MARCH 2025

Proposed updated - Traffic Control - Avoiding End of Queue Collisions on High-Speed Roads

Queueing is expected at locations when undertaking traffic control. This may result in end of queue collisions. It is therefore imperative that appropriate traffic management planning occurs.

Note: this document has been prepared to seek feedback on the modified process for estimating queue length, the intent being to simplify the process using a similar method to AGTTM (changes in red). Any feedback can be sent to roadsafety@mainroads.wa.gov.au

Queueing and delays are an expected consequence when any roadworks require the use of traffic control. Before implementing any type of traffic control, it is the responsibility of the traffic management designer to consider the following:

- The speed of traffic
- The road environment (e.g. horizontal and vertical curves, road surface, road grade[1])
- The sight distance road users will have to the traffic control position.
- Driver reaction times
- The traffic volume
- Work vehicle traffic volumes (e.g. side tippers and delivery vehicles etc.)
- The traffic composition (e.g. large vehicles may require greater stopping sight distance)
- Work times and duration.
- Expected time traffic will be stopped.
- Worksite length (refer to the Code of Practice Table 15)
- Personnel available

Once the traffic management designer has gained the above information the expected queue length can be predicted using the following steps:

1. Determine the hourly traffic volume in the direction of travel at the time of the works[2] for both light and heavy vehicles.
2. Divide the hourly traffic volume by 60 to determine the vehicles expected every minute; Do this for both average and heavy vehicles.
3. Determine the Maximum Stopping Time, (this includes stop time for work reasons and clearance times added together refer Table 1.1 for clearance times);
4. Multiply the Maximum Stopping Time by the vehicles expected per minute. Do this for both average and heavy vehicles.
5. Multiply the total number of vehicles during Maximum Stopping Time by (Ma) for light vehicles and (Mo) for heavy vehicles (noting different Mo values apply for metro or regional HVs); refer Table 1.2.
6. Add values for Ma and Mo together.

This will give you the expected queue length in meters.

[1] Downgrades may require greater stopping sight distance.

[2] Traffic volumes are available via https://trafficmap.mainroads.wa.gov.au/map or can be provided by the relevant road authority. Note that growth rates need to be considered when using data older than 12 months.

Calculation Tables –

Table 1.1 (for both 40km/h and 60km/h scenarios)

Clearance Time Calculator	
Length of Shuttle Flow (m)	Minimum Clearance Time to be Applied (mins)
60	1
70	1
100	1
150	1
250	1
400	2
600	2
800	2
1200	3
2200	4

Table 1.2

Ma (multiplier for light vehicles)	**Mo** (multiplier for Metro HV)	**Mo** (multiplier for Regional HV)
8.5	22.5	39.5

Working Example:

1. Hourly traffic volume 100 total vehicles per hour with 10 heavy vehicles north bound in Pilbara Region.
2. Determine vehicles per minute for light vehicles: 90/60 = 1.5 light vehicles per minute
3. Determine vehicles per min for heavy vehicles 10/60 = 0.167 heavy vehicles per minute.
4. Determine Maximum Stopping Time. This includes 3 minutes for a closure to allow a machine to cross the road plus clearance time. (ref table 1.1)
5. Assuming a 2200m shuttle flow length at 60km/h as per table 1.1 **(note table 1.1 applies in both 40km/h and 60km/h scenarios)**, 4 mins of clearance time.
6. Therefore, Maximum Stopping time is 3 mins + 4 mins = **7 mins.**
7. Determine **light vehicles** during Maximum Stopping Time 1.5 x 7 = 10.5 Round UP = **11**
8. Determine **heavy vehicles** during Maximum Stopping Time 0.167 x 7 = 1.17 Round UP = **2**
9. Using Table 1.2 multiply light vehicles during Maximum Stopping Time by Ma.11 x 8.5 = 93.5
10. Using Table 1.2 multiply heavy vehicles during Maximum Stopping Time by Mo. (noting either regional or metro multiplier) 2 x 39.5 = 79
11. Add Ma and Mo Values to determine predicted Queue Length. 93.5 + 79 = 172.5 m.

The predicted queue length is **172.5 m** north bound.

Note: the expected queue length in the opposing direction is often vastly different, particularly in am or pm peak.

Now you must determine how to adequately warn road users of the traffic control and end of queue.

End of Queue Protection

The PREPARE TO STOP sign must be placed a minimum distance as shown in table 12 in advance of the end of the queue when the permanent posted speed is greater than 70 km/h or the sight distance of approaching traffic to the end of the queue is:

• less than two times the speed limit in open road areas

• less than 1.5 times the speed limit in built-up areas.

It is important to ensure adequate Stopping Sight Distance is provided to the PREPARE TO STOP sign and the end of queue. This is the distance required to allow a driver to react and stop their vehicle, this distance will generally be the distance shown in table 12 however if there are downgrades, large vehicles, poor surface condition, etc. the stopping distance will exceed these distances (for more details on Stopping Sight Distance see Austroads Guide to Road Design Part 3).

Table 12 - end of queue sign spacing.

Speed of Traffic km/h	Distance D (m)
50 or less	30
60	90
70 or more	2 times the speed (km/h)

End of Queue sign spacing

The diagrams below depict how these signs should be laid out to ensure adequate advanced warning to road users (note this exceeds distances given in AGTTM Part 3).

Notes Regarding Diagrams:

- The diagrams do not depict speed reduction and advanced warning signage which must be included. Advance warning signs shall be at least D m in advance of the PREPARE TO STOP sign.
- The additional PREPARE TO STOP sign should be installed at least '2D m' from the end of the queue.
- It is recommended the PREPARE TO STOP sign (T1-18B) is used in advance of the end of queue.
- Provide PREPARE TO STOP and symbolic warning sign 'D m' from the control point.
- Sight distance to the end of queue should be a minimum of '2D m'.
- Where the queue is expected to be more than '4D m' provide additional PREPARE TO STOP sign at the predicted end of queue (figure 2).

Figure 1: Predicted Queue Length <4D.

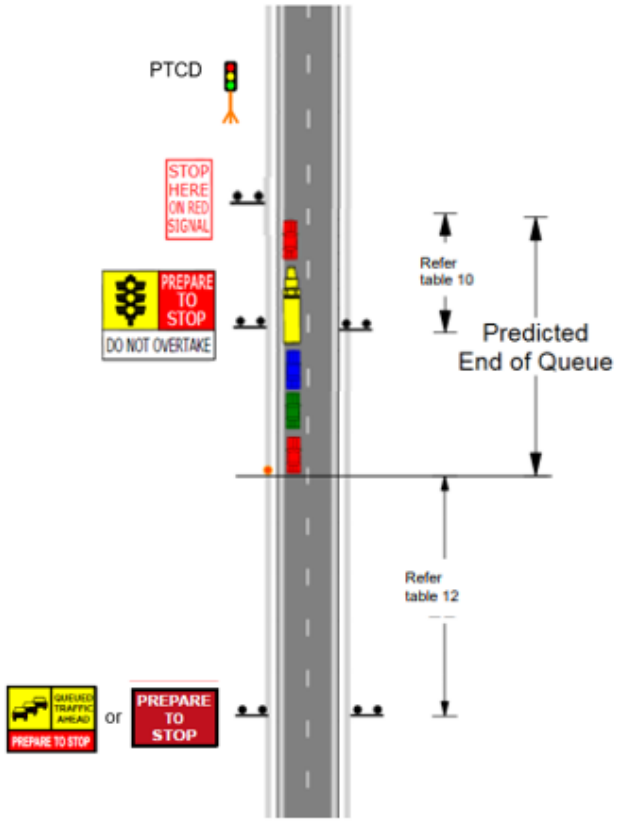
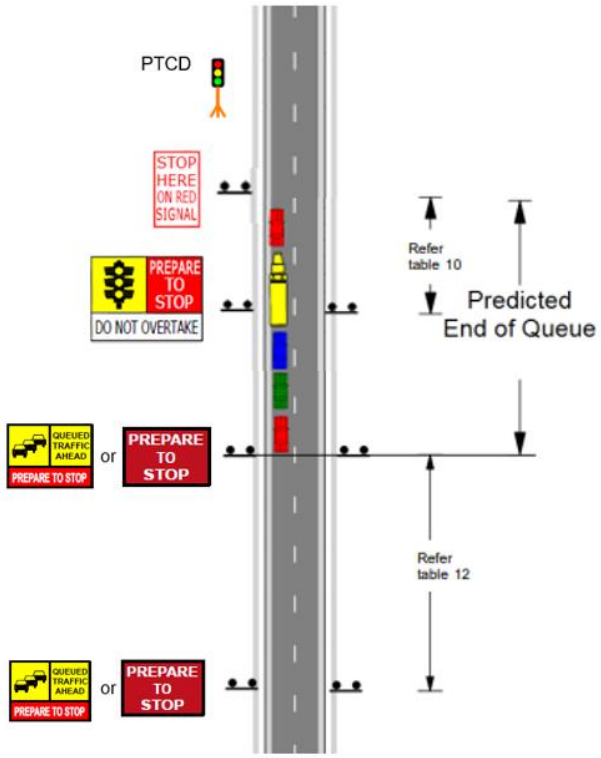


Figure 2: Predicted Queue Length >4D.

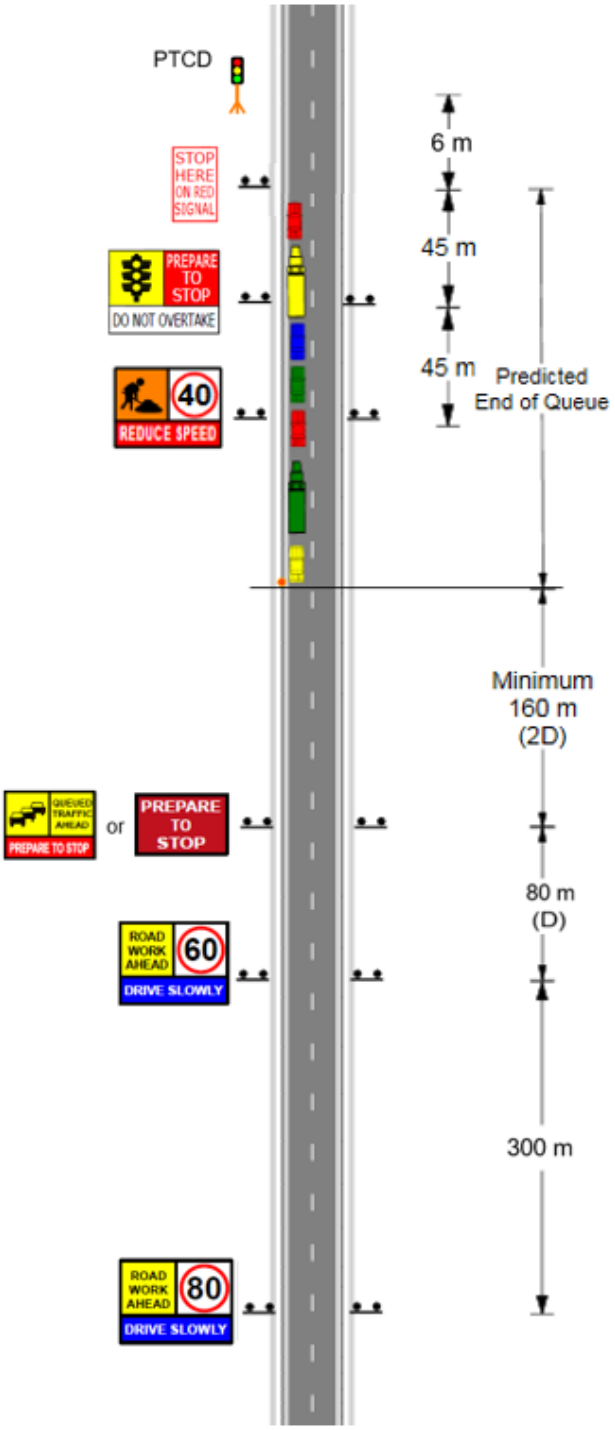


Measures to help reduce risk of end of queue collisions:

1. Avoid undertaking the works during peak periods and shut down the site when it gets too busy.
2. Ensure single lane operation complies with the requirements in Table 15 of the Code of Practice.
3. Ensure there is adequate sight distance to traffic controllers and the predicted end of queue, where there is a curve or crest with restricted sight distance have the traffic control position extend prior to that point to ensure adequate sight distance; and place additional Prepare to Stop signage prior to curve or crest.
4. Where practicable use a second traffic controller to slow vehicles down prior to the primary traffic controller.
5. Monitor queue lengths and ensure additional warning signs are erected beyond the end of queue.
6. Use advance warning variable message signs where practicable.
7. Drive through the site with traffic to ensure signs are adequately warning road users.
8. Use a UHF broadcast to warn heavy vehicles of queued traffic and wet slippery roads.
9. Install rumble strips to help alert motorists.
10. To ensure road users are compliant ensure signs are only erected when their need is warranted, remove all signs when they are no longer applicable.
11. Use of vehicle activated electronic warning signs.
12. Ensure end of queue calculations are based on actual stopping times and clearance times are considered based on the speed of traffic through the site.

Scenario 1:

Traffic Controller on 110 km/h 2 lane 2-way road reduced to 40 km/h – predicted end of queue less than ‘4D m’.

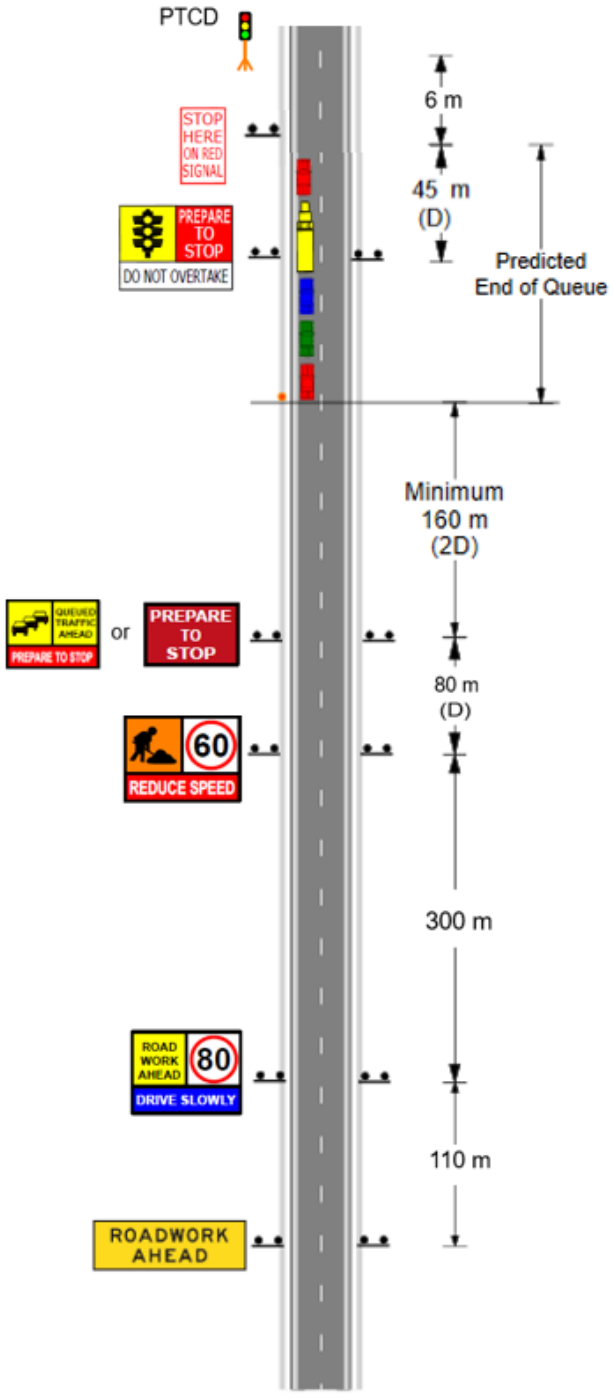


Notes:

1. The PREPARE TO STOP sign shall be placed a minimum of ‘2D m’ from the predicted end of queue (recommend T1-18B is used).
2. Sight Distance to the end of queue shall be a minimum of 160 m (2D).
3. The Traffic Controller (symbolic) and PREPARE TO STOP signs shall be D meters from the traffic controller position.
4. The 60 km/h buffer zone should be a minimum of 200 m.
5. It is recommended a traffic cone is placed at the predicted end of queue as a marker to assist in monitoring the end of queue.
6. The active Traffic Controller may not be able to see the expected queue length and may prompt other team members to conduct a drive through inspection to ensure adequate site distance to the end of the queue.
7. The 40 km/h work site speed limit is only warranted when worker clearance to traffic is less than 1.2m.

Scenario 2

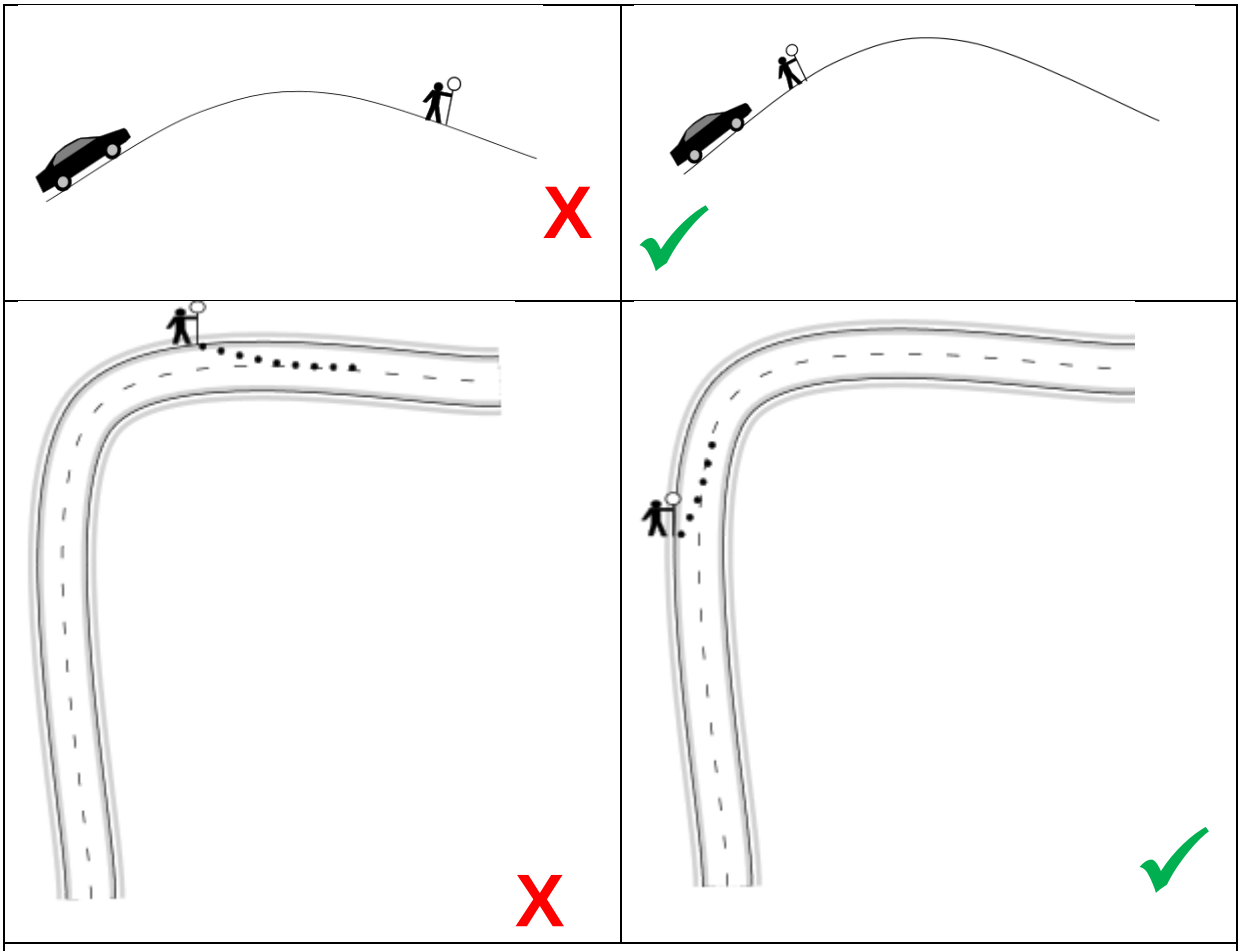
Traffic Controller on 110 km/h 2 lane 2-way road reduced to 60 km/h – predicted end of queue less than ‘4D m’.



Notes:

1. The PREPARE TO STOP sign shall be placed a minimum of ‘2D m’ from the predicted end of queue (recommend T1-18B is used).
2. Sight Distance to the end of queue shall be a minimum of 160 m (2D).
3. The Traffic Controller (symbolic) and PREPARE TO STOP signs shall be D meters from the traffic controller position.
4. The 60 km/h zone shall be a minimum of 200 m prior to the traffic controller.
5. It is recommended a traffic cone is placed at the predicted end of queue as a marker to assist in monitoring the end of queue.
6. The active Traffic Controller may not be able to see the expected queue length and may prompt other team members to conduct a drive through inspection to ensure adequate site distance to the end of the queue.

Traffic control near curves or crests



1. Ensure appropriate stopping sight distance to the traffic control position and end of queue.
2. If the curve or crest restricts the sight distance for road users, consider relocating the traffic control position before the curve or crest. This may also apply if sight distance is restricted to the predicted end of queue.
3. When implementing prior to a crest, consider the incline where heavy vehicles will be required to stop.
4. Provide drivers with adequate sight distance to interpret signage leading up to the roadwork site.