Developments near rail tunnels
T HR CI 12051 ST

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Background

• New standard – 1st issue in Nov. 2016

• Supersedes existing guideline documents such as APL & ECRL

• Single document for all Sydney rail tunnels

• Coherent approach to technical assessments

• Reviewed/referenced available in-house documents & relevant standards elsewhere

• Stakeholder consultation – RMS, ST, Syd. Metro, ARTC, SLR, Westconnex
Main highlights of the standard

- Provides technical requirements only
- Simplified protection reserves
- Construction restrictions on protection reserves
- Simplified loading criteria
- Engineering assessment
- Performance requirements
- List of document requirement at various stages of development
- Requirements for instrumentation and monitoring
Protection reserves

1st RESERVE
A: GREATER OF
   (1) 3m FROM THE CROWN OF THE TUNNEL
   (2) ONE-THIRD OF TUNNEL WIDTH PLUS ONE METRE \((1/3) \times W + 1\)
   (3) EXISTING PRE-DEFINED EASEMENT HEIGHT

B: GREATER OF
   (1) HALF OF TUNNEL WIDTH \((1/2) \times W\).
   (2) EXISTING PRE-DEFINED EASEMENT WIDTH

C: GREATER OF
   (1) 1m FROM THE LOWEST TUNNEL INVERT INCLUDING CABLE
       AND DRAINAGE TRENCHES
   (2) EXISTING PRE-DEFINED EASEMENT DEPTH

\[ W = \text{EXISTING TUNNEL WIDTH} \]
\[ H = \text{EXISTING TUNNEL HEIGHT} \]

2nd RESERVE
A+X: GREATER OF
   (1) 15 \times (W + H)
   (2) A+25m

B+Y: GREATER OF
   (1) W
   (2) B+25m

C+Z: C + 15 \times (Wn + Hn)

\[ Wn = \text{WIDTH OF NEW TUNNEL BELOW EXISTING TUNNEL} \]
\[ Hn = \text{HEIGHT OF NEW TUNNEL BELOW EXISTING TUNNEL} \]

NOTE ALL DIMENSIONS IN METRES
1st Reserve

- Immediate surrounds of the tunnel or the “support zone” required for the tunnel stability
- It represents the zone that shall not be encroached upon by any future construction or developments
Simplified loading criteria

Example: guideline load limits

<table>
<thead>
<tr>
<th>Tunnel type</th>
<th>Description</th>
<th>Load limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arch tunnels</td>
<td>Arch tunnels in good rock (Class I/II Sandstone)</td>
<td>500 kPa above the top of second reserve</td>
</tr>
<tr>
<td>Flat top tunnels</td>
<td>Shallow tunnels in poor rock, cut and cover tunnel</td>
<td>150 kPa above the top of second reserve</td>
</tr>
</tbody>
</table>

If the guideline limits are proposed to be exceeded then independent verification of the engineering analysis and impact assessment is required.
# Construction restrictions

<table>
<thead>
<tr>
<th></th>
<th><strong>FIRST RESERVE</strong></th>
<th><strong>SECOND RESERVE</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Excavations for basements, footings</td>
<td>Not Allowed</td>
<td>1. Excavations less than 2.0m depth from surface level, assessment not required.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Excavations greater than 2.0m depth, assessment required.</td>
</tr>
<tr>
<td>Shallow footings or pile foundations</td>
<td>Not Allowed</td>
<td>Allowed subject to load restrictions. Assessment required.</td>
</tr>
<tr>
<td>Tunnels and underground excavations</td>
<td>Not Allowed</td>
<td>Allowed subject to assessment</td>
</tr>
</tbody>
</table>


## Construction restrictions cont...

<table>
<thead>
<tr>
<th></th>
<th>FIRST RESERVE</th>
<th>SECOND RESERVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground anchors</td>
<td>Not Allowed</td>
<td>Allowed subject to assessment.</td>
</tr>
<tr>
<td>Demolition of existing subsurface structures</td>
<td>Not Allowed</td>
<td>Allowed subject to assessment</td>
</tr>
<tr>
<td>Penetrative subsurface investigations</td>
<td>Allowed away from structural elements. Assessment required</td>
<td>Allowed subject to assessment</td>
</tr>
</tbody>
</table>
Engineering assessment

• Engineering analysis & impact assessment
• Engineering assessment report
  • Geotechnical investigation report
  • Impact assessment report
  • Risk assessment report
• Independent verification
Recent update – Technical note TN 026: 2017

Section 6 Load limits

If the guideline load limits on tunnel reserve boundaries are proposed to be exceeded, then an independent verification of the engineering analysis and impact assessment is required. Refer to Section 8.4 for information on independent verification.
Recent update – Technical note TN 026: 2017 (cont.)

Section 6: Table 7 - Load limits on APL tunnels

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loading limit - soft ground tunnel</td>
<td><em>If the applied pressure on the tunnel lining from foundation loads exceeds 10 kPa, but less than 30 kPa, then independent verification of the engineering analysis and impact assessment is required.</em> When the applied pressure on the tunnel lining exceeds 30 kPa, then the foundation loads shall be transferred past the tunnel. 10 m minimum cover over tunnel to retain stability of the segmental concrete lining and to counter buoyancy effects. Load limits and associated ground movements shall not compromise the function of the waterproof gasket of the segmental lining. Gasket decompression assessment shall be performed based on the as-built details obtained from TfNSW.</td>
</tr>
</tbody>
</table>
Recent update – Technical note TN 026: 2017 (cont.)

Section 9.1.2 - Crack criteria

The following criteria shall be met for the cracking of tunnel lining and support structures as a result of the new development. The extent of cracking and crack criterion shall be confirmed for all stages of the development by engineering analysis and impact assessment.

The calculated maximum crack width shall be less than or equal to 0.3 mm. Cracks with lengths exceeding 300 mm and width exceeding 0.2 mm shall be repaired by the developer.
Recent update – Technical note TN 026: 2017 (cont.)

Section 9.5 – Monitoring plan

The monitoring requirements in this section are equally applicable for developments near or underneath existing dive structures.

Section A3 – Airport line

The soft ground tunnel is constructed as a circular bored tunnel supported by precast segments. There are eight 450 mm thick segments forming each circular ring.