dam compared to the Reference Design arrangements further to the north within the Botanical Gardens.

The flood levels upstream of the portal for all average recurrence interval events up to the 100 year ARI for the Changed Project operational arrangements would increase by between 700 mm to 980 mm compared to existing peak levels. The Changed Project increases would be confined to the open space areas within the new Botanic Gardens precinct. At peak flood levels, approximately 6.6ha would be inundated under the Changed Project compared with 4ha under the Reference Design.

Modelling confirms that there would be no significant changes in discharge volumes or velocity through the pipes or to downstream areas for the Changed Project during operations.

The altered surface connections at the western end for the Changed Project would result in some changes in regards to the collection, treatment and disposal of surface water runoff. Overall the designs have a comparable effect but the key differences are described below.

Pavement surface runoff on the eastbound Centenary Motorway would be collected and taken under the westbound Centenary Motorway carriageway to water quality management features before release to the existing natural watercourse. The westbound Centenary Motorway carriageway would drain to the existing drainage system including water quality management features before its release to the watercourse.

All surface runoff from the transitions to the tunnel portals would be collected and taken via water quality control features into a rock lined gully and directed into the newly constructed 18ML water storage dam in the south-east corner of the Botanic Gardens. Overflow from the water storage dam would discharge to the southern side of the existing Centenary Motorway into the existing watercourse.

Existing overland flow adjacent to Mt Coot-tha Road would be captured via the water storage dam. Overflow from larger events would be discharged through the pipes described above. Overland flow coming from the north-west would also be collected in the water storage dam as an integral part to the drought proofing of the Botanic Gardens.

In summary flooding and stormwater arrangements for the Changed Project does not cause any increase in flood level beyond the Botanic Gardens site, with no increase in peak flood level across the Centenary Motorway or in the areas downstream of the Changed Project. The Changed Project incorporates arrangements to protect against erosion or impacts on downstream water quality. The current Coordinator-General conditions remain appropriate.

### Flooding (Construction)

It is intended to fully excavate the western cut and cover structure prior to installing the roof girders and slab. Flood protection of the western cut and cover structure during construction would therefore be provided by temporary earth bunding of the northern (upstream) face of the cut and cover tunnel and ventilation duct structure. An earth bund with top at RL 24.50 would provide 300mm free board above the predicted Q100 year flood level during construction. The bund would be located near to the northern wall but far enough to permit excavation sufficient to construct headstocks and capping beams. The bund would be required until the majority of the roof structure was installed and ventilation structure (tunnel) constructed. A flood protection barrier would be constructed around the TBM access opening prior to the bund being removed to ensure Q100 year flood levels could not flow into the TBM tunnels during construction.

This compares to the Reference Design as follows. During construction, both the transition and cut and cover sections would have been exposed and required protection from local flooding. This was to be achieved by walls or sheet piles / diaphragm walls along the two faces of construction exposed to flooding, or a combination of the two.

In addition, the construction area upstream of the Centenary Motorway in the Botanical Gardens grounds was also to be protected from local flooding during construction in the Reference Design. This was to be achieved by construction of a bund, to provide 1 in 100 AEP immunity to the construction area and it would have been approximately 400-600 m long and 2 m high, at its highest point. An artificial channel would have been constructed on the upstream face of the bund to allow overland flow to flow into the detention area upstream of the Centenary Motorway. The existing 1.65m diameter reinforced concrete pipe under the Centenary Motorway was to be maintained during construction while the existing 0.9m diameter reinforced concrete pipe to the west would have become redundant and removed.

## Groundwater

The tunnel sections of the Changed Project would be fitted with a waterproof lining of segmental pre-cast concrete rings as part of the TBM operation. This is different to the Reference Design which proposed the use of a TBM for excavation and then the installation of an in-situ cast concrete lining and floor slab resulting in a drained tunnel.

As with the Reference Design, the cross passages, substation niches and drainage sumps for the Changed Project would have in-situ lining and will be drained. This may result in localised groundwater inflows, predominantly at the 120m longitudinal spacing of the cross passages. Construction treatments, such as grouting, would be undertaken if required in these drained sections to reduce groundwater inflows. The cut and cover sections at the tunnel portals would be 'tanked' or waterproofed where the structure sits within the soil horizon.

These arrangements would result in groundwater inflows anticipated to be substantially less than those anticipated for the drained Reference Design.

Groundwater entering either of the tunnels for the Changed Project would collect in sumps and be taken to treatment facilities located at the western worksite. The treated groundwater would be made available for beneficial use, or discharged in accordance with the existing Coordinator-General's conditions.

### 4.3.3 Air Quality and Greenhouse Gases

The Changed Project, at the western connection, would have flatter road alignments and possibly more efficient connections to the Centenary Motorway than the Reference Design, resulting in more freely flowing traffic in most conditions.

The flatter alignments may result in minor reductions in vehicle emissions within the Changed Project tunnels compared to the Reference Design. However, the differences in motor vehicle pollution, when measured at ground level, are expected to be very small and not significant.

The location of the western ventilation outlet would be approximately 43m to the north-west of the Reference Design outlet and the height would remain the same and be at least at the required RL 67m and 20m above ground level. The topography is the same and would not influence the performance of the ventilation outlet. Similarly, there are no different or additional sensitive receptors that would be affected by the minor relocation to the north-west. The proposed change in the location of the ventilation outlet would make no difference to the ambient air quality at either the regional or local levels.

The current Coordinator-General's conditions remain appropriate.

During the delivery phase, the earthworks associated with establishment of the western worksite and construction of the western connections would create the potential for dust. The potential for dust would be mitigated by worksite management and the observance of the existing Coordinator-General conditions

All stockpiling, truck and conveyor loading of tunnel construction spoil is required to occur within acoustically-lined and ventilated worksheds or within the tunnel excavation area to control dust emissions and noise.

Together with the existing Coordinator-General's conditions, these construction air quality measures will continue to respond to issues raised in submissions to the EIS regarding amenity impacts associated with the worksites.

#### 4.3.4 Noise and Vibration

Noise modelling of traffic flows through the western connection in the operational phase indicates the Coordinator-General's conditions would be achieved without the need for noise barriers to the south of the motorway and transition areas. The noise levels at all residences, including at the closest residents in Wool Street, are predicted to be less than or equal to 68 dBA LA10(18hour) as would be the case with the Reference Design. These modelled predictions took account of reflected noise from the proposed noise barrier to the north of the Centenary Motorway.

A noise barrier up to 4m high is proposed subject to detailed design on the northern side of the re-aligned east-bound Centenary Motorway lanes. Modelling indicates that the noise barrier would achieve the environmental (acoustic) outcome sought by the Department of Transport and Main Roads' (DTMR) Code of Practice for parks which requires that a minimum area of 2000m<sup>2</sup> to be less than or equal to 63 dBA L10(12hour). The predicted noise levels with the proposed barrier in place are marginally lower within the Botanical Gardens than would have existed in Year 2026 without the project.

It is noted that submissions to the EIS raised concerns regarding road traffic noise from the Western Freeway (Centenary Motorway). However, with the mitigation measures proposed for the Changed Project, the Coordinator-General's road traffic noise conditions would be achieved at the western connection. Noise barrier designs would be further refined using acoustic three dimensional modelling during detailed design.

During construction, noisy activities would be governed by the Coordinator-General's conditions, specifically Schedule 3, condition 18 – General construction. The conditions provide that surface construction works be restricted to 6.30 am to 6.30 pm Monday to Saturday, and at no time on Sundays and public holidays. Underground construction could be undertaken on a continuous basis, provided the environmental objectives and goals pertaining to regenerated noise and vibration are achieved.

For the Changed Project, the TBMs would be assembled in the uncovered, 'cut and cover' excavations and would be limited to standard construction hours by the Coordinator-General's conditions controlling hours of work (Schedule 3, condition 18) and noise (Schedule 3, condition 22). Once the TBMs are assembled, an acoustic shed would be constructed over the portals and the segment lay-down area to screen the operation of the gantry crane and segment delivery and handling activities during the TBM launch and operation.

The Changed Project would provide several forms of construction noise mitigation including:

- a noise barrier possibly up to 6m high, subject to detailed design, running along the northern side of the worksite as shown in **Figure 4-7** below;
- an acoustically lined spoil handling enclosure to contain night-time spoil handling noise and lighting impacts;
- an acoustically lined shed to contain TBM operation activity noise and lighting impacts;
- all conveyor motors and transfer stations either within the cut of the new road (closer to the tunnel portal) or within acoustically designed enclosures; and
- the installation of two construction ventilation fans with sound attenuators within a specific noise enclosure for the main body of the fans.



**Figure 4-7: Western worksite noise barrier location**

The proposed temporary construction workforce car park in Anzac Park would be approximately 80m from the nearest residences in Wool Street. Most of the temporary construction workforce car park along the existing bicycle path would be approximately 200m from the nearest residences along Wool Street. The Coordinator-General's conditions (condition 22) require that where there is a potential for the goals to be exceeded, further action would be required to mitigate the predicted impact. Any such further action would be supported by consultation with potentially-affected sensitive receptors to discuss possible mitigation measures.

Protocols and procedures for all construction personnel in interacting with the community will be established and implemented through ongoing workforce induction, training and an agreed code of conduct or code of behaviour to be adhered to by all personnel while on any construction site associated with the Changed Project. This code of behaviour will include reference to, and as a condition of employment on the Changed Project, parking only in designated parking areas and not parking "on-street" under any circumstances. A further imposed condition is also proposed in Section 8 of this application to address the potential for temporary construction workforce parking to cause nuisance.

These construction noise management measures, and the existing Coordinator-General's conditions, will continue to respond to submissions on the EIS regarding amenity impacts associated with the construction worksites.

#### 4.3.5 Ecology

##### Reference Design

The potential loss of remnant vegetation and potential fauna habitat associated with construction of the Reference Design was estimated at approximately 1.6 hectares of remnant vegetation. The relevant vegetation was identified under the State Regional Ecosystem mapping as remnant regional ecosystems (12.11.5 / 12.12.5). These ecosystems are classified as 'of least concern' vegetation under the Vegetation Management Act 1999 (VM Act).

## Changed Project – Effects on flora

The impact on vegetation will be further assessed during detailed design and the undertaking of more detailed surveys. Current information suggests that the Changed Project would impact a total of approximately up to 15 hectares of VM Act protected vegetation to accommodate the realignment of the Centenary Motorway and construction activities. This total includes:

- Approximately 9 hectares of 'least concern' RE (12.11.3 and 12.11.5)
- Less than 6 hectares of regulated regrowth.

The Changed Project would not impact upon fragmented RE to the south of the Centenary Highway, compared to the loss of approximately less than 2 ha that would occur under the Reference Design.

The Mount Coot-tha Forest and the Botanic Gardens contain approximately 25,000 hectares of contiguous remnant vegetation. Some of the areas cleared of remnant vegetation would not be used for road use purposes following the completion of construction and would be replanted with native species. Also some work areas would be rehabilitated and returned to the Botanic Gardens as part of the expansion area.

For the western worksite, the Changed Project would require an expansion of the Reference Design worksite by approximately 2.1ha. This additional worksite area would encompass two categories of vegetation:

- an area of approximately 1.8ha containing a sparse landscaped eucalypt community; and
- an area of approximately 0.3ha affecting the Botanic Gardens.

The eucalyptus community is dominated by Forest Red Gums (*Eucalyptus tereticornis*), Tallowood (*Eucalyptus microcorys*) and contains several Cabbage Tree Palms (*Livisonia australis*) and Ficus sp. This community appears to be predominately regrowth vegetation containing some remnant individuals.

The encroachment by the construction area into the boundary of the Botanic Gardens will impact upon a small area of subtropical plantings including bamboo sp., *Syzygium* sp., *Cycad* sp. and a Wollemi (*Wollemi nobilis*).

Neither area is mapped under the *Vegetation Management Act 1999* (VMA).

The alignment required for the spoil conveyor would have a footprint of approximately 2 hectares. Vegetation covering approximately 1.3 hectares of this area is mapped under the VMA as 'of least concern' remnant regional ecosystems. On completion of the tunnelling works and removal of the structures, the conveyor route would be rehabilitated.

The proposed temporary construction workforce car park in Anzac Park comprises open grassland with scattered trees. Existing trees within the proposed car park would be retained and protected during its construction and use.

## Changed Project – Effects on fauna

There would be potential for construction activities to indirectly impact on local fauna for the Changed Project as there would be for the Reference Design.

Fauna species currently occurring within the study area are likely to be exposed to indirect impacts such as noise, lighting, vibration and odours, which are common within urban environments. With the exception of some nocturnal species, most of the fauna likely to occur within the study area are mobile and disperse through the urban landscape. Mobile fauna in the immediate vicinity of each worksite, and particularly the Western worksite, are expected to be readily able to temporarily move away from the worksites for the duration of the construction activities. In the Northern Link EIS, the Reference Project was assessed for its potential threats to Endangered, Vulnerable and Rare fauna. The EIS concluded that there would be no significant impact on these species or their habitat as a result of the Project works in the vicinity of the western worksite. The Changed Project results in no change in this regard.

It is noted that prior to construction activities, fauna surveys will be undertaken to identify the presence of all fauna species inhabiting the site. Prior to construction it is the responsibility of the Contractor to assess construction activities against the requirements of the Nature Conservation Act 1992. Also prior to construction, a suitably licensed fauna spotter-catcher will be engaged to assist with decisions regarding the need to capture and relocate any potentially affected animals to a nearby suitable equivalent habitat. Any relocation will be undertaken by a licensed spotter-catcher.

Concentrated lighting sources during construction may deter nocturnal fauna such as arboreal mammals, birds and bats from being present in the area. However, the Centenary Motorway already provides a source of artificial lighting which would buffer the effect of additional lighting for the worksite on fauna in the wider area. Light spill onto surrounding areas is also controlled through the approval conditions.

Impacts from worksites are temporary and mobile fauna are expected to continue to utilise the study area once construction activities have ceased and the rehabilitation of the area is completed.

Rehabilitation of the worksites associated with the Changed Project, including plantings and water features, would result in improved habitat values within the Mount Coot-tha Forest / Botanic Gardens.

### **Approvals for clearing vegetation**

As with the Reference Design, there would be a range of approvals required for the clearing of vegetation proposed for the Change Report. These approvals are summarised below:

- Nature Conservation Act 1992 (NC Act) – An approval for the clearing of protected native vegetation may be required for the proposed works prior to the disturbance of protected vegetation. The clearing of any listed Endangered, Vulnerable or Near Threatened (EVNT) species as recognised under the NC Act requires a clearing (protected plants) permit to be granted prior to clearing.
- Vegetation Management Act 1999 (VM Act) – Since the assessment of the Reference Design was completed, regulated regrowth vegetation has become protected under the VM Act. However, 'Significant Community projects' are exempt from assessment under the regrowth vegetation code for the clearing of regulated regrowth as is clearing in a road reserve for the purposes of road construction. Clearing activities outside of the proposed road reserve is assessable under the VMA. The construction of the spoil conveyor to the quarry would also be likely to require an approval under the VMA.
- Natural Assets Local Law 2003 (NALL) – The clearing of all vegetation within the proposed realignment of the Centenary Motorway and also for the spoil conveyor would require assessment under NALL.

#### **4.3.6 Cultural Heritage**

The Changed Project would have no effective change on the State Heritage Registered Mount Coot-tha Forest from that predicted for the Reference Design. The Reference Design required approximately 1.4 hectares of land clearing on both northern and southern sides of the Centenary Motorway through the

Mount Coot-tha Forest section of the motorway. The Changed Project also requires approximately 1.4 hectares of land clearing, all on the northern side of the Mount Coot-tha Forest area. The heritage values of the place would not be affected differently from the Reference Design and the Coordinator-General's conditions for development on a State Heritage Place continue to be relevant to the Mount Coot-tha Forest section of the Changed Project.

Anzac Park is a local heritage place listed on the City Plan 2000 Heritage Register. Anzac Park would have been impacted by the Reference Design exit tunnel and connection to the Centenary Motorway.

In the Changed Project it would only be affected by the temporary construction workforce car park. Development on a local heritage place requiring a CHMP would be relevant to the Changed Project for the design and development of the proposed temporary parking area.

Anzac Park was once a paddock and was originally part of the Crown Cemetery Reserve. In September 1918, a number of ornamental trees including Macadamia nut trees (*Macadamia integrifolia*), were planted in Anzac Park to commemorate the men from the district who died in World War I. The trees were apparently planted in rows, with the nearby palms being a later addition. There are no records which indicate the number of trees that were planted or which trees were memorials. Although the exact location of the memorial plantings is unknown, a 1946 aerial photograph shows a distinct double row of trees along the park border on Wool Street, which are possibly part of the plantings.

The trees within and in the immediate vicinity of the proposed carpark have been surveyed. There is no indication that any of the trees surveyed are associated with the memorial plantings of 1918. As identified above, all existing trees within or adjacent to the construction area dedicated to temporary parking must be retained and protected.

#### 4.3.7 Social Environment

The potential effects of the Reference Design on the social values of the locality around the western connections were discussed in relation to the Botanic Gardens, Toowong Cemetery and Anzac Park. Other social and community values stemmed from environmental amenity characterised by air quality, acoustic amenity and accessibility to transport and urban facilities.

The Changed Project, being of similar configuration and operation to the Reference Design, would have the same effects on the Botanic Gardens during construction, but would present a comprehensive mitigation strategy for the worksite, for the post-construction phase.

The effects of the Changed Project on Toowong Cemetery also would be similar to those predicted for the Reference Project, and would require the implementation of a cultural heritage management plan prepared for the purpose of minimising and mitigating such impacts.

Whereas the Reference Project required part of Anzac Park for realignment of the westbound lanes of the Centenary Motorway, the Changed Project on Anzac Park would be initiated by the provision of up to 300 car parking spaces for workforce parking.

While this would be a significant temporary change in the character of the park in this area, it is not considered to be as extensive as the permanent change that would have been introduced by the Reference Design to the area of the park adjacent to the existing Centenary Motorway. It is also noted that comprehensive rehabilitation would be carried out upon completion of the Changed Project construction. During construction, the loss of access to parts of Anzac Park would require consultation

with the local community. While there would be no direct mitigation for the temporary loss of access to part of Anzac park during construction, the maintenance of the pedestrian / cycle overpass of the Centenary Motorway would assist in linking the Toowong (west) community with alternative open space and recreation opportunities.

#### **4.3.8 Urban Design and Visual Environment**

The Coordinator-General's Urban Design and Landscape condition (Appendix 1 Schedule 3 condition 24(c)) requires that the project must rehabilitate the western worksite to a state fit for incorporation into the Botanic Gardens master plan, and revegetate disturbed areas to retain the integrity of the "green gateway" experience along the Centenary Motorway.

The rehabilitation proposed for the western worksite for the Changed Project would adopt the principles of the Botanic Gardens Expansion Plan.

The Changed Project would have reduced impacts on the southern side of the Centenary Motorway, when compared with the Reference Design. The Changed Project would provide noise walls, sound berms and embankment planting to reduce noise and visual impacts on the Botanic Gardens during construction. However, there would be some deterioration of existing viewsheds to the Cemetery.

In the short-term, the visual effect of the western worksite and surface works along the Centenary Motorway for both the Reference Design and the Changed Project would be to diminish the 'green gateway' sought by the Coordinator-General's conditions. This effect would be mitigated with the implementation of the condition requiring rehabilitation of the works areas.

The ventilation station would be buried and integrated into the visual and functional setting of the Botanic Gardens. The ventilation outlet would be visually subsumed into the landscape as a consequence of the changed location, retention of vegetation on the ridge to the south, and the effective architectural and colour treatments proposed.

The Coordinator-General's conditions require that any construction spoil handling facilities within the Mt Coot-tha Botanic Gardens, such as the conveyor, must not impede existing access to public areas. The Changed Project proposes to realign the spoil conveyor further south to avoid public areas within the Botanic Gardens, in response to this condition.

## 5 Tollroad Control Centre

The EIS for the Northern Link Road Tunnel Project identified that in the operational phase of the project, a number of services would be required for the safe and effective operation of the tunnel. These services would be monitored and controlled from the Tunnel Control Centre (since identified as the Tollroad Control Centre (TCC) due to the wider application of the definition of the tollroad rather than being simply applied to the tunnel aspect of the tollroad).

The TCC would be a dedicated building with the need for road network and tollroad access. The Reference Design proposed that the TCC would be located adjacent to the Centenary Motorway within the rehabilitated worksite area. The TCC for the Changed Project would be located at the corner of Richer Street and Mt Coot-tha Road adjacent to the existing Botanic Gardens overflow car park. In the Northern Link EIS, this site was identified and subsequently approved by the Coordinator-General for use as temporary construction workforce car parking.

The construction of the TCC is currently programmed for mid 2012, with building works taking approximately one year. Works will continue at the TCC once constructed for activities such as fitout, commissioning and testing. Full operation of the TCC would commence once the tollroad is opened.

A site accessed from the Centenary Motorway within the rehabilitated worksite as proposed in the Reference Design would have required access through the Botanic Gardens or directly from the Centenary Motorway. Reasonable attempts have been made with the Changed Project to avoid above ground road tunnel infrastructure within the Botanic Gardens and the Botanic Gardens strongly opposed further above ground infrastructure and TCC access through the public areas of the gardens. The proposed site has direct access off Mt Coot-tha Road.

A site option was developed off Miskin Street within the existing bus depot area. The development on this site however would constrain depot operations, which include bus assembly, maintenance and stabling. This depot is of strategic importance to the operations of the bus fleet servicing the western suburbs, and is one of the principal stabling areas within reasonable proximity to the city centre. Access from this location to the main tunnels would be further constrained, and would not present the efficiencies offered by the site proposed in the Changed Project. The developed option also required the retention of existing parking under the building adding considerably to building cost and to the height and visual impact of the building, even when stepping down the steep slope of Miskin Street.

The consideration of a further alternative associated with land proposed for the temporary site offices on Sir Samuel Griffith Drive was not considered possible due to the temporary lease of the land under consideration and also less favourable access to the toll road and the associated greater impact of TCC traffic on Mt Coot-tha Road.

The TCC concept plan identifies a two storey building approximately 90m long by 20m wide with the height varying from approximately 9 m for the eastern half (due to the additional ground floor height of 5m for the garage area) to approximately 7 m for the western half of the building.

Within the TCC would be the support workshops (for tunnel equipment maintenance and spare parts storage), incident control room, traffic control room and office space for administration. A motor vehicle workshop is not included in the TCC and vehicle maintenance will not be undertaken at the TCC. All data collected by the in-tunnel monitoring systems would be processed and all the services controlled from this location. Obtaining water for the tunnel wash down operations, and installation of the pressure booster

for use by the fire brigade would not be undertaken at the Changed Project TCC location as proposed in the EIS.

The Changed Project TCC will contain the control room which will be a 24 hour, seven days per week operation with at least two on-duty operators at any time while other functions such as office administration and tunnel equipment maintenance would generally take place during 6:30am to 6:30pm Monday to Friday. Equipment maintenance would include the servicing of a range of tunnel equipment including, for example, electronic monitoring equipment, pumps and fans. The TCC would include a training and incident room, office space for the operations and maintenance contractor staff as well as Council and emergency services personnel, a computer and communications equipment room, a plant room, two meeting rooms, workshop space for the maintenance of tunnel equipment, tunnel spare parts store, toilets, showers, change rooms, a reception area and a lunch room. A secure hardstand area will provide parking for incident management vehicles and replacement equipment movements. Driveway access to and from the TCC would be provided from Mt Coot-tha Road.

The TCC would occupy part of a 1 hectare site with all access to and from Mt Coot-tha Road on the southern side of the building. The concept plan for the TCC building is shown on **Figure 5-1**. The current overflow carpark area for the Botanic Gardens on the site contains approximately 88 car spaces. Approximately 58 spaces would be retained for the gardens overflow car park following the toll-road construction. Approximately 30 spaces would be incorporated into the new TCC car park.



**Figure 5-1: TCC concept plan**

### 5.1.1 Traffic and Transport

Before construction of the TCC, due to start in mid 2012 the 88 parking spaces used as an overflow from the Botanic Gardens would remain available for public use. During construction from mid 2012, all public car parking will be unavailable as it will be used for construction purposes. Once construction of the TCC is complete, approximately 58 overflow car parking spaces for the Botanic Gardens would be reopened

for public use. There would be an associated long-term impact from the loss of approximately 30 overflow parking spaces. Council is investigating alternatives to addressing this loss to avoid impacts on local streets.

During operation the TCC, based on preliminary designs and experience with other facilities of similar size, is anticipated to generate approximately 20 vehicle trips per hour in the peak, and 80 vehicle trips per day. The majority of these would be cars for workers within the TCC, with some being incident management vehicles and trucks for the movement of tunnel maintenance parts.

The peak hour trip generation of the TCC represents less than 1% of the expected peak hour traffic at the Mt Coot-tha Road / Centenary Motorway roundabout in 2014 with the Changed Project in place. During operation of the Changed Project this intersection is expected to operate within capacity and with a reasonable level of service. The TCC would not be expected to materially affect the operation of the intersection.

Across the day during operation, the TCC would add less than 0.5% to the forecast traffic volume of approximately 15,000 vehicles per day on Mt Coot-tha Road and would not have a material effect on overall traffic levels.

### **5.1.2 Geology and Soils**

Construction of the TCC building is proposed to involve excavation into the hillside on the subject site to create a level platform and to enhance the way in which the building is incorporated sympathetically into the existing land profile. A retaining wall will be required to ensure the stability of the embankment after excavation of the cutting. The design of this retaining wall will be subject to engineering assessment of the ground conditions in order to determine the required strength and construction method, as well as the expected rate of seepage of groundwater. In addition, the permanent drainage design will need to ensure that ground and surface water can be adequately captured and discharged to Council's stormwater system.

During construction, erosion and sediment controls will need to be implemented to ensure that sediment-laden stormwater does not enter Council's stormwater drainage system or adjacent waterways.

### **5.1.3 Air Quality and Greenhouse Gases**

The primary purpose of the TCC will be management of the ongoing operation and maintenance of the NLRT. The design of any air exhaust systems for the building, including air-conditioning will be undertaken in accordance with the relevant standards.

### **5.1.4 Noise and Vibration**

Protection of adjacent residential amenity will be undertaken in accordance with Brisbane City Council's Noise Impact Assessment Planning Scheme Policy (NIAPSP). The three main acoustic issues associated with such a facility will be air conditioning, maintenance activities, and vehicles entering and exiting the car park.

A preliminary assessment against NIAPSP has been undertaken for the Changed Project to give confidence that an acceptable acoustic amenity will be achievable for the residences directly behind the proposed TCC, and the findings are set out below. Modelling of the predicted maximum noise levels will be carried out during detailed design to determine any appropriate mitigation measures to comply with the NIAPSP requirements.

## Air Conditioning

- The applicable limits from NIAPSP are (1) internal noise levels in adjoining residences under the levels recommended in Australian Standard (AS) 2107 and (2) 'background creep' where noise attributable to steady-state sources from the TCC are not allowed to exceed existing background levels.
- A high standard of noise attenuation is readily available for mechanical plant to ensure compliance with NIAPSP via methods such as full acoustic enclosures incorporating acoustic louvres, localised noise barriers or silencers, selecting quiet plant and/or locating such plant at the base of the large cut at the back of the TCC where significant shielding is likely.

## Maintenance Activities

- The Sound Power Levels (SWL) of some limited workshop activities may be such that specific noise mitigations, including screening and potentially acoustic linings, may be required to ensure that NIAPSP requirements are achieved.
- The applicable limit from NIAPSP is 'comparison of like parameters' where the intermittent noise emissions from a workshop are not allowed to exceed other short-term noise event noise levels (for example from car passbys, fauna calls, neighbourly residential activities) by more than 3 dBA. In addition, NIAPSP conditions in regard to sleep disturbance will be applicable. Any maintenance activities that need to be carried out at night would be limited and would not exceed night time noise limits.
- A worst case scenario was undertaken involving a hypothetical noise source of up to 105 dBA L10. Unmitigated, it is predicted that such levels would result in noise levels of around 65 dBA L10 at the nearest residences. This compares to existing noise levels around 60 dBA L10 during the day (based on the measurements undertaken at 9 Horrocks St for the Northern Link Road Tunnel EIS). This is a minor 2 dBA exceedence of the NIAPSP goal which may be mitigated by the screening effects of the retaining wall behind the TCC and the rear wall of the workshop. If this was not the case, further mitigations would be required.

## Vehicle Movements

- The applicable limit from NIAPSP is 'comparison of like parameters' where the intermittent noise emissions from vehicle movements are not allowed to exceed other short-term noise event noise levels (for example from car pass-bys, fauna calls, neighbourly residential activities) by more than 3 dBA. As the carpark will be used during the night-time period (it is a 24 hour operation), the 45 dBA 'sleep disturbance' limit from NIAPSP would also be applicable.
- The predicted maximum intermittent noise level of cars using the car park at the western end of the TCC at the nearest homes is 54 dBA (based on a 60m separation distance). This is below ambient maximum intermittent noise levels in the area of 55-65 dBA (based on the noise monitoring results in Horrocks St) and the 'comparison of like parameters' limit would be achieved. Using NIAPSP's 5 dBA façade noise reduction for open windows, the external 'sleep disturbance' limit becomes 50 dBA. Without mitigation measures, car parking activities at night, in this area could exceed the sleep disturbance limit by 4 dBA.
- A 4 dBA noise reduction can be readily achieved through the implementation of mitigation measures. The exact mitigation measure(s) for ensuring the sleep disturbance limit is not exceeded will be determined as part of the detailed design process. An example of how the estimated required noise reduction may be readily achieved if found to be required is by the use of a noise barrier to block line of sight between the residences and the carpark. Given the topography, a possible location could either be directly surrounding the western end of the TCC car park itself or at the top of the bank/retaining wall near the footpath.
- For all vehicle movements due south of the proposed TCC building (including the truck parking area), compliance with NIAPSP limits would be achieved by the acoustic shielding provided by the TCC building itself.

During the construction period, all construction activities will occur between the hours of 6:30am and 6:30pm Monday to Saturday (in accordance with the Environmental Protection Act and the Coordinator-General's Report conditions for the NLRT).

## **Vibration**

Excavation of the site to create a level construction platform will primarily be carried out using excavators and dozers. Near the surface, the rock is likely to be weathered and therefore relatively soft. However, for the deeper rock, it is possible that limited use of rockbreakers will be required. If required, rockbreakers would be used on site for a short duration and would be operated only during normal daylight construction hours as referred to above.

The nearest dwelling is approximately 20 m from the likely position of the cut face. At this distance, and given that rockbreakers (if required) will only be needed for the deeper rock, vibration is unlikely to pose any structural risk to nearby properties. However, to allay any residential concerns, vibration monitoring would be carried out if requested during rockbreaking activities at the two closest identified properties, in Horrocks Street. Additionally, consultation will be undertaken with adjacent property owners in accordance with the Coordinator-General's conditions.

### **5.1.5 Cultural Heritage**

Despite the land being held in the same land holding as the parcels associated with the Toowong Cemetery, Lot 2/18901 required for the TCC is not part of the Queensland State Heritage registered listing of the Toowong Cemetery.

### **5.1.6 Ecology**

Brisbane City Council's mapping shows a designated watercourse generally following the southern side of Mt Coot-tha Road. This is in relation to a creek within the Mt Coot-tha Botanic Gardens, however, the waterway buffer zone as mapped under City Plan 2000 encroaches on the TCC allotment but not the building footprint. This area does not generally contain riparian habitat and therefore there will be no significant impact on habitat values associated with this waterway buffer zone mapping.

Given the TCC site's proximity to the Mt Coot-tha Botanic Gardens and Toowong Cemetery, and given the number of mature native trees on the site, it is likely that there are arboreal and terrestrial fauna species inhabiting the site, in addition to birds.

Prior to construction of the TCC, fauna surveys will be undertaken to identify the presence of all fauna species inhabiting the site. Prior to construction it is the responsibility of the Contractor to assess construction activities against the requirements of the Nature Conservation Act 1992. Also prior to construction, a suitably licensed fauna spotter-catcher will be engaged to assist with decisions regarding the need to capture and relocate any potentially affected animals to a nearby suitable equivalent habitat. Any relocation will be undertaken by a licensed spotter-catcher.

There is no mapped remnant vegetation on the land. Detailed flora and fauna survey for protected species under the Nature Conservation Act 1992 will be required before construction.

All vegetation within the TCC site is protected under the Natural Assets Local Law 2003. A NALL Permit for this vegetation will be required.

### **5.1.7 Planning and Land Use**

The land is classified mostly as parkland with a smaller section covering most of the bitumen carparking areas used as overflow for the Botanic Gardens as unclassified land being the old Mt-Coot-tha road reserve. Having regard to the setting of the TCC adjacent to the Botanic Gardens and the Toowong Cemetery, the loss of less than 1 ha of green space is not considered to be significant. Development

approval for the TCC would be sought, where required in accordance with the *Sustainable Planning Act 2009* and City Plan. The TCC will result in a loss of approximately 1 hectare of public parkland including car parking areas for the Botanic Gardens. It is considered that the immediate area is well served in terms of both park and conservation areas. A building approval certificate will be required from a building certifier.

The TCC is being assessed by the Coordinator-General under the provisions of the State Development and Public Works Organisation Act 1971 (Qld) (SDPWO Act), as part of the Northern Link Road Tunnel Project. The purpose of the project as a whole is to assist in reducing road congestion in the western and northern areas of Brisbane. As part of an overall transport strategy, the project would help relieve congestion currently experienced on major roads from the west of Brisbane and would assist in providing an effective bypass of the Brisbane CBD.

The current land tenure of the TCC site is a State Reserve (Parks and Recreation) owned by the State with Council as the trustee. The TCC land was originally part of the Toowong Cemetery Deed of Grant in Trust (DOGIT or State Land in trust to Council for a Cemetery). In 2005 Council requested the State to modify the DOGIT to transfer the Deed of Grant for this land from Cemetery to Parks and Recreation. The reason for this was that the land was never used for burial but it was being used by the Botanic Gardens, and still is, as an overflow car park. It was assessed by the cemetery at the time of the transfer that there were never any graves on this land.

### 5.1.8 Social Environment

Concerns have been raised in relation to a range of issues that are perceived as potentially causing a deterioration in amenity for local residents. Specifically, residents have expressed concerns regarding matters including:

#### Light Spill

External lighting will be required to illuminate the TCC entry, garage forecourt and staff parking areas, all of which will be located at the front (southern) side of the building. There will be limited requirements to illuminate the rear (northern) side of the building or its rooftop, nor the eastern and western ends of the building. The limited lighting in these areas would be primarily for the purpose of security.

Brisbane City Plan 2000 provides guidance for outdoor lighting through the Light Nuisance Code. While City Plan 2000 and the respective Codes do not apply to the Northern Link Project, the Code provides a useful guide in terms of protecting residential amenity. External lighting of the TCC building will comply with the Light Nuisance Code which requires compliance with AS4282 – Control of the Obtrusive Effects of Outdoor Lighting. The Code goes further to restrict flood lighting to the types of light that give no upward illumination where mounted horizontally, ie a full cut off luminaire. It is expected that this further requirement would only be applicable to the limited lighting at the rear and sides of the building. The lighting at the front of the building is likely to require a greater level of illumination for safe access and operation of the TCC.

It is likely that window openings in the western and eastern facades (subject to detailed design) will spill some light from internal spaces. However, at the eastern end (Richer Street) this will have no impact on any nearby residences, while the western end of the building (closest to Ada Street) will be screened by landscaping.

## Local Access to Properties

Some residents currently use land along the rear of the TCC site to access the rear of properties in Ada Street and Horrocks Street. Residents refer to this as 'Little Ada Street'. This area is designated "Parkland" under the current planning scheme. There is no road reserve or other form of land title to what is referred to as Little Ada Street, and there is no designated formal access to residences from this land. Residents have expressed concern that the TCC development will result in loss of this access to the rear of properties.

All residential properties can be accessed from their road reserve boundary, either from Ada Street or Horrocks Street. It may be possible to formalise some of the current informal local access arrangements in consultation with affected residents during the detailed design of the TCC.

The existing extension to Horrocks Street within the boundary of the proposed TCC land will be retained and protected from construction work. This area provides a necessary turning ability at the end of Horrocks Street and will not be affected by the location of the TCC as it is presently within the proposed vegetated buffer area.

### 5.1.9 Urban Design and Visual Environment

The TCC concept plan identifies a 2 storey building approximately 90m long by 20m wide with the height varying from approximately 9m for the eastern half (due to the additional ground floor height of 5m for the garage area) to approximately 7m for the western half of the building.

In isolation, on a flat piece of open ground, and without any attention to the design of the building enclosure, the TCC would have a significant impact on the character of the surrounding residential area.

The building however would be situated on a steeply sloping site with the natural ground level at the rear of the site (ie closest to adjoining residents) between 10 and 14 metres higher than at the front of the site (along Mt Coot-tha Road). The site rises from a level of approximately 28m AHD on Mt Coot-tha Road to approximately 42m AHD on Richer St, 41m AHD at the end of Horrocks St and 32m AHD on Ada St. The building will be cut into this slope, and an existing vegetated buffer approximately 10 to 20m wide will be retained along the northern residential boundary. With the inclusion of a flat roof and integrated landscaping, the potential visual impact to the adjoining residences would be mitigated. An indication of this effect is shown in **Figure 2-34** and **Figure 2-36**.

Views over the TCC toward the Botanic Gardens will be affected only to the extent that the TCC's roof line breaks the horizon from any particular vantage point. It is noted that the existing tree canopy, which already obstructs these views to some extent, will also provide a natural screen against the visibility of the TCC. Additional landscaping is proposed to fill gaps in the existing natural vegetation screen.

When viewed from Mt Coot-tha Road, the overall length of the TCC and its setting cut into the site, will give the building a low-set appearance. While a detailed design has not been prepared, the materials and colours chosen will be sympathetic to the semi-natural setting, and the façade design will be articulated so as to soften its appearance. The site will also be landscaped, with the remaining overflow car parking area returned for use by the Botanic Gardens. The appearance and visual amenity of this portion of the site would not be altered significantly other than through some additional landscaping, in keeping with the approach to landscaping across the remainder of the TCC site.

## 6 Project Changes to Eastern Connection

### 6.1 Changes to Project Design – Eastern Connection

The Changed Project would be similar to the Reference Design at the eastern connection, with the tunnel portals in much the same location just to the west of Victoria Park Road.

The key differences between the Changed Project and the Reference Design for the Eastern Connection would be:

- tunnel portals surfacing to the west of the Victoria Park Road access to the ICB
- tunnel portals to be located centrally in the ICB
- tunnel portals to be accommodated by realigning ICB eastbound lanes to the north with access under an additional bridged section of the Inner Northern Busway and adjacent footbridge
- stormwater infrastructure realignment and upgrade works
- new construction site offices and parking allowances.

Similar to the western connection arrangement, the Changed Project would provide both portals in the centre, with the eastbound lanes of the ICB being realigned just to the north and outside of the portals. Compared to the Reference Design, the eastbound exit portal would be approximately 60m further east, adjacent to the western side of the Inner Northern Busway (INB) overpass. The westbound entry portal would be approximately 300m further west of the location proposed in the Reference Design.

The transition structures to the ICB would also be in a similar location to the Reference Design but the ICB lanes have been moved to the north with access under an additional bridged section of the INB structure over the ICB. Consequently, the Northern Link transition structures would be located in the centre of the realigned ICB, with the westbound entry transition structure much shorter than was proposed in the Reference Design.

ICB road works are proposed to extend to the existing land bridge in the east as per the Reference Design, although the Changed Project will have different lane merge and diverge markings. A new span is proposed on the north side of the existing INB bridge, and also for the existing pedestrian bridge to allow for the realigned, eastbound lanes of the ICB. The westbound ICB lanes would remain largely unaffected.

The ventilation station for the Changed Project would be in the same location as proposed in the Reference Design. The ventilation outlet location is also in the same location as the Reference Design.

The Changed Project would provide pedestrian and cycle pathways that are similar to those proposed in the Reference Design. Access would be maintained to existing public transport services.

### 6.2 Changes to Project Delivery – Eastern Connection

#### 6.2.1 Worksite Layout and Construction Areas

The eastern worksite would extend from Victoria Park Road to the land bridge spanning the Inner City Bypass. The worksite would encompass playing fields used by the Brisbane Grammar School, the northern abutment of the INB and the southern edge of Victoria Park golf course. As with the Reference Design, land within the ICB corridor and to the south of Normanby Terrace would be required.

The site compound for the eastern construction areas would be located on the northern side of the ICB and to the east of the Inner Northern Busway overbridge. Work would also occur between the eastbound and westbound lanes of the ICB.

Access to the site compound would be provided by left-in, left-out connections to the ICB and from Victoria Park Road near the ICB intersection. A site access from Victoria Park Road was proposed also in the Reference Design. Access to the median worksite would also be provided from the ICB westbound.

The ICB surface road works would be constructed in various stages, interacting with and maintaining the existing traffic conditions on the ICB.

The works for the eastern connections would progress in stages, as would works for the Reference Design. During much of the works programme, traffic would continue to use the existing lanes of the ICB in both directions. Eastbound traffic will be restricted to two lanes during phases of the eastern portal construction. The final stage would require a traffic switch for eastbound motorists on the ICB to the new, permanent alignment, to the north of the Northern Link lanes. Westbound lanes on the ICB would be retained on their present alignment throughout the full construction program. There would be some minor disruption when the Northern Link diverge lanes westbound are built into the ICB median.

Access for the ventilation station construction area east of the INB would be provided from the ICB eastbound, via Victoria Park Road. This area includes sites offices and associated functional areas. .

Workforce car parking would be provided for in the construction area adjacent to the ventilation station construction area east of the INB. This area includes sites offices and associated functional areas. Access for construction workers would be provided from the ICB eastbound, via Victoria Park Road. A left-in, left-out access directly from the ICB would be provided for secondary visitor access.

The majority of the workforce parking would be accommodated at an off-site parking area at the eastern end of Gilchrist Avenue, north of the ICB, as proposed in the Reference Design and shown on **Figure 6-1**.

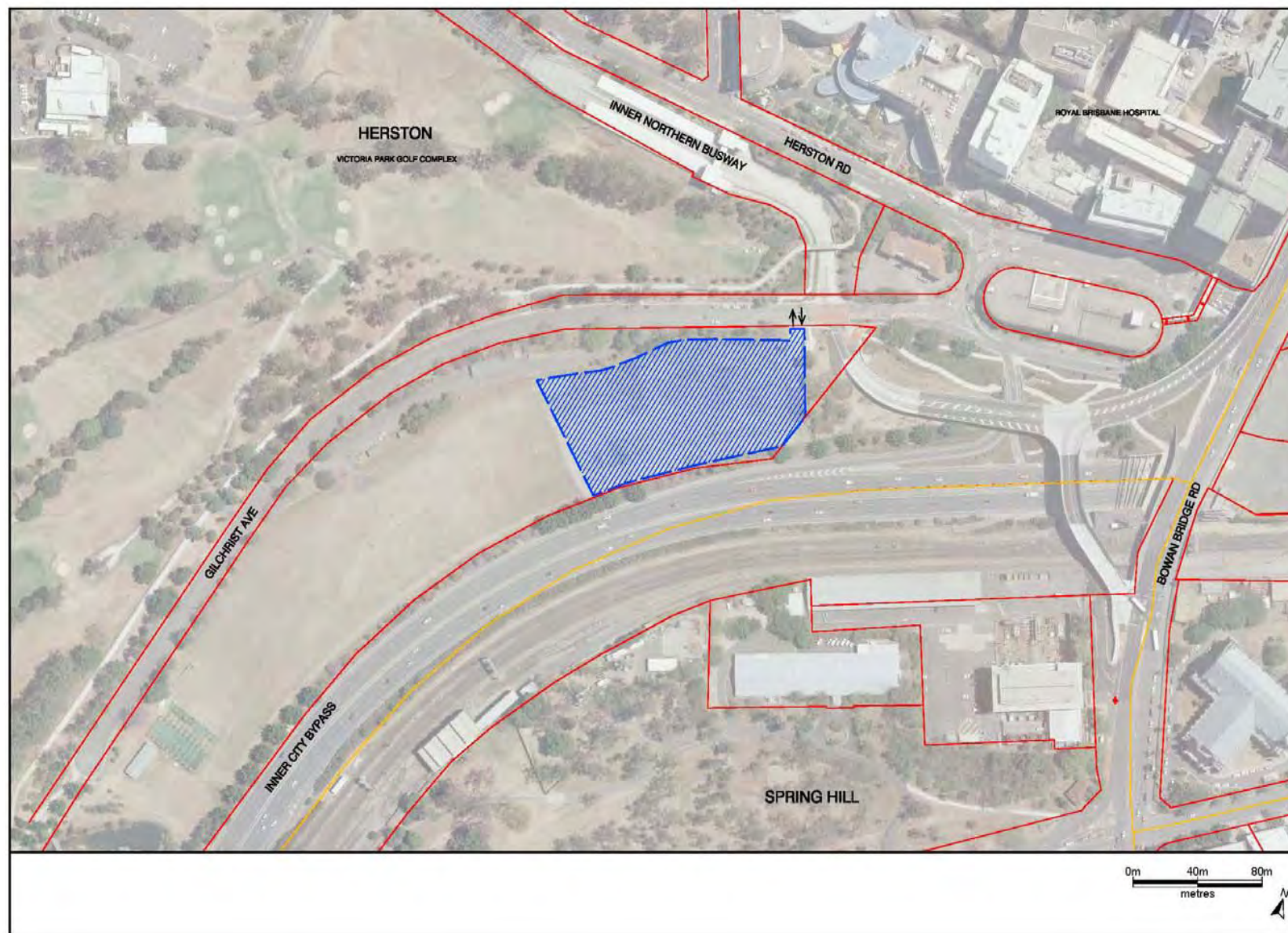


Figure 6-1: Proposed temporary workforce construction parking – Gilchrist Ave, Herston

Shuttle buses would be provided between the Roma Street Transit Centre and the eastern worksite, linking workers to both the rail and busway networks. To avoid and manage the effects of parking in local streets, construction personnel would be directed to use either public transport or the dedicated parking areas. Prepaid public transport tickets would be provided to encourage workers to use these options.

Access to local roads would be maintained during construction. Pedestrian and cyclist facilities would also be maintained but would be diverted around the worksite on its northern side.

The existing pedestrian bridge spanning the ICB would be extended to a new concrete path through the site and adjacent to the INB, linking to the realigned path around the construction site and over the INB. Prior to the final stages of construction the path south of Normanby Terrace would be realigned directly along the back of the residential properties facing the worksite west of Victoria Park Road. Noise barriers would also be constructed.

### 6.2.2 Crossing under the Inner Northern Busway

With the Changed Project, the proposed realignment of the eastbound carriageway of the ICB would require a restructuring of the current INB bridge over the ICB.

In order to minimise the effect on bus operations on the INB, the Changed Project would provide a separate, temporary INB overbridge that would be used during the realignment of the ICB and construction of the final extended INB structure. Switches in INB traffic between the temporary and permanent bridges would occur at night.

Planning for the switches in busway traffic would be in consultation with the DTMR busway manager, Translink and other stakeholders. With these measures it is expected that the works could be carried out without major interruption to INB services.

### 6.2.3 Spoil Handling, Haulage and Placement

For the Reference Project, spoil generated at the eastern worksite from construction of the transition structures and cut and cover tunnels would be transported to the Port of Brisbane. For the Changed Project, spoil from the eastern worksite is currently proposed to be transported to an approved placement site adjacent to the Brisbane Airport at Pinkenba.

There may be a requirement for development approval to be obtained prior to the commencement of spoil placement at this site. There may also be a need to consult with the Commonwealth Government to ensure that spoil placement at Pinkenba would not impact on matters of national environmental significance or Commonwealth land. Other suitable approved locations may be identified during the course of the project and would be subject to complying with appropriate approvals and referrals where necessary as well as the Coordinator-General's conditions (refer Schedule 3, Condition 16).

Spoil from the eastern worksite would originate from the cut and cover tunnels and transition ramps onto and from the ICB, the eastern portal structure to extract the TBMs, the eastern site compound and works for the ventilation station and ventilation shaft connecting with the outlet.

Spoil haulage arrangements from the eastern worksite for the Changed Project and for the Reference Design are summarised in **Table 6-1**.

**Table 6-1: Summary of change in spoil haulage from eastern worksite**

Criterion	Reference Design	Changed Project
Disposal site	Port of Brisbane	Eagle Farm Road, Pinkenba (or other approved route)
Haulage route	Inner City Bypass – Kingsford Smith Drive – Gateway Motorway – Port of Brisbane Motorway	Inner City Bypass – Kingsford Smith Drive – Eagle Farm Rd
Spoil by truck (Bank m <sup>3</sup> )	25,000	40,500
Haulage hours	6:30 am Monday to 6:30 pm Saturday, 18 hours per day	6:30 am to 6:30 pm Monday to Saturday,
Ave. haulage per hour (trucks in each direction)	less than 1 for 23 months (3 per day)	2 for 3 months; 1 for 15 months

Site access for haulage vehicles from the Inner City Bypass initially would be via the ICB and Victoria Park Road and then directly from the worksites once necessary works have been undertaken.

The spoil from the eastern worksite would be taken to Eagle Farm Road, Pinkenba via the Inner City Bypass, Kingsford Smith Drive and Eagle Farm Road. The haulage tasks would involve on average two trucks per hour in each direction for the first three months, and then one truck per hour on average in each direction for 15 months. Spoil haulage traffic would be of little significance in terms of traffic flows on Kingsford Smith Drive and Eagle Farm Road. Haulage routes for any other spoil disposal sites would need to be approved by the relevant road authorities.

## 6.3 Effects of Project Changes – Eastern Connection

### 6.3.1 Traffic and Transport

The Changed Project would provide connections between the central lanes of the Inner City Bypass and Northern Link in both directions, in contrast to the Reference Design which proposed a tunnel connection to the kerbside lanes of the Inner City Bypass eastbound. To achieve this, the ICB eastbound carriageway would be realigned northwards in the vicinity of Victoria Park Road, and the Victoria Park Road connection to the ICB would be moved slightly to the west. As with the Reference Design, the entry portal for westbound traffic on Northern Link would be from the centre.

The Changed Project would locate the ICB eastbound lanes on the left side of the Northern Link eastbound lanes in the merge area. The most appropriate line-marking arrangement to be implemented would be developed during detailed design. It is likely that an arrangement termed a 'Major Branch Connection' layout which would maintain priority for the two ICB eastbound lanes would be best for implementation in early years of operation. This line marking would reflect the expected balance of traffic demands which would initially have the higher eastbound flows associated with the ICB lanes (rather than Northern Link).

The auxiliary lane in the Northern Link / ICB eastbound merge area would have a similar length to the Reference Design, with the auxiliary lane length for the westbound diverge to the tunnel entry reduced by approximately 80 m.

### Performance of merge / diverge arrangements

The performance of the eastern connection for the Changed Project would operate safely and effectively particularly in respect of the proposed merge and diverge arrangements.

Micro-simulation modelling (Paramics) indicate that the performance of the Changed Project would be similar to the Reference Design, as presented in the EIS Supplementary Report and shown in **Table 6-2**. Levels of service are generally similar to the Reference Design, and remain Level of Service C or better, as previously forecast. These results demonstrate that the Northern Link / Inner City Bypass merge and diverge areas would operate with satisfactory levels of service. This finding, together with the application of suitable geometric design standards for sight distance and manoeuvring space, supports the expectation of safe traffic operations.

**Table 6-2: Comparison of eastern connection performance results (2014)**

Road Network Element	Reference Design				Changed Project			
	Eastbound		Westbound		Eastbound		Westbound	
	Av Speed <sup>(2)</sup>	LoS <sup>(3)</sup>	Av Speed <sup>(2)</sup>	LoS <sup>(3)</sup>	Av Speed <sup>(2)</sup>	LoS <sup>(3)</sup>	Av Speed <sup>(2)</sup>	LoS <sup>(3)</sup>
<b>AM Peak</b>								
Northern Link Tunnel	80	A	80	A	76	A	80	A
Inner City Bypass east of tunnel portal (towards Landbridge)	68	B	64	B	66	B	52	C
Inner City Bypass west of tunnel portal (towards Kelvin Grove Road on-ramp)	65	B	-	-	67	A	-	-
Inner City Bypass west of tunnel portal (towards Ithaca Street off-ramp)	-	-	55	C	-	-	65	B
<b>PM Peak</b>								
Northern Link Tunnel	80	A	80	A	73	A	80	A
Inner City Bypass east of tunnel portal (towards Landbridge)	65	B	71	B	60	B	72	B
Inner City Bypass west of tunnel portal (towards Kelvin Grove Road on-ramp)	59	B	-	-	53	B	-	-
Inner City Bypass west of tunnel portal (towards Ithaca Street off-ramp)	-	-	71	B	-	-	75	A

Table Notes: 1. Data extracted from Paramics micro-simulation modelling using input 2 hour peak demands from cordon matrix prepared using Northern Link Traffic Model run TR\_2014\_257. No peak spreading applied.

2. Average Speed = average speed on link during the middle hour of the peak two hour micro-simulation period.

3. Level of service (LoS) is an index of the operational performance of traffic on a road when accommodating various traffic volumes under different operating conditions. The indicative level of service has been calculated based upon ratio between actual speed and free-flow speed, using Figure 5.12 of the Road Planning and Design Manual (Queensland Department of Main Roads, 2005). Level of service ranges from A (highest) to F (lowest performance).

### **Ventilation station access**

As with the Reference Design, the Changed Project proposes access to the eastern ventilation station from the northern side of the Inner City Bypass, east of the Inner Northern Busway overpass.

The building would require only occasional maintenance access, which would be obtained from the eastbound carriageway of the ICB via a specially widened section of the shared pedestrian/cycle pathway. Maintenance vehicles would be able to decelerate safely, with suitable notice to other vehicles, to use the proposed access point. Use of the shared pathway by project maintenance vehicles would be subject to manned traffic control on these occasions. Brisbane City Council (Road Use Management) have indicated that in principle this arrangement is acceptable.

### **Pedestrian, cyclist and public transport issues**

On completion of construction, the Changed Project would reinstate the level of connectivity provided by pedestrian and cycle facilities in the vicinity of the eastern connection.

During construction, temporary pedestrian and cycle links would be provided around the northern side of the worksite to connect the Victoria Park cycleway with Victoria Park Road, and from there, to Kelvin Grove Road via Musk Avenue and the Kelvin Grove Urban Village. The existing pedestrian bridge across the ICB would be extended to allow connection into the new pedestrian / cycleway to the north. This would be done offline in the early stages of construction, with a temporary closure to install the new deck which would be scheduled in consultation with the relevant parties.

The existing pedestrian bridge between the grammar schools and playing fields would be extended to the north, over the realigned eastbound carriageway of the Inner City Bypass, to re-establish its existing connectivity.

Once complete, Northern Link would not affect bus operations on the Inner Northern Busway.

The Changed Project responds to issues raised in submissions on the EIS regarding pedestrian/cycle connectivity, particularly along Kelvin Grove Road and to the Kelvin Grove Urban Village.

### **Traffic effects during construction**

With the Changed Project, the majority of works for the eastern connection would take place outside the existing carriageways, limiting the impact on road users in this area.

The western carriageway would remain in its existing configuration until the final stage of construction, when a minor realignment would be required to allow completion of the tunnel transition structures. Capacity would not be affected with three traffic lanes maintained throughout the works.

Eastbound, the existing three lanes would be maintained until after the completion of the main tunnel. As with the Reference Design, there would be a limited two lane section eastbound, east of Victoria Park Road, during phases of the works.

In each direction, only a single alignment change would be required, as traffic switches from the existing to the final configurations. Tie-in works would be undertaken during night works to minimise impacts on the existing traffic on the ICB.

The existing connectivity of the local area would be maintained throughout the project. The Victoria Park Road connection to the Inner City Bypass, would be switched to a temporary alignment east of its existing location before switching to its final position. This connection would remain open throughout construction.

It would not be necessary for construction traffic to pass residential areas on Victoria Park Road to reach the site access points. This would be managed through the provisions of the construction traffic management plan and the sub-plan(s) for the eastern worksite.

### Spoil haulage

Hourly spoil truck numbers would be higher with the Changed Project than with the Reference Design, due to higher total spoil volumes, reduced operating hours, and a shorter construction period. However, with an average of 2 truck loads per hour moved during the busiest construction period, the spoil haulage traffic generation on this route would remain very low.

This represents a minimal increase in the background traffic on the haulage route, and would not be expected to have any material impact on traffic conditions.

The haulage route from the eastern worksite for the Changed Project would follow the ICB, Kingsford Smith Drive to Eagle Farm Road. The proposed spoil placement site for the Changed Project would be on land adjacent to but separate from the Brisbane Airport at Pinkenba. The spoil haul route would be the same as that nominated for the Reference Design, up to the Gateway Motorway. The proposed change in spoil placement sites, from the Port of Brisbane to Pinkenba would avoid spoil traffic using the Gateway Bridge and Port of Brisbane Motorway. Eagle Farm Road is the primary route serving the Pinkenba heavy industry area and is a designated 25m B-Double route. Eagle Farm Road is an appropriate route for spoil haulage vehicles.

As for spoil haulage from the western worksite, a Construction Management EMP Sub-Plan for the removal of spoil from the eastern worksite would be prepared, in accordance with the approval conditions, to ensure that acceptable operating conditions are maintained. This would include the proposed use of Hale Street / Caxton Street interchange by empty haulage vehicles returning from Pinkenba to U-turn to the Inner City Bypass eastern carriageway. For the Reference Design, returning spoil trucks would travel north along Hale Street to access and reverse into the ICB worksite for loading. The increase in return trips from 3 returning trucks per day to 2 returning trucks per hour would be insignificant in traffic terms and would not impact on road traffic noise on either road. Other suitable locations may be identified during the course of the project and would be subject to complying with the Coordinator-General's conditions (refer Schedule 3, Condition 16).

The haulage hours identified in **Table 6-1** include an allowance of two hours non-haulage time daily to avoid peak hour traffic. This allowance would be reviewed during the preparation of the Construction Traffic Management Plan and EMP Sub-Plan.

Overall, the expected impact from the change in spoil haulage traffic and journey times around the eastern connection associated with the Changed Project would be minimal.

### 6.3.2 Hydrology

#### Flooding (Operational)

The location of the eastern connection for the Changed Project is substantially the same as that proposed for the Reference Design. The worksites would also be in the same locations.

The site of the proposed eastern portal is not affected by flooding from the Brisbane River in the estimated 10,000 year ARI flood event (Northern Link EIS – Flooding Report, SKM-Connell Wagner JV, October 2008).

As part of the Changed Project, the following stormwater drainage works in the vicinity of the eastern portal would be undertaken to convey the flood flows from the external catchment:

- reconstruction of the three existing stormwater pipes within the BGS sports field;
- relocation of the grated inlet structure at associated stormwater culverts located within the BGS sports field;
- provide an opening through the existing earth embankment at the northern end of the Inner Northern Busway bridge, to allow for the reconstruction of the cycleway in this area;
- reconstruction of the bikeway and open channel located adjacent to the ICB.

As a result of the above works, the flood levels for all average recurrence interval events up to the 100 year event for the Changed Project (operational) at the BGS fields will be within 20 mm of the existing modelled peak levels. The construction of the eastern portal for the Changed Project would not cause an adverse impact on flood levels in the vicinity of the BGS sports field.

#### Flooding (Construction)

Flood protection of the eastern cut and cover structure during construction will be provided by a combination of bunding and appropriately staged construction of the external drainage and ventilation duct tunnel structures for the Changed Project. These ventilation tunnel structures, from the take off at the eastbound tunnel to the ventilation station building are in a different location to the Reference Design, hence the structure can be utilised for provision of flood immunity to the works during construction of the Changed Project. The construction of the ICB interchange over stages 1 and 2 (25 month duration) will involve the construction of the eastbound and part of the westbound cut and cover structure, the INB bridge extension, the BGS footbridge extension, tunnel ventilation duct, tunnel structures, drainage culverts and open channel and new eastbound ICB roadway east of Victoria Park Road.

The construction of the cut and cover tunnel requires the installation of a secant pile wall along the northern face of the eastbound cut and cover. A temporary platform will be constructed to facilitate installation of these piles, and this platform will apply over the length of the secant pile wall. The secant piles will extend above the Q10,000 year flood level along the majority of this wall.

Following construction of the INB and BGS bridge extensions, it is planned to excavate for and construct the new drainage inlet pit and culvert and that section of ventilation duct tunnel alongside whilst maintaining the existing pit, culvert and drainage channel to cater for storm events. Following construction of the final open drainage channel and bunding around the new inlet pit and across to the existing ICB eastbound, the existing drainage line will become redundant and it will be demolished. The new ICB eastbound carriageway and northern barrier would then be constructed and will contain any overflow from the detention basin within the designated overland flow path and open drainage channel. An earth bund would then extend around the ventilation duct tunnel to the secant pile wall, thus providing flood immunity for the completion of the ventilation duct tunnel and its connection to the cut and cover structure. This is

similar to the Reference Design where it was proposed to construct the new permanent drainage elements first, then commence construction works, including temporary bunding, such that the Q100 year flood immunity of the tunnelling works could be achieved.

Thus, all of the proposed drainage system for the local catchment will be in place prior to the construction of the eastern portal commencing. The construction site for the eastern portal will therefore have the same immunity as the ultimate design, i.e. 10,000 year ARI event as per the Reference Design.

### **Groundwater and Surface Waters**

The Coordinator-General's conditions for groundwater and surface water conditions are presented in Schedule 3, conditions 21 and 32. These conditions remain relevant to the Changed Project.

No changes to the existing conditions are warranted on the basis of the design changes described above in relation to eastern part of the Changed Project. The various management measures in the Changed Project as part of the construction and operation groundwater and surface water EMP sub-plans are still considered to be appropriate as they are expected to effectively mitigate water-related impacts arising from the construction and operation of the Changed Project.

#### **6.3.3 Air Quality and Greenhouse Gases**

The Changed Project, at the eastern connection, would have flatter road alignments and possibly more efficient connections to the ICB than the Reference Design, resulting in more freely flowing traffic in most conditions.

The flatter alignments may result in minor reductions in vehicle emissions within the Changed Project tunnels compared to the Reference Design. However, the differences in motor vehicle pollution, when measured at ground level, are expected to be very small and not significant.

The air quality design and operational features are generally unchanged compared to the Reference Design and the current Coordinator-General conditions remain appropriate.

The eastern ventilation outlet and ventilation station would be situated in the same location as proposed by the Reference Design. The height of the ventilation outlet would be in accordance with the coordinator-General's conditions.

There is no predicted change for construction air quality from the Reference Project.

#### **6.3.4 Noise and Vibration**

The main tunnels and connections in the east, for the Changed Project, would be aligned just to the north of the alignments proposed in the Reference Design. There would be some differences in the position and length of the connecting ramps from the Changed Project to the ICB.

The traffic flows through the Changed Project would be substantially the same as anticipated for the Reference Design.

Preliminary modelling (noting that detailed 3D modelling of the new portal/transition areas will form part of the detailed design phase of the project) indicates that compliance with the Coordinator-General's Conditions can be achieved:

- by increasing the existing noise barriers adjacent the Normanby Terrace residences by 1m;
- by installing two new noise barriers – one up to 6m high to the west of Victoria Park Road and one to the east of Victoria Park Rd adjacent to the Brisbane Grammar School sports fields – north of the ICB; and
- without the need for noise barriers to mitigate noise to the schools south of the ICB.

Full compliance with the Coordinator-General's road traffic noise conditions will be achieved through detailed design.

The Coordinator-General's conditions addressing noise and vibration are presented in Schedule 3 conditions 23 and 31. These conditions remain relevant to the Changed Project. The Changed Project and the conditions respond to the issues raised in submissions to the EIS in relation to amenity impacts associated with the construction worksites.

That is, no changes to the existing noise conditions are warranted on the basis of the design changes described above in relation to the eastern part of the Changed Project. The various management measures being proposed as part of the construction and operation Noise EMP sub-plans are still considered to be appropriate as they are expected to effectively mitigate noise impacts arising from the construction and operation of the Changed Project.

### 6.3.5 Planning and Land Use

The Changed Project would impact on land and land use in the same locations as would the Reference Design.

The extent of property impact would be increased on the playing fields used by the Brisbane Grammar School, to accommodate the realignment of the eastbound lanes of the ICB and the central portals of the Changed Project. Subject to detailed design it is expected that the long term land requirement for operation of the Changed Project will be similar to that described and illustrated in the NLRT EIS for the Reference Project.

The impacts on the use of the Victoria Park golf course would be the same for the Changed Project as those for the Reference Design, with construction of the ventilation shaft between the ventilation station and the ventilation outlet crossing under the 6th green to the 7th tee. As with the Reference Design, this impact would be resolved in consultation with management of the golf course.

## 7 Relationship with Other Projects

### 7.1 Centenary Motorway

As described in Chapter 2 of this Application, the connection between the Centenary Motorway and the Changed Project would be via centrally-located portals, within the Botanic Gardens worksite. This will enable a single excavation into the tunnel, co-location of all major road construction to the northern side of the Centenary Motorway, retention of the cycleway and the existing pedestrian and cycle bridge over the motorway with minimal traffic disruption during construction as well as significant benefits to traffic management on the motorway and the roundabout during construction. The central transition structure configuration would meet DTMR requirements, allowing for a continuous motorway arrangement from the Centenary Motorway to the NRLT.

The Changed Project configuration would ensure a minimum of three lanes in each direction along the Centenary Motorway is achievable in the future. Provision has been made for the earthworks for the future widening of the realigned inbound lanes of the motorway as well as a three lane bridge over the centrally aligned tunnel ramps where the tunnel ramps pass into the Botanic Gardens precinct.

DTMR future planning requirements for the Centenary Motorway past the NLRT portals must be achieved without any impact on structures forming part of the NLRT project. This requirement includes provision for cost-effective widening of any new bridge structures provided as part of the project.

### 7.2 Future planning for a new 'Inner Orbital'

Future planning for Brisbane has identified a new 'Inner Orbital' tunnel between the Centenary Motorway and Stafford Road at Everton Park as a western Brisbane transport network improvement option. Condition 26(b) requires that the connection and 'tie in' of the project to the Centenary Motorway is to be designed and constructed to ensure that:

- operation of the project shall not compromise the ability for a future connection of Centenary Motorway with an 'Inner Orbital' tunnel;
- operation of the project should not compromise the ability for future operation of the 'Inner Orbital' tunnel and the Centenary Motorway as a continuous motorway route (that is, maintaining the speed environment) with traffic flow priority on Centenary Motorway directed to the continuous route;
- the Northern Link connection excavation works are not to be below the existing motorway surface levels west of a line drawn between the two points (E46987.038, N157425.253) and (E47071.605, N157283.886).

Condition 26(b)(iv) seeking an arrangement favouring the outer lanes of the motorway, would need to be varied, or deleted to accommodate the Changed Project tie-in with the Centenary Motorway.

The proposed western interchange configuration for the Changed Project would not compromise the ability for a future connection of Centenary Motorway with an 'Inner Orbital' tunnel. There would be no excavation works for the Changed Project to the west of the line identified in the existing condition. The likely or possible future staging at the transition to the Inner Orbital has been identified for the Changed Project to include the following possible stage approach:

### Stage 1:

- The Centenary Motorway traffic would remain (as required for the NLRT) while the ultimate southbound carriageway is constructed south;
- The existing shared path along the southern edge would need to be retained and possibly temporarily relocated while the new infrastructure is being built along the southern edge;
- Existing services located along the Centenary Motorway to the south would need to be maintained and relocated to the south.

### Stage 2:

- Both Centenary Motorway carriageways would switch to the constructed southbound carriageway. Northern alignments would then be constructed;
- The temporary eastbound approach to the NLRT would require careful consideration. Clear visibility to the major fork is needed and would likely involve the relocation of gantry structures and [set out in full] (ITS) provisions;
- The temporary westbound lanes departing from the NLRT would merge with the Centenary Motorway. Consideration would need to be given to the lane arrangement, parallel lane length and merge visibility;
- This stage would enable the Inner Orbital tunnel portal to be constructed.

### Stage 3:

- Following the construction of the tunnel portal area, the Centenary Motorway traffic would then be split along outer edges, allowing the completion of the Inner Orbital transition structures;
- The eastbound traffic lanes would be repositioned in this stage to a permanent alignment. This would involve new gantry locations for the signage and new ITS provisions;
- The westbound traffic lanes would be able to be repositioned onto a permanent alignment.

Council, in agreement with DTMR, will request as part of the conclusion and recommendations of this Application for Project Change that the Condition 26(b) (iv) is amended such that the NLRT portals, troughs and associated tie-in with the Centenary Motorway favours the inner lanes of the motorway.

## 7.3 Moggill Road Interchange

The amendment of the Reference Design by deleting the local Toowong connections in response to community submissions lodged in relation to the EIS, resulted in predicted increases in traffic at the connections of the Centenary Motorway to Moggill Road. The amended project, now known as the Reference Design, was projected to increase volumes through the signalised intersections at the motorway on and off ramps at Moggill Road by approximately 5% and 13% in the AM and PM peaks respectively in 2014 compared to the scenario without NLRT.

Potential users of NLRT from Taringa, Indooroopilly and St Lucia would utilise this route. The forecast daily traffic increase on Moggill Road between Indooroopilly and the motorway was 3% in 2014 and 4% in 2026. The assessment concluded that the connections could be managed satisfactorily with signal co-ordination in early years post NLRT opening given the lower forecast traffic volumes following the removal of the Toowong Connections. Ultimately upgrades to the interchange configuration at Moggill Road were anticipated in association with the future upgrading of the Centenary Motorway in the 2010 to 2031 time-frame identified in the Southeast Queensland Infrastructure Plan and Program and/or in association with any future 'Inner Orbital' connection with the Centenary Motorway.

DTMR anticipate that the Level of Service (LoS) for the Centenary Motorway on-ramp at Moggill Road would decline with implementation of the Reference Design.

To mitigate the potential for impacts in relation to the Moggill Road/Centenary Motorway Interchange, Council is required, through imposed condition 27 in Schedule 3 of Appendix 1 to the Coordinator-General's Report to design and upgrade the interchange to mitigate traffic impacts resulting from the operation of the project.

The Coordinator-General has recommended that an Interface Agreement between DTMR and Council (Condition 27(d)) be finalised within 120 days of commencement of construction to permit the Interchange upgrades to be in place before the NLRT becomes operational.

The Changed Project would not change this situation at the Moggill Road intersection, such that the conditions for the Reference Design, including the implementation of the Interface Agreement between Council and DTMR, remain relevant and necessary.

Council, in agreement with DTMR, would request as part of the conclusion and recommendations of this application for Project Change that the wording of Condition 27(d)(i) is amended to clarify the LoS for the Moggill Road Interchange.

#### **7.4 Connection with the Inner Northern Busway**

The NLRT project would provide an opportunity to deliver a busway-type link for future cross-town bus services between key trip generators in the western and northern suburbs (e.g. Chermside to Indooroopilly, Indooroopilly to Australia TradeCoast) to travel via the NLRT and the Northern Busway or other surface routes. Council is also in consultation with DTMR to examine the potential for efficient and cost-effective bus connectivity between the Inner Northern Busway and the project for the diversion of existing 'Rocket' bus services that operate in peak periods between the western suburbs and the CBD.

Council will continue working with the state to analyse the potential for bus-only ramp options at the eastern end of the project to join the Inner Northern Busway or Northern Busway.

Approval for any future connection with the Inner Northern Busway or Northern Busway would be undertaken through the Transport Infrastructure Act.

## 8 Recommendations and Conclusions

The need and justification for the NLRT project was established when the Coordinator-General recommended that NLRT project proceed in April 2010. The Changed Project is substantially the same as the Reference Project to which the Coordinator-General's evaluation report and conditions of approval relate. The changes for which approval is now sought, relate to redesigned connections with both the Centenary Motorway and the Inner City Bypass for improved traffic flow during both construction and operation, realignment of the tunnel, relocation of the TCC, together with related Project delivery requirements.

The Changed Project would achieve the strategic objectives of Council's Transport Plan for Brisbane 2006-2026, which provides strategies and actions around the public transport services and infrastructure needed for a sustainable future.

The Project would have a significant strategic role in delivering State and Federal infrastructure strategies, including:

- the South East Queensland Regional Plan (SEQRP);
- the South East Queensland Infrastructure Plan and Program (SEQIPP);
- the Australia TradeCoast development; and
- the AusLink national objectives.

It is recommended that the Changed Project proceed, subject to the conditions of the Coordinator-General's Report on the Northern Link Road Tunnel dated April 2010, except where varied by the conditions described below.

### 8.1 Miscellaneous Conditions

There are a number of miscellaneous matters arising from the Changed Project which could be addressed by further suggested conditions in the Change Report. This includes corrections to typographicals and for clarification. Such matters, and the recommendations with regard to possible additional conditions include:

Amendments or additions to the existing Planning Approval conditions in Appendix 1, Schedule 3 (Imposed Conditions) of the Coordinator-General's Report as follows:

- Add to the end of condition 1(a) the words "as varied by the Coordinator-General's Change Report and the application for the Change Report", to address that the Conditions will include those of the Change Report.
- The Council has engaged an environmental representative to conduct the functions contemplated by condition 14. To avoid unnecessary duplication of functions it is suggested that to the end of condition 5 (c) the following words are added: "The Environmental Management Representative may undertake the audit provided it complies with these requirements".
- The Environmental Management Representative is not tasked with managing compliance. The role is to monitor compliance. In these circumstances, the condition requires amendment and in particular replace in condition 14(b)(iii) the word "manage" with the words "monitor and audit".
- Replace in condition 18(c)(ii) the words "condition 21" with the words "condition 22" to correct typographical error.

Permanent construction works definition should not be limited to the Toowong Worksite. Further, the definition of surface construction works requires amendment to correct a typographical and to allow for

works in an acoustic enclosure not to be classified as surface construction works. The following changes are recommended therefore to Appendix 1, Schedule 6 (Glossary) of the Coordinator-General's Report:

- Delete in the definition of "permanent construction works" the words "for the main Toowong worksite defined in the supplementary report" and "up to the boundary of the main Toowong worksite".
- Add to the definition of "Surface Works" the word "Construction" between the words "Surface" and "Works" and the words "or on and above the surface within an acoustic enclosure" after the words "underground works".

The proposal to provide a temporary car park for the construction workforce in Anzac Park would meet the requirements for the Changed Project, while having the potential to cause nuisance due to noise from the change-over to the night shift workforce. There would be an increase in traffic flows into and from the temporary car parking. This activity would require careful management and monitoring to ensure the acoustic objectives are achieved for nearby sensitive receptors, such as the residential areas to the south of Wool Street. A specific condition is proposed to address this issue. The condition could be addressed most effectively by way of an amendment to Schedule 3, condition 22(h) of the Coordinator-General's conditions as follows:

- Add to Schedule 3, condition 22(h):  
Any night-time noise sources from designated temporary construction workforce car parking must be managed in such a way to achieve the limits set out in Table 10.

Replace to Schedule 3, condition 22(h):

**Table 10: Night-time noise limit**

Noise type	Time of day	LA <sub>10,(adj)</sub> (10mins) (measures at a sensitive place) <sup>1</sup>	LA <sub>1,(adj)</sub> (10mins) (measures at a sensitive place) <sup>1</sup>
<ul style="list-style-type: none"> <li>• steady construction noise</li> <li>• noise from designated temporary construction workforce car parking</li> </ul>	6:30pm – 6:30am	Background +3dB(A)	Background +5dB(A)

1. Measured in accordance with the most recent edition of the *Queensland Government's Noise Measurement Manual*

## 8.2 Changes to Mainline Tunnel Alignment

As a consequence of the changed alignment, the following State Heritage listed properties are not affected by the Changed Project:

- Baroona, 90 Howard Street, Paddington.

The Changed Project does however have an alignment that directly passes beneath the following State Heritage listed properties:

- Cross Terrace, 50 Upper Cairns Terrace, Paddington;
- Boondah, 50 Howard Street, Auchenflower.

### 8.3 Connections of the Project to the Centenary Motorway

As identified in Appendix 1, Schedule 3, Condition 26 (a) of the Coordinator-General's Report, the connection and 'tie in' of the project to the Centenary Motorway would be designed, constructed and operated so that it does not limit the ability for possible future widening of the Centenary Motorway to six 'through lanes' – 3 lanes each way. The condition at 26(a)(i) requires a minimum future construction zone to provide for the possible future widening and refers to this as "(Schedule 8). However the drawing referred to (ANX1-6-01 Rev B) as shown in **Figure 8.1** is not the figure shown in Schedule 8 of the Appendix 1. **Figure 8-1** is illustrative only of the Reference Design in relation to outside portals and the allowance for a future construction zone within the median area of the Centenary Motorway.

The Changed Project would satisfy the requirement of the Coordinator-General's condition 26 in that construction would not impede operation of the Centenary Motorway. However, the requirements of condition 26(a)(i) should be amended to accommodate the Changed Project's connection with the Centenary Motorway and provision for future widening on the outside of the motorway.

Condition 26(a)(ii) also requires amendment to remove reference to Schedule 8. The Schedule 8 figure relates to the future planning for a new 'Inner Orbital' and specifically the Condition 26(b)(iii) identifying the extent of Northern Link excavation works. A recommended revised Schedule 8 figure to identify the limit of the future construction zone for a possible future widening of the Centenary Motorway is shown below as **Figure 8-2**.

As a consequence of the changes to the connections of the Changed Project with the Centenary Motorway as well as corrections to the existing conditions it is recommended that:

- The following wording is used to replace conditions 26(a)(i) and 26(a)(ii):
  - "Completed earthworks are required for a possible third lane on the left-hand side of the inbound carriageway of the Centenary Motorway between its junction with the Mt Coot-tha intersection and the limit line of below grade Northern Links Works identified in Schedule 8 and being a line drawn between the two points (E46987.038, N157425.253) and (E47071.605, N157283.886).
  - This future construction zone shall exclude structures, drainage pipes, drainage materials (aggregate), lighting columns, conduits, cabling, pits, manholes, etc."
- Schedule 8 is replaced by the **Figure 8-2** above
- Add reference to Schedule 8 to the end of Condition 26(b)(iii), and
- Delete condition 26(b)(iv).

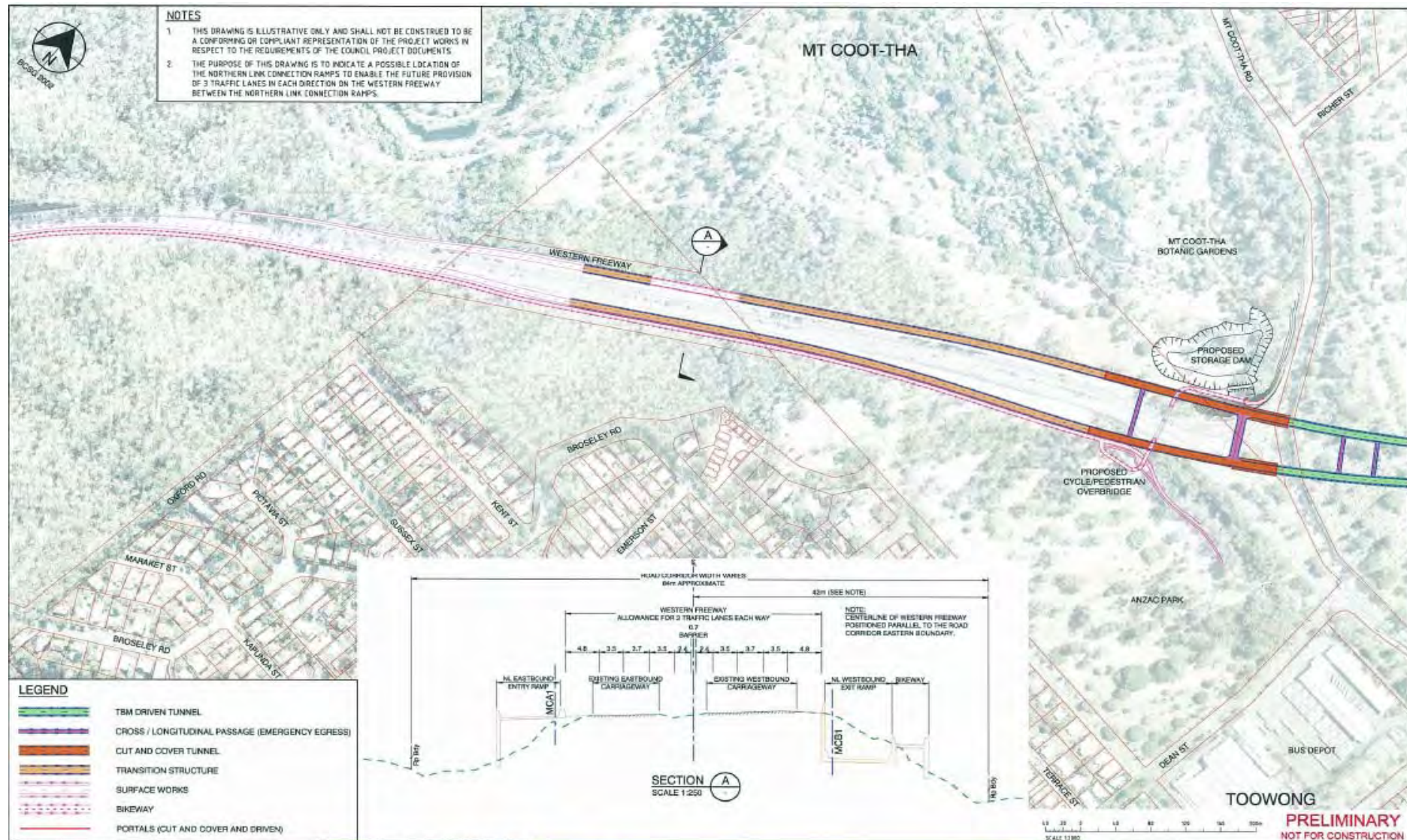


Figure 8-1: Minimum construction zone width for future Centenary Motorway widening



Figure 8-2: Changed Project – Limit of excavation works below Centenary Motorway

## 8.4 Spoil Conveyor and Quarry Placement

For the Changed Project, the spoil would be placed to facilitate the eventual rehabilitation of the quarry. This is different to the Reference Design. The placement of spoil would not affect the continued operation of the quarry.

The existing quarry development permit remains appropriate for the quarry operations. It is proposed that for delivery of spoil into the quarry, the following new Coordinator-General's conditions should apply:

Conveyor spoil delivery into the quarry must be managed to mitigate any adverse environmental impacts including:

- Spoil may be delivered by conveyor into the quarry providing the environmental objectives and the performance criteria for noise (Schedule 3, condition 22 Table 10 of the Coordinator-General's conditions) are met; and
- the environmental objectives and the performance criteria for air quality (Schedule 3, condition 20 of the Coordinator-General's conditions) are met at adjacent residential properties for spoil delivery and placement in the Mt Coot-tha Quarry;

Spoil placement within the quarry, being the distribution, spreading and compaction of conveyor spoil from the project works, must be controlled in accordance with the existing quarry development permit rather than condition 17 of the Coordinator-General's conditions.

As delivery of spoil via the conveyor into the quarry will occur on a continuous basis, this will need to be reflected in condition 18, subject to meeting the noise limits in condition 22 and the air quality requirements of condition 20. Hours of operation for conveyor spoil placement, being the distribution, spreading and compaction of conveyor spoil from the project works, are limited to and the same as the hours of the Mt Coot-tha quarry operations.

It is recommended then that Condition 22(h) is modified to include the words "delivery of spoil into the Mt Coot-tha Quarry" after the word "conveyor".

It is recommended that condition 20(b) is modified to add the words "at a sensitive place of more than" after the words "dust deposition".

It is recommended that condition 18 (c) (ii) is amended to replace the words "to the Mt Coot-tha Quarry" with the words " and delivery into the Mt Coot-tha Quarry". Add to the end of condition 18(c)(ii) the words "Delivery into the Mt Coot-tha Quarry does not include spreading and compaction of the conveyor spoil."

These proposed and existing Coordinator-General conditions will ensure that concerns raised in submissions to the EIS regarding amenity impacts of the conveyor and spoil placement operation at the quarry will continue to be appropriately managed.