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SUBJECT	Review of Sarawia St underpass report - August 2014

A review of '*The solution for the Newmarket Level Crossing closure – Sarawia Street underpass fully compliant update, August 2014*' was conducted by Opus International Consultants. During the review, a number of issues were identified throughout the document. The major issues identified are detailed below, with an assessment of their impact on CPTED compliance, construction cost, and construction time of the project.

CPTED issues

1. **Footpath widening:** The recommendation of the Harrison Grierson CPTED report is for a 2 m wide footpath on the northern side of the approach and along the western side of the underpass, allowing for 2 pedestrians side-by-side. The implications of accommodating the CPTED footpath recommendations would be twofold:
    - Increasing the width from 1.3 m to 2.0 m would increase the span of the bridge leading to increased cost, and weight of the units.
    - Moving the footpath to the other side of the road would require a longer span structure to accommodate turning circles and sight distances for vehicles with associated costs and weight of the units.
2. **Underpass widening:** Another recommendation from the CPTED report is for overall widening of the underpass. The CPTED report is based on a 9.0 m underpass width, consistent with the width between retaining walls along the approaches but wider than the 7.98 m between columns of the bridge. Widening of the underpass even further than the 9 m width assumed during CPTED analysis has significant implications for construction time and costs as follows:
    - An increased underpass width increases the bridge span, increasing the size and cost of the precast trough beams and of the abutment elements. The increased weight of the trough beams would incur further construction time and cost due to additional lifting demands.
    - Adhering to the current concept design of 9.0 m underpass width would negatively impact on the CPTED compliance of the final solution.
3. **Chamfering of approach:** The CPTED report also recommends chamfering of the northern underpass entrance, a change from the vertical retaining walls shown in the concept design. Implications of this change are:
    - Increased construction costs due to sloping walls.
    - This is further exacerbated by the moving of the footpath to the north side
4. **Vertical grade:** It is important to note that the CPTED study provided is a desktop study (no site visit has been undertaken) which does not seem to address the steep

vertical gradients of Sarawia Street or the proposed underpass. Implications of the vertical grade are:

- Sightlines and natural light penetration for pedestrians, as well as vehicular traffic, is compromised. This results in a negative impact on a major CPTED criterion.

5. **Convex mirror:** The recommendation of the CPTED report for placement of a convex mirror at the northern approach to the underpass indicates a less-than-ideal solution, where the available visibility is potentially lower than acceptable standards. Convex mirrors are generally an accepted solution for existing structures and not standard practice for new structures. Therefore, the implication of installation of a convex mirror within the underpass are:
    - Compromised CPTED compliance.

Construction issues

1. **Construction programme:** The construction programme needs to be clearly defined to ensure that there is minimal impact on rail operations as stated in the report. Achieving the quoted 'days not weeks' of Block of Line requirement will require careful planning and consideration of the hazards associated with working around an electrified rail line. Implications of an imprecisely defined construction programme include:
    - Increased construction time due
    - Additional construction costs
    - Allowance for de-powering of the OLE
    - Accommodation of key services such as signals cabling and communications
2. **Sheet piling construction:** An example of the importance of a well-defined construction programme is the construction of the sheet piling. As a general guide, the ratio of embedded height to 'free' height of sheet piling required is 2:1. Therefore, to achieve the approximate 4.0 m 'free' height in the underpass concept design, a total sheet pile height of 12.0 m is required. However, and contrary to the assertions in the underpass concept design report, it is difficult to envisage a construction methodology for ~12 m high sheet piles in close proximity of electrified rail lines which would not require, at a minimum, power down of the OLE. Therefore, implications of the sheet piling construction are:
    - Power down of the OLE during construction
    - Removal of 4 cable tension masts with associated impact on adjacent OLE masts and wire.
3. **Lifting of precast elements:** Close scrutiny of the construction sequence, and its' implications on BoL requirements, is required. Lifting and placement of the precast beams will require 2 or 3 crane movements, with the OLE to be removed for at least most, if not all, of this sequence. Implications of these requirements are:
    - The additional time required to allow for 2-3 crane movements;
    - Powerdown or removal of the OLE to be accounted for within the programme
4. **Ground support for trough beams:** The design is based on reliable ground support for the precast trough beams during the initial phases of the construction sequence which will require grouting beneath the precast beams and potential ground strengthening measures to provide this support. This will:
    - Incur additional time and cost for construction associated with both placement of the grout and the extended BoL required for this work.
    - Potentially require cement stabilization of the soil to provide the required vertical support and slope requirements during the excavation and placement of the temporary and permanent support structures
5. **KiwiRail access:** KiwiRail have indicated that a requirement for any replacement of the level crossing is maintained service access to the rail line approach along both approaches, from both northern and southern sides of the bridge. Factoring this into the

concept design will result in a wider bridge and increased retaining wall requirements, including a barrier along the top of the northern wall on the northern approach to the crossing. The impacts of these changes are:

- A stronger retaining wall is required to account for the vehicle and construction surcharge load, incurring additional construction costs.
- Installation of a barrier along the top of the retaining wall for safety along the access road, incurring additional construction costs and time.
- Impact on the overall width of the structure will have a serious impact on the CPTED assessment for this solution.
- Increased size and weight of the ground beam which will impact the viability of the beams being placed with a single crane lift

Additional construction issues to be addressed include a detailed allowance for **craneage costs** and an outline of the expected programme for **track hand-back**.

Structural issues

1. **Piling:** The current concept design has no allowance for piles in the bridge structure. The structural viability of the shallow foundation is dependent on the ground conditions, and presents a major risk to construction time and cost if piling is required. Implications of piling requirements at the abutments are:
    - Additional construction time and costs associated with both the piling construction and the additional BoL required during piling.
    - Noise and vibration resulting from piling in close proximity to residents of Laxon Terrace and Youngs Lane.
2. **Trough beam hogging capacity:** The trough beams, while simply supported during the initial construction phase, will be subjected to sizeable hogging moments following construction of the temporary and permanent columns. Due to the geometry of the trough beams, developing the required hogging capacity will be difficult. The impact of redesign of the trough beams to account for the required hogging moments is:
    - A larger, heavier section will likely be required which will incur additional costs and impact the proposed construction methodology due to the excessive weight of the beam.
    - A deeper bottom flange section that would increase the required construction depth and require the road to be lower than currently designed.
3. **Seismic resilience:** Review of the concept design also called attention to the seismic resilience of the bridge design. In particular, the lack of direct connectivity between the precast abutment beams and insitu concrete supports compromises the seismic resilience of the substructure when subjected to longitudinal seismic actions. Due to the time constraints associated with placement of the precast abutment beam, achieving a ductile connection between precast and insitu abutment elements will be challenging. Due to the shallow abutment depth, reliance on the soil behind the abutment for seismic resistance will not be sufficient. This issue is further exacerbated by the high skew angle of the bridge, with the rotational effects associated with the skew increasing the seismic demands on the abutments at the corners. The impacts of addressing this issue are:
    - Detailing of the abutment connection will minimally increase the cost of construction materials but significantly increase construction time and associated costs due to additional BoL.
4. **Undermining abutment foundation:** The installation of the pier supports and foundations, is proposed to be undertaken under normal rail operations. The position of the pier foundations would undermine the abutment support. The impact of this is likely to be :
    - Installation of the piers would require block of line.

- The abutments would need to be piled into bedrock with the lateral support offered by the soils only contributing below finished road level.

Other issues

A number of the assumptions and exclusions identified in the BBD concept design estimate need to be addressed.

1. **Resource & building consents:** Due to the location of the project, notified resource and building consents are considered a near-certain requirement, affecting the project programme, as well as costs relating to AT consultants.
2. **Rail works:** The assumed cost of KiwiRail works is considered low, based on previous experience. Relocation of KiwiRail services (OLE tension masts, signal boxes, etc) is likely to incur considerably greater costs than assumed in the underpass cost estimate.
3. **Access during normal working hours:** Unrestricted access during normal working hours is considered as an unrealistic assumption. The works will have to be undertaken during BoL's and evenings which carry additional costs compared to normal working hours.
4. **Land acquisition:** KiwiRail-owned land will need to be purchased by Auckland Transport, and the exclusion of this cost provides an unrealistic cost estimate for the underpass.
5. **Relocation of services:** The relocation of existing in-ground services was also excluded from the underpass cost estimate. There is an abundance of existing in-ground services within the scope of works of the project, and relocation of these services will require some design effort as well as considerable construction time and cost.
6. **Signalling issues:** Relocation of the OLE masts and signal cables may have an impact on the existing signals which would impact the construction costs and programme, as these works would be required prior to the disestablishment of the level crossing.

Summary

The table below provides a summary of the main issues identified during review of the underpass option presented in '*The solution for the Newmarket Level Crossing closure – Sarawia Street underpass fully compliant update, August 2014*', and the impact of these issues on CPTED compliance, construction cost, and construction time of the project.

Issue	**CPTED**	**Cost**	**Time**
Footpath widening	✓	✓	✓
Underpass widening	✓	✓	✓
Chamfering of approach	✓	✓	
Vertical grade	✓		
Convex mirror	✓		
Construction programme risks		✓	✓
Sheet piling construction		✓	✓
Lifting of precast elements		✓	✓
Ground support for trough beams		✓	✓
Allowance for KiwiRail access		✓	✓
*Piling**		✓	✓
Trough beam hogging capacity		✓	✓
Seismic resilience		✓	✓
Undermining abutment foundation		✓	✓
Resource and building consent		✓	✓
Rail works		✓	
Access during normal working hours			✓
Land acquisition		✓	
Relocation of services		✓	✓
Signalling issues		✓	✓

**Piling is also expected to result in a negative environmental impact*

Conclusions & Recommendation

The design outlined in '*The solution for the Newmarket Level Crossing closure – Sarawia Street underpass fully compliant update, August 2014*' provides support for the feasibility of an underpass linking Sarawia Street and Laxon Terrace. However, there are significant issues with the concept design presented in the report relating to CPTED, constructability, traffic safety, and structural and geotechnical engineering.

Recommended remediation for the identified CPTED issues included footpath widening, underpass widening, chamfering of approach, allowance for sightline issues relating to steep vertical grades, and the installation of a convex mirror. Similarly, remediation for traffic safety issues in the concept design would require widening of the underpass and chamfering of the approaches to improve vehicular sightlines and turning circles.

Several deficiencies were identified in the underpass concept design presented relating to structural and geotechnical design. Remediation for these deficiencies would result in

increased section sizes for the over-road bridge structure, the use of piling at the abutments, and more sophisticated abutment articulation to provide seismic resilience, among other changes.

Identified constructability issues related to Block of Line requirements, KiwiRail access, lifting of precast elements, and sheet pile construction. These issues are further compounded by all the changes to the current underpass concept design required to arrive at a viable solution. The resulting final underpass design would therefore be markedly different from the proposed concept design, with considerably increased construction time, rail network disruption, and cost.

Furthermore, the underpass option presented needs to be assessed alongside the other options considered for replacement of the Newmarket Level Crossing. In this context, the Cowie Street bridge option delivers more favourable traffic safety and CPTED outcomes while providing significant efficiencies in construction time, rail disruptions, and cost.