Technical Note TN195

Traffic Guidance Scheme worked examples

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1 Introduction and purpose

This Technical Note provides worked examples of the Traffic Guidance Scheme (TGS) development applicable for various work and road type scenarios.

These worked examples are based on:

- the Australian Standard AS 1742.3:2019 *Manual of Uniform Traffic Control Devices, Part 3: Traffic Control for Works on Roads* and
- the Austroads *Guide to Temporary Traffic Management* series (AGTTM) Edition 1 published December 2019,

and relevant temporary traffic management guidance in force at 1 August 2021 in Queensland, including:

- the Queensland *Manual of Uniform Traffic Control Devices* (Queensland MUTCD),
- *Queensland Guide to Temporary Traffic Management* (QGTTM), and
- the *Guideline – Traffic Management at Works on Roads*.

The purpose of this Technical Note is to provide assistance to Traffic Management Designers in applying the requirements of the harmonised AGTTM approach in designing TGSs by providing a worked example with explanations and references to given scenarios.

References provided with the worked examples are generally to the Queensland documents (Queensland MUTCD and QGTTM) which give head of power to the Australian Standard AS1742.3 and the AGTTM for use in Queensland.

The layout and order of the temporary traffic management (TTM) elements of TGS designs may be arranged a few different ways. The worked examples in this document are just one example the Designer in this case has chosen to adopt in order to address the provided scenarios.

The worked examples included in this Technical Note will be added to over time as further scenarios are developed.

These worked example TGSs shall not be used as generic traffic guidance schemes or for any other purpose.

2 Definitions and abbreviations

Terms and abbreviations used in this Technical Note are described in Table 2.

Table 2 – Definitions

Term / abbreviation	Definition
AADT	Annual Average Daily Traffic
AGTTM	Austroads *Guide to Temporary Traffic Management*
Guideline	*Traffic Management at Works on Roads guideline*
May	A permissive condition, indicates that the guidance is conditional or optional
PTCD	Portable traffic control device, includes portable traffic signal systems and boom barriers
PTS	Prepare to Stop (sign)

Term / abbreviation	Definition
PTSS	Portable traffic signal system
QGTTM	*Queensland Guide to Temporary Traffic Management*
Queensland MUTCD	Queensland *Manual of Uniform Traffic Control Devices*
RPEQ	Registered Professional Engineer of Queensland
Shall / Must	A mandatory condition, indicates that the guidance must be followed
Should	Indicates a recommendation, any recommendation that is not applied must be based on sound engineering judgement and documented
TC sign	Traffic Control sign
TGS	Traffic Guidance Scheme
TTM	Temporary Traffic Management
TMA	Truck mounted attenuator
TMD / Designer	Traffic Management Designer
TMP	Traffic Management Plan

3 List of worked examples

Further detail on the following list of worked examples is provided in Section 4:

- Example 1 – Lane closure with traffic control on a multi-lane, high-speed divided road

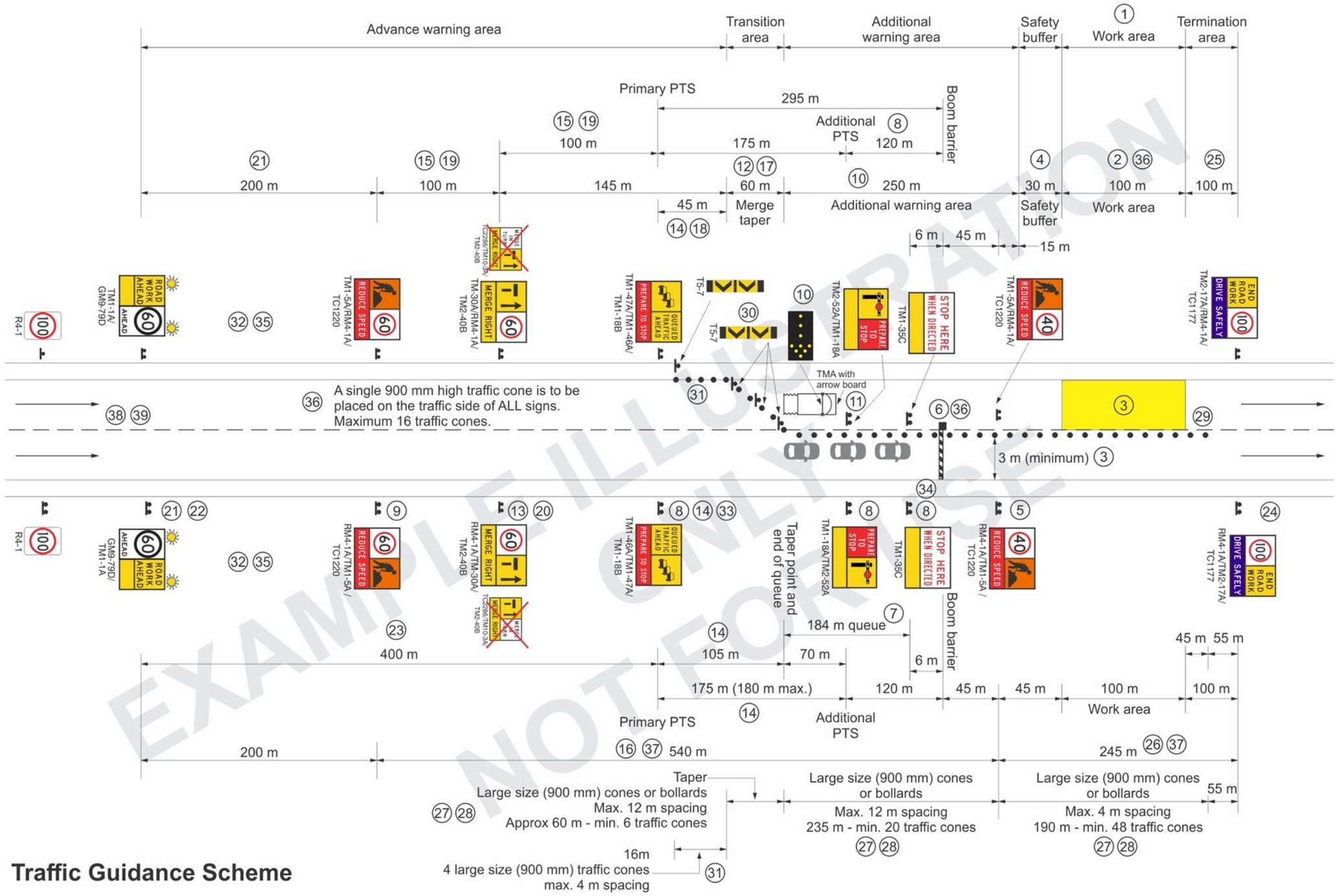
4 Detail of worked examples

4.1 Example 1 – Lane closure with traffic control on a multi-lane, high-speed, divided road

Figure 4.1 illustrates Example 1.

The TGS example design steps and discussions detailed at Section 4.1.4 should be read in conjunction with the following example TGS diagram (see Figure 4.1).

Figure 4.1 – Example 1: Lane closure with traffic control on a multi-lane, high-speed, divided road



4.1.1 Scenario

An asphalt contractor needs to replace a 50 m section of rutted pavement on a multi-lane divided road (Category 2 Road) with two lanes in each direction. The maintenance works are planned for nightshift (when traffic volumes are low) and are expected to take a maximum of six hours. The works will require sporadic truck and plant movements into and out of the site (with delays of no more than 10 minutes at a time), managed by traffic controllers. The entire width of the left-hand lane needs to be replaced; therefore, there is an expectation that works will be within 1.2 m of live traffic.

The contractor has advised a five-minute traffic count conducted at the site previously, returned 12 average vehicles and one large vehicle as the maximum expected during the hours of work. There is some street lighting in this area, but this is well spaced.

4.1.2 Understanding contractor requirements

Table 4.1.2 lists contractor requirements.

Table 4.1.2 – Contractor requirements

Nature of requirement	Detail of requirement
Road Category	2
Type of closure	Single lane (left lane)
Works duration	Single shift (night work) – maximum 6 hours
Work zone speed	40 km/h is required due to worker proximity
Live traffic stoppage	Manually-operated boom barrier to stop traffic Required for ingress / egress and some works (maximum 10 minutes stopped at a time)
Posted speed	100 km/h
Existing lane width	Both lanes 3.5 m
Existing sealed shoulder	1 m (both sides)
Existing unsealed shoulder	1.5 m (both sides)
Work area	50 m length of works (plus include an additional 50 m area for access / working room) = 100 m in total
Maximum traffic during works	12 average vehicles and one large vehicle for a five-minute count.

4.1.3 Traffic Management Plan

A complete Traffic Management Plan (TMP) has been prepared for these works (in accordance with QGTTM Part 2) and, where relevant to the discussion following in developing the TGS, items which were determined in the Traffic Management Plan (TMP) have been introduced to provide clarity to the TGS notes / discussion.

4.1.4 Designing the Traffic Guidance Scheme

The site is located on a high-speed multi-lane divided road and, to accommodate a work zone on one carriageway, the left-hand lane will be temporarily closed to traffic.

The following notes and discussion are based on the Queensland MUTCD and QGTTM documents (July 2021), including the requirements and options specific to Queensland.

The layout and order of the TTM elements of this TGS design may be completed in different ways, and this is just an example of one way that the Designer in this scenario has adopted.

1. As part of the TMP design, the required method of control was identified, and the general worksite layout required for the works to occur safely was determined. In this scenario, the outcome of the planning process was to implement a 'traffic past the worksite' approach using a static worksite with a single lane closure and using traffic control as required in the 'open' lane to accommodate the works.

For guidance regarding the design process and hierarchy of control refer to QGTTM Part 3, Section 2 and, for the preparation of a TMP, refer to QGTTM Part 2.

2. The contractor requires 50 m of physical working area and has requested an additional length of 50 m to allow for ingress / egress / parking. This results in a work area of 100 m. Due to the full lane being replaced, workers on foot will be within 1.2 m of traffic and the full length of the 100 m work area will be signed at 40 km/h.

   Note: The maximum length for 40 km/h speed zones for workers within 1.2 m of traffic is 500 m. This maximum length will need to be checked further once the location of the speed restriction signs is determined (see Note 26).

For information on speed zones, recommended speed zone lengths and methods for reducing speeds, refer to QGTTM Part 3, Section 5.5, and Tables 5.5 and 5.6.

3. From the TMP, work area separation is via lateral separation ('PAST' the worksite) and delineation / separation using traffic cones or bollards is appropriate for a single shift operation. Traffic cones and bollards are to be spaced in accordance with Table 5.3 and using the speed zone they are in (the 200 m distance beyond a change in speed zone for sign spacing does not apply to delineation – see Note 27). The existing lane width is 3.5 m, and the work area extends to the lane line between the two lanes. From Table 5.3, the 'PAST' edge clearance for traffic cones is 0.3 m (but may be reduced to zero if devices are also used to reduce speeds through lane narrowing). The minimum lane width for the open lane is 3.0 m (Table 2.5). Use an edge clearance of zero to reduce traffic speeds past the site (40 km/h is the speed zone past the work area) and position traffic cones 3.0 m from the existing right-hand edge line to the face of the traffic cones or bollards which should give sufficient space behind the cones or bollards for works to be completed up to the centreline.

- For information regarding work area separation, delineation and clearances, refer to QGTTM Part 3, Sections 5.3 and 5.4.
- For information regarding minimum lane widths, refer to QGTTM Part 3, Table 2.5.
- For additional information regarding the use of supplementary devices at roadworks to reduce speed in Queensland, refer to the *Guideline – Traffic Management Works on Roads*, Chapter 1, Section 1.
- For information regarding the use of temporary speed humps and rumble strips, refer QGTTM Part 3, Sections 5.5.2 and 5.5.3.

4. QGTTM Part 3 requires safety buffers immediately prior to work zones where the approach speed limit is 60 km/h or greater. The approach speed due to the use of traffic control will likely be 60 km/h (approach speeds have not yet been determined – see Note 5).

   A safety buffer of 30 m will be provided in this scenario.

   This site is a high-speed environment and a multi-lane carriageway, so the typical safety buffer length of 20 m to 30 m may be extended up to 100 m. In this scenario, the TMD has determined that there is no reason to extend the safety buffer as the site has good alignment and sight distance. Although not yet determined at this stage, a truck mounted attenuator (TMA) with arrow board in the taper and a long additional warning area (see Note 10) will be provided, which should further improve visibility of the taper and the work area and negate the need to extend the safety buffer.

For information and considerations about safety buffers, refer to QGTTM Part 3, Section 5.6.

5. Workers on foot are expected to be within 1.2 m of live traffic and, therefore, require a work zone speed limit of 40 km/h. The 40 km/h speed restriction sign needs to be in place prior to the work area (the Designer has chosen one sign spacing, as per Table 2.2, in advance of the work area). The speed restriction sign is also located clear of the safety buffer as traffic control devices are not permitted in the safety buffer. In this scenario, as the safety buffer is 30 m long, locate the work zone speed restriction sign 15 m into the additional warning area.

   The location of the 40 km/h speed restriction sign is now known, and we can determine that the safety buffer is actually within a 40 km/h zone (and may not be required by AGTTM); however, the safety buffer is located almost immediately after the 40 km/h sign, so would be within the 200 m zone following a speed reduction and, as such, should still be provided. In this scenario, a safety buffer of 30 m will be provided (see Note 4).

   Note: If the safety buffer was longer than 45 m, then this speed restriction sign would be located at the end of the additional warning area (start of the safety buffer) and be more than a sign spacing to the work area, as signs cannot be located within the safety buffer.

- For information and values of recommended work zone speed limits, refer to QGTTM Part 3, Table 5.5.
- For information and considerations about safety buffers, refer to QGTTM Part 3, Section 5.6.
- For recommended spacing of signs (and between traffic control devices), refer to QGTTM Part 3, Table 2.2, and Figure 2.2.

Multi-message sign arrangement

All panels in a multi-message frame are to be filled (if required, by a yellow blank – Queensland MUTCD Part 3 Clause 4.4.2(e) and Appendix B).

In the Queensland MUTCD, the REDUCE SPEED multi-message panel (TC1220 or TC1712) may only be used to supplement a speed restriction (or speed limit AHEAD) panel where a speed zone reduction is implemented or on the initial speed restriction sign on approach to the

site where this sign is used as a repeater speed restriction sign for traffic approaching / entering the site.

The reason for a temporary speed restriction sign should be clear to the road user. Where speed restrictions are applied for roadworker safety purposes, as is the case for the 40 km/h speed zone past the work area, the speed restriction sign should be used in conjunction with the WORKER (symbolic) sign (QGTTM Part 3 Section 5.5.1 *Operational*)

In this scenario, the Designer has chosen to use the REDUCE SPEED panel (1200 x 300), with a WORKER (symbolic) panel and the 40 km/h speed restriction sign. The 40 km/h speed restriction panel is placed closest to traffic (Queensland MUTCD Part 3 Clause 4.4.2(c)).

Note: The REDUCE SPEED message, if not used, may be replaced with a yellow blank panel (or another appropriate panel). If the speed limit was not for roadworker safety, then the WORKER (symbolic) panel would be replaced by a more relevant panel such as a SLIPPERY SURFACE, or if there is no relevant panel, by a 600 x 600 yellow blank. Only one yellow blank panel may be used on a multi-message sign.

- For requirements on the use of the REDUCE SPEED message in Queensland, refer to Queensland MUTCD Part 3 Appendix A and Table A.2.
- For information regarding the WORKER (symbolic) sign, refer to Queensland MUTCD Part 3 Clause 4.6.5.
- For requirements and information regarding the use of multi-message signs, refer to Queensland MUTCD Part 3 Clauses 4.2.2, 4.4.4 and 4.5.2, and Appendices A and B.
- For information and requirements for speed zones, refer to QGTTM Part 3 Section 5.5.

6. As the traffic control station is to be located in the single lane section, traffic control devices for traffic control will be considered now rather than later in the process (as per QGTTM Figure 5.1) which would be typical when the traffic control station is in advance of the transition (taper) area.

   Traffic in the 'open' lane will be required to be stopped for generally short periods (but may be up to a maximum of 10 minutes at a time) to enable truck and plant movements at the work area. This is achieved by using traffic controllers, with this site requiring a portable traffic control device (PTCD).

   In the QGTTM, PTCDs are recommended at all sites with a permanent speed limit of 70 km/h or greater and an annual average daily traffic (AADT) of greater than 500 vehicles per day; however, it is important to note that PTCDs may be used on any sites (even if not meeting this requirement).

   In this scenario, the permanent speed zone is 100 km/h and a PTCD would be recommended. Even without an AADT value being provided, as this site is multi-lane and divided, it would be expected that the traffic volume would be in excess of 500 vehicles per day.

   A boom barrier has been selected by the Designer as the PTCD to be used at this site. The traffic control station is to be located in the single-lane section in the additional warning area (clear of the safety buffer). The traffic control station will also need to be one sign spacing (from Table 2.2 and a 60 km/h speed zone, use 45 m) in advance of the 40 km/h

speed restriction sign for the work area to provide for separation between different traffic control devices (for example, between the boom barrier and work area speed zone sign).

The traffic controller operating the boom barrier is to be located in a position of safety, taking into account the requirements in QGTTM Part 7 Sections 2.6.2 and 2.7.3.

As works are occurring at night, the traffic control station (boom barrier) will require illumination (as will the work area, lane closure and taper).

- For considerations regarding traffic control placement / signage, refer to AGTTM Part 3, Section 5 10.2 and QGTTM Part 7.
- For information regarding the choice of manual traffic controllers or PTCDs, refer to QGTTM Part 3, Section 5.10.1.
- For recommended spacing of signs (and between traffic control devices), refer to QGTTM Part 3, Table 2.2.
- For information and considerations regarding night works, refer to QGTTM Part 3, Section 6.7 and for traffic control at night QGTTM Part 7, Section 2.6.5.

7. Calculate the expected maximum queue length for the traffic control station from the provided five-minute maximum traffic count of 12 average vehicles and one large vehicle.

   For a 10-minute delay and using Table 4.3 to estimate the queue length for this scenario, provides an estimated queue length of 184 m (12 x 12 + 1 x 40) for the maximum 10-minute delay period.

   Note: Traffic counts to be used with the multipliers in Table 4.3 are always for a five-minute count. Then use the appropriate delay time to select the multiplier to use.

For information about estimating the queue length, refer to QGTTM Part 3, Section 4.8, and Table 4.3.

8. Determine the advance warning signs for the traffic control station.

   A STOP HERE WHEN DIRECTED sign is optional in the Queensland MUTCD Part 3 (as per AS 1742.3); however, in this scenario, the Designer has chosen to install this sign which is placed 6 m in advance of the traffic control station (also within the additional warning area).

   As the estimated queue length of 184 m is between 145 m and 204 m, a primary and an additional PREPARE TO STOP (PTS) sign is required (Figure 4.4).

   The primary PTS sign is located a distance as per Table 2.3 in advance of the predicted end of queue. In this scenario, assuming the 60 km/h sign is more than 200 m in advance of the primary PTS sign location, the sight distance to the end of queue for a 60 km/h zone is 90 m.

   Locate the primary PTS sign at least a distance of 280 m (6 m from the queue stopping point + 184 m queue + 90 m sight distance) from the traffic control station (also see Note 14 for an adjustment in this distance due to spacing requirements for other traffic control devices).

   The additional PTS sign is located 120 m from the traffic control station.

In the QGTTM Part 3, the primary PTS sign may be substituted for a QUEUED TRAFFIC AHEAD sign when there is either a repeater PTS sign or an additional PTS sign in place. In this scenario, the Designer has chosen to use the QUEUED TRAFFIC AHEAD sign as the primary PTS sign, as the primary risk at this point for approaching traffic is the end of queue, not what sort of traffic control is provided at the traffic control station (which is shown on the additional PTS sign located closer to the traffic control station). The QUEUED TRAFFIC AHEAD sign assembly as shown in QGTTM Part 3, Figure 4.8 includes the PREPARE TO STOP panel in a 1200 x 300 size (TM1-18B) which is permitted in the Queensland MUTCD Part 3 (and AS 1742.3) but prohibited by AGTTM Part 7.

Note: There are some conflicting requirements regarding the use of the STOP HERE WHEN DIRECTED or STOP HERE ON RED SIGNAL sign between AS 1742.3 (optional / generally mandatory) and AGTTM (mandatory / required in all cases). In Queensland, this is clarified by the requirements in QGTTM and the Queensland MUTCD which make the use of these signs as per AS 1742. The STOP HERE WHEN DIRECTED sign is optional (Clause 4.7.2(d) and 4.7.5(c)). The STOP HERE ON RED SIGNAL sign is also optional but is mandatory when a temporary STOP line is not installed on the pavement (Clause 4.7.4(a)).

Note: There are also some conflicting requirements regarding the use of the PREPARE TO STOP (1200 x 300) multi-message panel which is included in AS 1742.3 Clause 4.7.2(b) and 4.7.5(b) for use but, in AGTTM Part 7, Section 2.6.3, it is prohibited for use (with only the 600 x 600 version being permitted). In Queensland, this is clarified by the requirements in QGTTM Parts 3 and 7 which permit the use of this size panel for the PREPARE TO STOP message when used in the QUEUED TRAFFIC AHEAD multi-message sign assembly.

- For considerations regarding traffic control placement / signage, refer to QGTTM Part 3, Section 4.8 and QGTTM Part 7.
- For information regarding when a STOP HERE WHEN DIRECTED sign is an option in Queensland, refer to QGTTM Part 3, Section 4.8 and Queensland MUTCD Part 3 Clause 4.7.2(d) and Clause 4.7.5(c).
- For information regarding using a QUEUED TRAFFIC AHEAD sign in Queensland, refer to QGTTM Part 3, Section 4.8.
- For sight distance requirements (end of queue), refer to QGTTM Part 3, Table 2.3.

Multi-message sign arrangements

Primary PREPARE TO STOP sign

The QUEUED TRAFFIC AHEAD sign assembly as shown in QGTTM Part 3, Figure 4.8 includes the PREPARE TO STOP panel in a 1200 x 300 size (TM1-18B), the queued traffic symbolic 600 x 600 panel and the QUEUED TRAFFIC AHEAD 600 x 600 panel. The QUEUED TRAFFIC AHEAD text panel is located closest to traffic (QGTTM Part 3 Section 4.8).

Additional PREPARE TO STOP sign

The additional PTS sign includes the 600 x 600 PREPARE TO STOP panel, a 600 x 600 boom barrier symbolic sign and a 1200 x 300 yellow blank panel (as all multi-message panels need to be filled, and there is no other appropriate 1200 x 300 sign panel to use with this arrangement). The PREPARE TO STOP panel is located closest to traffic (QGTTM Part 7 Section 2.6.3 *Warning signs)*.

Note: The DO NOT OVERTAKE panel is often used as the 1200 x 300 panel with the PTS sign; however, in this scenario, this sign is located in the one lane section of a divided road and there is no overtaking opportunity, so to include a panel saying that, would not be credible or appropriate.

STOP HERE sign

The STOP HERE sign includes a 1200 x 600 STOP HERE WHEN DIRECTED panel with a 1200 x 300 yellow blank (as all multi-message panels need to be filled, and there is no other appropriate 1200 x 300 sign panel to use with this arrangement).

For requirements and information regarding the use of multi-message signs, refer to Queensland MUTCD Part 3, Clauses 4.2.2, 4.4.4 and 4.5.2, and Appendices A and B.

9. The speed limit in advance of the traffic control station is to be a maximum of 60 km/h. In Queensland, the 60 km/h speed limit sign is to be located at least one sign spacing in advance of the primary PTS sign (QGTTM Part 3 Section 4.8). See Note 15 for location considerations and adjustments.

   The reason for a temporary speed restriction sign should be clear to the road user. Where speed restrictions are applied for roadworker safety purposes, the speed restriction sign should be used in conjunction with the WORKER (symbolic) sign (QGTTM Part 3 Section 5.5.1 *Operational*). In this case, the speed limit is for the presence of traffic control; however, due to the special requirements for the PTS signs, a speed limit cannot be used with the traffic controller (or PTCD) symbol. In this scenario, the Designer has chosen to use a WORKER (symbolic) with this assembly.

- For information on speed zones, recommended speed zone lengths and methods for reducing speeds, refer to QGTTM Part 3 Section 5.5 and Tables 5.5 and 5.6.
- For information regarding the speed zone in advance of a traffic control station, refer to QGTTM Part 3, Sections 4.7 and 5.10.1.
- For recommended spacing of signs (and between traffic control devices), refer to QGTTM Part 3, Table 2.2, and Figure 2.2.
- For information regarding the location of the 60 km/h sign in advance of a traffic control in Queensland, refer to QGTTM Part 3, Section 4.8.

Multi-message sign arrangements

In the Queensland MUTCD, the REDUCE SPEED multi-message panel (TC1220 or TC1712) may only be used to supplement a speed restriction (or speed limit AHEAD) panel where a speed zone reduction is implemented or on the initial speed restriction sign on approach to the

site where this sign is used as a repeater speed restriction sign for traffic approaching / entering the site.

In this scenario, the Designer chose to use the REDUCE SPEED panel (1200 x 300), with a 600 x 600 WORKER (symbolic) and the 60 km/h speed restriction sign. The 60 km/h speed restriction panel is placed closest to traffic (Queensland MUTCD Part 3 Clause 4.4.2(c)).

Note: The REDUCE SPEED message, if not used, may be replaced with a yellow blank panel (or another appropriate panel). The WORKER (symbolic) panel, if not used, may be replaced with another appropriate panel. A WORKER (symbolic) panel will be required on approach to the work area.

- For requirements and information regarding the use of multi-message signs, refer to Queensland MUTCD Part 3 Clauses 4.2.2, 4.4.4 and 4.5.2, and Appendices A and B.
- For requirements on the use of the REDUCE SPEED message in Queensland, refer to Queensland MUTCD Part 3, Appendix A and Table A.2.
- For information regarding the WORKER (symbolic) sign, refer to Queensland MUTCD Part 3 Clause 4.6.5.

10. Space in the additional warning areas may be required in order to provide room for a traffic control vehicle without it obstructing the safety buffer. In this scenario, a Category 2 road with a speed limit above 80 km/h, a lane closure and night works, the Designer should consider using a TMA in the additional warning area. In this scenario, the Designer has determined a TMA is warranted.

    QGTTM Section 5.8.1 requires a clear distance of at least 40 m in front of the TMA as a roll ahead distance and Figure 5.10 allows the safety buffer for the work area if required to also be used for the TMA roll ahead distance.

    The TMA roll ahead distance of 40 m in front of the TMA must be kept clear of any workers, materials, equipment, or obstructions (see Note 11).

    The Designer has chosen not to also use the work area safety buffer for the TMA roll ahead distance, meaning the additional warning area needs to be long enough to accommodate the TMA and the roll ahead distance of 40 m for the TMA. Allowing 15 m for the length of the deployed TMA and vehicle, plus the 40 m roll ahead, gives a minimum additional warning area of 55 m.

    As a further consideration, as it is undesirable to be asking drivers to do more than one action at a time, the Designer has chosen to also consider the distance between where traffic merges and the impact of the traffic control station location (vehicles stopping in the queue) and include additional space in the additional warning area so that the estimated traffic queue of 184 m is located wholly within the single lane section. This should reduce the risk of side swipes and rear end crashes (due to merging and stopping for the end of queue at the same time / location) and is achieved in this scenario by extending the additional warning area from 55 m to 250 m (184 m queue + 6 from the start of queue to the TC station + 45 m to the 40 km/h sign + 15 m to the safety buffer).

    Note: The TMA and associated flashing arrow board in this scenario are to be located at the start of the additional warning area (immediately after the taper) and are located well away from the traffic control station.

- For considerations when treating additional warning areas, refer to QGTTM Part 3, Section 5.8.
- For information regarding the use of TMAs, refer to QGTTM Part 3, Section 5.8.1.
- For information regarding the design and operation of arrow boards, refer to Queensland MUTCD Part 3 Clause 4.14.2.

11. Confirm there are no devices in the roll ahead distance for the TMA. The TMA is located at the start of the additional warning area and allowing for the TMA unit in the deployed position, the vehicle and 40 m roll ahead distance gives a length of 55 m from the end of the taper where no other traffic control devices (excluding delineation) should be located.

    The additional PTS sign is the closest traffic control device to this area and is located 70 m from the end of the taper and, thus, 15 m clear of the area required for the TMA, including the roll ahead distance.

12. A merge taper is required to reduce the two lanes of traffic into a single lane past the work area. The transition area is located immediately prior to the additional warning area.

    Drivers generally find a merge to the right is easier and, as such, a merge from the left-hand lane into the right-hand lane is the preferred merge arrangement.

    In this scenario, from Table 5.6 and based on a traffic speed in this area of 60 km/h, the merge taper length will be 60 m. This assumes (at this point in time) that the speed restriction sign to reduce traffic speeds to 60 km/h prior to the primary PTS sign will be located 200 m or more (Figure 2.2) prior to the start of the merge taper (see Note 17 for confirmation).

    Note: The merge taper length would increase if the start of the taper is in a different speed zone or within 200 m of the 60 km/h speed restriction sign (and would then depend on the speed zone prior to the 60 km/h sign).

- For recommended lengths of merge tapers, refer to QGTTM Part 3, Table 5.6, and Figure 2.2.
- For information regarding the design of merge tapers, refer to QGTTM Part 3, Section 5.9.1.

13. Lane status signs are required to give advance warning of the merge taper ahead. These signs are located in advance of the transition area (in the advance warning area) and, in the QGTTM, are to be positioned one sign spacing (Table 2.2) in advance of the start of the taper. The QGTTM also includes an option where the permanent speed limit of the road is 80 km/h or greater (which is the case in this scenario) that the distance between the lane status sign and the merge taper may be increased to two sign spacings. The location of the lane status sign may be affected by other signs (such as the traffic control signs) and may need to be adjusted to accommodate minimum sign spacing requirements of other signs and devices which are located in advance of the start of the taper (see Note 15).

For recommendations on required lane status signage, refer to QGTTM Part 3, Section 2.5.3, Figure 5.24, and Table 2 2.

Multi-message sign arrangements

In this scenario, the Designer originally chose to use the MERGE RIGHT panel (1200 x 300), with a 600 x 600 LANE STATUS (symbolic) and the MERGE IN TURN panel (to encourage courteous merging). The lane status panel is placed closest to traffic.

Note: The MERGE IN TURN sign is not included in AS 1742.3 or AGTTM and is a Queensland-specific sign design (TC2286) included in the Queensland MUTCD Part 3.

The MERGE IN TURN panel, if not used, may be replaced with a yellow blank panel (or another appropriate panel such as the WORKER (symbolic) panel). A WORKER (symbolic) panel will be required on approach to the work area and is currently provided with the speed limit reduction to 60 km/h sign assembly.

- For requirements and information regarding the use of multi-message signs, refer to Queensland MUTCD Part 3 Clauses 4.2.2, 4.4.4 and 4.5.2, and Appendices A and B.
- For information regarding the MERGE IN TURN sign in Queensland, refer to the Queensland MUTCD Part 3, Appendix A and Table A.2.
- For information regarding the WORKER (symbolic) sign, refer to Queensland MUTCD Part 3 Clause 4.6.5.

Note: Due to the length of the 60 km/h zone (see Note 16), a repeater speed limit sign is required and will affect the original design of this lane status multi-message sign assembly (see Note 20).

14. Locate the primary PTS sign one sign spacing (Table 2.2) in advance of the start of the merge taper, as the primary PTS sign (or any sign other than delineation) should not be located within the taper area.

    The primary PTS sign also needs to be a minimum of 90 m (see Note 8) from the end of queue location (which is also the start of the additional warning area in this scenario).

    Assuming the primary PTS sign is located more than 200 m beyond the 60 km/h speed restriction sign (see Note 18 for confirmation), this would place the primary PTS sign at 105 m (60 m for the merge taper and 45 m for the minimum sign spacing from the merge taper) from

the end of the queue. This is greater than the minimum of 90 m (Table 2.3) from the end of queue.

In this scenario, 105 m is used in lieu of the 90 m sight distance to the end of queue (this is an acceptable adjustment from the requirements discussed in Note 8).

Note: There is also a maximum distance between PTS signs on approach to the traffic control station of 180 m (for a 60 km/h speed zone and Table 4.4a, Figures 4.4 and 4.5) which is not exceeded in this scenario, as the distance between the primary PTS sign and the additional PTS sign is 175 m. Thus, there is no need to provide repeater PTS signs between the primary PTS and the additional PTS sign.

- For sign spacing requirements, refer to QGTTM Part 3, Table 2.2, and Figure 2.2.
- For sight distance requirements (end of queue), refer to QGTTM Part 3, Table 2.3.
- For maximum distance between PTS signs, refer to QGTTM Part 3, Table 4.4a and Figures 4.4 and 4.5.

15. Consider the relationship between several of the signs and devices in the transition and advance warning areas including the primary PTS, lane status, 60 km/h speed limit signs, and the merge taper. The layout and order of these elements of the design could be done a few different ways, and this is just one way that the Designer in this scenario has adopted (see the sign layout for this example TGS in Figure 4.1 for the arrangements and order of elements used in this area).

    The primary PTS sign is located one sign spacing (Table 2.2) in advance of the start of the merge taper (see Note 14).

    Locate the lane status sign one sign spacing (Table 2.2) in advance of the primary PTS sign. This then locates the lane status sign two sign spacings from the start of the merge taper, which is not an issue and is an option where the permanent speed limit of the road is 80 km/h or greater as discussed in Note 13.

    Assuming the 60 km/h speed reduction will be 200 m or less from the lane status sign (a 100 km/h speed value will be used for the spacing of signs in this zone – see Note 19 for confirmation). The spacing from the lane status sign to the primary PTS sign will be 100 m and, therefore, the distance from the lane status sign to the start of the taper will be 145 m (100 m between lane status and primary PTS + 45 m from primary PTS to the start of taper). Two sign spacings are used but, due to the location of the speed zone reduction to 60 km/h, different speed values are used and the sign spacing distances are different.

    The 60 km/h speed restriction sign may then be located a further sign spacing in advance of the lane status sign. Again, using a 100 km/h speed limit in this area (see Note 19 for confirmation), the 60 km/h speed restriction sign will be located 100 m in advance of the lane status sign.

    Note: a WORKER (symbolic) sign is also required in the advance warning area and may be placed with either the speed limit sign or the lane status sign. In this scenario, the Designer has chosen to locate the WORKER (symbolic) sign with the 60 km/h speed restriction sign.

For sign spacing requirements, refer to QGTTM Part 3, Table 2.2, and Figure 2.2.

16. The extent of the 60 km/h zone is now known.

    The total length of the 60 km/h speed zone is 540 m (100 m to lane status sign + 100 m to primary PTS sign + 295 m to TC station + 45 m to 40 km/h sign) and is greater than the minimum length of a 60 km/h zone of 150 m (Table 5.5).

    Also from Table 5.5, the length of the 60 km/h zone on approach to the TC station of 495 m (540 m total length of 60 km/h zone – 45 m to TC station) is greater than the 150 m minimum required on approach to the TC station.

    There is a requirement to provide speed limit repeater signs at a maximum spacing of 500 m and the length of the 60 km/h speed zone at 540 m requires a repeater speed limit sign to be used (see Note 20 for adjustment to lane status sign arrangement in Note 13).

For information on speed zones, recommended speed zone lengths, repeater speed sign spacings and methods for reducing speeds, refer to QGTTM Part 3, Section 5.5, and Tables 5 5 and 5.6.

17. Confirm the merge taper distance, as the location of the 60 km/h speed restriction sign is now known. Note 12 assumed the 60 km/h speed restriction sign would be 200 m or more from the start of the taper and the merge taper distance would be 60 m.

    The 60 km/h speed restriction sign is located 245 m from the start of the taper, so the assumption in Note 12 and the merge taper distance of 60 m is correct.

    Note: A repeater speed restriction sign does not impact on this, as it is the location of the initial speed restriction sign for the reduction in speed zone that is used for the 200 m requirement.

18. Confirm the sign spacing for the primary PTS sign, as the location of the 60 km/h speed restriction sign is now known. Note 14 assumes the 60 km/h speed restriction sign would be 200 m or more from the primary PTS signs and a speed of 60 km/h could be used for the spacing between the primary PTS and the start of the merge taper.

    The 60 km/h speed restriction sign is located 200 m from the primary PTS sign, so the assumption in Note 14 and the distance between the primary PTS sign and the start of the merge taper of 45 m is correct.

    Note: A repeater speed restriction sign does not impact on this, as it is the location of the initial speed restriction sign for the reduction in speed zone that is used for the 200 m requirement.

19. Confirm the sign spacings for the 60 km/h speed restriction sign, the lane status sign, and the primary PTS sign, as the location of the 60 km/h speed restriction sign is now known.

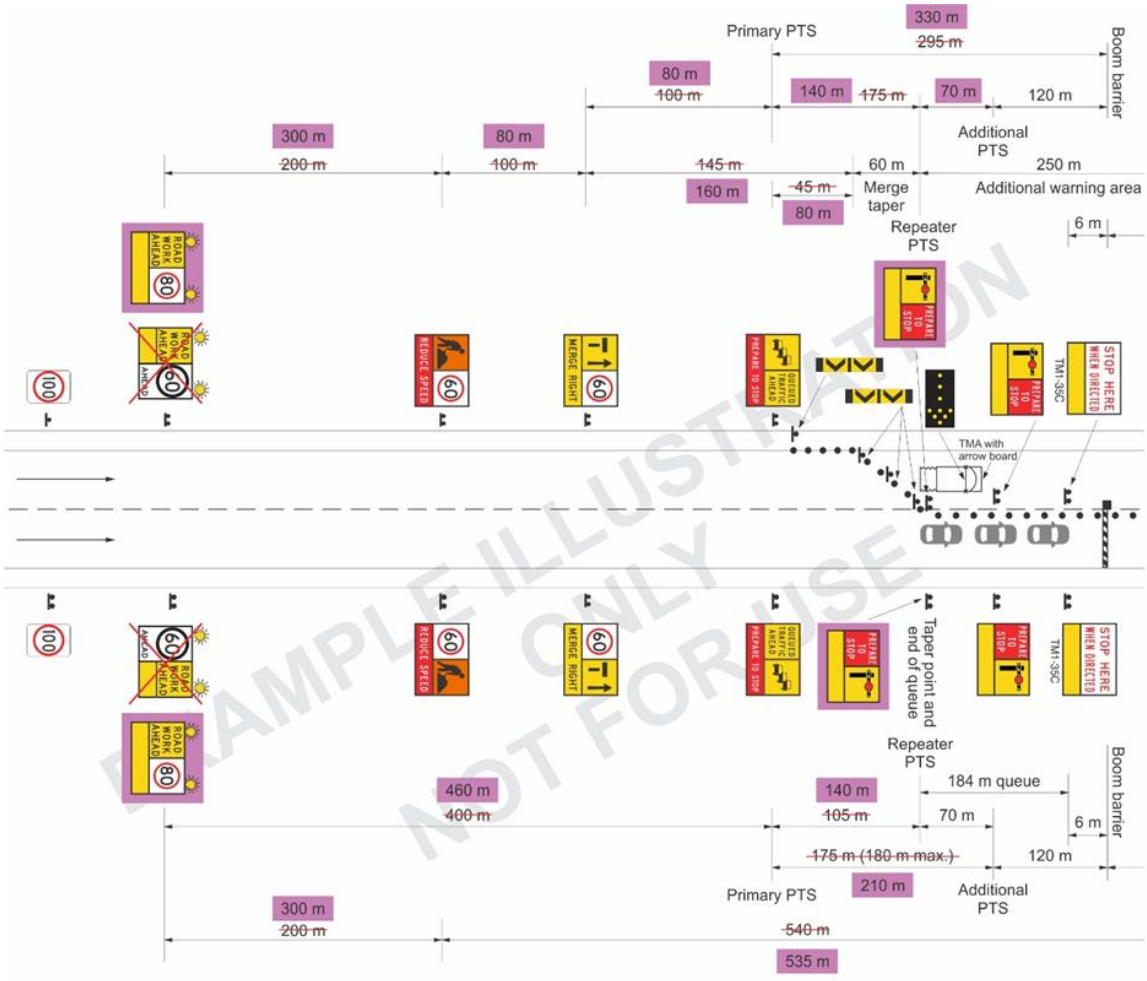
    Note 15 assumes the 60 km/h speed restriction sign would be 200 m or less from the lane status sign and a speed of 100 km/h could be used for the spacings between the 60 km/h speed restriction sign, the lane status sign, and the primary PTS sign.

The 60 km/h speed restriction sign is located 100 m from the lane status sign and the primary PTS sign is a further 100 m from the lane status sign, so the assumption in Note 15 and the distance between the 60 km/h speed restriction sign, the lane status sign and the primary PTS sign of 100 m are both correct.

Note: If an 80 km/h buffer zone was used in advance of the 60 km/h speed restriction sign (instead of the speed limit AHEAD sign as used in this scenario), then a speed of 80 km/h would be used in lieu of 100 km/h in calculating these sign spacings and a sign spacing of 80 m (not 100 m) would apply between each of the three signs. This would then also affect the spacing between the primary PTS sign and the taper as the primary PTS sign would now be within 200 m (80 m + 80 m = 160 m) of the 60 km/h speed restriction sign and a spacing for a speed of 80 km/h would then need to be used, increasing the distance from the primary PTS sign to the start of the taper from 45 m to 80 m. The flow-on effects would continue and the 180 m maximum between PTS signs would now be exceeded and a repeater PTS sign would be required. Also, an 80 km/h buffer zone is to be a minimum 300 m long which is different to the distance for a 60 km/h AHEAD sign in advance of the 60 km/h speed restriction sign, which would also affect the location of the ROADWORK AHEAD sign. See Figure 4.1.4 for variations to the original TGS.

Thus, determining speed limits and their extents (locations) including how they reduce or increase through a site is a critical part of the design exercise which affects many other elements / decisions.

Figure 4.1.4 – TGS adjustments if an 80 km/h buffer zone was used in lieu of the 60 AHEAD signs



20. Note 16 determined the requirement for a repeater speed restriction sign.

    Adding an additional speed restriction sign into the layout would require significant adjustment of sign spacings and other requirements. The only alternative to finding space for and adding an extra sign into the layout would be to incorporate the 60 km/h speed restriction sign into an existing multi-message sign assembly. The lane status multi-message sign (see Note 13) is the only choice as all other multi-message signs within the 60 km/h speed zone do not have an option for including the 600 x 600, 60 km/h speed restriction panel.

    This breaks the 540 m total length of the 60 km/h speed zone into a 100 m segment and a 440 m segment which meets the 500 m maximum spacing requirement for repeater speed restriction signs.

    Multi-message sign arrangements

    In this scenario, the Designer originally chose (Note 13) to use the MERGE RIGHT panel (1200 x 300), with a 600 x 600 LANE STATUS (symbolic) and the MERGE IN TURN panel (to encourage courteous merging). The lane status panel is placed closest to traffic.

    This multi-message sign arrangement now requires adjustment to accommodate a repeater speed restriction sign.

    The Designer has chosen to replace the MERGE IN TURN panel with a 600 x 600 speed restriction sign. The lane status panel now moves to the location of the MERGE IN TURN panel as the speed restriction panel must be placed closest to traffic.

    The reason for a temporary speed restriction sign should be clear to the road user. In this case, the 60 km/h speed zone is for the presence of traffic control; however, due to the special requirements for the PTS signs, a speed limit cannot be used with the traffic controller (or PTCD) symbol. In this scenario, the Designer has used the lane status panel with the repeater speed restriction sign to reinforce the reduced traffic speeds prior to the merge point.

    The Designer in this scenario has chosen to use the 1200 x 300 MERGE RIGHT panel on both sides of the road. It would also be acceptable to use the DO NOT OVERTAKE or MERGE IN TURN (1200 x 300) panel in lieu of the MERGE RIGHT message on the sign on the right hand side of the road. Vehicles in the right hand lane do not need to merge right, as this lane continues, but they may need to allow merging vehicles space to enter this lane.

- For requirements and information regarding the use of multi-message signs, refer to Queensland MUTCD PART 3 Clauses 4.2.2, 4.4.4 and 4.5.2, and Appendices A and B.
- For information on speed zones, recommended speed zone lengths, repeater speed sign spacings and methods for reducing speeds, refer to QGTTM Part 3 Section 5.5 and Tables 5.5 and 5.6.

21. A speed buffer comprising either an advance warning (speed limit AHEAD sign) or incremental reductions in speed limit (speed restriction sign/s of intermediate value) is required in advance of the 60 km/h speed zone for the TC station.

    In this scenario, the Designer has chosen to use a 60 km/h speed limit AHEAD sign which is located (as per QGTTM) a distance double the speed limit (using the higher speed zone value – not the new reduced speed limit) in advance of the 60 km/h speed restriction sign. As the

speed zone in advance of the 60 km/h zone is 100 km/h, '100' is doubled and the 60 km/h speed limit AHEAD sign is located 200 m in advance of the 60 km/h speed restriction sign for the reduced 60 km/h speed zone.

Note:

- The new design for a speed limit AHEAD sign as a multi-message panel in AS 1742.3 is now the full depth (600 mm wide x 900 mm high) panel of one side of the multi-message sign. Using the speed limit AHEAD sign panel will require the use of a 600 mm wide x 300 mm high yellow blank to fill the remaining area of the 1200 x 300 panel of the multi-message sign.
- While the use of the new 600 x 900 panel sizes for the speed limit AHEAD and END speed limit signs in AS 1742.3 are accepted for use in Queensland, as an option the Queensland MUTCD Part 3 Appendix A permits the continuing use of the existing size 600 x 600 speed limit AHEAD and END speed limit signs in Queensland.
- There are some conflicting requirements between AS 1742.3 and AGTTM regarding the use of speed limit signs to reduce speed. Regarding the use of the speed limit AHEAD sign, AGTTM only permits the use of this sign with speed drops of 30 km/h, while AS 1742.3 permits its use for drops of 40 km/h and 50 km/h (not 30 km/h where a standard speed limit sign is used). This will be resolved in a future national revision of both AS 1742.3 and AGTTM.

  In the interim, while waiting for the national documents to be amended, the QGTTM Part 3 Section 5.5 provides the requirements for speed signs and methods for reducing speeds to be used in Queensland.

- For information on speed zones, recommended speed zone lengths, repeated speed sign spacings and methods for reducing speeds, refer to QGTTM Part 3 Section 5.5 and Tables 5.5 and 5.6.
- For information and considerations regarding the signing of speed zones, refer to Queensland MUTCD Part 3 Clauses 3.4.4 and 4.7.6.
- For requirements and information regarding the use of multi-message signs, refer to Queensland MUTCD Part 3 Clauses 4.2.2, 4.4.4 and 4.5.2 and Appendices A and B.

Multi-message sign arrangements

In this scenario, the Designer chose to use the new AS 1742.3 version of the speed limit AHEAD panel (600 x 900), with a 600 x 600 ROAD WORK AHEAD message (see Note 22). The remaining 300 x 600 panel is filled with a yellow blank. The speed limit AHEAD panel is placed closest to traffic.

Note: The Queensland MUTCD Part 3 Appendix A permits the continued use of the existing size 600 x 600 speed limit AHEAD sign in Queensland.

For requirements and information regarding the use of multi-message signs, refer to Queensland MUTCD Part 3 Clauses 4.2.2, 4.4.4 and 4.5.2, and Appendices A and B.

22. As this is only a short-term site, advance warning signs, such as a ROADWORK AHEAD sign, would not be required by Queensland MUTCD Part 3 (which adopts the AS 1742.3 requirement for all long-term sites). It is, however, an option where additional advance warning is required.

In this scenario, the Designer has determined that additional advance warning is required, due to the high-speed approach (also see requirements in Note 23).

As a ROADWORK AHEAD sign is being used, and this is a short-term site, the use of a ROADWORK 1 km AHEAD sign is not warranted.

In this scenario (see Note 21), the ROADWORK AHEAD sign is located with the speed limit AHEAD sign.

As works are occurring at night, a pair of flashing lamps are to be used with the ROADWORK AHEAD multi-message sign assembly.

- For information and considerations regarding ROADWORK AHEAD signs, refer to QGTTM Part 3, Sections 4.8 and 5.11 and Queensland MUTCD Part 3 Clause 4.6.2.
- For information and considerations regarding night works, refer to QGTTM Part 3, Section 6.7.

23. QGTTM (Section 4.8) requires the use of a ROADWORK AHEAD sign or a VMS in advance of a Traffic Control station in all situations.

    The ROADWORK AHEAD sign (or a VMS) is required to be at a distance as per Table 4.4b in advance of the primary PTS sign (Section 4.8 Item 6).

    In this scenario, the ROADWORK AHEAD sign is to be at least four times the speed limit of 100 km/h (4 x 100), namely 400 m in advance of the primary PTS sign, which it is exactly.

    Note: The speed limit to use for Table 4.4b in this situation is the permanent posted speed limit in advance of the ROADWORK AHEAD sign. There is no need to consider the temporary speed limit reductions between the ROADWORK AHEAD sign and the primary PTS sign.

For the distance from the primary PTS sign to ROADWORK AHEAD sign or VMS, refer to QGTTM Part 3, Section 4.8(6), and Table 4.4b.

24. Termination signs are used to alert road users to the end of a work zone and a resumption of normal traffic conditions.

    The termination signs typically include both a speed reinstatement sign and the END ROADWORK sign.

    The DRIVE SAFELY multi-message panel is not included in AS 1742.3 but is permitted as an optional sign in the Queensland MUTCD, where the DRIVE SAFELY multi-message panel may only be used with the END ROADWORK panel. In this scenario, the DRIVE SAFELY message is included with the termination sign.

    The END ROADWORK panel is required at all static sites (QGTTM Part 3 Section 5.12) and is also required due to the ROADWORK AHEAD sign being used in this scenario (Queensland MUTCD Part 3 Clause 4.6.2).

    Note: There are some conflicting requirements between AS 1742.3 and AGTTM regarding the use of the END ROADWORK sign. AGTTM requires an END ROADWORK sign at all static worksites, while AS 1742.3 only requires the END ROADWORK sign when a ROADWORK AHEAD or ROADWORK

NEXT X km sign is used. This will be resolved in a future national revision of one or both of AS 1742.3 and AGTTM.

Given both relevant clauses in AS 1742.3 (Clause 4.6.2) and AGTTM Part 3 (Section 5.12) regarding the use of the END ROADWORK sign are 'accepted' in the Queensland MUTCD Part 3 and the QGTTM Part 3 respectively, and both require the use of the sign, the Designer has included the END ROADWORK panel in this scenario.

The END ROADWORK sign would also be an appropriate panel to use with a speed restriction panel for all sites which require a speed zone reinstatement to be applied on leaving the site.

- For information and considerations regarding termination signs, refer to QGTTM Part 3, Section 5.12.
- For requirements on the use of the END ROADWORK sign, refer to Queensland MUTCD Part 3 Clause 4.6.2.
- For requirements on the use of the DRIVE SAFELY message in Queensland, refer to Queensland MUTCD Part 3, Appendix A and Table A.2.

Multi-message sign arrangements

In the Queensland MUTCD, the DRIVE SAFELY multi-message panel is permitted; however, it may only be used with the END ROADWORK panel.

In this scenario, the Designer chose to use the DRIVE SAFELY panel (1200 x 300), with a 600 x 600 END ROADWORK panel and the 100 km/h speed limit reinstatement sign. The 100 km/h speed restriction panel is placed closest to traffic (Queensland MUTCD Part 3 Clause 4.4.2(c)).

Note: The DRIVE SAFELY message, if not used, may be replaced with a yellow blank panel.

For requirements and information regarding the use of multi-message signs, refer to Queensland MUTCD Part 3 Clauses 4.2.2, 4.4.4 and 4.5.2, and Appendices A and B.

25. Determine the spacing of termination signs from the work area.

    In this scenario, the end of the work area is 145 m (within 200 m) from the speed reduction to 40 km/h and there is no opposing traffic, so there are no offset speed zones to consider; thus, 60 km/h is to be used as the traffic speed in this area when using Table 5.8, which gives 45 m as the termination area distance in this scenario. As the speed limit increases from 40 km/h to 100 km/h, the Designer has considered 45 m is too short and vehicles would likely be travelling much faster than 40 km/h toward the end of the work area as they could see the termination signs ahead and start speeding up early (while still in the work area).

QGTTM Section 5.12 introduces the concept of placing the termination signs an 'appropriate distance' from the work area. This is much more critical for sites with no opposing traffic flows as offset speed zones are not a factor. Some considerations could include:

a) using sight distance to the termination sign as the spacing for the termination signs – from Table 2.3 and a speed limit of 60 km/h, this would give a termination distance of 90 m, or

b) assume that, like a reduction in speed (as per Section 2.5.3 and Figure 2.2), an increase in speed limit may also use an area of 200 m in advance of the speed limit increase where the new speed limit will apply to sign spacings. As the new speed limit is 100 km/h, this would equate to a sign spacing (Table 2.2) of 100 m as the termination distance.

As 45 m was considered too short and is a relatively small distance in this road environment, the Designer in this scenario has adopted 100 m as the termination distance. This distance is not considered too long in this road environment (high-speed, multi-lane divided road).

Note: If the start of the 40 km/h speed zone was further (greater than 200 m) from the end of the work area, 40 km/h could be used as the traffic speed in this area when using Table 5.8, and a termination area distance of just 15 m could be used. An increase from 40 km/h to 100 km/h just 15 m from the end of the work area would not be an appropriate outcome and a similar consideration of the appropriate termination distance would be required.

- For necessary termination distances, refer to QGTTM Part 3, Section 5.12, and Table 5.8.
- For sign spacing, refer to QGTTM Part 3, Section 2.5.3, Figure 2.2, and Table 2.2.

26. The extent of the 40 km/h speed zone is now known. The total length of the 40 km/h speed zone is 245 m (45 m to the work area + 100 m work area + 100 m termination area) and is less than the maximum length of a 40 km/h speed zone of 500 m for workers within 1.2 m of traffic and greater than the minimum length of 100 m.

    As the length of the 40 km/h speed zone is less than 500 m (the maximum requirement for a repeater sign), there is no requirement to repeat the 40 km/h speed restriction sign within this zone.

For information on speed zones, recommended speed zone lengths, repeater speed sign spacings and methods for reducing speeds, refer to QGTTM Part 3 Section 5.5 and Tables 5 5 and 5.6.

27. Traffic cone / bollard spacing requirements are provided in Table 5.3, which are recommended maximums and may be reduced to ensure adequate delineation is provided dependant on site conditions.

    Note: Do not make allowance for the 200 m zones following a reduction in speed limit as per Figure 2.2 when considering the spacing requirements for traffic cones and bollards; use the actual speed limit in place at the delineation device's location when considering spacing values in Table 5.3.

In this scenario, traffic cones or bollards have a recommended maximum spacing of:

a) in the merge taper, 12 m (use spacing for 60 km/h, as it is not a traffic control taper)

b) for the lane closure, between the merge taper and the 40 km/h speed restriction sign, 12 m (in a 60 km/h speed zone), and

c) for the lane closure within the 40 km/h speed zone, 4 m (in a 40 km/h speed zone).

The Designer has chosen to adopt these recommended maximum traffic cone / bollard spacings and has provided on the TGS the minimum number of traffic cones / bollards required at this maximum spacing.

Note: There are some extra spacing options for traffic cones and bollards in the AGTTM Part 3 Table 5.3 which do not appear in AS 1742.3 Table 4.7 and some conflict regarding the spacing of cones for protecting freshly painted lines on roads with a speed below 56 km/h. This is not an issue for this scenario but may be important to note for other works.

For traffic cone / bollard requirements and spacing, refer to QGTTM Part 3, Section 5.4, and Table 5.3.

28. Although not a Category 3 road, in this scenario (a Category 2 road), the Designer has chosen to use traffic cones that are the large size (900 mm high). This is in accordance with Queensland MUTCD Part 3 Clause 4.11.1 (which adopts the cone sizes as per AS 1742.3), as this worksite is located on a high-speed (100 km/h), high-volume road (divided multi-lane) with works occurring at night.

    Note: There are some conflicting requirements between AS 1742.3 and AGTTM regarding the size of traffic cones. This will be resolved in a future national revision of the AGTTM, with AGTTM expected to change to match the requirements of AS1742.3 which have been used in this scenario.

For traffic cone size requirements, refer to QGTTM Part 3, Section 5.4.1, and Queensland MUTCD Part 3 Clause 4.11.1.

29. Extend the traffic cones or bollards delineating the closed lane beyond the end of the work area by a short distance to allow work vehicles exiting the work area continued separation from the traffic lanes. The delineation of the closed lane may be extended a minimum of the termination distance from Table 5.8 or 45 m past the work area (as this location is within 200 m of the reduction in speed zone, 60 km/h is to be used as the traffic speed in this area when using Table 5.8).

    In this scenario, the END ROADWORK sign is 100 m from the end of the work area (see Note 25). The closed lane delineation could be extended all the way to the END ROADWORK signs; however, the Designer in this scenario chose to extend the delineation 45 m past the end of the work area which should be enough to allow work vehicles exiting the work area separation from the traffic lanes. These traffic cones should also assist with road user speed limit compliance when approaching the end of the work area.

    Note: If required, a few traffic cones could be installed as a short taper at the end of the closed lane to indicate both lanes could now be used by traffic. While considered by the Designer, a short taper at the end of the closed lane was not used as part of this scenario as work vehicles are to exit (or, under traffic control, enter) the worksite through this area.

For necessary termination distances, refer to QGTTM Part 3, Section 5.12, and Table 5.8.

30. As this is a short-term site, the Designer has chosen to use the T5-7 hazard marker (the narrow vertical hazard marker in lieu of the longer T5-4 version) to assist with delineation of the merge taper. Three of the T5-7 hazard markers are to be used, with one placed at the start and end of the taper, and one in the middle.

    Although the works are conducted at night, the use of these hazard markers along with the traffic cones forming the merge taper and assisted by the arrow board on the TMA (located at the end of the merge taper) will provide sufficient visibility of the merge taper location for approaching drivers. The T5-7 hazard markers are to be located 1 m behind the merge taper formed by the traffic cones. Also, as the traffic cones are 900 mm high, the three hazard boards should be located between the traffic cones when viewed on approach (not behind or very close to the high traffic cones as this would impact the visibility of the hazard markers).

    Note: If this was a long-term site, three of the longer T5-4 hazard boards should be used.

    The Designer has chosen the T5-7 hazard marker due to the short-term nature of the works and the ease of installation of this hazard marker (as compared to a T5-5 or T5-4 hazard marker).

For information and considerations regarding hazard markers, refer to QGTTM Part 3 Section 5.4.2 and Queensland MUTCD Part 3 Clause 4.11.3.

31. To further assist with delineation on approach to the taper and to close off the shoulder in this area, QGTTM allows, as an option, the use of four traffic cones at 4 m centres placed on the approach to the taper. In this scenario, the Designer has chosen to use the four traffic cones on the approach to the start of the taper and these will be located on the edge line. A T5-7 hazard marker (the narrow vertical hazard marker in lieu of a T5-5 version) will be placed adjacent to the first of these traffic cones to close off the 1 m sealed shoulder.

    Note: If there was a wide shoulder, traffic cones forming a short taper could also be used with this hazard marker to close off the shoulder area to traffic.

    The Design has chosen the T5-7 hazard marker due to the short-term nature of the works and the ease of installation of this hazard marker (as compared to a T5-5 or T5-4 hazard marker).

For information on the cones in advance of a taper, refer to QGTTM Part 3, Section 5.9.1.

32. As this is a multi-lane road, it is recommended to duplicate signs on both sides of the carriageway. In this scenario, the Designer has chosen to duplicate the signs as there is enough space on the shoulders to accommodate this without affecting other road users such as people walking or riding bikes.

    People walking or riding bikes were fully considered as part of the TMP process, and the Designer determined that, in this scenario (being a high-speed, multi-lane divided road with works occurring at night), there are no people walking and only very experienced people riding bikes (due to the 100 km/h speed limit), who would likely take the lane in the single-lane section on approach to the TC station (60 km/h speed zone) and past the work area (40 km/h speed zone). It was noted in the TMP that people riding bikes may be assisted by the traffic controller (if required) holding traffic while the people riding bikes traverse the work and termination areas.

    The Designer has also made the decision to duplicate the signs in the single-lane section of the worksite, due to both the general road environment and the use of 900 mm-high traffic cones in this area which may affect visibility of the multi-message signs located in the closed lane. This choice only added two extra multi-message signs (as the speed limit signs are required to be duplicated).

- For recommendations on duplicating signs on multi-lane roads, refer to QGTTM Part 3, Section 2.5.3.
- For information on duplicating speed signs, refer to QGTTM Part 3, Section 5.5.

33. When stopping traffic, it is possible for queues to extend beyond the predicted end of queue (and back towards the primary PTS sign), generating an increased risk of end-of-queue collisions.

    Contingency planning (for what to do on site) if this happens is an important consideration when preparing the TGS design. The traffic controller is to monitor queue lengths to ensure the end of queue is not extending back beyond the predicted end of queue location which, in this scenario, is the end of the taper. If this was to happen, the following would need to occur:

    a) another traffic controller or traffic management implementer would need to add additional PTS signs further in advance of the TC station, so the minimum sight distance requirements in Table 2.3 from this new location of the primary PTS sign to the end of the queue is achieved

    b) the speed reduction signs (to 60 km/h) must be not less than one sign spacing from this new location of the primary PTS sign, and

    c) if speed reduction signs are relocated, the advance speed limit warning or incremental speed limit reduction signs may also require relocation.

    d) The location of other signs such as the ROADWORK AHEAD sign will need to be adjusted due to the new primary PTS sign location.

    If the end of queue is getting close to (but not beyond) the end of queue location, this would be a trigger for the TC to keep a close watch on the end of queue location and to take action such as warning the other TTM team members that implementing the contingency plan may be required so they can be prepared for this requirement (should it be necessary).

    Note: In this scenario, the predicted end of queue was defined by the end of the merge taper; however, for other sites, an extra traffic cone may be installed on / outside the shoulder at the end of queue position to assist the Traffic Controller determine if the queue of traffic is extending past this point.

- For information regarding end-of-queue safety provisions, refer to QGTTM Part 3, Section 4.8.
- For information regarding monitoring the end-of-queue location, refer to QGTTM Part 7 Section 2.9.2 for the Traffic Controller and QGTTM Part 6 Sections 3.3.3, 7.7 and 7.8 for the Traffic Management Implementer.
- For additional information regarding end-of-queue safety provisions in Queensland, refer to the *Guideline – Traffic Management at Works on Roads*, Chapter 1, Section 2.

34. Depending on the width of the shoulder at the TC station, the 'open' lane may require delineation on the right-hand side on approach to the TC station where vehicles may drive (or may even be observed driving) around the end of the boom barrier using the sealed / unsealed shoulder.

    If required, provide a three traffic cone taper across the shoulder (as a short taper to close the shoulder) and a minimum of four traffic cones (at 4 m spacing) on the right-hand side of the 'open' lane to define the traffic lane on approach to the TC station. In this scenario, the Designer has determined that, due to a sealed shoulder of only 1 m and an unsealed shoulder

of 1.5 m that this should not be required. This could be included by the Designer as a contingency plan that could be implemented if this was observed on site to be an issue.

The boom for the boom barrier could also be extended out to its maximum length to also cover part of this shoulder area to discourage drivers from using the shoulder area to drive around the boom.

Note:

- Hazard markers are not to be used on both sides of the road (opposite or close to one another) as this may create confusing visual patterns for drivers; however, if the shoulder was wider in this scenario (or driving around the boom was an issue on site), the small hazard marker (T5-5 or T5-7) may be placed with the traffic cones, to close off the right-hand shoulder on approach to the TC station. This is due to the distance (in excess of 170 m) from the hazard markers for the taper and this hazard marker, to close off the right-hand shoulder, negating any potential confusing visual pattern (which could be checked / confirmed when doing a drive-through).
- Installing traffic cones on the right-hand side on approach to the TC station and past the work area may also assist with managing vehicle speeds by narrowing the lane (if vehicle speeds are an issue).

For additional information regarding the use of supplementary devices at roadworks to reduce speed in Queensland, refer to the *Guideline – Traffic Management at Works on Roads* Chapter 1 Section 1.

35. Ensuring adequate sight distance to each traffic control device is also a design requirement. In this scenario, a relatively short site on a straight, multi-lane divided road, sight distance would not be expected to be an issue. In other environments and roadside conditions, it may be a significant issue that would require device locations to be adjusted appropriately.

    Note: Sight distance also depends on speed.

For information regarding sight distance requirements, refer to QGTTM Part 3, Section 2.5.4, and Table 2.3.

36. As works are occurring at night, all signs should have a traffic cone (900 mm high – see Note 28) placed at the base of each sign on the traffic side of the multi-message frame. In this scenario, while some street lighting is available, it is well-spaced, and the Designer has determined that this traffic cone is required for all signs.

    The Designer has also determined that additional lighting is required for both the TC station (see Note 6), the taper / lane closure and the work area.

For information and considerations regarding night works (activity during low light), refer to QGTTM Part 3, Section 6.7 and Part 6, Section 9.

37. As workers are within 1.2 m of traffic and the 40 km/h speed zone past the work area is a primary risk mitigation strategy to reduce risk / injury to workers, it is essential that actual traffic speeds are monitored for compliance with the 40 km/h speed zone and that action is taken if traffic speeds are above 40 km/h.

    Monitoring traffic speeds on approach to the TC station (within the 60 km/h speed zone) is also required.

    Speed monitoring would be a role for the lead TMI onsite and would be assisted by feedback from the TC in terms of approach speeds to the traffic control station and feedback from workers regarding traffic speeds past the works area. Drive-throughs with traffic are also a good way to check on traffic speeds and driver behaviour through the site (and assists to identify areas for improvement).

- For information regarding monitoring traffic speed for compliance, refer to QGTTM Part 3, Sections 2.5.9 and 5.5.
- For additional information regarding the use of supplementary devices at roadworks to reduce speed in Queensland, refer to the *Guideline – Traffic Management at Works on Roads*, Chapter 1, Section 1.
- For information regarding the use of temporary speed humps and rumble strips, refer QGTTM Part 3, Sections 5.5.2 and 5.5.3.

38. Installation and removal order numbers and any special instructions could be added to the TGS design. For the purpose of this example, the installation and removal order numbers are not included on Figure 4.1 and the process for implementation and removal is provided following.

    Implementation

    Using the TMA (as one is required as part of the TGS) for protection of the TTM ute and TMIs doing the implementation, working in the direction of traffic, the general installation order would be signs in the median (right shoulder), followed by signs on the left shoulder (the END ROADWORK sign on the left may be left until after the on-road devices are all installed) and, then, the on-road devices commencing with the merge taper where the TMA would be used to close the lane in advance of the taper location. The start of the lane closure and signs up to and including the TC station would then be installed (working in the direction of traffic). Once the TC station is in place, the TMA could be moved and positioned in its final location at the end of the taper. Noting that the arrow board on the TMA would need to be changed to 'hazard lights', not an arrow, while traveling in the right lane to access the lane closure from beyond the TC station; once the TMA is moving back into the closed lane, the arrow is to be displayed again. Traffic could then be stopped by the TC while the remaining signs in the closed lane and the delineation for the closed lane (and the END ROADWORK sign if not installed earlier) are installed.

    Once all devices are in place and the TTM ute and TMIs are clear of the road, the TC releases traffic.

On completion of the implementation activities and before works commence, a drive-through of the site by the TMI (with traffic) is performed to confirm all devices are in place and the TTM measures are clear to approaching drivers and will perform as required.

Drive-throughs with traffic are also a good way to check on traffic speeds and behaviour through the site (and assists to identify areas for improvement).

Removal

The removal process is similar to the implementation process, but in a reverse order.

Traffic is stopped by the TC while the signs beyond the TC station in the closed lane and the delineation for the closed lane are removed. The END ROADWORK sign on the left shoulder may also be removed at this time. The TMA is then repositioned (the TC releases traffic once the TMA has cleared the site) in front of the merge taper (which will require a loop of the road network to get back to this location) to provide protection for the TTM ute and TMIs doing the removal activities and all the remaining on-road devices (merge taper, signs, and TC station) are removed. After all the on-road devices are removed, the TMA and TTM ute will loop around the site a couple of times to firstly remove the remaining signs and devices on the left shoulder (working in the direction of traffic), followed by the devices on the median (right shoulder).

A final drive-through of the site is performed to ensure all TTM devices have been removed.

For information regarding the installation and removal principles for the TTM arrangements, refer QGTTM Part 6, Sections 6 and 8.

39. The effectiveness of the TTM arrangements is to be monitored and checked at regular intervals by the lead TMI on the site.

For information regarding monitoring the effectiveness of the TTM arrangements, refer QGTTM Part 6, Sections 3.3.3 and 7.