Supplement

Traffic and Road Use Management
Volume 1 – Guide to Traffic Management

Part 10: Traffic Control and Communication Devices (2016)

November 2020

Queensland Government

Feedback

Please send your feedback regarding this document to: tmr.techdocs@tmr.qld.gov.au

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4.2 Types of signs

4.2-1 Cane haulage signs

1 Introduction

This supplement outlines the recommended signing practice for erection of cane haulage signs on all roads in the vicinity of cane haulage operations during the cane haulage and crushing season.

2 Sign types

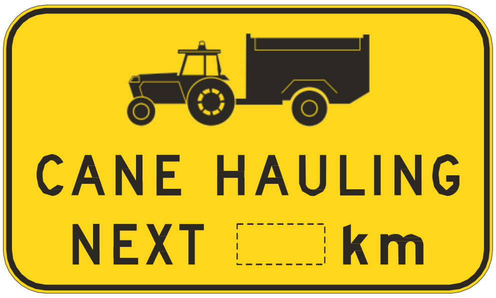
2.1 Area wide signs

G9-Q03

2.2 Warning signs

W5-Q07 CANE HAULING AHEAD is a temporary warning sign, with black letters on yellow fabric background. An alternative is a hinged sign, TC9757 CANE HAULING NEXT … km, which has a black legend and border on yellow reflectorized background.

W5-Q07



TC9757

3 Use of signs

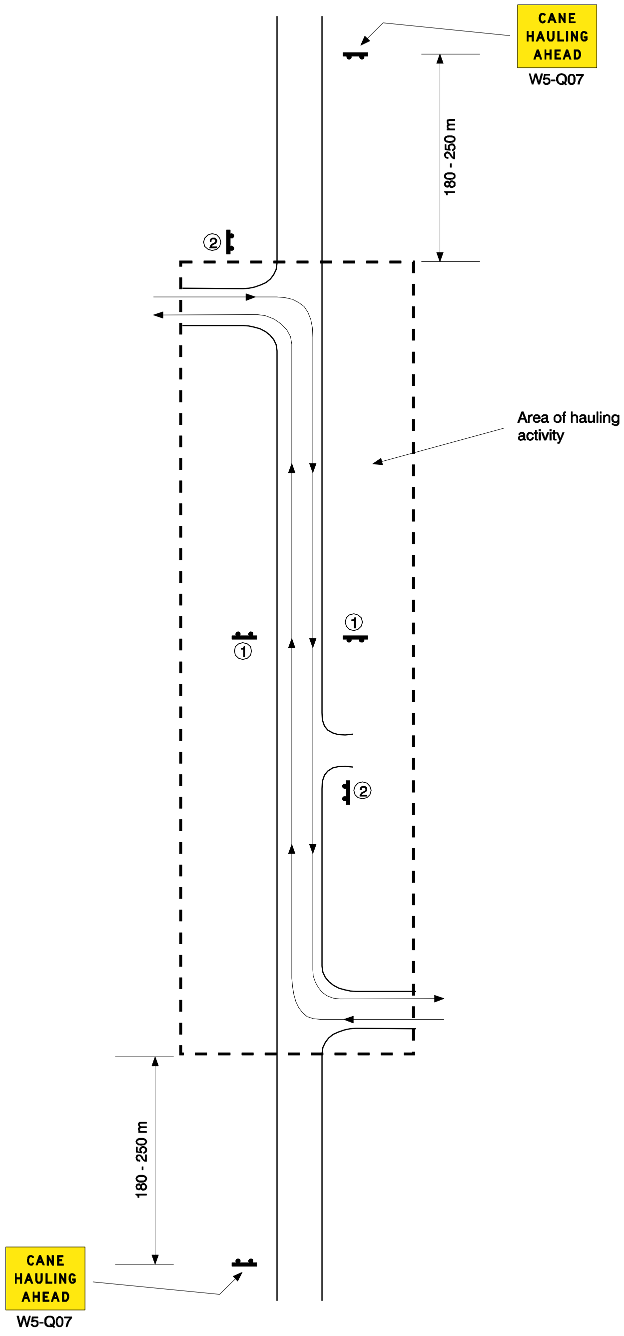
The G9-Q03 sign is used as an area-wide advisory sign, to be displayed during harvest seasons at entrances to sugar cane growing areas, to advise motorists of possible cane hauling activities. It should incorporate hinges for folding the sign during the non-harvest season. Repeater signs may be erected within the larger cane growing areas at intervals of approximately 1 km.

W5-Q07 is a temporary flag-type sign made of PVC-coated nylon, with wooden handles at the top and bottom. These are used to warn motorists of actual cane hauling in progress. These signs are only displayed immediately in advance of cane hauling activities and are to be removed when no hauling activities are in progress.

Figure 3 shows a typical layout where these signs are used.

TC9757 is a fixed warning sign that can be used in lieu of the use of temporary sign W5-Q07 on sections of roads where extensive and regular haulage occurs. The signs should be removed or covered at the end of haulage.

Figure 3 – Location of CANE HAULING AHEAD signs



Notes:

1. Provide additional CANE HAULING AHEAD signs where section exceeds 1 km in length. Signs should be provided such that spacing between signs does not exceed 1 km.
2. Additional CANE HAULING AHEAD signs are also required at intersections within the area of cane hauling activity.

4 *Installation of signs*

Transport and Main Roads will, at its cost, install and maintain the area-wide advisory signs (G9-Q03).

The temporary warning sign W5-Q07 requires a post or a suitable frame for erection. The installation of a post or the siting of a frame shall not be carried out without approval from Transport and Main Roads or the appropriate local government. On Queensland roads, approved facilities will be installed to departmental standards, by the department, at the user's expense. The current standard is shown on drawing TC9308 for supporting posts. The fabric signs are not supplied by the department but may be purchased from sign suppliers. Advice of suitable suppliers can be obtained from Transport and Main Roads District Offices or TrafficEngineering.Support@tmr.qld.gov.au.

An alternative to the use of posts for the fabric signs is to use appropriate supporting frames. These require special fittings and advice should be obtained from the department before purchase.

The warning sign TC9757 can be installed at sites agreed upon by Transport and Main Roads, and the relevant mill, providing that:

- the user will pay all costs
- TC9757 will be more effective than temporary signs
- all warning signs are removed or covered at the end of haulage.

5 *Removal and covering of signs*

The area-wide sign G9-Q03 is to be covered or the message appropriately hidden during the non-harvest season. Responsibility for folding and securing of these signs rests with the respective mill. Sugar cane haulage should not occur before the signs are open, nor continue after the signs are closed.

The fabric signs (W5-Q07 CANE HAULING AHEAD) are to be displayed only when cane hauling is in progress and at no other time. It will be the responsibility of the user to display and dismantle this type of sign. The same applies to any TC9757 signs. The mill should have agreed arrangements with the cane growers to reinforce the department's conditions of usage or local government requirements.

6 *For further information*

For more information on application, approval and conditions of use regarding cane haulage signs, see *Other matters requiring approval: Road corridor permits* on the departmental website.

4.2-2 Service and tourist signing guides

Refer to *Tourist and service signs* guideline available on the Transport and Main Roads website.

4.2-3 Wine tourism signing guidelines

Refer to *Tourist and service signs* guideline available on the Transport and Main Roads website.

4.2.4 Other signs and markings

4.2.4-1 Engine compression braking

1 Introduction

The objective of this supplement is to minimise noise levels from trucks and heavy vehicles while travelling through residential areas.

2 Background

Many heavy vehicles are fitted with engine compression brakes to relieve the loads exerted on traditional braking systems working at the wheels.

Most states and territories have produced guidelines for the use of engine brake signage, but most see signage as a short-term measure that will only be used until effective regulation of engine noise is implemented.

Trucks are defined as those vehicles that are Class 3 or above in the Austroads Vehicle Classification system.

3 Application

3.1 Criteria for installation of signs

Truck noise signs may be installed on roads where:

- the posted speed limit is 80 km/h or less – generally, signs should not be required on roads with a speed limit above 80 km/h, but may be considered in special circumstances
- abutting areas are predominantly residential rather than commercial and adjoining built-up area as defined in the Transport Operations (Road Use Management—Road Rules) Regulation 2009
- the 12-hour truck volume is at least 60 at night (7pm–7am) or at least 500 during the day (7am–7pm), and/or
- in advance of a requirement for traffic to stop or slow (for example, signals, roundabout, pedestrian crossing STOP or GIVE WAY signs, curves, or road sections commonly subject to congestion) or steep downgrades.

Sites shall not be selected on the basis of managing an individual complainant at a specific location.

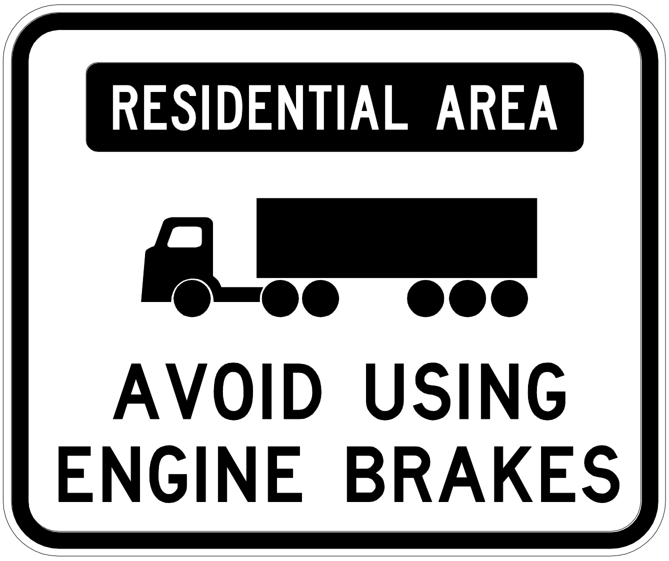
3.2 Location of signs

- Signs shall be installed 300 metres or more in advance of a built-up area.
- Signs shall be installed 300 metres or more in advance of a requirement for traffic to stop or slow (for example, signals, roundabout, pedestrian crossing STOP or GIVE WAY signs, curves, or road sections commonly subject to congestion) or steep downgrades.
- Signs shall be sighted at least 5 kilometres apart on a particular route, for each direction of travel or at least 10 kilometres apart where the route is in excess of 20 kilometres.
- Only one sign should be used on each entrance to a rural town.

3.3 Sign details

Details of the truck noise advisory signs are given on drawing TC9709.

RESIDENTIAL AREA is a white legend on a black patch.



4.3 Design of sign faces

4.3.3 Colour of signs

4.3.3-1 Target boards for signs

This content has been incorporated into the Queensland *Manual of Uniform Traffic Control Devices* (MUTCD) Part 1.

4.5 Location and placement of signs

4.5-1 Advisory speeds on roundabout diagrammatic signs

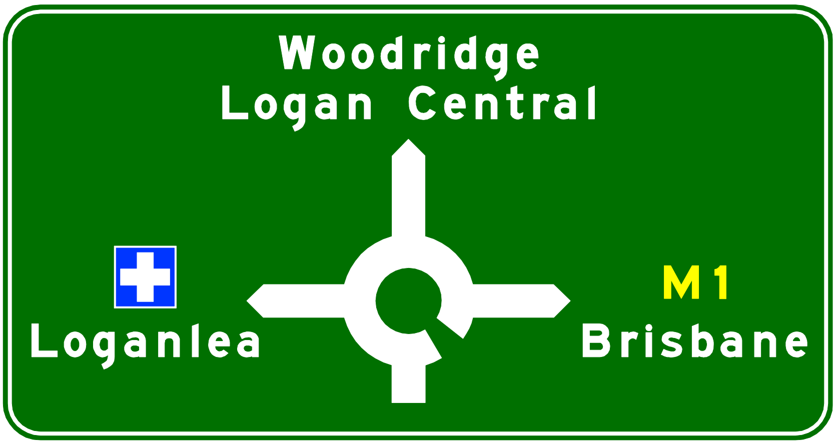
1 Introduction

The purpose of this supplement is to introduce the use of a supplementary advisory speed information panel, in conjunction with advance direction signs at isolated roundabouts on high-speed roads.

Advance roundabout direction signs are used to indicate to drivers the presence of a roundabout on the road ahead and the layout of the roads intersecting at the roundabout.

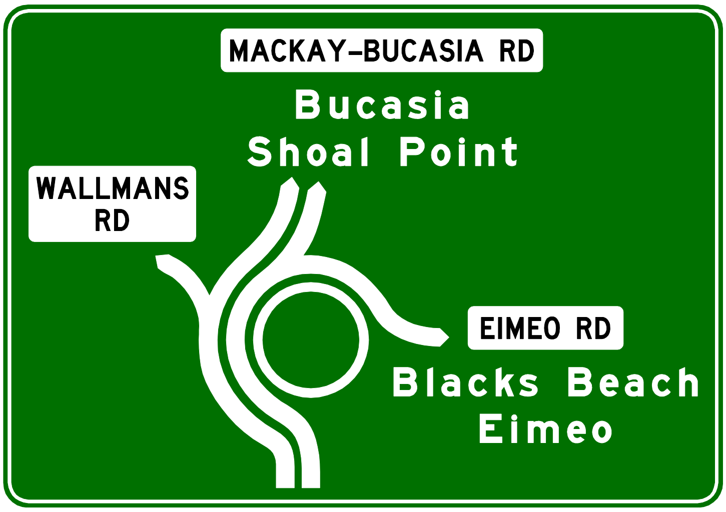
The advance roundabout direction sign may take the form of a standard advance direction sign for simple roundabout layouts, for example, G1-5 type as shown in Figure 1(A).

Figure 1(A) – Standard advance roundabout direction sign



Where the geometry of a multi-lane roundabout is such that selection of the correct lane is not clearly apparent to drivers with a standard advance roundabout direction sign, a special advance direction sign indicating the lane(s) to be used is usually provided as shown in Figure 1(B).

Figure 1(B) – Special advance roundabout direction sign



At isolated roundabouts on high-speed roads in rural and outer metropolitan areas, drivers may not perceive the need to reduce speed in sufficient time to slow down and negotiate the roundabout in safety.

The supplementary advisory speed information panel has been introduced to assist in addressing this need. It is based on practice in Victoria which, for some years, has used the advisory speed panel to supplement roundabout advance direction signing for this purpose.

2 Current practice

Roundabouts are designed so that through movements by cars within the roundabout are typically limited to a maximum speed of 50 km/h. This is achieved by adjusting the geometry of the entry carriageway to ensure adequate deflection of the through vehicle paths, by one or more of the following:

i) alignment of the entry carriageway and the shape, size and position of approach splitter islands

ii) provision of a suitable size of central island.

On high-speed roads in rural and outer metropolitan areas, additional measures may be needed to assist in controlling the speed of traffic on the approaches to the roundabout.

Current practice for controlling vehicle speeds on high-speed approaches to roundabouts in south-east Queensland includes provision of a reverse curve alignment and the reduction of the posted speed limit to 60 km/h, with changes in the posted speed limit in accordance with the Queensland *Manual of Uniform Traffic Control Devices* (MUTCD). High-impact warning signs (on a red background), and rumble strips, are also used where appropriate.

Even with these measures in place, some drivers may not appreciate that a substantial speed reduction is needed to ensure they are able to travel through the roundabout at a 'safe' speed, entering the roundabout at higher speeds. This reduces their safety and the safety of all other roundabout users.

3 New practice

The supplementary advisory speed information panel is used to inform drivers of the 'safe' speed at which vehicles should travel through the roundabout.

The supplementary advisory speed information panel for use, in conjunction with advance roundabout direction signs, is only used on rural and outer metropolitan roads where typical approach speeds are higher than 80 km/h.

The supplementary advisory speed information panel is shown in Figure 3(A).

Figure 3(A) – Supplementary advisory speed information panel

The advisory speeds shown on the supplementary advisory speed information panel apply to through movements only as it is reasonable to assume that drivers of vehicles turning at a roundabout would already be aware of the need to slow down to turn.

In view of this, the supplementary advisory speed information panel is not normally used where drivers are approaching a T-intersection roundabout along the 'stem' or terminating road approach. In this case, an alternative information panel REDUCE SPEED NOW, as shown in Figure 3(B), may be used where there is an existing or potential safety concern. This alternative information panel may also be considered for use on an approach which does not have a clearly-defined through movement, but where at least one movement at the roundabout might not be perceived by drivers as a turn movement requiring substantial speed reduction.

Figure 3(B) – Alternative REDUCE SPEED NOW information panel

The advisory speed for a particular roundabout approach is determined in the same manner as advisory speed signing on curves along rural roads. A ball bank indicator or other suitable means is used to determine the advisory speed in accordance with procedures in Part 2 of the MUTCD. Calculated speed values are then rounded to the nearest multiple of 10 km/h for display as the 'safe' speed on the supplementary panel.

Where there is more than one lane available for through movements on the circulating carriageway for the particular approach to the roundabout, the 'safe' speed is determined for each lane and the lower speed shown on the supplementary panel. In this case, the car must remain in one lane as it passes through the roundabout, rather than changing lanes through the roundabout to drive the path of least deflection.

The supplementary advisory speed information panel, for example, SLOW TO 40 km/h and the alternative information panel REDUCE SPEED NOW will be designed as part of the advance roundabout diagrammatic direction sign, with letter heights consistent with the balance of the sign, but with a white legend on red background.

Examples of supplementary advisory speed information panels are shown in Figure 3(C) and Figure 3(D). Examples of alternative information panel REDUCE SPEED NOW are shown in Figure 3(E).

Figure 3(C) – Example of supplementary advisory speed information panel fitted as a separate panel under an existing sign

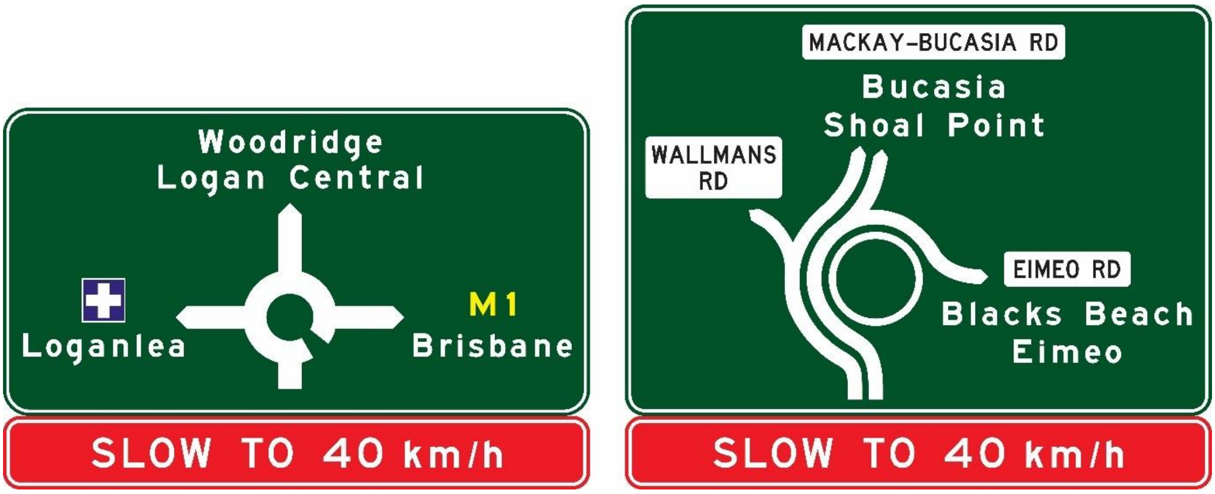


Figure 3(D) – Examples of supplementary advisory speed information panel incorporated into the direction sign (preferred option)

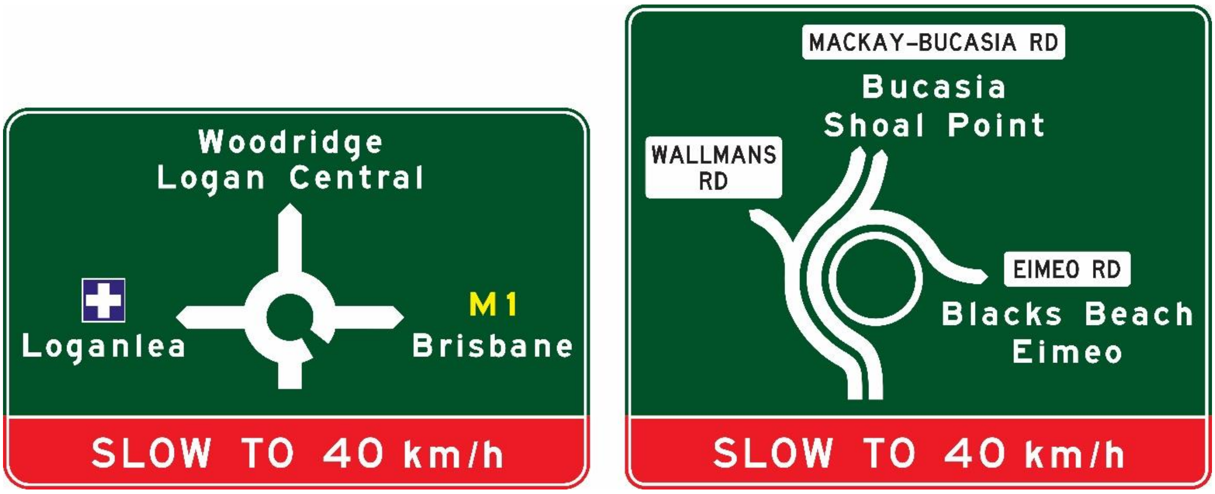


Figure 3(E) – Examples of alternative information panel REDUCE SPEED NOW incorporated into the direction sign (preferred option)

4.5-2 Erection of clearance signs

1 Introduction

This supplement provides advice on signing requirements at locations with restricted vertical clearances.

The Heavy Vehicle (Mass, Dimension and Loading) National Regulation nominates the height restrictions for vehicles.

These limits may be exceeded only with the prior written permission of the Superintendent of Traffic (Queensland Police Service) or performance guidelines issued by the Chief Executive (Transport and Main Roads) and subject to compliance with any conditions of such permission or guidelines. The limits apply to the motor vehicle, together with its loading and equipment.

2 Signing requirements

The signing requirements at underpasses are set out in Part 2 of the *Manual of Uniform Traffic Control Devices*. Clearances are specified in metres to one decimal place.

3 Vertical clearance measurement

To determine the appropriate clearance height to be shown on the sign, the minimum clearance above the carriageway (or lane as appropriate) is measured to two decimal places, and then rounded to the nearest 0.1 m below the measured height. A carriageway is that portion of the road devoted particularly to the use of vehicles, inclusive of shoulders and auxiliary lanes.

In determining the minimum clearance, care must be taken to measure it at the correct point, taking account of road cross fall and bridge grade and geometry. On two-way undivided carriageways, only one value for minimum clearance is to be posted. On divided carriageways, the minimum clearance applicable to each direction is to be posted for viewing on the approach side only. It may also be necessary to allow for a sag vertical alignment correction.

Where it is necessary to make allowance for any sag curvature in the roadway under the structure, the following table can be used to determine the amount by which the measured clearance should be reduced because of the curvature. In such cases, the procedure is:

a) measure minimum height clearance to two decimal places

b) read the sag correction, using Table 3 following – subtract the sag correction from the measured minimum clearance

c) round down to nearest 0.1 m below this figure.

Table 3 – Sag correction table

Minimum radii of sag V.C. (metres)	**Sag correction (metres) 1. All routes except over-dimension vehicle routes**	**Sag correction (metres) 2. Over-dimension vehicle routes**
800	0.01	0.03
500	0.02	0.05
300	0.04	0.09
200	0.06	0.13
130	0.09	0.20
70	0.16	0.37

Notes:

1. Based on a maximum effective wheelbase component of 9.5 m and covers all single unit vehicles. medium combination vehicles and road trains
2. Based on a maximum effective wheelbase component of 14.4 m and covers low loaders and extendible semi-trailers

In the following situations, it will be necessary to measure the sag correction using a tape 9.5 m long (14.4 m for an over-dimension vehicle route) stretched tightly between longitudinal points on the road surface (the correction is the maximum height of the tape above the road surface):

a) the radius of the vertical curve is unknown

b) the radius is less than 70 m

c) the vertical alignment under the structure is a combination of curves and straights.

4 Other considerations

No allowance is made in the signing for changes in clearance, which may occur from resealing or resheeting of the pavement. Attention to signs should be made if a reseal or resheet reduces the clearance by more than the rounding in Section 3 *Vertical clearance measurement*.

Correct clearance must be displayed at all times. In the case of roadworks, a check on the exact clearance should be included in the works:

- new construction – prior to opening to traffic for the first time, and
- resurfacing – prior to reopening to traffic.

No allowance on the signed clearance is made for variations in vehicle height due to vehicle load or atmospheric conditions. It is considered that operators should allow for such variations.

4.5.3 Lateral placement and height

4.5.3-1 Support selection for roadside signs and other equipment

1 Introduction

This supplement provides guidance on the selection of supports for roadside signs and other devices used beside the road including, but not limited to, cameras, solar panels, and so on. Performance of different types of posts is discussed with limitations of use placed on classes of post as necessary.

There are three types of support that have been certified for use by Transport and Main Roads in Queensland:

- standard support posts
- Lattix energy absorbing posts
- Signfix frangible support system.

Selection of each of these support systems require similar design processes using product-dedicated specific wind loading charts to determine the most appropriate and efficient sign support structure.

1.1 Standard support posts

This option maintains a standard approach for the determination of sign supports in Circular Hollow Section (CHS) pipe, Rectangular Hollow Section (RHS) pipe and truss supports. Supports for signs having a surface area greater than 40 m² should be designed and certified by a registered professional structural engineer. Supports for sign with surface areas less than 40 m² may be calculated in conjunction with either:

a) the design procedures outlined in the *Traffic and Road Use Management* manual, Volume 3 *Signing and Pavement Marking* Part 5 *Design Guide for Roadside Signs* (TRUM Vol 3 Pt 5)

   This method of sign support selection enables the designer to determine manually the most appropriate support structures by calculations using sign height, sign surface areas (in three categories of up to 10 m², up to 28 m² and up to 40 m²), environmental specifications (within wind loading regions A, B, C and D based on Australian Standard AS 1170.2) and foundation strengths. Post-selection charts are included in TRUM Vol 3 Pt 5.

b) use of the TraSiS (Traffic Sign Support) software design tool

   TraSiS is a computer software design tool developed by Transport and Main Roads to calculate and select sign supports. The calculations used in TraSiS are based on the same methods outlined in Appendix B of TRUM Vol 3 Pt 5, subject to the input of sign parameters, terrain profiles and environmental conditions.

   TraSiS has output capabilities displaying separate support design details and project-based ordering detail summaries to assist in the manufacture of road signs and their supports, as well as standard construction installation details.

1.2 Lattix energy absorbing posts

- Single post, capable of supporting signs of up to 13 m² in Wind Region A. 10 m² in Wind Region B and 8 m² in Wind Region C.
- Multi-post, capable of supporting signs of up to 28 m².

Lattix support designs should use procedures outlined in Section 6 *Use of Lattix selection charts*.

1.3 Signfix frangible support system

- Single post, capable of supporting signs of up to 9 m² in Wind Region A, 6 m² in Wind Region B and 4 m² in Wind Region C.
- Multi-post, capable of supporting signs of up to 16 m² in Wind Region A, 12 m² in Wind Region B and 10 m² in Wind Region C.

Signfix support designs should use procedures outlined in Section 7 *Use of Signfix selection charts*.

2 Discussion

Signs, road lighting, traffic signals, cameras and other roadside furniture often need to be placed close to the travelled way. This places them inside the clear zone where they, and their supports, become a hazard to motorists. Supports need to be strong enough to resist wind loads, yet safe if struck by an errant vehicle. Currently there are four classes of supports that are considered to be relatively safe for occupants of vehicles that strike them.

2.1 Frangible-sized rigid steel posts

Frangible-sized steel posts are described in AS 1742.2: 2009 *Manual of Uniform Traffic Control Devices Part 2 Traffic Control Devices for General Use*. The concept is that the post is weak and will collapse safely when struck by a vehicle. The vehicle usually runs over the post.

2.2 Slip base posts

Slip base posts are made from steel sections with mechanisms to allow the post to break away at the base and to hinge underneath the sign face, allowing a light vehicle to pass underneath with relatively little damage.

2.3 High-energy absorbing posts

High-energy absorbing posts deform locally where struck and bend around the vehicle, slowing the vehicle in a controlled manner similar to a non-redirective crash cushion on a crash barrier. This type of post usually ‘captures’ the errant vehicle, stopping it while it is still in contact with the post. High-energy absorbing posts are not designed to detach from the foundation. These posts must be long enough to allow controlled reduction in velocity of the vehicle so that the G-forces generated by the deceleration are survivable. Typically, these posts are used for road lighting as those poles provide the required length to slow the vehicle.

2.4 Low-energy absorbing posts

Low-energy absorbing posts transfer little of the vehicle’s kinetic energy to the post. Tests have shown minimal reduction in vehicle speed through impact. The posts can collapse by bending with the vehicle running over the post or the post can break away or do both.

3 Summary of approved sign support systems

The following is a summary of approved sign support systems.

3.1 Rigid steel posts

Rigid steel posts of any size may be used behind a road safety barrier that is shielding another hazard and the barrier is in a suitable position for the sign location. Rigid steel posts may also be located unprotected where they cannot be reached by vehicles which run off the road.

3.2 Frangible-sized rigid steel posts

Rigid steel posts conforming to AS 1163:2009 *Cold-formed structural steel hollow sections* may be used at any place where the size of the post is considered frangible for the likely impact speed. For multiple post signs, post spacing must be at least 1.5 m between the posts.

3.3 Steel slip base posts

Only steel slip base posts complying with Standard Drawings 1363, 1364, 1365, 1368 and fabricated by companies on the Transport and Main Roads *Approved Supplier List – Approved sign supports* are allowed.

3.4 High-energy absorbing posts

There are currently no products approved by the department for this class of post.

3.5 Low-energy absorbing posts

3.5.1 Lattix energy absorbing posts

Lattix energy absorbing posts are approved by Transport and Main Roads. Lattix is made from marine-grade aluminium extrusion that is slotted and stretched. The unique expanded shape gives them strength for wind load and softness in a collision. The post is factory bolted to a base plate which, in turn, is bolted to the foundation on site. In an impact, the post deforms locally and may detach from the base plate. Lattix posts can be hit at any angle.

All sizes of Lattix may be used for single or multiple-post use for roadside signs anywhere on the road network. Lattix posts may be used for single post use for signs ranging in width from 1200 mm to 2500 mm. The standard two-post spacing is 0.6 x the width of the sign; that is. 2500 x 0.6 = 1500 mm. Any sign with less width should be installed on one safety post or be shielded by a barrier.

Lattix posts are designated as follows.

The first two numbers represent the number of sides the post has.

- 33 (triangular section)
- 44 (square section).

The second two numbers represent the width of the sides in centimetres.

- 12 (125 mm), 20 (200 mm), 25 (250 mm), 38 (380 mm).

Example – Lattix 4420 = a four-sided post with a width of 200 mm.

Lattix types are 3320, 3325, 4412, 4420, 4425 and 4438. Selection charts follow.

Each step up in size represents approximately double the bending moment and torsion moment capacity from the previous type.

3.5.2 Signfix aluminium frangible pole system

Signfix poles are available in 50, 65, 80, 90 and 100 NB sizes.

The Signfix aluminium frangible pole system is approved by Transport and Main Roads. Signfix poles are manufactured from high-strength marine-grade alloy with typical yield strength of 275 MPa. It is a patented system that works with a purpose-made ground sleeve designed to be a snug fit between the pole and the sleeve.

Sleeves are supplied up to 1 metre in length, depending on the pole diameter and length. The sleeves are set in concrete foundations designed to meet local engineering requirements.

The sleeve top acts as a shear point and, combined with the molecular structure of the alloy, will, under sudden impact, bend the pole at the point of impact and will ultimately shear and breakaway at the sleeve top. The pole flues are designed to further assist in the breakaway process by reducing the external surface area of the pole. Frangibility is multidirectional.

Manufacturer's specifications and recommendations shall be followed in the installation of the Signfix aluminium frangible pole system.

Section 7 *Use of Signfix selection charts* shows Signfix Wind Loading Charts for each of the wind regions A, B, C and D throughout Australia, based on those set in Australian Standard AS 1170.2 (for representation of these regional boundaries, refer to Figure 4).

Use of the appropriate chart based on desired wind region, surface area of the sign/s and height of the sign aboveground level is used to determine optimal number and size of the poles to be used for each particular installation.

4 Other sign support considerations

It should be noted that some of these supports have inherent limitations on their performance due to their design.

Due to their low strength, frangible sized steel posts are not suitable for large signs.

Their low strength, while supporting the small sign, still allows the supports to bend when struck by a vehicle or subjected to high wind forces (thereby protecting the sign from being dislodged and becoming a projectile).

Where large signs are to be installed in a clear zone and there may be a requirement to use either slip base or energy-absorbing supports that will 'give way' in order to minimise the impact of the vehicle, a slip base design may be used.

For slip base supports to operate effectively, all design specifications must be adhered to. These include:

a) fuse plates welded as per Standard Drawing 1365, oriented correctly and located 100 mm from the bottom edge of the sign

b) base plate bolts tensioned to allow both base plates to slip when the support is struck by a vehicle (it is very important that the securing bolts are tensioned to the correct tension; incorrectly tensioning may interfere with the 'slipping' action of the two matched base plates)

c) the foundation stubs installed according to Standard Drawing 1363, which requires the base plates to be installed at 100 mm above the surrounding terrain – not adhering to these specifications may cause 'snagging' of the impacting vehicle's chassis and affecting the operation of the slip base or the possibility of an undesirable rapid deceleration of the vehicle

d) ensuring single slip base post designs (Standard Drawing 1368) and multi-post slip base designs (Standard Drawing 1365) are not mixed or interchanged

e) the height of the support posts is to be sufficient to allow the bottom of the sign to be no less than 2.1 metres from the ground to allow the vehicle to pass under the sign / load on impact

f) the spacing of any two slip base supports being no less than 1500 mm to minimise the risk of a vehicle sweeping through more than one of the supports, thereby affecting the slipping action

g) careful consideration when slip base posts are installed on steep filled slopes to ensure the impact of the vehicle will still be low on the supports to allow the correct operation of the slip base

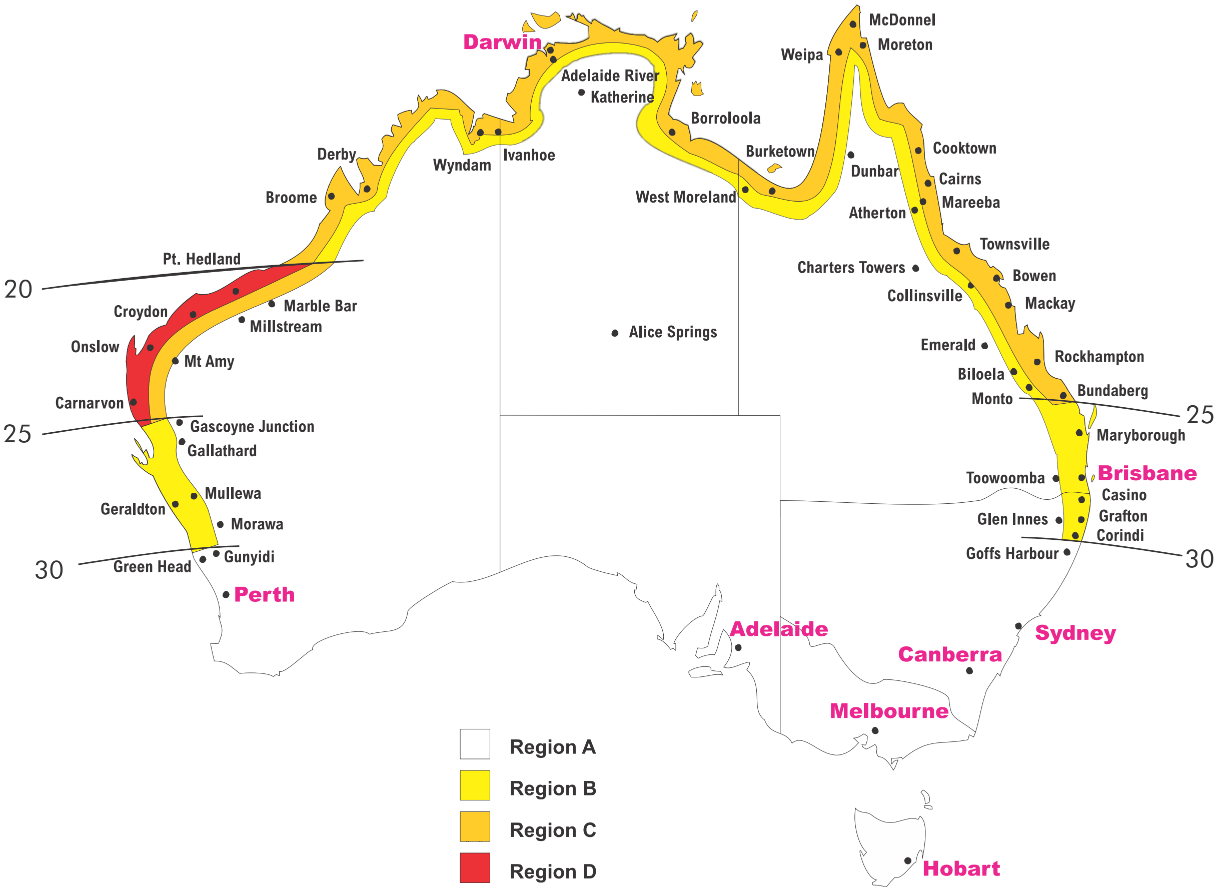
h) ensuring the orientation of the slip bases are correctly installed to operate on a proposed impact angle

i) use of accredited manufacturers to supply certified slip base supports. A full list of accredited manufacturers is available from Transport and Main Roads.

Where supports are required in a clear zone, Lattix and Signfix type supports may also be used.

For all support options to operate effectively, they must be installed according to the manufacturer's specifications and proper engineering processes.

Figure 4 – Australian wind regions



5 Use of standard support selection charts

Refer to TRUM Vol 3 Pt 5 Appendix B.

Note: TraSiS (Traffic Sign Support) may be used. This is a software program that can be downloaded from the Transport and Main Roads website. This automatically selects sign supports according to the relative specific user data input.

6 Use of Lattix selection charts

Use Figure 3.1 from AS 1170.2:2002 *Structural design actions – Wind actions* to determine the wind region of the site. Figure 4 has been reproduced from AS 1170 for convenience of the reader.

Lattix sign supports for signs with surface areas and wind regions are available on separate specific single and multiple support selection charts in Section 6.1 and Section 6.2 respectively. For signs with larger surface areas, other support options mentioned in this supplement should be considered.

Note: If the sign site is installed in an exposed location, a selection chart for the next higher wind region should be used.

6.1 Single-post selection

Single-post selection charts are shown following.

If the sign width is less than 2.6 m, use the single-post chart first. Check that the Maximum Sign Stiffener Overhang will not exceed the values shown in TRUM Vol 3 Pt 5 Appendix B Table B2. From the sign size and ground profile, calculate the height to centre of pressure, that is, 0.5 x sign height, plus clearance from bottom of centre of sign to ground level. Lattix requires a minimum of 2 m clearance, so a light vehicle can run underneath the sign. Next, calculate the area of the sign face(s). On the graph, take a horizontal line from the height to centre of pressure across until it intersects with a vertical line from the area of the sign. The next curve to the right of the intersection point represents the smallest Lattix post that can be used.

Consider this worked example for a GE9-2, shown at Figure 6.1(B)).

The sign is 1400 mm x 1800 mm, wind region is B. Sign is to have 2.5 m clearance above road level. Assume ground clearance to be 2.925 m. Height to Centre of Pressure will be 3.825 m. Area is 1.4 x 1.8 = 2.52 m².

Select the Chart for Wind Region B and take a horizontal line from just under 3.9 for Height to Centre of Pressure. Now, take a vertical line from halfway between '2' and '3' for the area. A curve to the right from the point at which they intersect is for 4420 / 3325; however, this curve stops below the horizontal line. Go to the next curve which is for 4425. This is the correct post to use.

Figure 6.1(A) – Lattix single post selection chart (Wind Region A)

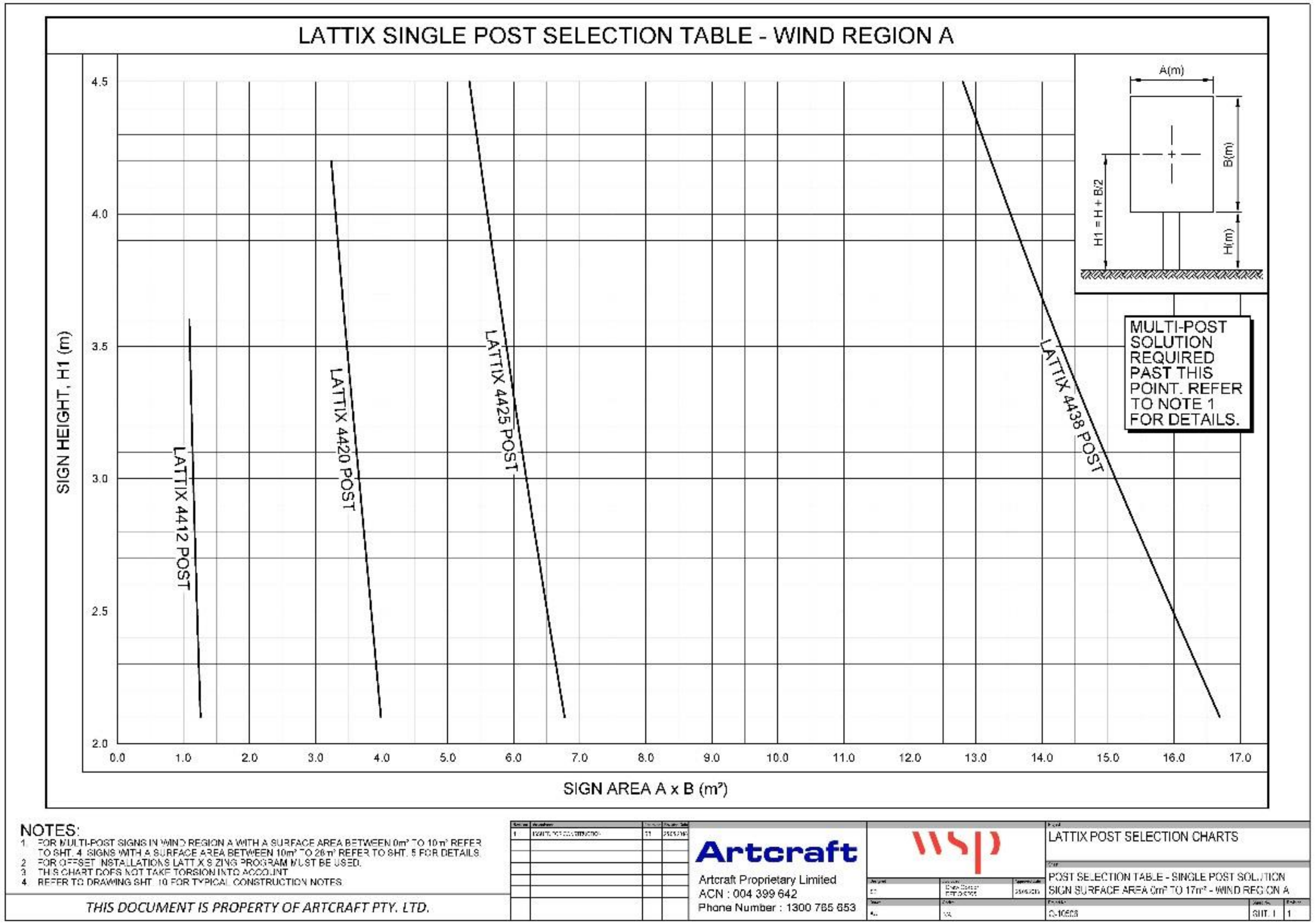


Figure 6.1(B) – Lattix single post selection chart (Wind Region B)

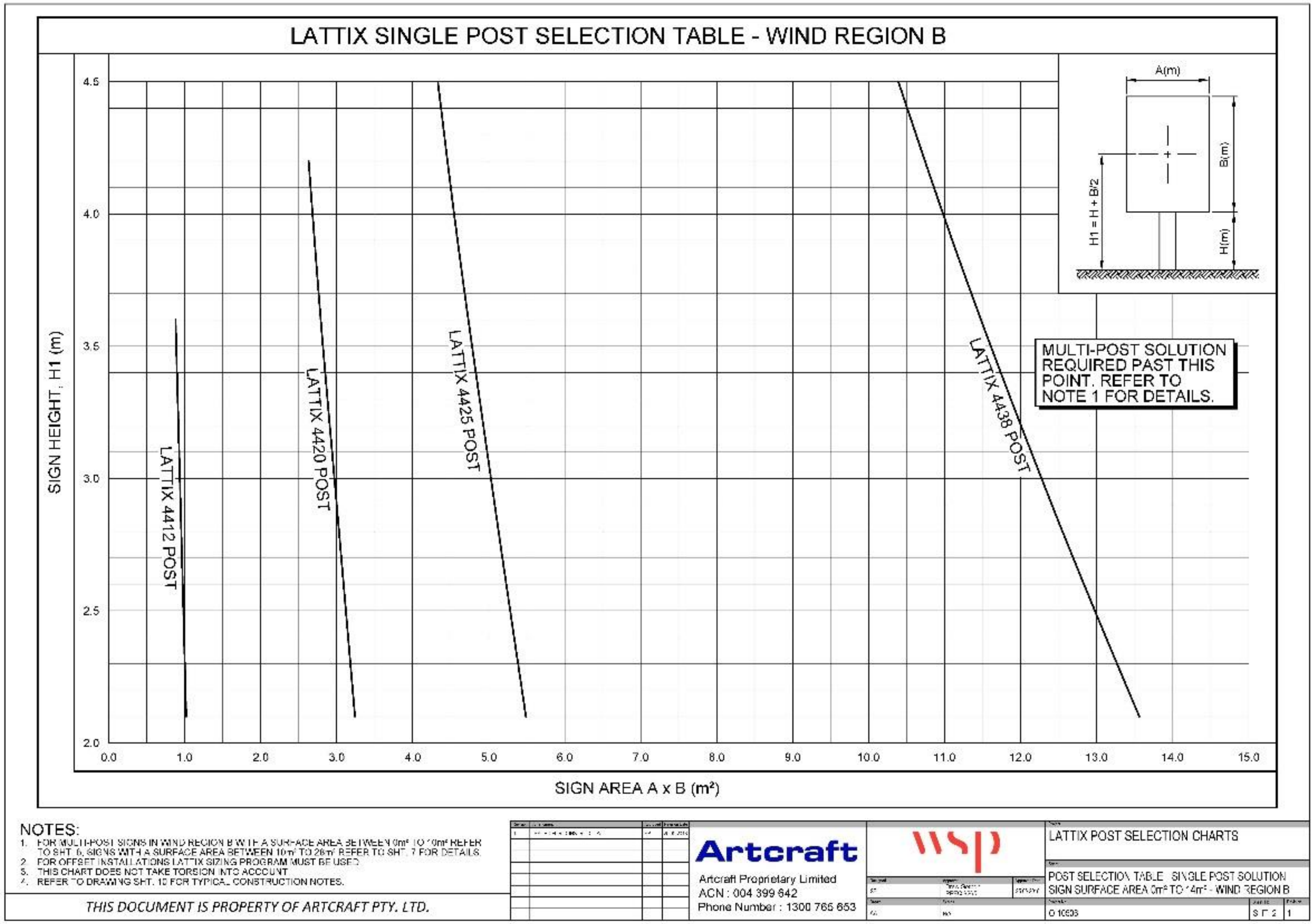
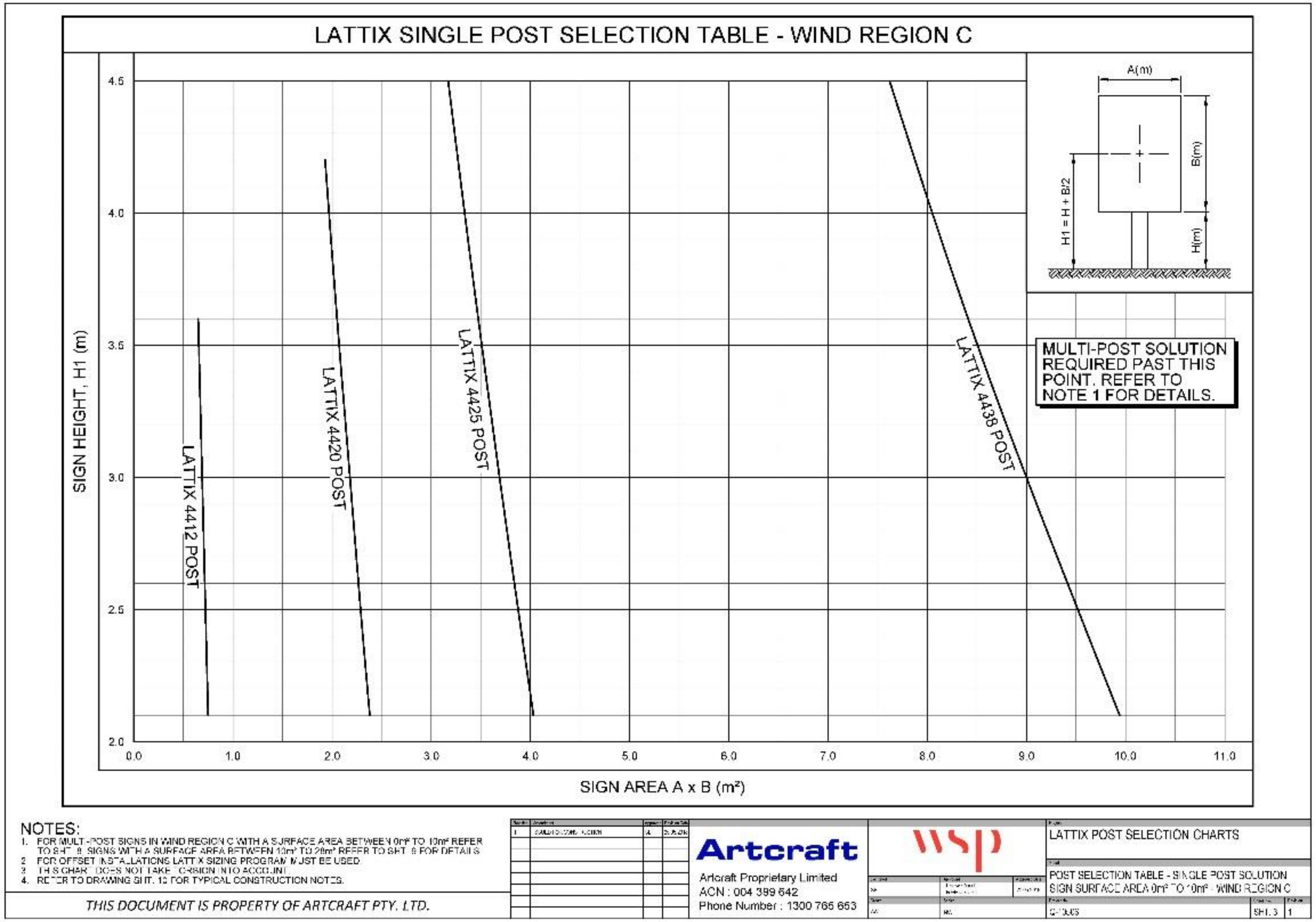


Figure 6.1(C) – Lattix single post selection chart (Wind Region C)



6.2 Multiple post selection

For signs over 2.5 m wide, use the multiple-post selection charts shown following.

From the sign size and ground profile, calculate the height to centre of pressure, that is, 0.5 x sign height, plus clearance from bottom of centre of sign to ground level. Lattix requires a minimum of 2 m clearance, so a light vehicle can run underneath the sign. Next, calculate the area of the sign face(s). On the chart, find the oblique line that represents the height to centre of sign across until it intersects with a vertical line from the area of the sign. From there, take a horizontal line to the right. The most economical way to use Lattix is to specify the least number of posts.

Consider this worked example for a sign is 5 m x 3 m in Wind Region B (Figure 6.2(E)). Sign is to have 2.2 m clearance above road level. Assume ground clearance to be 3.075 m. Height to Centre of sign will be 4.575 m. Area is 5 x 3 = 15 m^2.

Select the Chart for Wind Region B and follow the oblique line marked H1 = 4.5 m. This represents the Height to Centre of sign line. Now, take a vertical line from 15 m^2. Take a horizontal line to the right from the point at which they intersect. The line shows 2 x 4425 posts. These are the correct posts to use. Check maximum stiffener overhang from Table B.2 in TRUM Vol 3 Pt 5 Appendix B is okay. Check spacing from Table B.1 in TRUM Vol 3 Pt 5 Appendix B is okay.

The chart shows you may also use 4 x 4420, but this would cost more as a total and the spacing would be only 1.25 m, which is less than 1.5 m and, therefore, unacceptable.

Note that the Lattix support selection is available for both single and multiple supports for signs with surface areas outlined in Section 1.2 *Lattix energy absorbing posts*. For signs with larger areas, other standard supports mentioned in Section 1.1 *Standard support posts* of this supplement should be considered.

Figure 6.2(A) – Lattix multi-post selection table 0m² to 10m² wind region A

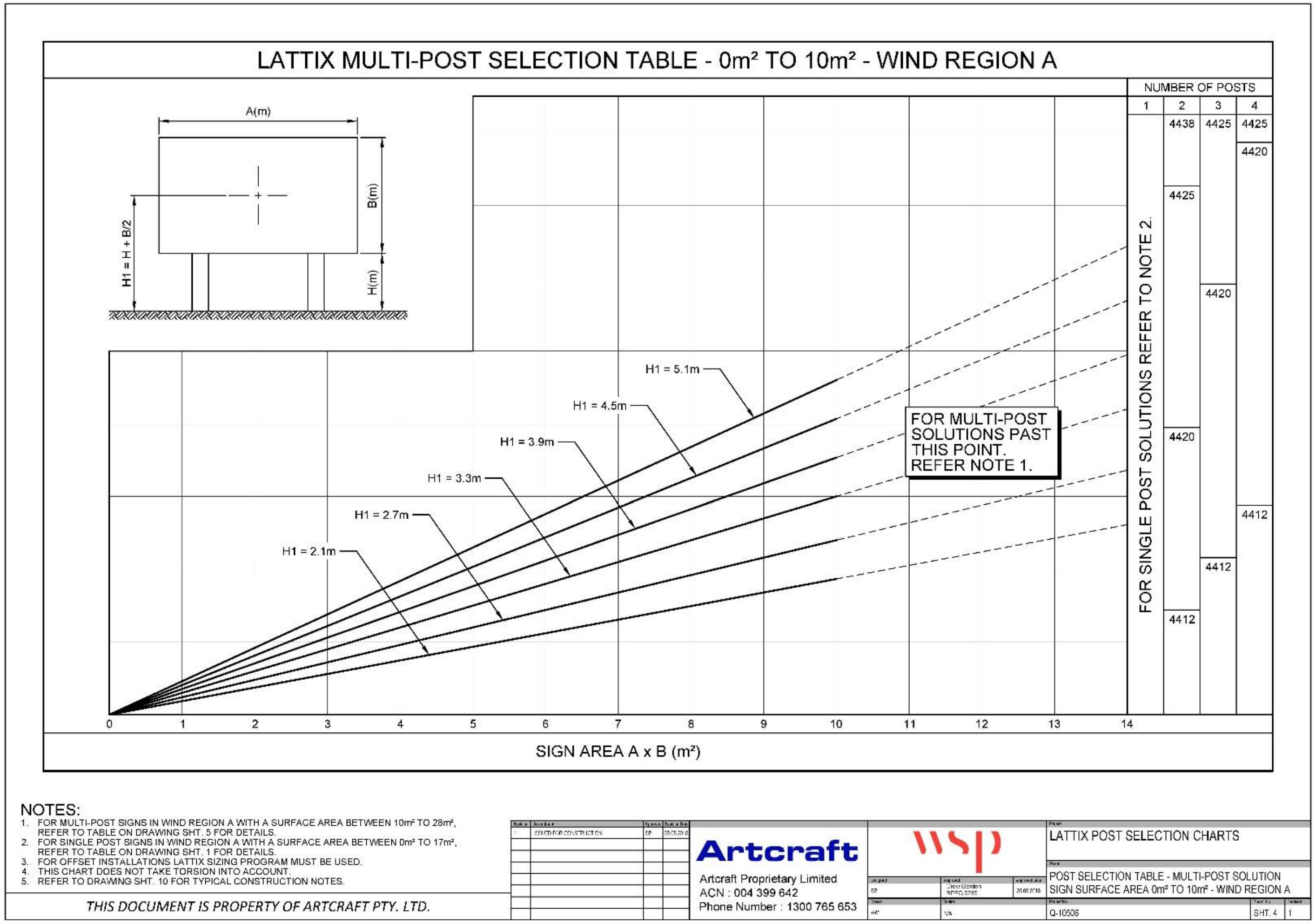


Figure 6.2(B) – Lattix multi-post selection table 0m² to 10m² wind region B

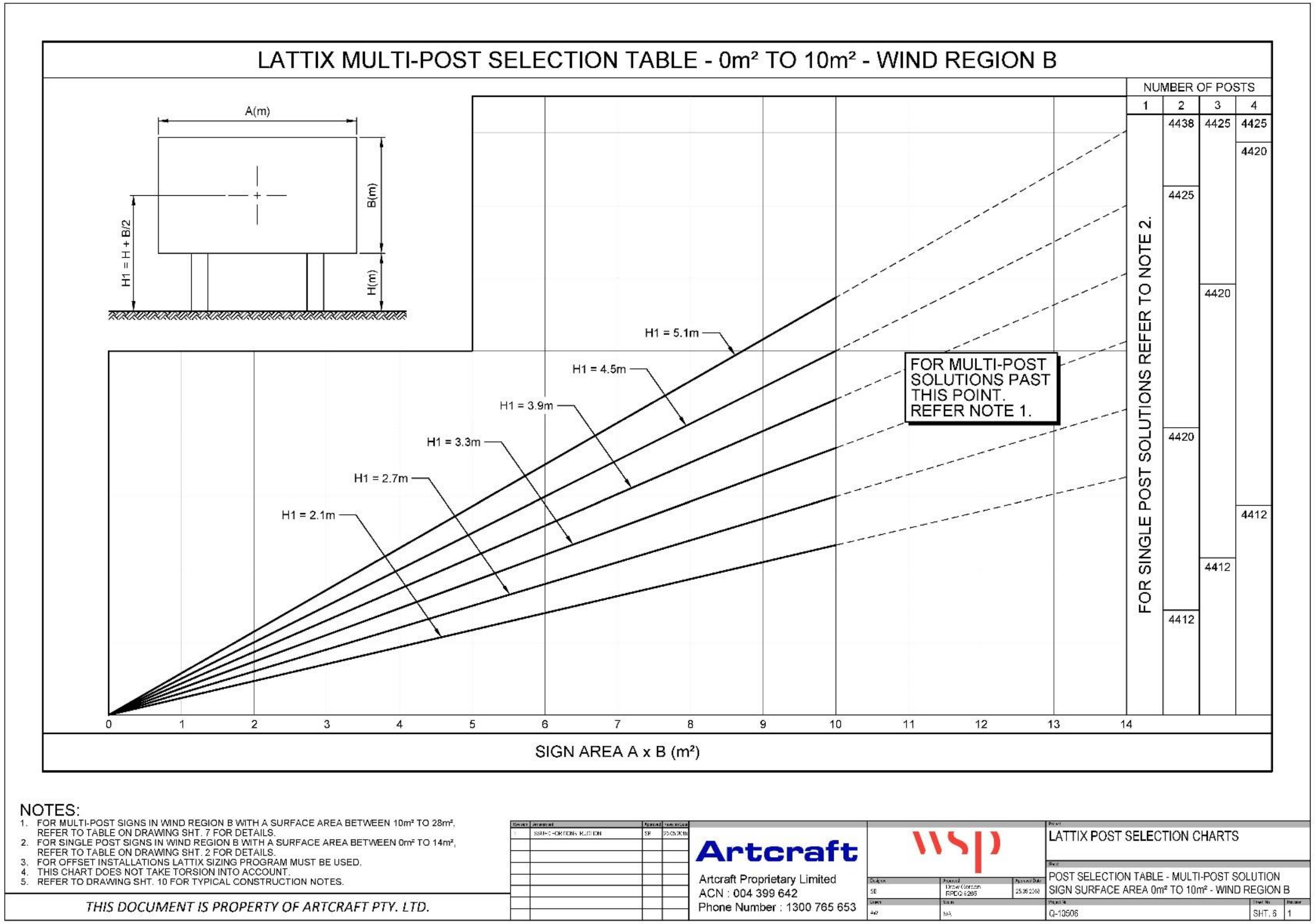


Figure 6.2(C) – Lattix multi-post selection table 0m² to 10m² wind region C

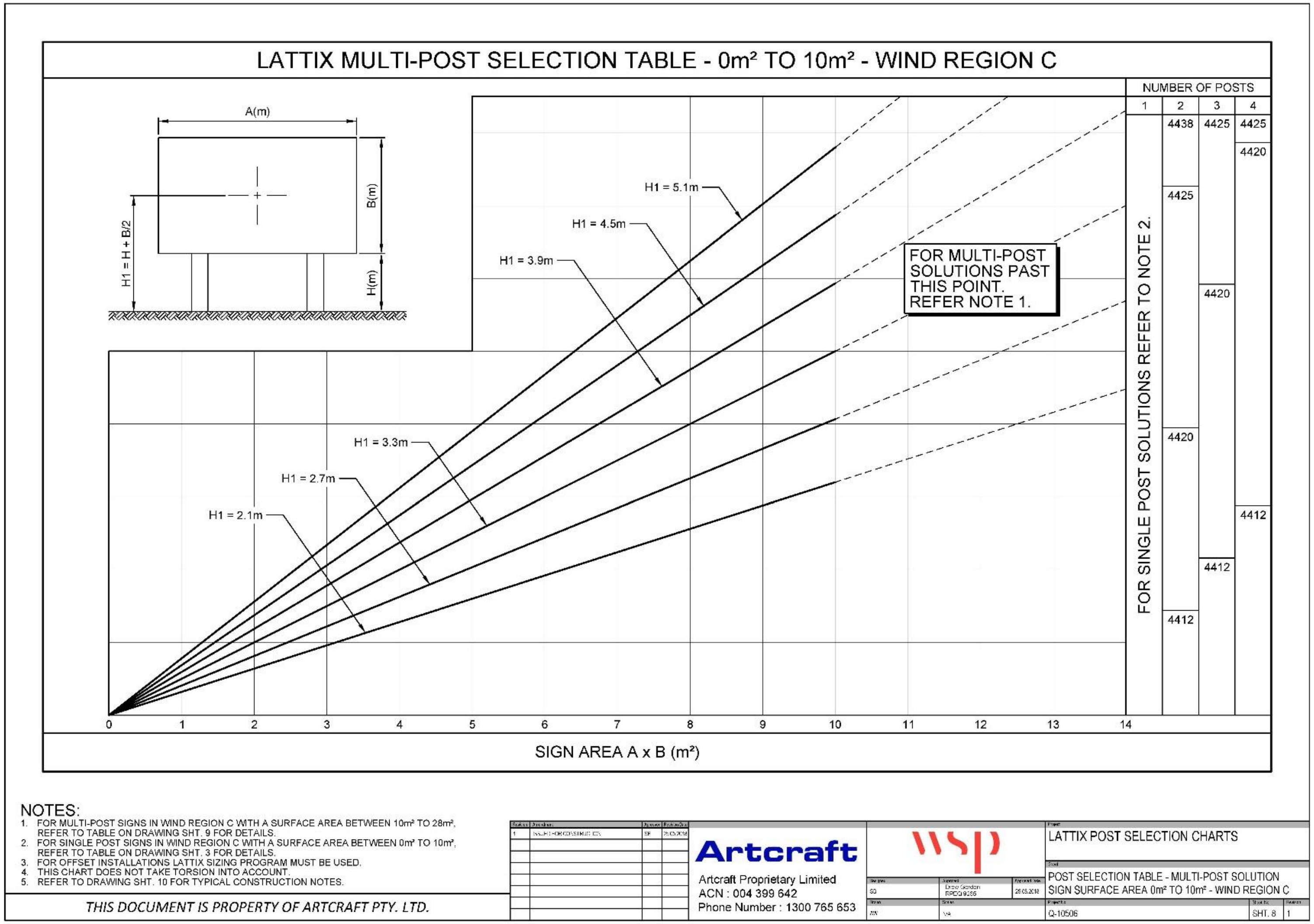


Figure 6.2(D) – Lattix multi-post selection table 10m² to 28m² wind region A

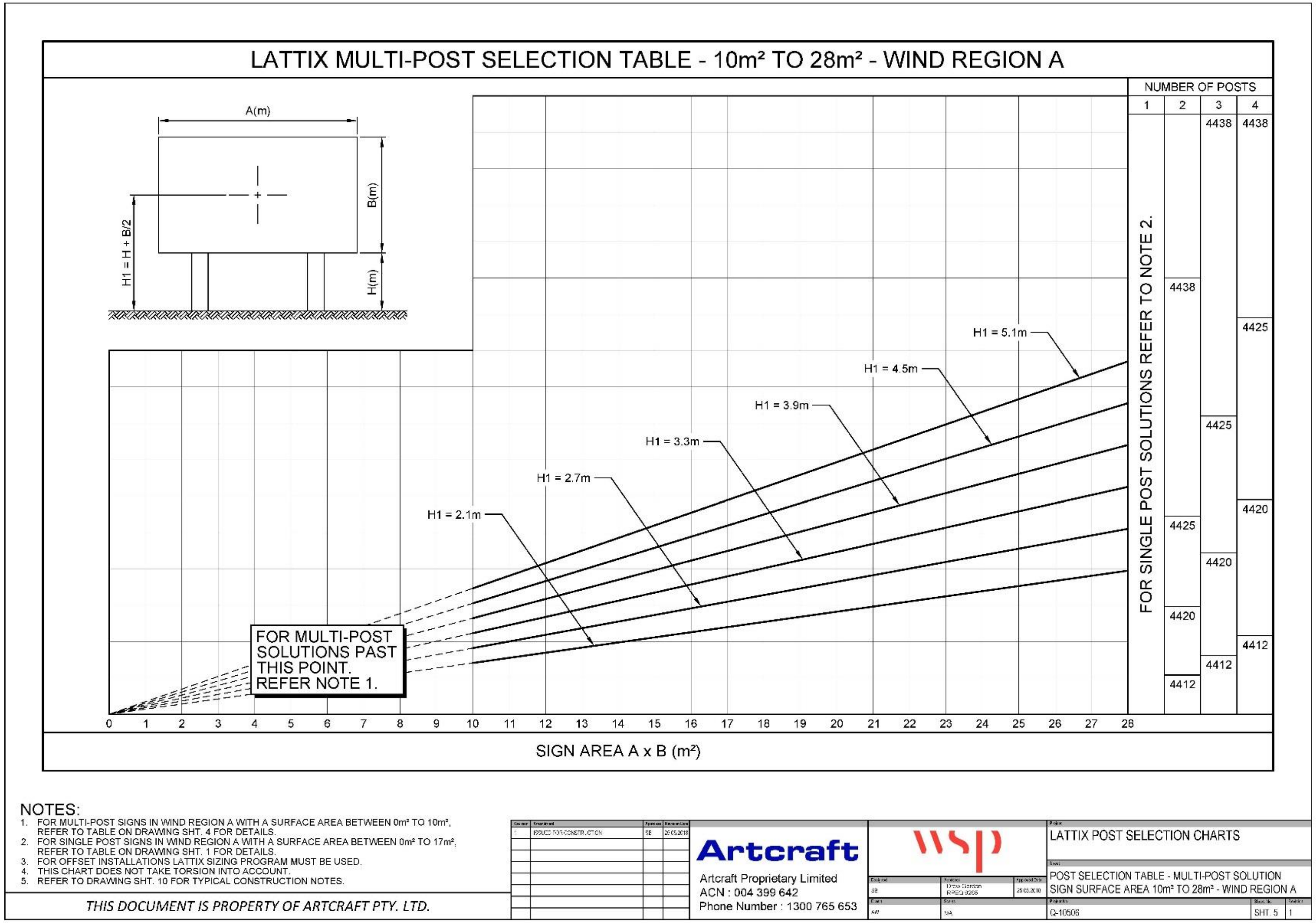


Figure 6.2(E) – Lattix multi-post selection table 10m² to 28m² wind region B

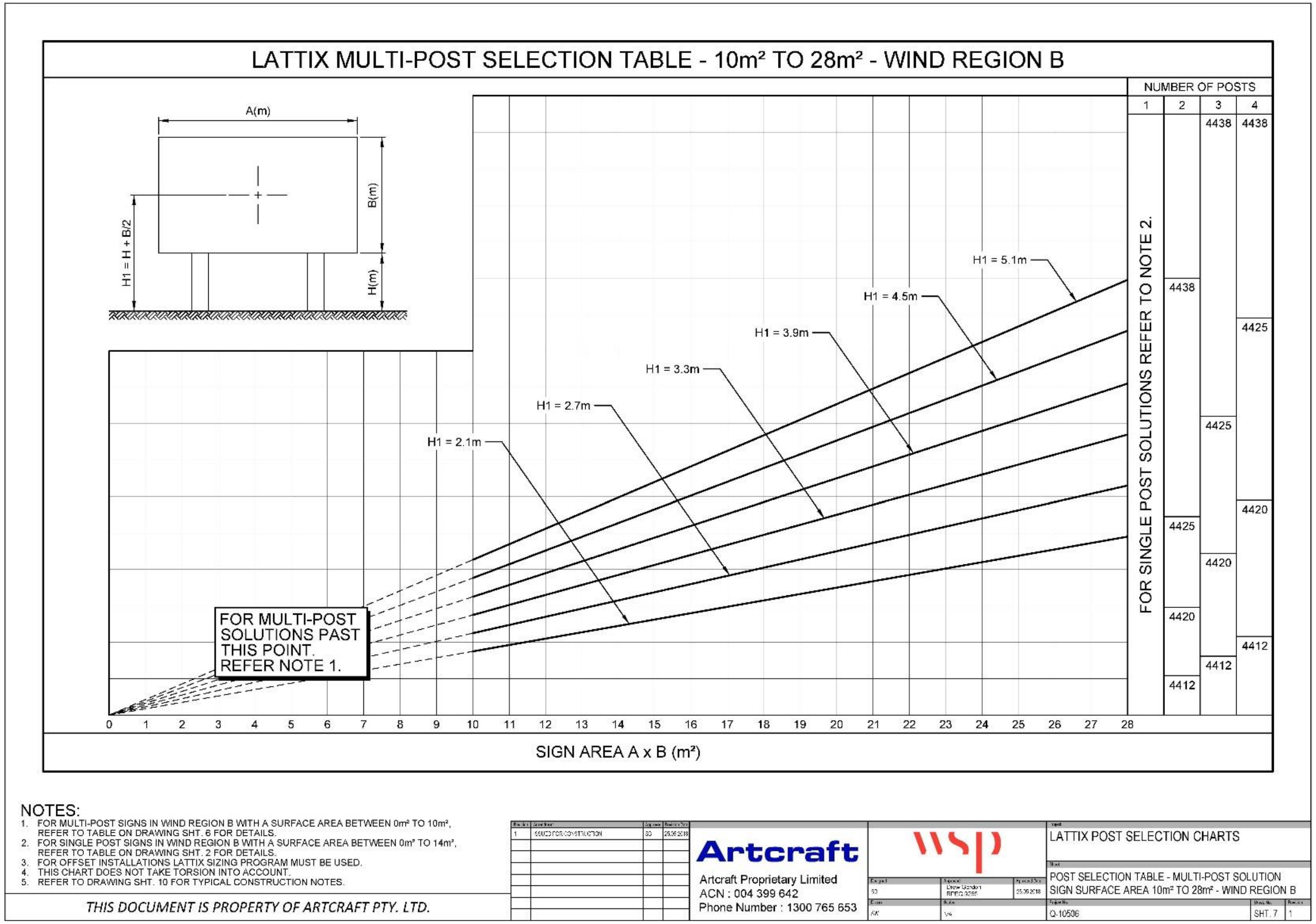
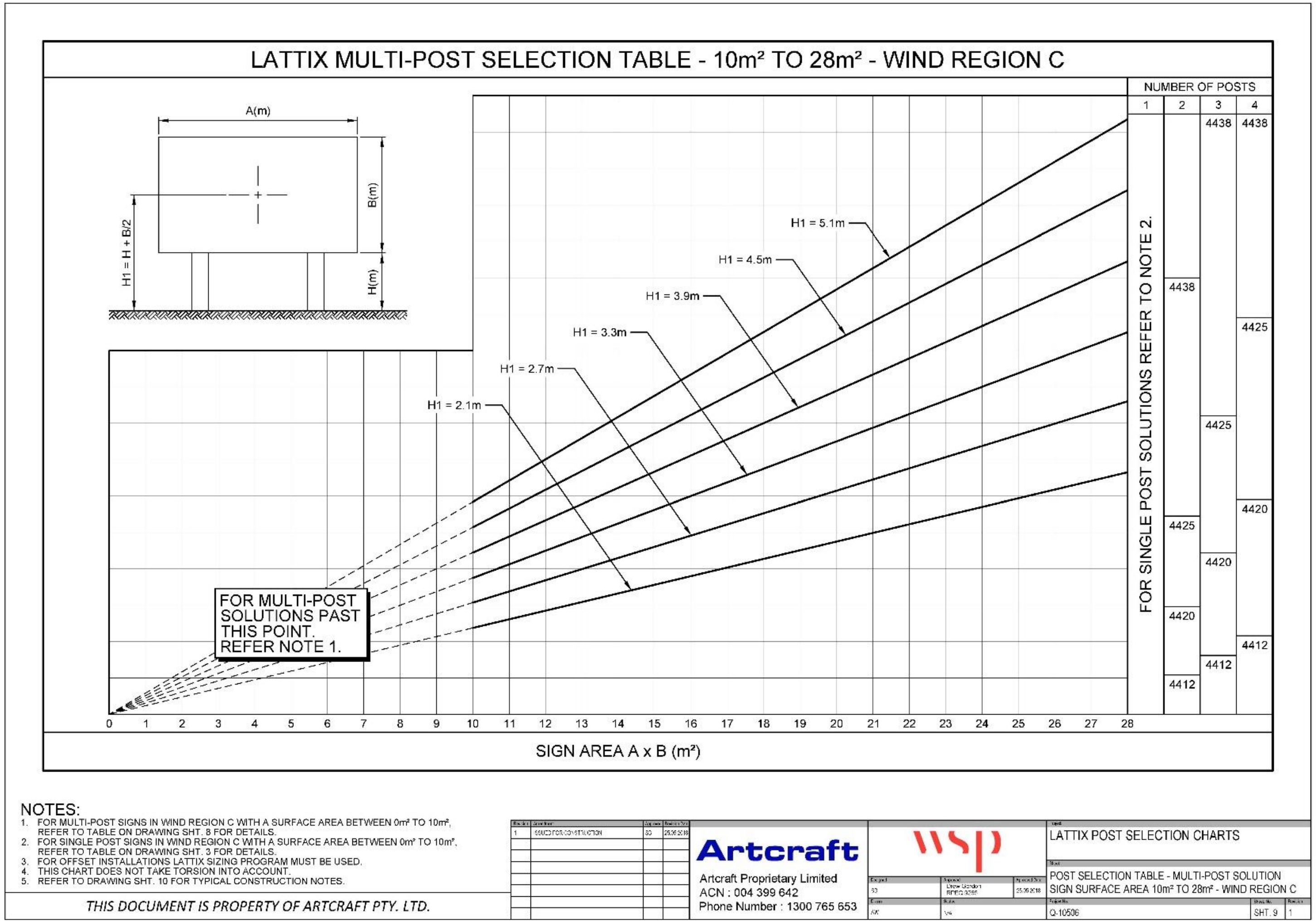


Figure 6.2(F) – Lattix multi-post selection table 10m² to 28m² wind region C



7 Use of Signfix selection charts

Use Figure 3.1 from AS 1170.2:2002 *Structural design actions – Wind actions* to determine the Wind Region of the site. Figure 4 has been reproduced from AS 1170 for convenience of the reader.

Signfix sign supports for signs with surface areas and wind regions outlined in Section 1.3 *Signfix frangible support system* are available from specific support selection charts (following). For signs with larger surface areas, other support options mentioned in this supplement should be considered.

Major considerations for the installation of Signfix aluminium fluted poles

- Using Signfix Wind Loading Charts for regions A, B and C (refer to following) as appropriate to determine the correct pole size and number of poles to be used for each particular installation.
- It is recommended foundation details are obtained from a local engineer, prior to any installation or by footing details determined in TRUM Vol 3 Pt 5.
- Foundations should be excavated to the required depth maintaining a minimum diameter of 400 mm.
- Setting out and pouring concrete on multi-pole sites the kerbside socket should always be installed first.
- The sleeve must be centralised in the hole and set on a concrete base, ensuring the sleeve top is between 50–100 mm above ground level.
- It is important to ensure during the final pour the sleeve remains perpendicular.
- For adequate foundation strength, it is recommended not less than 28 mpa concrete is used.
- For frangibility to work within the requirements of NCHRP-350, all pole sizes 65 mm NB and above must be installed using a matching sleeve and all sockets must be fully encased using wet premixed concrete.
- To prevent difficulty in removing the security bolt from a damaged or bent pole, all sleeves must be sited with the locking device facing oncoming traffic.
- It is recommended the security locking bolts are evenly tightened between 10 and 12 Nm.
- The stainless-steel Transition Shoe must be fitted between the pole and locking bolts prior to tightening.
- In sandy conditions, it is recommended that a silicone bead is placed around the sleeve top to prevent the ingress of sand into the sleeve. It has been found that sand deposits between the pole and sleeve can wedge the pole and prevent removal.
- To reduce water ingress, standard galvanised post cap or equivalent must be fitted.
- Restraint devices are recommended to be fitted in high pedestrian areas.

Figure 7(A) – Signfix frangible fluted poles: Wind region A

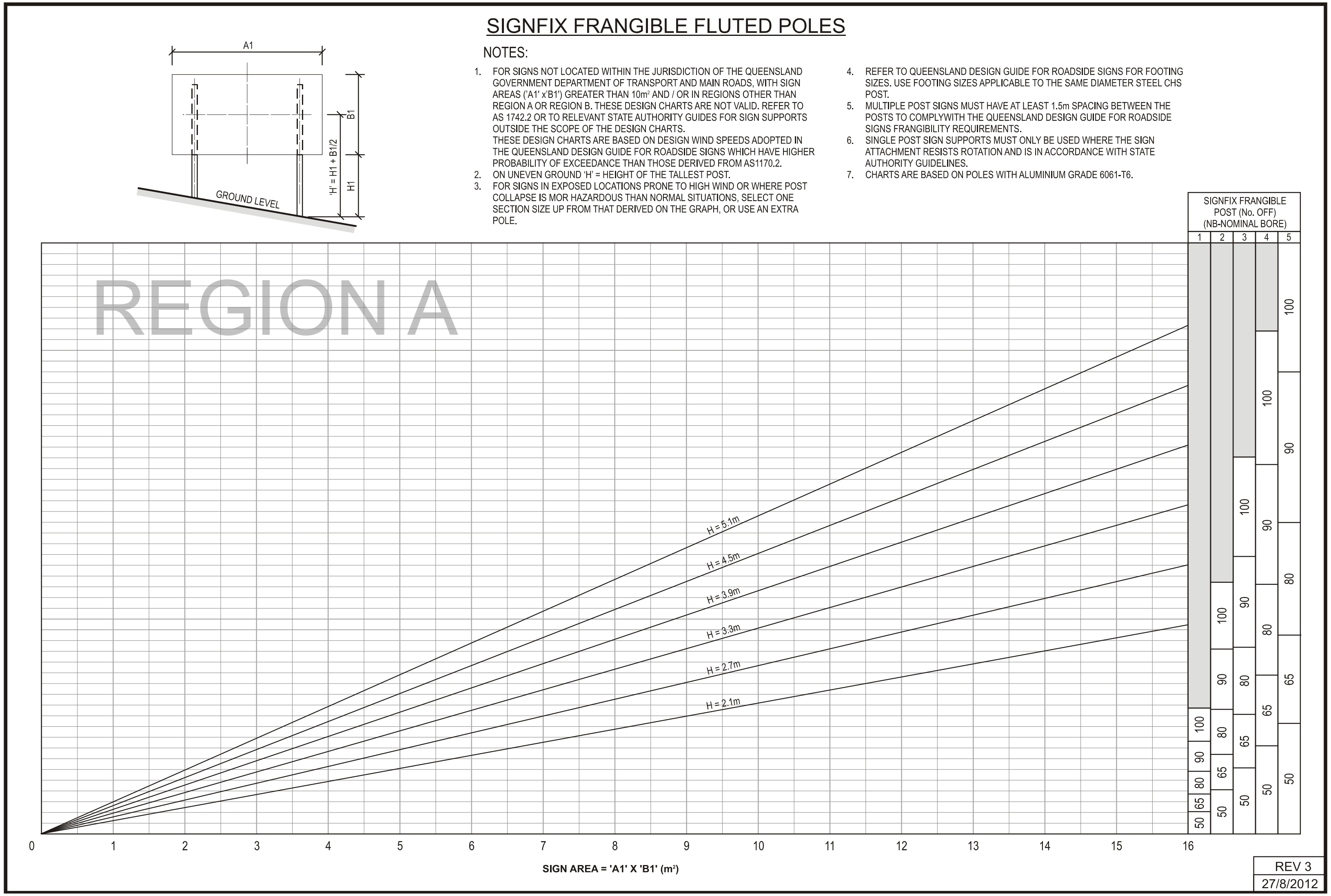


Figure 7(B) – Signfix frangible fluted poles: Wind region B

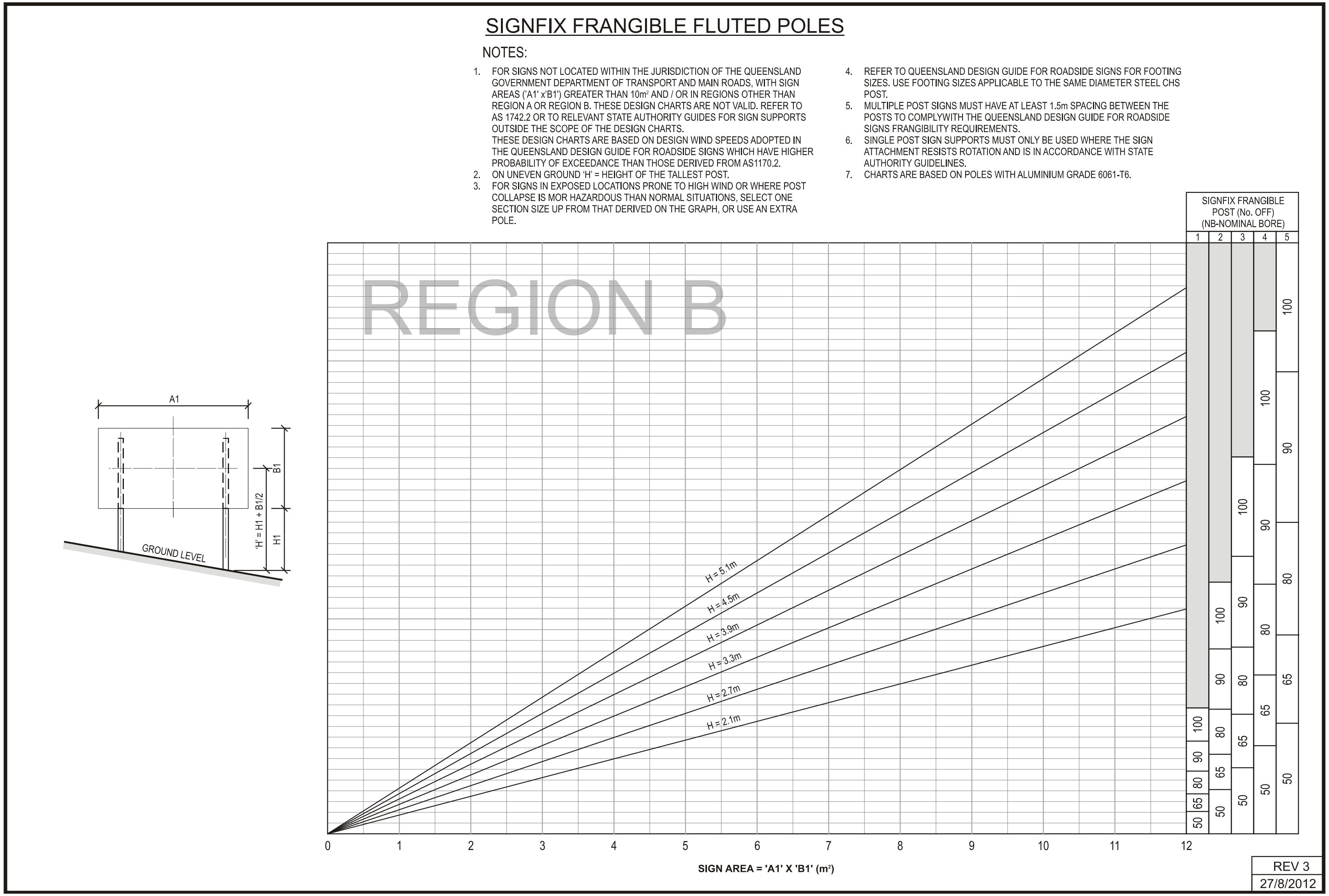
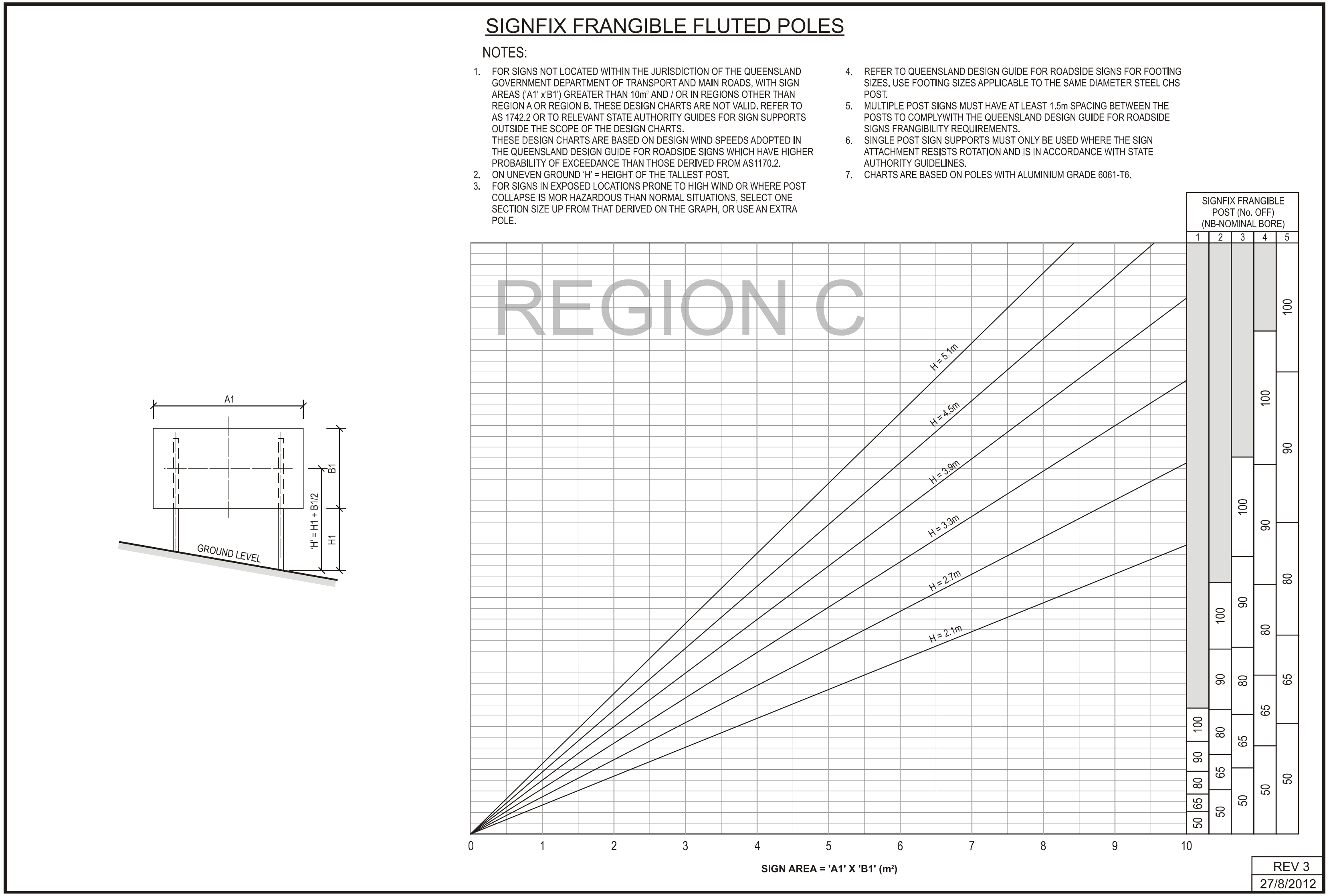


Figure 7(C) – Signfix frangible fluted poles: Wind region C



8 Standard post selection charts (CHS / RHS / TRUSS)

Standard post selection charts are contained in the *Traffic and Road Use Management* manual, Volume 3 *Signing and Pavement Marking* Part 5 *Design guide for roadside signs*.

5 Electronic signs

5.1 Variable Message Signs

5.1.2 Applications

5.1.2-1 Non-Transport and Main Roads variable message sign installation applications on state-controlled roads for displaying road and traffic condition information

1 Overview

The purpose is to provide advice to ensure road safety on Queensland roads is not compromised in the operation of variable message signs (VMS) whilst supporting communication with the local community.

The conditional use of VMS by other state agencies, local government or private road operators on Queensland roads can provide benefits for communities and motorists.

Any state agency, local government or private road operator seeking to purchase and install a VMS device should seek early advice from the relevant Transport and Main Roads office.

2 Installation application

Any organisation seeking to install a device within Queensland's state-controlled road network must first apply for a Road Corridor Permit.

2.1 Application technical requirements

The VMS must comply with Transport and Main Roads Technical Specification MRTS202 *Variable Message Signs*.

It is expected, in providing approval for installation of a VMS device within the Queensland road environment that all relevant safety-related guidelines will be adhered to.

A condition of approval is that the State is able to access and operate the VMS during times of emergency. To enable this, the sign must be supported* by STREAMS, which is the Transport and Main Roads traffic management system and primary user interface to Intelligent Transport Systems (ITS).

*'supported by STREAMS' means that the VMS device could be connected to the current release of STREAMS without further software development. Any decision to actually connect the sign to STREAMS will be taken by the state at a later time.

2.2 Application location considerations

The location of a VMS close to an intersection or pedestrian crossing is of particular concern to the department due to the proximity of LED traffic lights and the many conflict points between vehicles and pedestrians.

3 Messaging restrictions

The use of the VMS is restricted to the display of information of community significance and/or of 'state importance' and must not be used for other purposes.

‘State importance’ is defined as a message that is approved by authorised officers of the Queensland Police Service, the Queensland Fire and Emergency Services or Transport and Main Roads. Any use of VMS is required to be in accordance with this supplement.

VMS must not be used to for:

- displaying organisation names
- political advertising*
- commercial use
- deriving revenue.

*Political advertising is defined as any message which identifies political candidates and/or promotes a political party at local, state or federal elections.

The VMS is to be appropriately branded to identify ownership by the purchasing organisation.

It is acceptable to use VMS to promote local government initiatives (for example, ‘Watch every drop’).

5.3 Variable message sign messages

5.3.1 Types of messages and symbols

5.3.1-1 Queensland-specific advice for message priorities

1 Overview

Messages are to be limited to the following categories and according to priority. Details of these categories of messages and their respective priority are:

1) warnings of hazards or unexpected conditions (Category 1)
2) disasters or emergency alerts (Category 1E)
3) child abduction alert (amber alert) (Category 2)
4) traffic management information (Category 3)
5) travel information (Category 4)
6) filler messages, including road safety messages, general transportation messages and community benefit messages (Category 5).

2 Category 1: Incident messages

Category	1: Incident messages
Definition	These messages alert motorists to immediate hazards affecting the road network or unexpected road conditions, such as: • an incident, for example, crash • a lane blockage • reduced speed limit • a disabled vehicle or an object on the road • an animal on the road **reduced visibility resulting from smoke or localised fog** • slippery conditions resulting from an oil / chemical spill, or • unexpected queues from non-recurrent congestion.
Approval	Traffic Management Centre (TMC)
Conditions of display	This message type has the highest priority, unless regional management consider another message type is considered higher.
Text case selection	ALL UPPER CASE This allows for traffic-related unplanned incidents and network changes to be clearly legible and does not jeopardise this important test to real-time information and action.

3 Category 1E: Disaster or emergency alerts

Category	1E: Disaster or emergency alerts
Definition	These messages alert motorists to assist them in the preparedness, response and recovery of disasters or road use emergencies, such as: • general safety, evacuation and other emergency-related advice to the public, or • an impending or existing disaster event likely to, or already affecting, road conditions. Distance guidance does not apply for emergency-related warnings and advice.
Approval	If considered **urgent**, Transport Network Security and Resilience (TNSR) request TMC direct. If **not** urgent, consultation between TNSR and Mobility Policy & Insights (MPI) *Advice to be sent about message to: Director (Statewide Operations), Deputy Chief Engineer and Chief Operations Officer, Transport and Main Roads.*
Conditions of display	This message type has the highest priority, unless regional management consider another message type is considered higher.
Text case selection	ALL UPPER CASE This allows for traffic-related unplanned incidents and network changes to be clearly legible and does not jeopardise this important test to real-time information and action.

4 Category 2: Child abduction message (amber alert)

Category	2: Child abduction message (amber alert)
Definition	In the event of a child abduction or suspected child abduction, the QPS may decide to inform the public rapidly of permissible details to assist with its investigation.
Approval	QPS request to TMC
Conditions of display	Limit to permissible details provided by QPS. An option is to use: CHILD ABDUCT ALERT TUNE TO LOCAL RADIO The message is to be displayed for at least three hours or until further notification is received from QPS. In the event a VMS is also required for emergent operational purposes, the Category 1 message/s will take priority over the amber alert. All requests for amber alerts are to be logged with the time commenced and terminated.
Text case selection	ALL UPPER CASE This allows for traffic-related unplanned incidents and network changes to be clearly legible and does not jeopardise this important test to real-time information and action.

5 Category 3: Traffic management information

Category	3: Traffic management information
Definition	These messages indicate the location and degree of localised recurrent congestion, directional signage and travel times.
Approval	TMC
Conditions of display	These messages will be replaced by incident and other category messages if regional management consider another message type is considered higher.
Text case selection	Upper and Lower Case Upper and lower case with capital letters at the start of each word on VMS where systems allow for this to occur. This allows for the necessary distinction between critical messages and lower-order (non-critical) message types.

6 Category 4: Planned roadworks and special events messages

Category	4. Planned roadworks and special events messages
Definition	These messages provide advanced information of special events or planned roadworks, which have an ability to affect traffic (generally including a description and date / time of the event, expectation of delay and/or suggestion to consider alternative routes).
Approval	TMC
Conditions of display	These messages will be replaced by incident and other category messages if considered of higher importance. For special events, advance information should only be displayed up to one week before the start of the event. Wherever possible, generic descriptors of sporting events will be used when companies have purchased naming rights. Avoid advertising.
Text case selection	Upper and Lower Case Upper and lower case with capital letters at the start of each word on VMS where systems allow for this to occur. This allows for the necessary distinction between critical messages and lower-order (non-critical) message types.

7 Category 5: Filler messages (community benefit / campaign messages)

Category	5. Filler messages (community benefit / campaign messages)
Definition	Filler messages are only displayed when there is no requirement for higher-priority messages and are limited to enhance the safety or performance of the Queensland network or influence / inform the public in cases of potential or declared natural disasters. These groups are: • **Road safety messages** Road safety messages are filler messages that are directly related to the driving task or deal with on-road driver / passenger safety and behaviour. Messages should be rotated between signs and the same message not displayed for more than 2–3 days. Road safety messages include speed, fatigue, following distance, vehicle maintenance; and excessive lane changing. • **Community benefit messages** Community benefit filler messages are only to be used where: – there are significant community interest benefits with these types of VMS filler messages; for example, drought conditions with critically-low water storage levels or extreme fire danger conditions, and – the message can be shown to be relevant to a significant proportion of the travelling public, and – no commercial or advertising benefit is given to any person or organisation (for example, business names shall not appear on signs). • **General transportation messages** General transportation messages must be relevant to a significant proportion of the travelling public and be in the interest of improving network performance / efficiency. These types of messages provide general transportation information through advice of alternative route options and traffic information. These may include messages such as Qld*Traffic* / 13 19 40 traffic and travel information (web and phone) and information about the use of toll roads (not commercial use).

Category	5. Filler messages (community benefit / campaign messages)
Application	Applicants can request a copy of the Filler Message Request Form (F4974) and quick reference guide by: • contacting TIManagement@tmr.qld.gov.au; or. • internal applicants can access this form through corporate forms database. For further assistance or to submit the completed application, email TIManagement@tmr.qld.gov.au On receipt of the completed application, it will be assessed, and response provided. Before submitting, the applicant must ensure the following message conditions are met: • it clearly falls into one of the three message groups outlined in the definition section; and • is short, clear and concise as not to distract road users from their primary driving tasks; and • kept within one screen and within the character limitations; and • it is constructed to meet the requirements of Section 5.4-1 *Variable message sign statements* outlined in this supplement. Please note, that due to the conditions of display placed on filler messages and number of requests, no guarantee can be made that they will be displayed and for what period of time.
Approval	Mobility Policy and Insights Unit (Road Operations, E&T) If it is a 'road safety message' request, approval is also required by Community Road Safety (Road & Rail Safety, CSSR).
Conditions of display	The following limitations apply to the use of filler messages: • Filler messages must not be displayed during peak periods (peak is generally 6:00–9:00 am and 3:00–6:00 pm, Monday to Friday, but can vary depending on regional traffic conditions) as the VMS shall only be used for incident and traffic management purposes during peak period times. • Filler messages must not be displayed when the traffic flows in the direction relevant to the VMS device are greater than 85% of the road capacity and are only to be used on devices programmed through STREAMS. • Filler messages must be displayed for a minimum of 20% and not exceed more than 30% of the available time. Road safety messages shall account for at least half of the filler messages being displayed. • Limiting the display of filler messages to not more than 30% of off-peak times shall reduce the risk of frequent exposure to non-critical information leading to VMS messages being ignored. At all other times, the VMS will be blank or in 'exercise' mode, with displays of wording of hazards, conditions and/or traffic management information.
Text case selection	Upper and Lower Case Upper and lower case with capital letters at the start of each word on VMS where systems allow for this to occur. This allows for the necessary distinction between critical messages and lower-order (non-critical) message types.

5.3.2 Abbreviations

5.3.2-1 Abbreviations – Queensland

See Appendix C-1 for approved Queensland-specific variants on national guidance for abbreviations for use on variable message signs.

5.4 Message content and format

5.4-1 Variable message sign statements

See Appendix D-1 for approved Queensland-specific variants on national guidance for variable message signs problem statements.

See Appendix E-1 for approved Queensland-specific variants on national guidance for generic messages.

5.6 Applications of Variable Message Signs

5.6.9 Vehicle activated intersection and road geometry signs

5.6.9-1 Bicycle activated warning signs

1 Purpose and scope of this section

Road treatments to improve operational safety for cyclists at hazards (such as road or bridge carriageway narrowings or sightline restricted locations 'blind spots') have, to date, taken the form of Bicycle Awareness Zones (BAZ), which use road pavement markings and associated signage to highlight the possible presence of cyclists.

Research[1] undertaken by the Department of Transport and Main Roads has demonstrated the effectiveness of the BAZ treatment at various narrow road lanes in Queensland; however, these permanent static hazard warning signs and pavement markings may lose credibility if the location is infrequently used by cyclists, to the point that motorists who use a location regularly may not be expecting to see cyclists. This can result in the treatment being ignored or disregarded by impatient drivers, particularly in situations such as lengthy two-lane bridges or stretches of narrow roads. The installation of dynamic signage, in the form of bicycle- or cyclist-activated electronic signs, is an additional measure which may improve driver awareness and reduce operational risks for all road users at high-risk squeeze point locations.

The 2013 Transport and Main Roads commissioned-AARB study *Innovative Treatment for Pinch Points* reviewed current practice in Australia and New Zealand (where dynamic cyclist warning signage is in use). In this study, bicycle-activated hazard warning signs were trialled at eight narrow bridge locations already fitted with BAZ markings. Qualitative benefits (such as user perception) were observed during the trials and a perception survey was undertaken to evaluate the installations. Though attempts were made to measure the immediate effects of installations, the wide range of behaviours observed, and lateral overtaking distance measured, did not enable a robust quantification of benefits. Based on these trials, the study recommended that these devices be used sparingly as additional enhancements in high-risk locations, that their installation be closely monitored, and that advice be developed. The implementation of these devices is only recommended if it meets the use application qualifications detailed following.

This section should be read in conjunction with the following:

- Austroads *Guide to Road Design* Part 3 *Geometric Design*, Section 4.8 *Bicycle Lanes*
- Austroads *Cycling Aspects of Austroads Guides*, Section 4.2 *Key Design Criteria and Considerations*
- NZ Transport Agency *P32 Notes for Electronic Warning Signs on State Highways*
- NZ Transport Agency *P32 Specification for Electronic Warning Signs on State Highways*
- Queensland Department of Transport and Main Roads, *Traffic and Road Use Management* manual, Volume 1 Part 10 Section 6.5-1 *Bicycle Awareness Zones*

[1] Munro 2011, *Evaluation of narrow bridge treatments for cyclist safety: final report*, prepared by Sinclair Knight Merz, Transport and Main Roads, Brisbane, Queensland.

- Queensland Department of Transport and Main Roads, *Traffic and Road Use Management manual, Volume 3* Part 5 *Design Guide for Roadside signs*
- Queensland Department of Transport and Main Roads, Queensland *Manual of Uniform Traffic Control Devices*, Part 9 *Bicycle Facilities*
- Queensland Department of Transport and Main Roads Technical Note TN160 *Vehicle Activated Signs*
- Charlton, SG & Baas, PH 2006, *Assessment of hazard warning signs used on New Zealand roads*, research report 288, Land Transport New Zealand, Wellington, NZ.
- Koorey, G, *Planning & Design for Cycling – SIGN OF THE TIMES*, http://can.org.nz/system/files/Design-0504-WarningSigns.pdf
- Munro, C 2011, *Evaluation of narrow bridge treatments for cyclist safety: final report*, prepared by Sinclair Knight Merz, Transport and Main Roads, Brisbane, Qld
- Winnett, MA & Wheeler, AH 2002, *Vehicle-activated signs: a large-scale evaluation*, report TRL548, Transport Research Laboratory, Crowthorne, UK (TMR 2013).

2 *Purpose of active warning signs*

Bicycle activated warning signs (BAWS) can be installed as an interim treatment to alert motorists to the risk of encountering cyclists on a hazardous section of road. They are only for use where the standard reflectorized warning signs and pavement marking have been tried and found not to be sufficiently effective in warning drivers to modify their behaviour so that cyclists can safely negotiate the hazard(s). These traditional warning signs and pavement markings are especially likely to be ignored if cyclists are relatively rare, such as on rural routes with fewer than 100 cyclists a day.

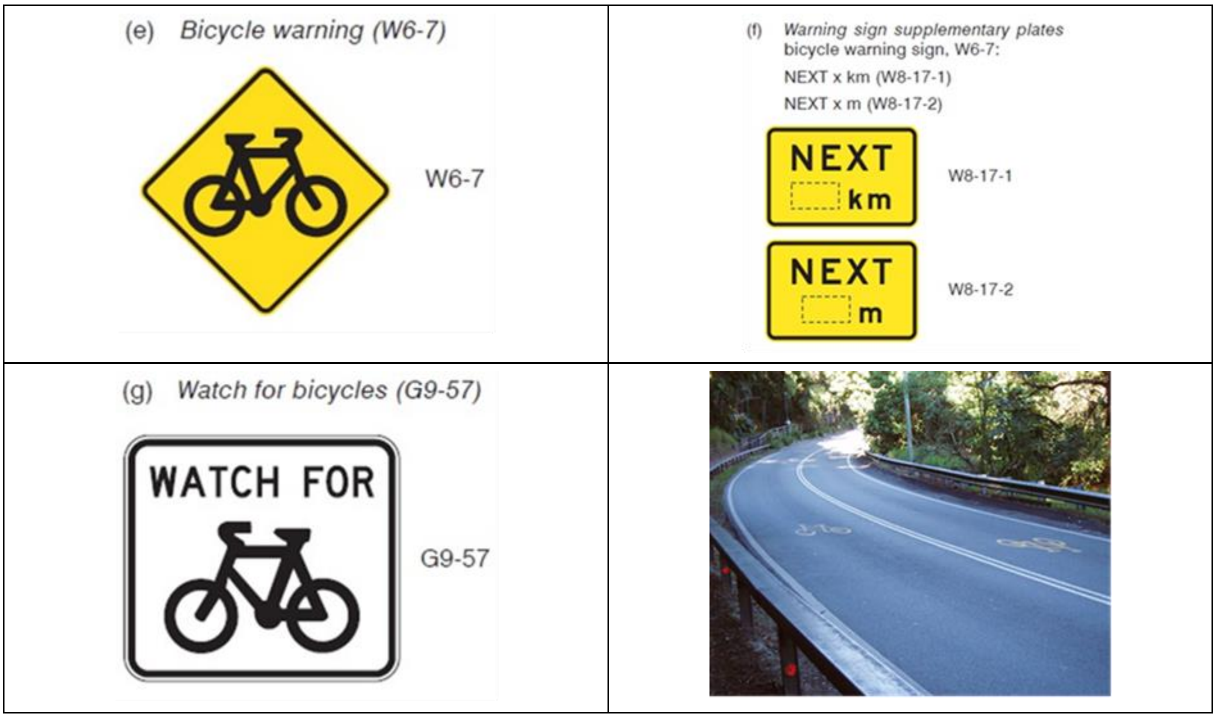
BAWS, when used, are intended to meet the following objectives:

- to highlight and draw drivers' attention to the presence of cyclists on the road, and
- to reinforce driver expectation of, and engender correct responses to, the hazard depicted by the sign.

BAWS can be an additional positive safety measure at hazardous locations when implemented in conjunction with traditional pavement markings and signage. This type of device can greatly improve credibility and awareness of existing signs and markings, by only activating when a cyclist is present.

BAWS must only be used as a supportive measure to increase awareness of the risks and to support already installed or co installed signs and pavement markings. They must not be installed on their own.

Figure 2 – Standard warning signs and pavement markings treatment options



3 When should bicycle activated warning signs be used?

BAWS may be considered as a retrofit advisory treatment in addition to standard warning signage and pavement marking, used to supplement, but not intended to replace them. BAWS must only be used as a treatment of last resort, after:

- an evaluation of existing treatments has shown them to be ineffective
- the risks (as outlined in this document) have been considered, and
- there is commitment to ongoing maintenance requirements.

It is only appropriate to use BAWS at locations where:

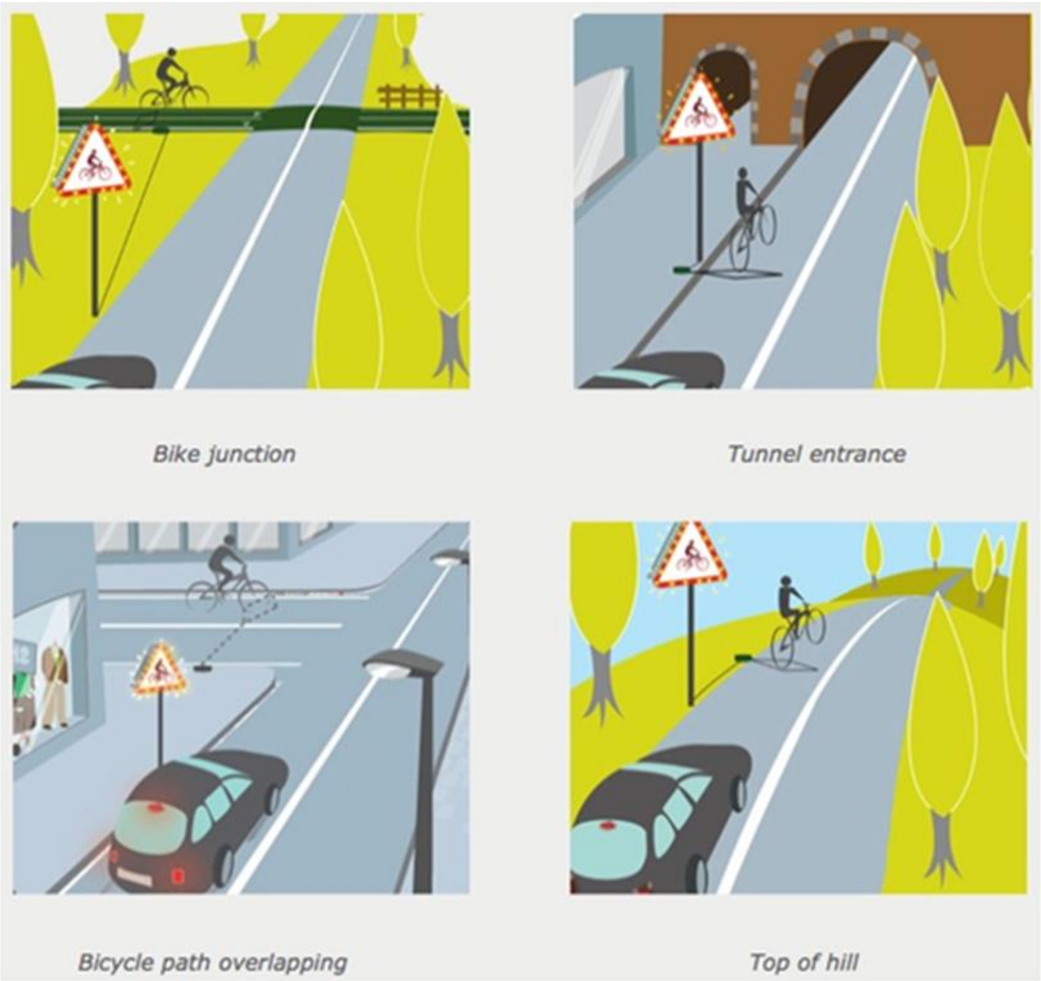
- there is a permanent feature of the road that is a hazard (especially one that is not obvious or apparent to the driver of a motor vehicle), and
- where cyclists are infrequent (or present only at irregular times of the day).

Historically, these signs have been installed at high risk locations, where the road width or space is constrained due to road design / layout which continues for some distance (such as on narrow bridges and viaducts) causing concerns for safety of cyclists using the area. Examples (shown at Figure 3) include:

- on narrow (lane width <3.5 m) bridges as a supplement to sign TC9700 NO OVERTAKING BICYCLES ON BRIDGE (see Figure 6(B)
- bicycle path priority crossing across local roads and on adjacent side roads with limited visibility from the road of the crossing (in advance of the intersection or path)
- on a sight-restricted crest or curve with a narrow (width <3.5 m) lane or a steep descent, and
- in advance of a tunnel, narrow or winding road system with restricted passing space.

BAWS have a supplementary purpose and must not be used to replace a primary static sign warning of the hazard – that is, all standard primary (static) signage must be in place before a BAWS can be installed as secondary signage.

Figure 3 – Examples of applications of use for the active warning signs



Note: The sign examples are from overseas and hence any similar signs installed in Queensland must meet MUTCD and TC requirements.

4 Risks associated with bicycle activated warning signs

Before a decision is made to install and operate a BAWS, there are several risks that are unique to this type of signage (that are not risks for standard signage). These risks must be carefully considered, and countermeasures must be put in place.

Risk of ‘conditioning’ the driver

The intent of these signs is that they will only activate when a cyclist is present in the ‘hazardous’ section of road, to inform motorists of the presence of cyclists and the need to alter their driving behaviour. The inherent risk of installing such a system is that drivers may become ‘dependant’ upon the sign activating to inform them of the presence of a cyclist. If motorists do become conditioned in this way, there is a risk that if the sign malfunctions or is damaged / vandalised then they will not expect to see the cyclist.

Risk of lack of activation

The sign must also be activated by cyclists by either a push button or cycling over a pavement bicycle detector. If the detector or push button are not properly maintained and are repeatedly out-of-order, this will affect user confidence and acceptance of the system. In some instances, there is a risk that, even once repaired, cyclists may fail to activate the sign. If a cyclist deliberately fails to activate the sign, then the credibility of the sign will be damaged, and it will be ignored.

Need for continual monitoring and maintenance

Research on similar systems (school zone flashing lights) has shown that hardware reliability is a major issue, particularly if the system to be installed does not have an inbuilt electronic ‘report-fault-to-base’ capability. As a result, there is a need for a dedicated maintenance program to ensure the sign is continually operational and to have maintenance systems in place. If the system does not have an inbuilt electronic ‘report-fault-to-base’ capability, then information must be provided on site (such as a toll-free phone number to contact) to allow for prompt repairs. If batteries are used as part of the system, they must be checked and replaced as part of the regular maintenance program.

Risk of electrical failure

When compared with static warning signage, the life of active warning signage is considerably shorter due to the inevitable deterioration of electrical components and exposure to the elements. In addition to regular maintenance, plans must be made to replace the signage in line with the manufacturers’ information on the expected life of the product. Mains power may be difficult to obtain in isolated locations. If solar powered, battery backup will be essential for cloudy days.

Risk of mechanical failure

If the bicycle detector is using an ‘in pavement’ detector (such as an induction loop), there will be a risk of damage of equipment from road resealing or pavement rehabilitation works. Coordination with the asset manager will be essential.

Risk of vandalism and theft of components

A case study from New Zealand highlighted the risk of deliberate vandalism and theft of high-value electrical components. In this case, a pair of solar-powered BAWS installed on a 300 m-long bridge was stolen twice (the entire pole was cut down). At the same site, due to the prominence of the sign, they were also shot at with a shotgun, which required the replacement of the full door assembly and electronics on both signs.

5 When are bicycle activated warning signs not suitable?

BAWS are not suitable treatments:

- in locations where there are large numbers of cyclists (regular presence on the road)
- in greenfield applications – higher order bicycle facilities such as bicycle lanes and paths should always be provided in newly developing areas

- where bicycle lanes are achievable through minimal infrastructure works (for example, lane width reallocation after resurfacing program)
- as a wayfinding device or 'gap filling' in mixed off road / on road routes, and
- on roads with an AADT greater than 20,000 vehicles per day in one direction and/or more than two lanes in each direction.

The BAWS treatment is used primarily as a warning symbol but must be used sparingly and limited to specific conflict / danger points.

6 Signage specification

Active warning signs are discrete signs, which remain blank until activated by an approaching bicycle. Signs shall be operational only when cyclists are present in the hazard zone. Activation should be by means of bicycle-sensitive induction loops. A separate signed manual activation button is also recommended to build cyclist confidence in the system's operational capacity (see Figure 6(B)).

The display size must be comparable with the static sign for that speed environment, with larger sizes required in higher speed environments.

Supplementary plates must be used in conjunction with the particular sign to indicate the condition that is in place when the lights flash, for example:

- (BICYCLES) ON BRIDGE
- (BICYCLES) ON ROAD
- (BICYCLES) IN TUNNEL.

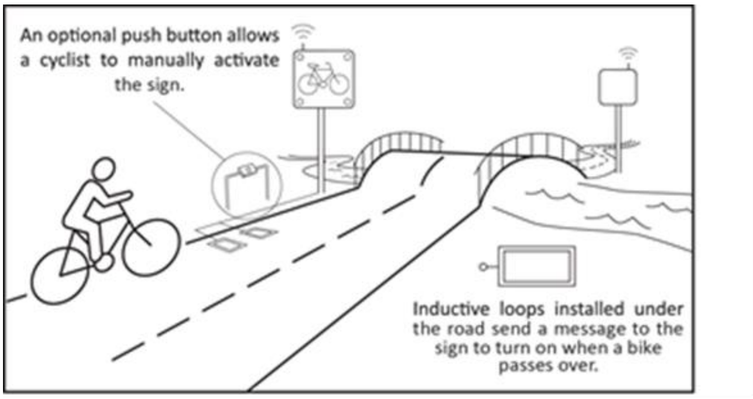
BAWS must always be installed in conjunction with an approved TC or MUTCD sign displaying the appropriate message relative to the hazard (see Figure 6(A)). For an approved example of an active warning sign, refer to TC sign TC1921.

Figure 6(A) – Examples of bicycle activated warning signs that replicate MUTCD requirements

The left sign uses LED displays. The right sign uses alternating flashing lights and static warning signs. For an approved example of an active warning sign, refer to TC sign TC1921.

Frangible sign supports must also be used to minimise the risk of a serious injury to vehicle occupants, should a collision occur. The use of the slip base mechanism on the signpost is a better alternative than the construction of a barrier to protect a stiffer post or sign support.

Figure 6(B) – Layout of sign assembly and detector loops



Note: This figure does not show the required static sign associated with the flashing warning sign and the sign example is from overseas, hence any similar signs installed in Queensland must meet MUTCD and TC requirements.

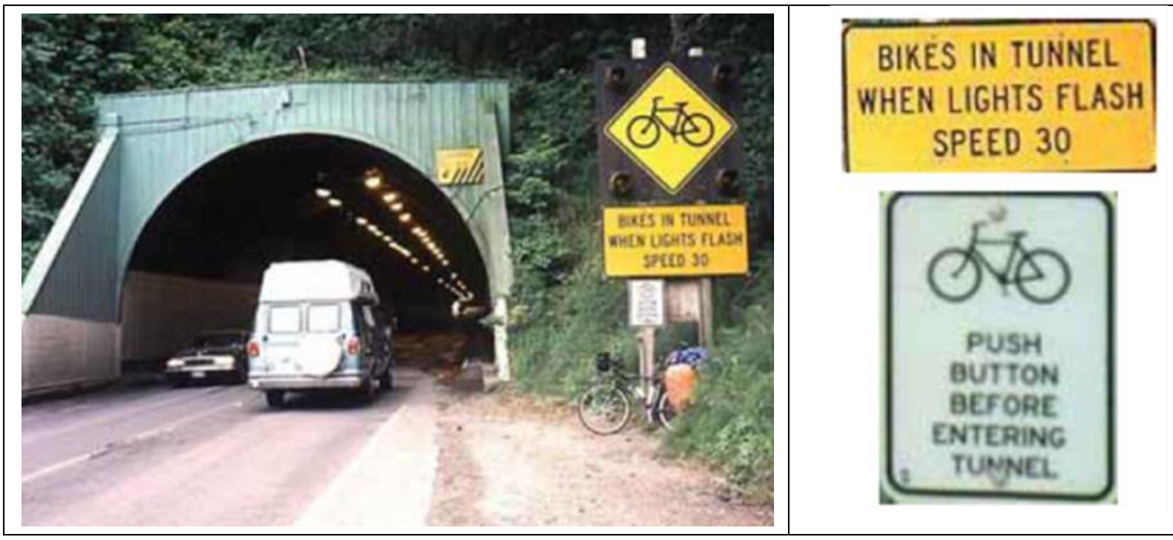
Figure 6(C) – United States' examples of bicycle activated warning signs

Note the use of supplementary plates to indicate the presence of cyclists. The sign examples are from overseas and hence any similar signs installed in Queensland must meet MUTCD and TC requirements.

Figure 6(D) – Active warning sign on a narrow winding road near Steamboat, Colorado

Figure 6(E) – Mad River Bridge, California

Figure 6(F) – Arch Cape Tunnel, Oregon



7 Site assessment and selection process

Before making a decision to install a BAWS, it is important to undertake an audit of existing road furniture, fixed signs, road condition and road markings to assess their standard and condition. A BAWS must only be deployed when it is clear that the problem cannot be remedied by improving the existing static signing and/or line marking.

Selecting a site

The aim of the installation of BAWS is to enhance driver awareness of a hazard ahead, but some sites may not be suitable. A recent evaluation of the performance of (motor) vehicle activated signs (VAS) in Queensland found that the signs generally do not perform well[2]:

- on roads with high volume of traffic – it is generally not recommended to install a VAS on roads with an AADT greater than 20,000 vehicles per day in one direction (this figure was determined for roads with two lanes in each direction)
- on roads with a speed limit equal to or greater than 100 km/h (the signposted speed limit may be reduced in advance of the hazard and a VAS installed)
- on roads with more than two lanes in each direction
- on approaches with vertical or horizontal curves or gradients (external radars may be more effective on some such approaches)
- on roads with a high percentage of heavy vehicles (that may result in the sign frequently being obscured by the slower moving vehicles)
- in areas with a dense canopy of trees (option to locate solar panel remotely)
- on roads with a limited forward visibility (for example, due to road geometry), and
- on roads with an overtaking lane (speeding vehicles are often obscured by larger vehicles on the nearside lane).

[2] Vehicle Activated Signs Operational Guidelines (under development), Queensland Government, 2012

These issues will be similar for BAWS and therefore site assessments are required. Table 7(A) details the key evaluation components of sites, and the installation of these signs.

***Table 7(A) – Site assessments for Bicycle Activated Warning Signs* [3]**

Criteria	Considerations
Crash history	Review crashes that have occurred at the location related to cyclists. Did vehicles wanting to overtake cyclists in narrow space cause the crashes? Where there is limited crash history, site observations of behaviours should be considered.
Posted speed limits	Wherever possible, conduct a speed survey at the proposed location to establish what the speed of traffic is and whether there is a problem with vehicles travelling at inappropriately high speeds.
Traffic volumes	Traffic volumes must be below 20,000 vehicles per day in one direction.
Site geometry	BAWS are most effective on a straight, level road; however, signs with external radars may be implemented on approaches with vertical or horizontal curves or gradients, providing there is a clear sight line between the driver and the sign, so the driver can be exposed to the sign message for at least three seconds. If the road geometry prevents these criteria being met with an external radar, the site is not suitable for treatment with BAWS. BAWS must be placed on roads with only one lane in each direction.

Positioning of the sign

In addition to standard signage practice, consideration should be given to the following requirements:

Cyclist activation of the sign

- What is the likely path of the cyclist(s)?
- Is the likely path of cyclist(s) clear of parking spaces, driveways or other property access points?
- Is the bicycle detector type suitable for the application? (for example: for an exclusive bicycle lane approach to the pinch point, a more sensitive detector can be used, whereas a narrow lane with mixed traffic will require a detector that can distinguish between bicycles and motor vehicles).

Operation of the sign

- Is the sign clear of vegetation that could potentially affect the operation of the solar panels?
- Does the installation location have sufficient sunlight for solar panels to charge the batteries for the predicted number of actuations?
- Is the mounting height sufficient to optimise visibility and reduce the risks of vandalism?
- Is there any existing infrastructure requiring modifications? (for example, parking spaces, no stopping lines).

[3] Content sourced from Vehicle Activated Signs Operational Guidelines (under development), Queensland Government, 2012.

Visibility of the sign

- Is the sign suitably visible to minimise potential conflict with existing signs? Is there a risk it will be lost in the signage clutter?
- Is the signage clear of vegetation that may obscure the visibility of the sign?

The site needs to be assessed to ensure the appropriate placement of the sign can occur before implementation. Operation and ongoing maintenance of the sign should also be considered; see Table 7(B) for further details.

Table 7(B) –Bicycle Activated Warning Signs: placement and operation

Criteria	Considerations
Sign placement	• Sign must be clearly visible and not obscured by trees, shrubs or other signs (now and into the future). • There must be no overhanging trees to obscure the solar panel. • Signs should not be located under power lines but, if this cannot be avoided, there must be sufficient clearance between the top of the signs and the power cables. • Signs must be located on a straight, level approach where possible to ensure there is enough time for the radar to detect the cyclist and to display an appropriate message. • Other factors that may affect the function of any sign and should be considered include locations of driveways, parking bays, vegetation obstruction, and other conflict zones that may impede driver's view of the sign or otherwise interfere with the sign's radar operation. • Signs shall be placed at, or immediately prior to, the hazard zone. There must be a static sign warning of the hazard (for example, narrow bridge, tunnel ahead, road narrows) before the BAWS, which should be placed between the static sign and the hazard. • Activation should be sensors placed where cyclists will reliably activate them. A separate signed manual activation button is also recommended to build cyclist confidence in the system's operational capacity. The manual activation button must be lit so it is visible for night-time operation.
Lateral placement and mounting height	The lateral placement of a BAWS must be determined in accordance with MUTCD Part 1 Sections 12.3.2 Similarly, the mounting height of BAWS must be determined in accordance with MUTCD.
Operation	The sign LED colours must replicate the sign display (design and colour) in the MUTCD or TC as closely as possible (but with black background). The intensity of the LEDs should be able to be adjusted according to different light conditions (including night-time activation). When the sign is not activated, it must remain blacked out. The sign must be programmed so, if there is a malfunction, the sign should remain blank / blacked out.
Sign display	Signs must conform with the MUTCD or TC sign designs (design and colour must be replicated) and must not contain any non-standard pictograms or messages.

Criteria	Considerations
Sign support	To maintain the forward visibility of a BAWS, it may be necessary to place the installation within the clear zone. While the speed reducing feature of a BAWS is likely to reduce the likelihood of a crash, placing the sign in the clear zone increases the risk of an errant vehicle colliding with the BAWS support. If the sign is placed in the clear zone, frangible sign supports must be used to minimise the risk of a serious injury to vehicle occupants, should such a collision occur. The use of the slip base mechanism on the signpost is a better alternative than the construction of a barrier to protect a stiffer post or sign support.
Maintenance	A regular maintenance program is essential for these signs. Back to base monitoring or remote alert technology should be included in the sign design to improve operational reliability. If the system does not have an inbuilt electronic 'report fault to base' capability, then information must be provided on site (such as a toll-free phone number to contact) to allow for prompt repairs.

8 Case studies

Figure 8(A) – Narrow bridge treatments in Marlborough and Arthur, New Zealand

Note: The sign examples in this image are from overseas; any similar signs installed in Queensland must meet MUTCD and TC requirements.

Flashing LED warning signs have been installed in various parts of urban and rural New Zealand since 2009. A number of these signs have been located on busy rural roads on the approaches to narrow two-lane bridges. The first of these signs at Appleby in the north of New Zealand's South Island was mains powered. Units subsequently installed have been solar-powered.

The unit pictured is on State Highway 1 at the bridge across Wairau River between Spring Creek and Tuamarina in the Marlborough district. It is powered by a solar panel. This unit is in a remote location and has been subject to theft and vandalism attacks on three occasions since its installation in 2011.

The installation consists of a cyclist activated sign panel at each end of a 300 m long river bridge. Each sign is powered by its own solar panel. The signs are triggered by cyclists riding over bicycle detection loops located in the roadway adjacent to the signs. In June 2011, new loops were put into the pavement approximately 20 m before each sign so that, as the cyclist rides over the loops, he or she will be able to see the sign light up and know that the sign is on. These trigger the sign to display for approximately 1 minute 45 secs (enough time for a cyclist to get across the bridge).

The sign is manufactured by HMI Technologies and the loop detector circuitry is made by Eco counter with Zelt Inductive Loops.

The batteries inside the sign and the loop detector circuitry need to be checked and replaced with a regular maintenance program. Approximate battery life expectancies are one year for the batteries in the Eco counter circuitry and three years for the HMI sign panel.

The first systems to be installed lacked built in remote alert features which reduced reliability. The newer systems have this technology included in the sign.

Other systems have been installed in different locations, some to warn road users on narrow sections of roadway without a sufficient shoulder. A solar powered hazard sign has been installed in Auckland City for $60,000 at the intersection of Tamaki Drive and Ngapipi Road east of central Auckland.

A cyclist-activated flashing LED panel associated with a static warning sign is activated when citybound (westbound) cyclists approach the intersection. The purpose of the signage is to warn eastbound motorists queuing to turn right at the intersection into Ngapipi Road that cyclists are approaching from the opposite direction.

The council's transport committee decided to install the sign as a trial after 12 cyclists were injured in crashes at the intersection over five years, making it the city's second worst black spot for cyclists.

Figure 8(B) – Narrow roadway (no shoulder), Rocky Point, Washington USA

Note: The sign examples in this photo are from overseas; any similar signs installed in Queensland must meet MUTCD and TC requirements.

This flashing-beacon system was installed at Rocky Point on State Route 150 between Chelan and Manson in Washington State, northwest USA. The solar powered yellow flashing lights are automatically triggered when a bicycle passes, alerting drivers to the signs between the beacons that say, ‘narrow shoulder’ and ‘watch for bikes’.

The project originated in July 2011 when Washington State Department of Transport (WSDOT) was contacted by a Manson resident concerned about the increase in vehicle and bicycle traffic on the highway during the summer tourism season. During the next two years, WSDOT analysed collision data and conducted outreach efforts that generated feedback from residents and a variety of user groups confirming the need.

WSDOT determined flashing beacons were the best alternative; however, bringing power to the site was cost prohibitive. Eventually, a solar panel system combined with a seasonally scheduled daily timer was developed. The next issue to resolve was the detection system. Current WSDOT bike beacons are manually activated by the rider; this one detects bikes with a radar system that differentiates between bicycles, pedestrians and motorcycles.

Engineers completed final design and plans, a contractor was selected, and the new flashing beacon pole was fabricated before installation and testing, and final adjustments were complete before the US$16,000 system went into service.

Feedback from drivers and riders during the initial operational period has been positive. If the system proves successful, WSDOT will consider other remote locations for installation.

Figure 8(C) – Narrow bridge (no shoulder), Noosa Parade, Munna Point Bridge, Noosa Heads, Australia

Note: The sign examples were based on a trial and hence any similar signs installed in Queensland must meet MUTCD and TC requirements.

The BAWS trial is located at two narrow bridges along Noosa Parade in Noosa Heads – the Munna Point Bridge and the Sheraton Bridge. The bridges are approximately 120 m and 60 m long respectively and very narrow (6.5–7.5 m in width). In addition, as can be seen in the photo provided, the Munna Point Bridge is located on a hill with the crest halfway along the bridge, creating a potential hazard as motorists often cannot see cyclists on the bridge over the crest. The BAWS operate with an on-route detection loop and have solar panel operation. BAZs also exist on both bridges.

Sunshine Coast Regional Council had experienced a large number of customer complaints at Munna Bridge on Noosa Parade when the BAZ pavement markings were installed. The number of complaints reduced when additional signs were installed to supplement the BAZ markings. There had also been a number of pinch point related crashes at both locations. Council proposed a trial of BAWS at the two bridges.

Surveys undertaken at the trial locations observed vehicles slowing down significantly prior to overtaking a cyclist, when the dynamic sign was activated. Early braking was also employed by drivers once the dynamic sign was activated even when cyclists were not visible to drivers. Drivers also gave cyclists ample room when overtaking on the bridge, including crossing the double lines to do so. It is noted that Queensland legislation requiring motorists to leave 1–1.5 m clearance when overtaking cyclists legally permits crossing the double lines, providing it is safe to do so. The treatment also had positive influences on cyclists' perceptions of safety.

Due to the relatively low cost of installing BAWS compared with a full infrastructure upgrade, it is logical to consider them as the next level of treatment for high traffic volume and high cyclist demand locations with physical constraints and engineering challenges, for example, high bridge widening costs.

5.7 Electronic speed limit signs

5.7-1 Guidelines for the permanent placement of variable speed limit and lane control signs for motorways, long bridges and tunnels

1 Introduction

This supplement defines the placement and mounting requirements for variable speed limit (VSLS) and variable speed limit and lane control signs (VSL / LCS) on motorways, long bridges and in tunnels.

2 Scope

2.1 In scope

This supplement defines the requirements for VSLS and VSL / LCS necessary to implement a variable speed limit zone and lane control on motorways, long bridges and in tunnels. This supplement defines the placement of electronic variable speed limit signs as described in the Queensland *Manual of Uniform Traffic Control Devices* (MUTCD) Part 4 *Speed controls*.

This supplement defines the requirements for the permanent:

i) placement of VSLS and VSL / LCS, and

ii) mounting arrangements for VSLS and VSL / LCS.

This supplement shall be read in conjunction with all relevant technical standards – in particular, the technical standard for *Provision of Variable Speed Limit and Lane Control Signs* (MRTS206).

2.2 Out of scope

This supplement does not define the placement of static variable speed limit signs (for example, school zones) and changing message variable speed limit signs as described in MUTCD Part 4 *Speed Controls*.

This supplement does not define the placement of electronic VSLS or VSL / LCS for:

i) arterial roads (including school zones and other special speed zones), and

ii) work zones. Refer to MUTCD Part 3 *Works on roads* and the *Traffic and Road Use Management* manual and relevant Supplements for the use of permanent variable speed limit and lane control signs in construction and maintenance work areas on motorways.

This supplement does not define the placement of:

i) lane control for the purposes of tidal flow, and

ii) dynamic lane use signs for the purpose of designating special purpose lanes: that is, transit lanes.

This supplement does not define the procedure for determining the maximum posted speed limit of a road. Refer to *Manual of Uniform Traffic Control Devices* (MUTCD): Part 4 *Speed controls*.

2.3 References

The following documents should be considered in conjunction with this document.

- The Queensland Manual of Uniform Traffic Control Devices (MUTCD), and
  - Part 1 *General information and sign illustration*
  - Part 3 *Works on roads*
  - Part 4 *Speed controls*
  - Part 14 *Traffic signals*
- Traffic Control (TC) signs
- Transport and Main Roads Technical Specification MRTS206 *Provision of Variable Speed Limit and Lane Control Signs*
- Road Planning and Design Manual (2nd edition) Vol. 5 *Intelligent Transport Systems*
- Transport and Main Roads' *ITS Placement Guideline*
- Transport and Main Roads' Engineering Policy EP149 *Managed Motorways*
- Austroads *Guide to Smart Motorways*.

For further details, please contact Director (Active Network Operations) in Engineering and Technology Branch.

3 Background

3.1 Variable speed limit zones

A VSL zone may be applied on a motorway, long bridge or in a tunnel to allow a reduction in the posted speed limit at times when road safety and performance are compromised, and where fulltime lower static speed limits are inappropriate. The variable speed limit zone is implemented through the use of VSLS and selected static signs.

The main objectives of a VSL zone are to control the posted speed limit within the zone to:

i) manage the operating speed and, thus, optimise the traffic flow rates by reducing the probability of flow breakdown and congestion

ii) if congestion occurs, manage the operating speed of traffic approaching and departing the congestion to restore the optimal flow rate as quickly as practicable

iii) reduce the likelihood of traffic crashes (especially secondary crashes) by reducing the speed of vehicles as they approach an incident, traffic queue or stoppage

iv) reduce the speed differentials between mainline traffic and entrance ramp traffic to improve safety and help prevent traffic flow breakdown

v) minimise the potential risk of injury to the public and emergency personnel at incidents or workers during maintenance / construction by reducing the speed limit approaching and passing through the site, and

vi) manage safety during poor weather or road conditions by reducing the speed limit to an appropriate speed for the prevailing conditions.

Variable speed limits are used in the management of two types of traffic congestion as defined in Table 3.1.

Table 3.1 – Management of traffic congestion using variable speed limits

Type of congestion	Example of conditions
Recurrent	• Regular periods of congestion where throughput, safety and emissions could be improved, or • where the performance of the road consistently changes depending on the time of day.
Non-recurrent	• Congestion due to incidents • maintenance / construction activities • inclement weather, or • special events.

3.2 Variable speed limit signs

VSLS are regulatory signs as defined by the Transport Operations (Road Use Management – Road Rules) Regulation 2009. The sign shall appear similar in layout to the speed restriction sign (R4-1), except with illuminated white numerals within an illuminated red annulus on a black background.

3.3 Lane control

Lane control may be used to close lanes on motorways, long bridges or in tunnels, in response to traffic incidents to improve safety.

The main objectives of lane control are to:

i) promptly close lanes to improve the safety of individuals impacted by, or responding to, an incident and to minimise the likelihood of secondary incidents

ii) complement traffic control during maintenance (see Queensland MUTCD Part 3 for the use of permanent variable speed limit and lane control signs in construction and maintenance work areas on motorways for details)

iii) change lane allocations or function during works or incidents, and

iv) restrict lane use to facilitate safe enforcement operations where interception sites are provided.

Lane control shall be considered:

i) for enforcement purposes if it is required by Queensland Police Service (QPS)

ii) for carriageways that do not meet the minimum specified design requirements: for example, narrow lanes or inadequate shoulder width

iii) if the variable speed limit zone is located on the critical structure: for example, bridges, tunnels

iv) for specific operational and maintenance requirements if it is identified by the road authorities who manage the facilities

v) for specific physical / geometric constraints where the road authority decide that lane control is required.

Refer to Section 12 *Selection of a gantry type for lane use management system, variable speed limit signs and other signs* as a reference tool for mounting considerations.

- Devices must be able to be accessed and maintained effectively from the overpass.
- The whole-of-life evaluation includes the cost of the gantry, the cost of maintenance of the gantry and devices and the cost of traffic control for the road closure if required. A walk-on gantry is required if the devices cannot be maintained from the road.
- If the base of the gantry cannot be accessed with a vehicle parking space, then the devices and structure will need to be maintained using a cherry picker from the ground.
- The decision to maintain the gantry from the road will require a whole-of-life evaluation of the cost of the gantry, the cost of maintenance of the gantry and devices and the cost of traffic control for the road closure if required

3.4 Lane control signs

The lane control signs are regulatory signs as defined by Queensland MUTCD Part 14 and TORUM. They comprise:

i) a green or white arrow or a speed limit sign to indicate the lane is open

ii) a flashing red cross to indicate the lane is closing

iii) a red cross to indicate the lane is closed.

In general, only hybrid VSL / LCS are used where speed display indicates the lane is open. Lane control signs are incorporated as part of the variable speed limit signs as discussed in Section 3.5 *Integration of variable speed limit signs and lane control signs*.

Advice shall be sought from Traffic Engineering Technology and Systems, Engineering & Technology, Transport and Main Roads to display standalone lane control signs.

3.5 Integration of variable speed limit signs and lane control signs

A VSL / LCS integrates both variable speed limit and lane control displays into one sign for use on motorways, long bridges or in tunnels. The VSL / LCS is installed on an overhead structure, one sign per lane, to control each lane of the mainline carriageway.

The concept of operation of VSL/LCS is shown in Figure 3.5 for each display, where:

i) the lane is open to all traffic at the indicated posted speed limit when a variable speed limit is displayed above the lane

ii) the lane is soon to close to all traffic when a flashing red cross is displayed above the lane

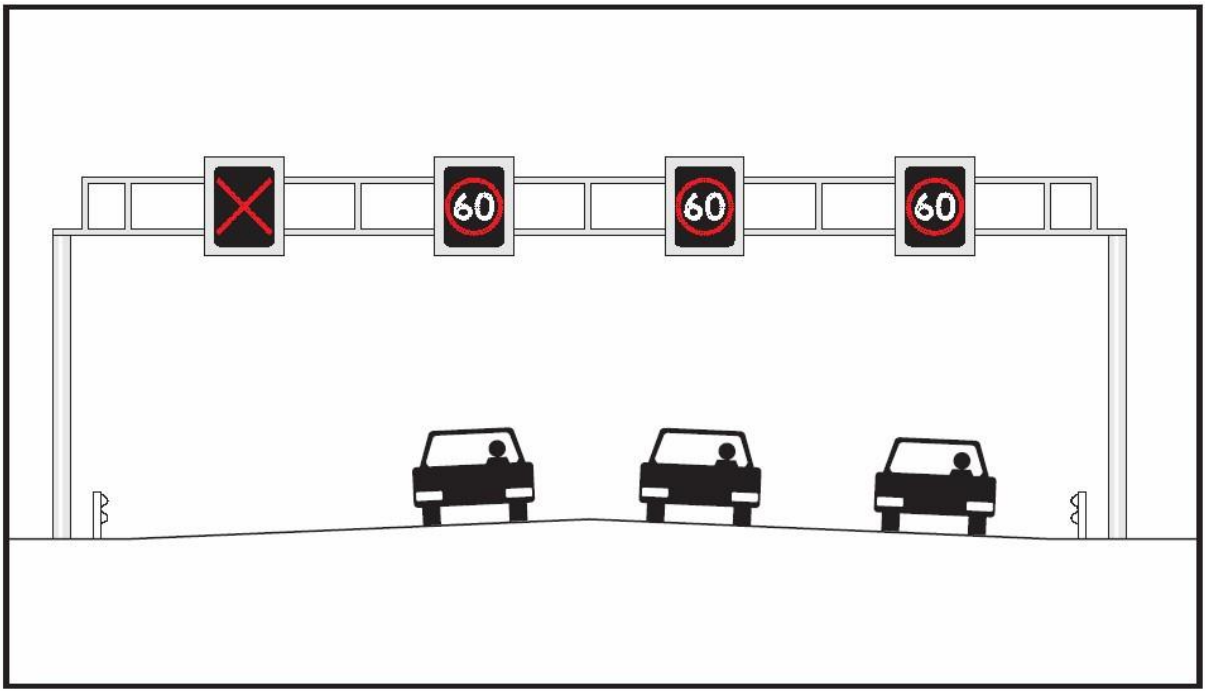
iii) the lane is closed to all traffic when a red cross is displayed above the lane, and

iv) the lane will remain closed until a downstream VSL / LC displays a speed limit above that lane or a lane control ends sign (TC9060) is placed after the last downstream VSL / LCS (see Section 6.2 *Exit point from a variable speed limit and lane control zone*).

The variable speed limit component of the VSL / LCS shall meet the regulatory requirements as defined in Section 3.2 *Variable speed limit signs* previously. The lane control component consists of a red cross that meets the regulatory requirements of Section 3.5(ii) previously.

In addition, the VSL / LCS shall be capable of displaying a left and a right arrow diagonally upwards. A pointing arrow indicates that drivers can follow the direction of the arrow and exit the motorway using the nearest exit ramp.

Figure 3.5 – Concept of operation of Variable Speed Limit / Lane Control Signs



4 Display

4.1 Variable speed limit signs

Section 21 of the Transport Operations (Road Use Management – Road Rules) Regulation 2009 provides for a permitted variation of the standard speed restriction sign in the form of a variable illuminated speed limit sign.

The VSLS shall be in accordance with TC1785. All variations from this section shall be approved by the Active Network Operations Unit of Transport and Main Roads.

A light emitting display for the VSLS shall be implemented using light emitting diode (LED) technology as shown in Figure 4.2(A) and shall comply with the following:

i) white LEDs shall be used for the numerals

ii) the red annulus shall comprise red LEDs: the inner part of the annulus shall flash so as to highlight to drivers that the regulatory speed is that other than the default speed limit, and

iii) the flashing annulus of all signs at the same site shall flash in synchronisation.

4.2 Variable speed limit / lane control signs

The variable speed limit component of the VSL / LCS shall comply with the requirements of Section 4.1 *Variable speed limit signs* previously.

The VSL / LCS shall be in accordance with TC1792 and capable of displaying a solid and flashing cross as per Figure 4.2(A). All variations from this section shall be approved by the Active Network Operations Unit of Transport and Main Roads.

It is required that the VSL / LCS also include the ability to display two white arrows as shown in Figure 4.2(B). All variations from this section shall be approved by Active Network Operations of Transport and Main Roads. The arrows shall comply with the following:

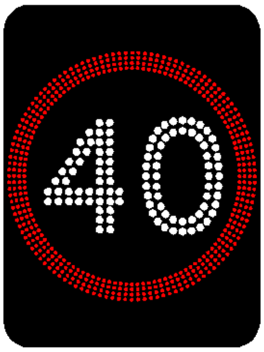
i) left arrows can only be displayed in the kerbside (left-most) lane(s), immediately upstream of a left-hand side (LHS) exit ramp and right arrows can only be displayed in the median (right-most) lane(s), immediately upstream of a right-hand side (RHS) exit ramp

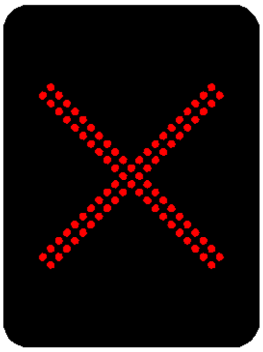
ii) arrows shall not be displayed in lanes that do not have provision for traffic to exit

iii) arrows shall not be displayed in lanes other than those closest to the exit ramp, and

iv) arrows cannot be used to instruct traffic to merge into another mainline lane. Arrows can only be used to direct traffic to exit the motorway.

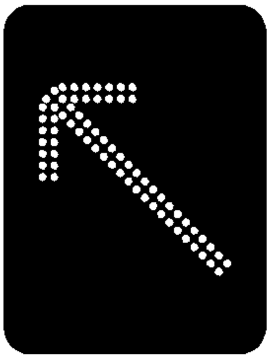
Figure 4.2(A) – Variable speed limit and lane control signs

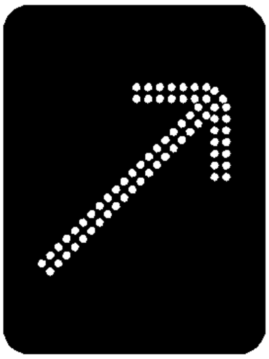




Variable speed limit	Lane control sign

Figure 4.2(B) – Sign displays





Sign display for an open left-hand side exit during kerbside lane closure	Sign display for open right-hand side exit during median lane closure

5 Sign placement

5.1 Exit points from a variable speed limit zone

Static speed restriction signs shall be provided at all exit points from a variable speed limit zone (including on the mainline carriageways and at each exit ramp).

Static speed restriction signs shall be installed in accordance with Part 4 of the MUTCD.

Fixed speed zone on the mainline carriageway shall be established prior to an entry ramp. Placement of a speed restriction sign R4-1 should allow suitable acceleration distance for the mainline traffic prior to interacting with entering traffic.

Exit points on the mainline road shall be a distance downstream from the last VSLS consistent with the maximum VSLS length (described as spacing in Section 6.3 *Variable speed limit signs and variable speed limit / lane control signs on motorway and long bridge carriageways*).

5.2 Exit point from a variable speed limit and lane control zone

Further to Section 6.1 *Exit points from a variable speed limit zone*, mainline exit points from a lane control zone shall be designated by a static Lane Control Ends sign (TC9060 as shown in Figure 6.2).

TC9060 shall be installed downstream from the last VSL / LCS on the mainline carriageway and should be installed at a distance consistent with the average spacing guidelines (Section 6.3 *Variable speed limit signs and variable speed limit / lane control signs on motorway and long bridge carriageways*) of VSL / LCS on that mainline carriageway.

TC9060 should be installed prior to the exit ramp, immediately downstream of the last VSL / LCS to allow sufficient safe merge distance of traffic from the furthermost lane to the exit and where a minimum VSL / LCS length (described as spacing in Section 6.3 *VSLS and VSL / LCS on motorway and long bridge carriageways*) between TC9060 and the last VSL / LCS cannot be achieved, it is permitted to place TC9060 after the exit ramp. Installing a TC9060 downstream from an exit will restrict the VSLS' and/or LCS's ability to reopen lane(s) to allow drivers to exit.

Static speed restriction signs R4-1 shall be provided after the lane control ends sign and their placement shall be in accordance with Section 6.1 *Exit points from a variable speed limit zone*.

Longitudinal placement of all signs shall be in accordance with Part 1 of the Queensland MUTCD and the TC signs database.

Figure 6.2 – TC9060 LANE CONTROL ENDS sign

5.3 Variable speed limit signs and variable speed limit / lane control signs on motorway and long bridge carriageways

VSLS or VSL / LCS shall be placed after the entry points to the variable speed limit zone to reinforce the current posted speed limit. The spacing between mainline variable speed limit signs (VSLS or VSL / LCS) shall be between 400 and 600 meters. The average spacing shall be 500 metres, the maximum spacing for VSLS shall not exceed 1000 meters.

A VSLS or VSL / LCS is required downstream of a motorway entrance ramp to reinforce the variable speed limit to drivers as they enter a VSL zone. Entering a motorway provides a high workload for drivers in terms of accelerating to the posted speed limit, merging with mainline traffic and observing the road conditions ahead; therefore, it is necessary to provide this reinforcement after any acceleration and merging has been completed and the driver is comfortable within the motorway environment. To reinforce the speed limit, a VSLS or VSL / LCS shall be provided 200 to 400 metres beyond the end of a motorway entry ramp taper (for both taper and parallel merges). For some parallel merges, this distance may vary according to the site conditions; however, if the design does not comply with this section, advice shall be sought from Traffic Engineering Technology and Systems, Engineering & Technology, Transport and Main Roads. Where an added lane results at an entrance ramp, the VSLS or VSL / LCS is to be located 200 to 400 metres downstream of the painted gore area.

It is not permitted to place VSLS or VSL / LCS in a merge or diverge taper. Advice may be sought from Active Network Operations, Engineering & Technology, Transport and Main Roads to place VSLS or VSL / LCS in an added parallel lane.

It is not permitted to place a single repeater VSLS in a road environment with VSL / LCS. Advice for inclusion of single repeater VSLS may be sought from Active Network Operations, Engineering & Technology, Transport and Main Roads.

Default speed limit static signs are not required on repeater VSLS or VSL / LCS.

5.4 Repeater variable speed limit / lane control signs in tunnels

Repeater VSL / LCS shall be placed after the entry points to the tunnel to reinforce the current posted speed limit.

The spacing adopted is site-specific, such that motorists are able to view at least one downstream sign at all times; therefore, the adopted spacing will depend on the sight distance to signs. The maximum spacing shall be 240 metres.

For side-mounted VSLS (for tunnels where the lane control function is not required), the maximum spacing shall be same as surface road as per MUTCD Part 4 requirements.

Default speed limit static signs shall not be provided on repeater VSL / LCS.

5.5 Change of maximum posted speed of road

Changes in the road geometry or road function may require a change to the maximum posted speed limit in variable speed limit zones. In these circumstances, a new default speed limit sign (TC1568) shall be installed in conjunction with the VSLS or VSL / LCS immediately upstream from the change.

5.6 Colocation of other signage with variable speed limit / lane control signs

On motorways or long bridges, it may be attractive to designers to collocate other signage (such as static signage and variable message signs) on the same gantries as VSL / LCS. Designers shall be aware of the amount of information presented to drivers at a single location. As such, the Road Operations Directorate of Transport and Main Roads may require the designer to undertake driver behaviour and comprehension studies prior to a decision being made about collocation.

Generally, in order to achieve optimal operational outcomes, lane-based static direction signs (provided 500 m prior to major decision points) should be collocated with VSL / LCS. Advice shall be sought from the Engineering and Technology Branch of Transport and Main Roads where this is not possible.

Non-lane-based static direction signs (provided at a nominal distance of 1000 m prior to major decision points) may be collocated with VSL / LCS in accordance with the requirements of the Austroads *Guide to Traffic Management* and Section 5.7-2 in this supplement.

Variable message signs may be collocated with VSL / LCS in accordance with the requirements of the Austroads *Guide to Traffic Management* and Section 5.7-2.

It is not permitted to collocate any signage other than that described previously (either static or variable) with VSL / LCS.

5.7 System interchanges

At system interchanges, where two connecting motorways are controlled by variable speed limits, the number of VSLS to be provided on the interchange ramps shall be the same as the requirement for static signage (refer to MUTCD Part 4). Where the EXIT SPEED sign (W1-9-1) is required, it shall be replaced with VSLS.

6 Maximum and minimum speed displays

VSLS and VSL / LCS shall be capable of displaying speeds in increments of 10 km/h between a minimum of 20 km/h and a maximum of 110 km/h. These speeds are in accordance with the range permitted in MUTCD Part 4 *Speed Controls* but are not absolute. During planning and design for VSLS and VSL / LCS on a specific road, MUTCD requirements and operational strategies shall be considered.

7 Mounting arrangements

On motorways and long bridges, Table 8 shall be used to determine appropriate mounting arrangements for VSLS and VSL / LCS. The details for side and overhead structure mountings are contained in sections 8.1 *Side-mounted* and 8.2 *Overhead structure mounting* of this supplement.

For major diverge of parallel carriageway, refer to Transport and Main Roads' *ITS Placement Guideline*.

For mounting arrangements in tunnels, refer to Section 8.3 *Tunnels* of this supplement.

Table 8 – Mounting arrangements

Number of lanes (entry ramp or carriageway)	VSLS or VSL/LC	Mounting arrangement required
1	VSLS	Side-mounted
2–5	VSLS	Side-mounted
	VSL/LC	Overhead structure
6 or more	VSL/LC	Overhead structure

7.1 Side-mounted

On single-lane entry ramps, a single VSLS shall be located on the left side of the ramp. On entry ramps with two or more lanes, a VSLS shall be located on each side of the ramp, opposite one another. While they are usually located in pairs, the signs may be separated longitudinally by up to 200 m.

On motorways and long bridges with two or more lane carriageways where lane control is not required, VSLS shall be located on each side of the carriageway, opposite one another. While they are usually located in pairs, the signs may be separated longitudinally by up to 200 m.

On motorways, the VSLS shall be mounted on poles and set into the ground or mounted in concrete barriers. Poles may only be installed in concrete barriers if the clearances comply with the working widths as specified in the Austroads *Guide to Road Design*.

On long bridges, the VSLS shall be mounted on the bridge structure such that errant vehicles sliding along the barrier cannot come into contact with the sign.

On entry ramps with variable speed limits and ramp metering, the VSLS shall be located downstream of the ramp metering stop line. Spacing between signs shall comply with the MUTCD.

The VSLS using pole mounting arrangements shall be in accordance with Figure 8.1. The VSLS pole-mounted installation shall include the installation of a safety barrier if the sign supports are located within the clear zone (refer to *Road Planning and Design Manual*).

As a minimum, size C VSLS (TC1785) signs shall be installed.

Figure 8.1 – Concept drawing for pole-mounted variable speed limit sign with supplementary static default sign (where applicable)

7.2 Overhead structure mounting

On motorways and long bridges, overhead structure mounting is required when lane control is required. The VSL / LCS shall be located on an overhead structure, with one sign located over the centre of each lane, in accordance with Figure 3.5.

The overhead structure may be either an overpass structure or a gantry. As a minimum, size C VSL / LCS (TC1792), size as defined in Part 4 of the MUTCD, shall be installed. The VSL / LCS overhead structure shall include:

i) minimum vertical clearance for heavy and oversize vehicles

ii) a safety barrier if the overhead structure supports are located within the clear zone

iii) in liaison with enforcement authorities, provision to mount and operate speed enforcement devices, and

iv) protection from vandalism and unwanted public access to equipment especially where signs are mounted on bridges with pedestrian access.

Lightweight gantries may be used as an overhead structure on bridges and where it is impracticable to provide shoulders or parking facilities for maintenance personnel. The decision to adopt a light or heavyweight gantry is a business decision at design stage.

7.3 Tunnels

In tunnels, entry ramp signs may be located overhead and may be integrated with lane control signs where required to sign a tunnel closure.

The VSL / LCS shall be mounted centrally above each lane as shown in Figure 3.5 except signs are roof-mounted instead of gantry-mounted.

Where tunnel height is insufficient to install VSL / LCS overhead, advice shall be sought from the Road Operations Directorate of Transport and Main Roads.

Note: it may be possible to protrude part of the sign above the signage allocation into the duct, ventilation or luminary space.

As a minimum, size B VSL / LCS (TC1792_1) shall be installed in tunnels. This sign may be used as a repeater sign or to change the speed limit. Where specific constraints prevent the tunnel accommodating this size sign, the designer and Principal may consider a smaller size display. Prior to fabrication, the specifics of this smaller display shall be submitted to the Transport and Main Roads Representative for consideration and advice from the Road Operations Directorate of Transport and Main Roads.

8 Enforcement of variable speed limits

Enforcement of variable speed limits is essential to ensure compliance of the system. Enforcement requirements, including site-specific warrants, methods of enforcement and the impact on various aspects of the motorway design, shall be addressed on a project-by-project basis and in conjunction with the Customer, Traffic Engineering Technology and Systems, Engineering & Technology, Transport and Main Roads and Land Transport Safety Directorate of Transport and Main Roads, and QPS.

9 Associated Intelligent Transport System devices

It is recommended that closed circuit television (CCTV) is provided such that all VSLS or VSL / LCS displays are visible to Traffic Management Centre (TMC) operators both night and day.

Mainline vehicle detector sites should be located with each VSLS and VSL / LCS, in accordance with Transport and Main Roads TRUM Volume 4 *ITS and Electrical Technology Part 2 Road Lighting Maintenance*.

Weather monitoring stations may also be considered as an input for STREAMS under either manual or automatic control.

VSLS and VSL / LCS relating to tunnels should consider TRUM Volume 1 Part 9 for information in relation to traffic management practices for tunnel closures.

10 Considerations of future upgrade projects

If future upgrade projects are planned for a section of road where VSLS or VSL / LCS is being designed, road designers need to take into consideration the future road geometry when determining the location and mounting arrangements for VSLS and VSL / LCS.

11 Selection of a gantry type for lane use management system, variable speed limit signs and other signs

Selection of the appropriate gantry type is based on functional requirements. In general, gantries extend from one side of the carriageway or road to the other side (of the carriageway or road). There are other ways of supporting signs; for example, side mounted on posts, on an overpass structure, lightweight gantry structure.

This section refers to the traditional gantries, although there needs to be continued innovation to design and use systems that reduce the cost of construction, maintenance of the gantry and the devices and signs installed on the gantry.

In selecting a gantry type, designers need to consider its function.

1. Are cameras and other devices going to be used for enforcement?

   Enforcement devices require gantries to be stiffer and to limit both deflection and vibration. Cameras for automated number plate recognition (ANPR) systems that are used for tracking vehicle movements may not need the same restriction of gantry deflection if not used for enforcement.

2. What are the types of signs that will be supported by the gantry?

   The number and type of signs will affect the strength of the gantry; for instance, whether there will be VSL / LC, or VSLS signs alone, whether there will be static signs or changeable message signs installed as well.

3. Is there a need for power and communication links to be taken across the road or carriageway?

   This may require a gantry when other mountings may have been satisfactory.

4. Can the maintenance of the gantry and devices it carries be maintained using a cherry picker or must the gantry be a 'walk-on' type?

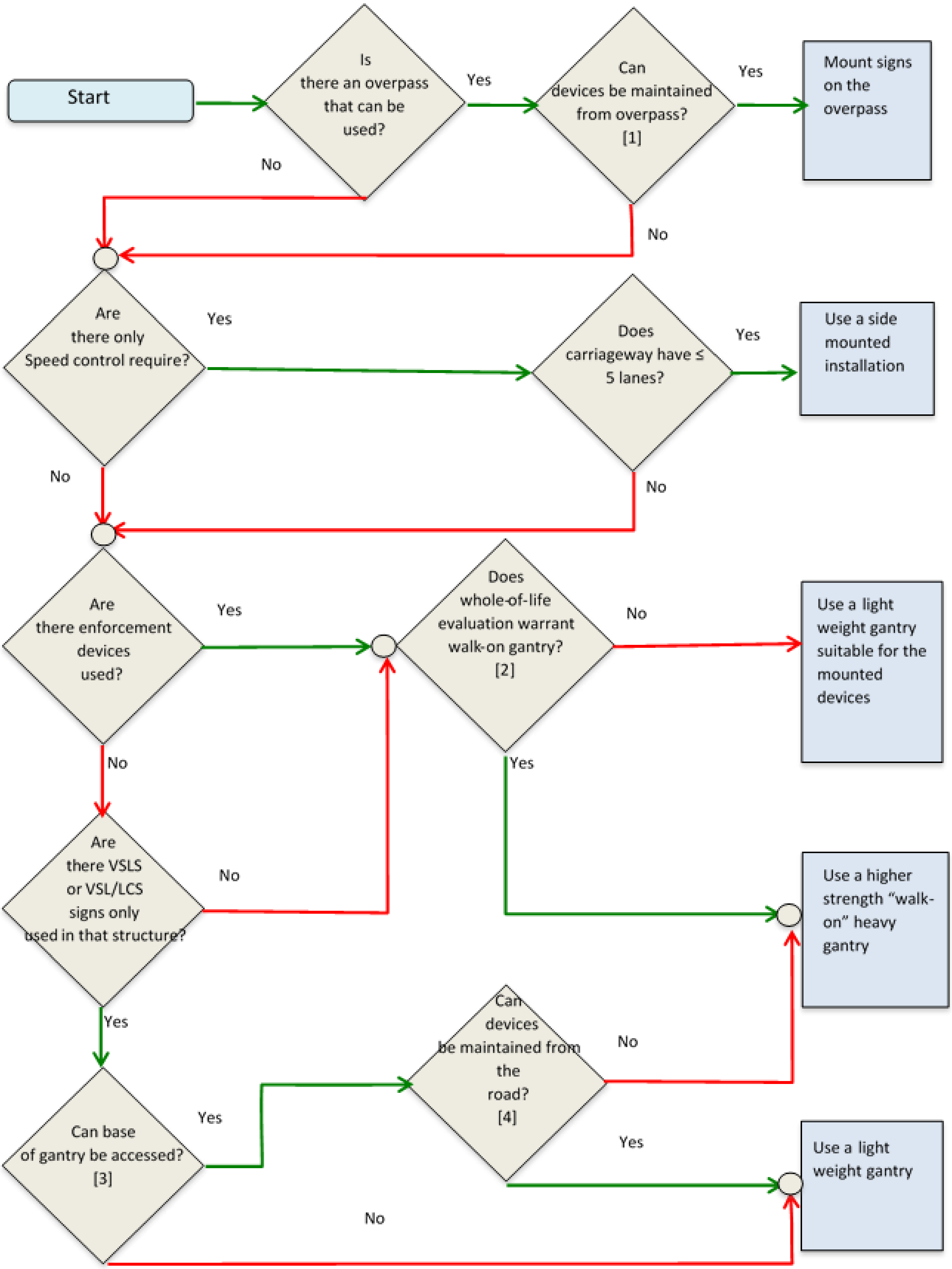
   Other gantry types in the vicinity may also influence this decision. If there are a number of other gantries that are maintained from below, and if several gantries can have their maintenance at the one time, then this may affect the decision. The whole-of-life costs of the system need to be identified.

5. Can the gantry be secure from trespassers?

   This decision may not affect the type of gantry, but it does affect its configuration.

The following flow chart lists the important decisions in selecting a gantry type.

Figure 12 – Selection of a gantry type



5.7-2 Collocation of gantry-mounted variable speed limit signs with static and monochrome variable message signs

1 Introduction

This supplement provides guidance when collocating static and dynamic signs on the same supporting gantry as variable speed limit (VSL) signs.

The ever-increasing traffic volumes occurring on highways is not only resulting in an increase in the number of traffic lanes required to cope with this traffic, but also changes in the way traffic is managed on highways in general. In addition to providing operational benefits, the introduction of new technology such as lane-based VSL and other Intelligent Transport System (ITS) devices provides potential for the collocation of ITS devices with other signs on overhead gantries.

Collocation maximises the use of overhead gantries and reduces the need for side-mounted signs. In addition, due to the number of static and dynamic message devices being placed on the road network, lateral spacing requirements between signage may not be met and collocation is a viable alternative.

2 Scopes

This supplement provides information for the design and construction of motorway direction signs, gantry-mounted VSL signs and dynamic signs in Queensland.

This supplement adds to existing motorway signing provisions in Part 15 of the Queensland MUTCD / AS1742.15 Direction signs, information signs and route numbering for gantry-mounted advance direction signs as a replacement for roadside-mounted signs.

3 Collocation of gantry-mounted variable speed limit signs and advance direction signs

The collocation of static advance direction signs (SADS) with VSL signing should be applied whenever there is the opportunity to make full use of existing or proposed gantries and/or in the following circumstances:

a) where the exit is located partway around a left curve or just beyond a crest, or

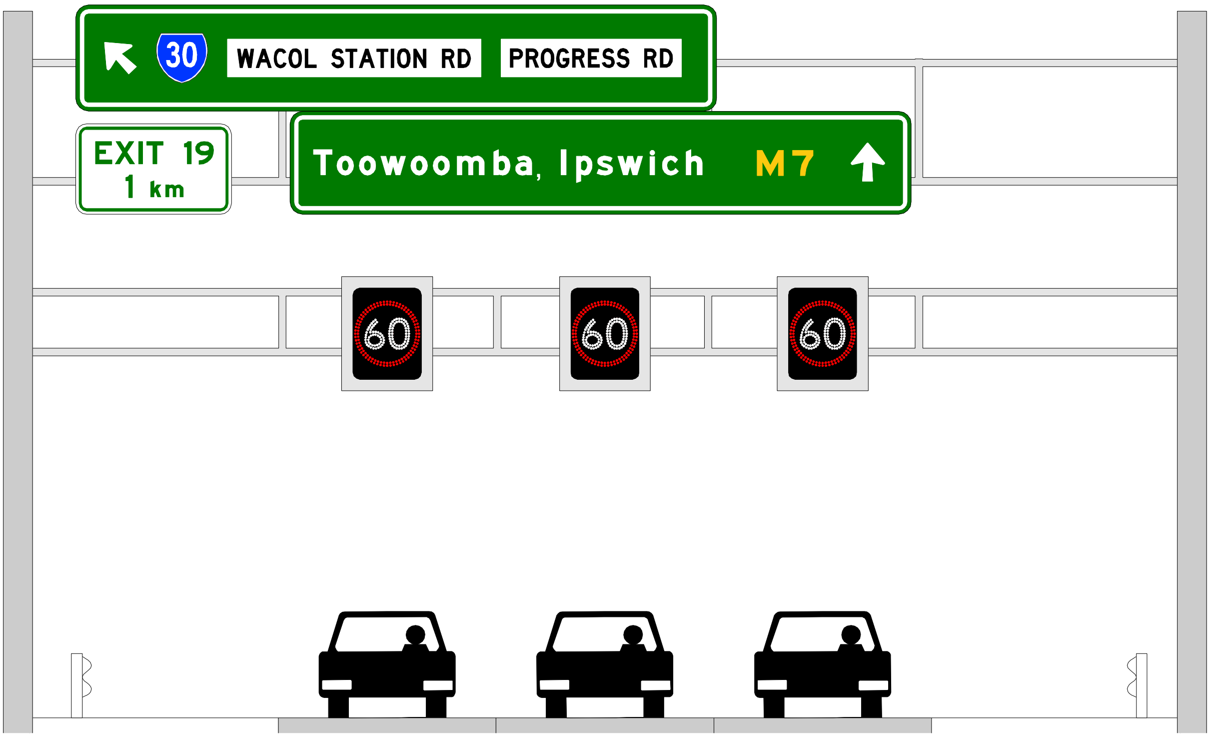
b) when roadside features, such as batters, make installation of roadside signs impracticable.

This application relates to highway junctions with a single exit, identified by the number and distance shown in the exit plate, which is located to the lower left side of the direction signs. The exit destinations and routes are shown in the upper left side of the direction sign and with an indication of the destinations reached by remaining on the motorway. For a single exit off a highway, the exit should be signed 1 km in advance of the exit as shown in Figure 3.1(A).

The decision to collocate SADS and VSLS should ensure consistency of application along a given route.

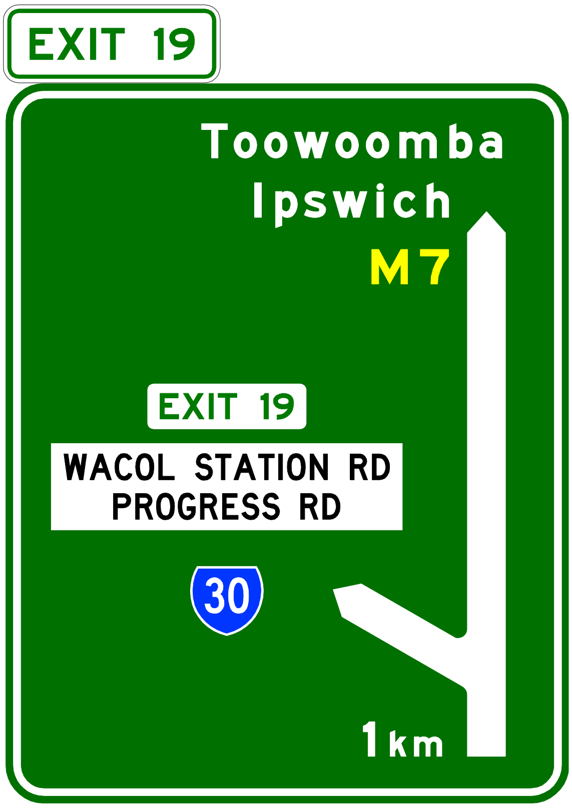
3.1 Typical layout

Figure 3.1(A) – Collocation of gantry-mounted SADS and VSLS in the case of a single exit



When collocation of gantry-mounted SADS and VSL occurs, it will not be necessary to provide additional side-mounted roadside signage such as GE1-12-1 (shown in Figure 3.1(B)).

Figure 3.1(B) – GE1-12-1 signage



3.2 Benefits of gantry-mounted variable speed limit and advance direction signs

The collocation of gantry-mounted SADS and VSLS provides a number of operational and safety benefits:

a) allows flexibility for individual lane-based direction signs

b) increased visibility of direction signs in all lanes

c) removes the potential for direction signs to be obstructed by commercial traffic

d) creates potential for cost-neutral outcomes or, in some instances, reduced costs from using existing / proposed gantries rather than the provision of additional support structures for side-mounted roadside signage.

4 Collocation of gantry-mounted variable speed limit and monochrome variable message signs

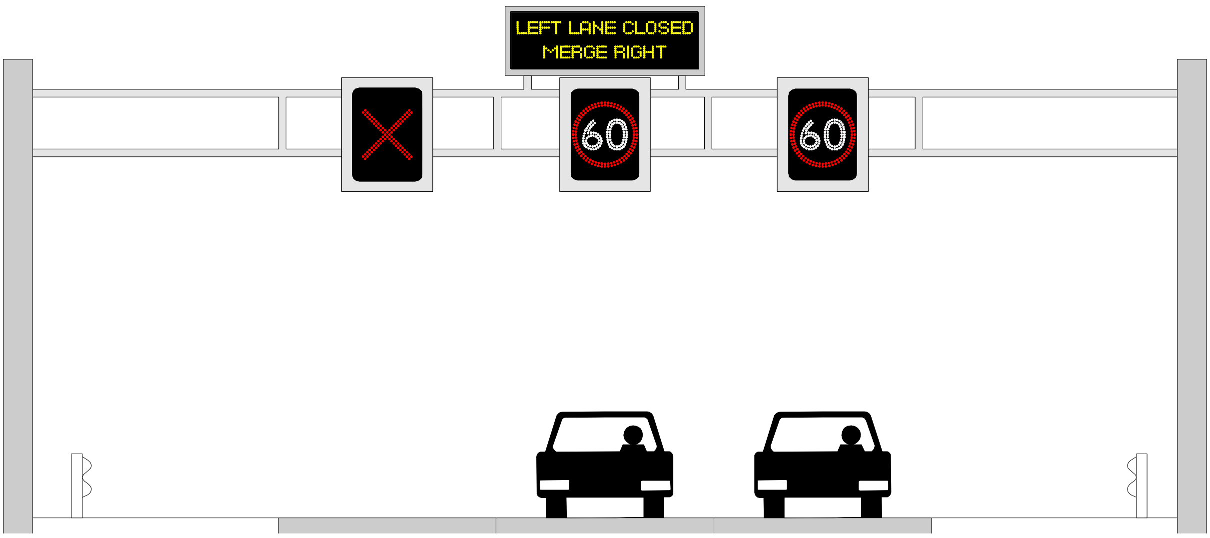
The decision to collocate VSL and VMS should only be considered for monochrome signs in severely constrained environments and is acceptable, subject to:

a) approval of significant corridor constraints by relevant regions

b) compliance with relevant standards and guidelines.

4.1 Typical layout

Figure 4.1 – Collocation of monochrome variable message signs and variable speed limit signs



4.2 Benefits of gantry-mounted variable speed limit and monochrome variable message signs

The collocation of gantry-mounted VSL and a monochrome VMS has the potential to provide a number of benefits:

- aid compliance by reinforcing speed reduction and/or lane closures in place for traffic management
- increased visibility of VMS in all lanes
- removes the potential for VMS to be obstructed by commercial traffic
- creates potential for cost-neutral outcomes or, in some instances, reduced costs from using existing / proposed gantries rather than the provision of additional support structures for side-mounted roadside signage.

5.8 Portable / temporary variable message signs

5.8-1 Use of temporary variable speed limit signs in construction and maintenance work areas on motorways

This content has been incorporated into the *Queensland Guide to Temporary Traffic Management* (QGTTM) released on 30 November 2020.

6 Pavement markings

6.3 Line marking materials

6.3.3 Barrier lines

6.3.3-1 Determination of centre line markings adjacent to property access

1 Introduction

The purpose of this supplement is to provide information that assists in determining the appropriate centre line marking (a single continuous, unidirectional continuous dividing line or a double barrier line) to allow motorists from turning right either into or out of a property access, or to restrict such movement.

Note: Rule 134 of the Transport Operations (Road Use Management – Road Rules) Regulation 2009 permits a driver to cross a continuous dividing line to enter or leave the road, but not to overtake (a continuous dividing line includes both a single continuous dividing line and a continuous dividing line to the left of a broken dividing line).

2 Assessment criteria

Determination of the line marking at the centreline adjacent to a property access is highly susceptible to having adequate sight distance. Adequate sight distance is referred as the capacity for the stationary vehicle to select a gap in oncoming traffic to make the right turn, and also to have sight distance for the vehicles in behind to either stop when they have identified the presence of the stationary vehicle or decelerate and pass to the left of the stationary vehicle.

Adequate sight distance is determined sufficient when standard requirements for *Sight distance at property entrances* and *Stopping sight distance* provided in the Austroads *Guide to Road Design* (AGRD) are satisfied.

Requirements to sight distance at property entrances are provided in Section 3.2.3, Part 4A AGRD.

Requirements of stopping sight distance are provided in Section 5.3, Part 3 AGRD.

3 Line marking

A single continuous or unidirectional continuous dividing line may be installed when sufficient sight distance is present and is determined as adequate sight distance to allow right turning manoeuvres either into or out of the property access. Where adequate sight distance is not met, a double barrier line may be used to restrict such movement.

Modification to the existing line marking is required when potential safety problems are identified using the methodology (*Assessment criteria*) outlined in this supplement. The minimum length of double barrier line that should be marked is 40 m (that is, 20 m each side of the property access). Consideration should also be given to impacts on other property accesses, which meet the assessment criteria and the presence of double barrier line marking in the near vicinity (it may be necessary to join new barrier lines with existing lines).

4 Consultation

The property owner should be consulted, given that modification of property access line marking from unidirectional to double barrier lines will always result in the restriction of one existing legal movement (for example, marking a double barrier line to restrict right turns into a property access from a road retains the status quo of the right-turn movement into the property, but makes the existing legal right-turn movement from the property illegal).

6.5 Other markings

6.5-1 Bicycle Awareness Zones

1 Purpose

This supplement provides guidelines for the provision of Bicycle Awareness Zones (BAZ) as an advisory treatment. Traffic engineering judgement needs to be applied to site-specific treatments to ensure that BAZ treatments are used safely, taking into account local conditions.

BAZ treatments are 'retrofit only' facilities for application to the existing road surface. BAZ must not be used in greenfield or capital improvement projects.

1.1 Introduction

Advisory treatments are defined as*:*

> *…treatments are used to indicate or advise road users of the potential presence of cyclists and of the location where cyclists may be expected to ride on a road (AS1742.9: 2018)*.

Within Queensland, there are currently different approaches to implementing advisory treatments for cyclists. This section has been developed to assist with broader application of the BAZ treatment in Queensland and to ensure that the treatment receives consistent applications across both state and local governments.

1.2 Transport and Main Roads policy

BAZ treatments are not considered 'explicit provision' under the Transport and Main Roads *Cycling Infrastructure Policy*. BAZ treatments are considered 'implicit provision' if used in accordance with the instructions provided in this section. At all times, Transport and Main Roads will strongly pursue the implementation of safer bicycle facilities in lieu of BAZ.

The BAZ treatment attempts to promote safer road user behaviours; its ability to improve road safety is weak compared to dedicated facilities that separate motor vehicles and bicycles. BAZ treatments shall only be used as a treatment of last resort where the existing road surface cannot be manipulated to support visual of physical separation of motor vehicles and bicycles. BAZ must not be used as a mid-block treatment in greenfield or capital improvement projects.

1.3 Related documents

This supplement should be read in conjunction with the following guidelines:

- Queensland Department of Transport and Main Roads:
  - Queensland *Manual of Uniform Traffic Control Devices*
    - Part 9: *Bicycle Facilities,* and
    - Part 11: *Parking Controls*.
  - *Road Planning and Design Manual*
  - *Traffic and Road Use Management manual* Volume 1*: Guide to Traffic Management,* Part 8: *Local area traffic management,* and
- Australian Standard AS 2890.5 *Parking facilities, Part 5: On-street parking.*

2 *Bicycle Awareness Zones: description and use*

BAZ are advisory treatments, similar to warning signs. BAZ are used to indicate or 'advise' road users of the potential presence of cyclists and the position where cyclists may be expected to ride on the road. A BAZ treatment gives a similar message to, and may be used in conjunction with, a W6-7 (Bicycle warning) sign as specified in MUTCD Part 9.

BAZ are not dedicated bicycle facilities –they do not serve a route provision function. They serve only as a warning function. Dedicated on-road bicycle facilities are represented by white-painted bicycle symbols, pole-mounted signs and unbroken lane lines as per MUTCD Part 9.

The BAZ symbol is used to alert motorists that cyclists must temporarily leave the far left of the road space to ensure their own safety. The use of the BAZ symbol does not override the road rule (S129) requiring drivers (including riders of bicycles) to keep as near as practicable to the far left side of the road; rather, the BAZ symbol is to be used in situations that have been identified by a road authority as being ones where it is not possible to ride safely on the far left side of the road.

2.1 Pavement marking specification

A BAZ is marked by on-road yellow bicycle symbols. The bicycle symbol shall comply with Figure 2.2(1) in MUTCD Part 9, with a preferred dimension of 1100 mm x 1800 mm. For extra emphasis over short lengths (for example, 100 m or less) of highly constrained road (for example, over a narrow bridge), 1530 mm x 2500 mm symbols may be used. Symbols are to be coloured yellow (Y14 Golden Yellow colouring as defined in AS 2700) and placed at nominal intervals of 200 m or less. Additional symbols may be required on curves and crests to ensure the symbols remain visible to drivers. The markings and their application to streets and roads are described fully in Section 3 *Design and implementation of Bicycle Awareness Zones* of this supplement.

Figure 2.1 – Bicycle Awareness Zone for insufficient lane width

This example of the preferred pavement marking layout for BAZ shows it applied to a narrowing at a two-lane bridge (Bli Bridge Eastern approach (SKM 2011)). BAZ is primarily a mid-block treatment, although the treatment may be used on the approach and departure of intersections and roundabouts.

2.2 The intended purpose of Bicycle Awareness Zones

BAZ are used on sections of roadway to:

- increase awareness among motorists and cyclists of the need to share road space to maximise safety for cyclists
- warn both cyclists and motorists that the road is not wide enough to accommodate a standard bicycle lane and that they should consequently be more cautious
- show the likely path of travel and positioning of cyclists on the road
- encourage cyclists to position themselves where they have maximum visibility to motorists
- reinforce that bicycles may use the entire lane, where there is insufficient lane width for a motor vehicle to safely pass (Figure 2.1)
- improve driver tolerance of cyclists at pinch points[4]
- influence vehicle positioning within the lane (Figure 2.2) and increase passing clearance, and
- encourage considerate driving behaviour, such as motorists only attempting to pass cyclists where there is adequate lane width.

Figure 2.2 – Bicycle Awareness Zone to influence vehicle positioning

This photo shows the application of BAZ symbols on a narrow street to influence the positioning of cyclists and motorists in situations where dedicated bicycle lanes may not be possible (Grey St, South Bank).

4 Research finding from: (SKM 2011) *Evaluation of narrow bridge treatments for cyclists' safety*. Prepared for Transport and Main Roads.

2.3 When should Bicycle Awareness Zones be used?

When investigating the most appropriate method of providing bicycle operating space on streets and roads, higher order treatments (for example, bicycle lanes) must be considered first.
Section 3.1 *Assessment and selection process* details the required assessment and selection of possible treatments. Where there is insufficient road width or space is constrained due to road design / layout, BAZ may be considered as an advisory treatment to meet the purposes listed in Section 2.2 *The intended purpose of Bicycle Awareness Zones*. It is only appropriate to use BAZ treatments in the following circumstances (the listed examples refer to the Figures shown following):

- on a wide kerbside lane (width ≥ 3.9 m) to influence rider and driver positioning (see Figure 2.2)
- on a 'weave right' transition to indicate bicycle positioning crossing the left turn lane to continue straight ahead (see Figure 2.3(A))
- on a 'left turn only' lane with insufficient width for either a separate bicycle turn lane, an adequate width sealed shoulder (see Figure 2.3(B)) or W6-Q05 *Retrofit Bicycle Lane in a Left Turn Lane* (see Figure 2.3(C))
- in left turn slip lanes where either a bicycle lane cannot be protected from the swept path of turning vehicles or an (off-road) bypass is not feasible
- on narrow (lane width < 3.7 m) bridges as a supplement to sign TC9700 *No Overtaking Bicycles on Bridge* (see Figure 2.3(D))
- on a wide kerbside lane with a history or high likelihood of 'dooring' crashes (DCA Code: 604 'CAR DOOR') placed outside the 'door zone' (1 m from vehicle) to indicate safe cycling position (see Figure 2.3(E))
- where a bicycle lane terminates mid-block due to either a physical obstruction (such as parked cars), a narrowing of the lane width (< 4 m) or inadequate width shoulder for the speed environment (see Figure 2.3(F))
- on a sight-restricted crest or curve with a narrow (width < 3.7 m) lane (see Figure 2.3(G))
- to indicate cyclists' position in the lane, in conjunction with the TC2003 sign *Lane narrows – Change lane* to overtake cyclists (see Figure 2.3(H)), and
- on the descent side of a hill where the road is only wide enough for a bicycle lane on the uphill side only (see Figure 2.3(I)).

The appropriateness of existing speed limits should be reviewed in areas where BAZ treatments are required. The road authority should document the options considered and put in place measures to ensure a safer, and more attractive, treatment can be achieved in the longer term.

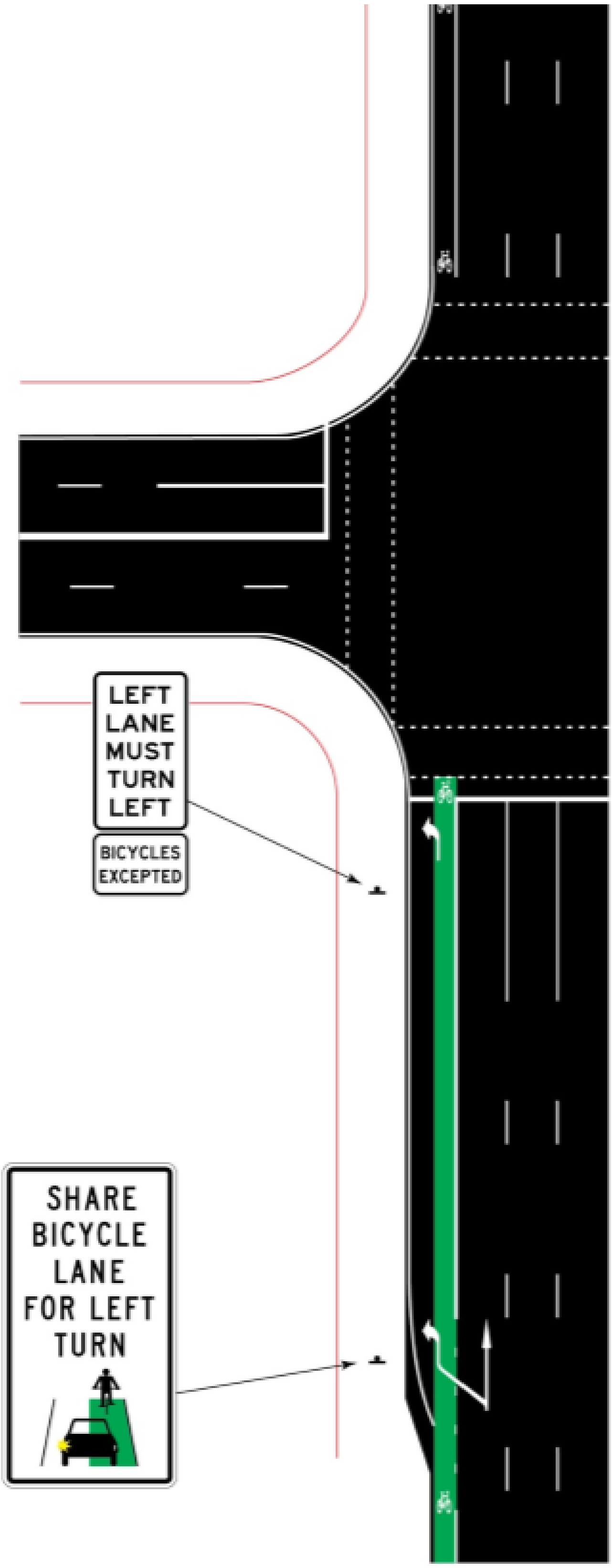
Figure 2.3(A) – Weave right transition

Weave right transition marked with a BAZ symbol to clearly indicate cyclists' positioning when transitioning to continue through the intersection (Gympie Road, Stafford).

Figure 2.3(B) – Left turn lane

The left turn lane is marked with a BAZ symbol to clearly indicate cyclists' positioning and turning intention when turning left. Cyclists are advised to travel in the middle of the lane for their own safety (Gympie Road, Stafford).

Figure 2.3(C) – Retrofit bicycle lane in a left turn lane



W6-Q05, 'Retrofit bicycle lane in a left turn lane' is the preferred treatment for cyclists' safety in a left turn lane. Refer to W6-Q05 for full details.

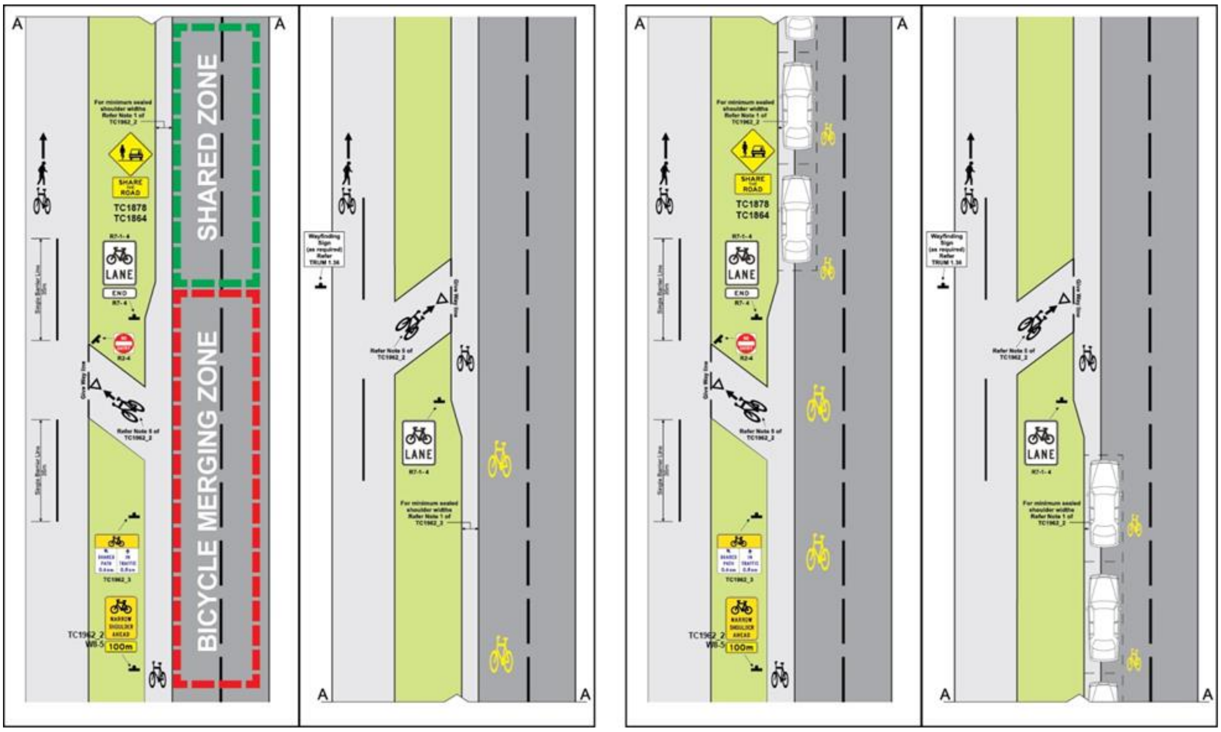
Figure 2.3(D) – Narrow bridge

This narrow bridge in Noosa has no bicycle lane or adequate-width shoulder. BAZ symbols have been applied to the travel lanes. The positioning of the BAZ symbols indicates to cyclists that they travel in the centre of the travel lane for their own safety. The sign erected on the bridge approach is a specific LGA response to the issue. The sign TC9700 *No overtaking bicycles on bridge* (see inset) is recommended for erection on both bridge approaches.

Figure 2.3(E) – Wide kerbside lane

BAZ symbols used in a wide kerbside lane with a history or high likelihood of 'dooring' crashes. The pavement symbols are placed outside the 'door zone' (1 m from vehicle) to indicate a safe cycling position. See Figure 4 and Figure 4.1.1(A), Figure 4.1.1(B) and Figure 4.1.1(C) for detailed guidance on the placement of BAZ symbols.

Figure 2.3(F) – Bicycle lane terminates mid-block



BAZ symbols are used to clearly indicate cyclists positioning when a bicycle lane terminates mid-block due to a narrowing of the lane or an obstruction, for example, parked cars. The right pair of diagrams shows the layout for a clearway with parking out of peak. Where the lane narrows, cyclists are advised to travel in the middle of the lane for their own safety to keep clear of the 'door zone'.

Note: The drawings in this figure are indicative only. For greater detail, refer to TC1962 and Figure 4 and Figure 4.1.1(A), 4.1.1(B) and Figure 4.1.1(C) for dimensioning.

Figure 2.3(G) – Narrow road lanes on sight-restricted corners

Narrow road lanes on a sight-restricted corners where BAZ symbols clearly indicate cyclists' positioning. Cyclists are advised to travel in the middle of the lane for their own safety (St Lucia, Brisbane and Noosa).

Figure 2.3(H) – TC2003 sign assembly for road or lane narrowing

The TC2003 sign assembly recommended for use in conjunction with a BAZ treatment where road or lane narrowing occurs.

Figure 2.3(I) – Bicycle Awareness Zone on descending hill

The use of BAZ would be appropriate in this situation on the descending side of a hill where the road is only wide enough for one bicycle lane on the uphill side. The median is required to accommodate a right-turn lane and parking prohibitions are in place on the descending lane. Refer also to MUTCD Part 9 *Bicycle facilities* section 2.4.1 and MUTCD Part 2 Figure 4.16(a) *Zip Merge* (Hamilton Rd, Brisbane).

2.4 When are Bicycle Awareness Zones not suitable?

BAZ are not suitable treatments in the following situations:

- in greenfield applications – higher order bicycle facilities, such as bicycle lanes and paths, should always be provided in newly developing areas
- on roads with posted speeds greater than 70 km/h
- where bicycle lanes are achievable through minimal infrastructure works (for example, lane width reallocation after resurfacing program), and
- as a wayfinding device or 'gap-filling' in mixed off-road / on-road routes.

The BAZ treatment is used primarily as a warning symbol, similar to green pavement treatment. Its use needs to be limited to conflict / danger points.

The images following illustrate outdated applications of the BAZ treatment although they met the relevant guidelines at the time of installation. Research undertaken by Transport and Main Roads has shown that motorists confuse this treatment with bicycle lanes, which pressures cyclists to ride in the 'door zone'[5]. Rather, cyclists should be encouraged to ride away from the 'dooring' zone through the use of painted buffers, shared lane markings and traffic calming that encourages lane sharing[6]. At the same time, authorities must ensure the road space is most effectively used by marking parking bays that are no wider than absolutely necessary in order to encourage parking discipline as close to the kerb as possible[7].

Figure 2.4(A) – Inappropriate use of Bicycle Awareness Zone on the inside of an edge line

BAZ symbol used inappropriately on the inside of an edge line, encouraging cyclists to travel in the 'door zone', increasing the likelihood of a serious crash (Tahiti Ave, Palm Beach).

5 Smart, N. (2011) *An Evaluation of Bicycle Awareness Zones*. Report for Transport and Main Roads.
6 CDM Research (2012) *Bicycle Rider Collisions with Car Doors* Report commissioned for Road Safety Action Group Melbourne.
7 CDM Research (2012) *Bicycle Rider Collisions with Car Doors* Report commissioned for Road Safety Action Group Melbourne.

Figure 2.4(B) – Inappropriate application of a Bicycle Awareness Zone in the 'door zone'

Inappropriate application of a BAZ, encouraging cyclists to travel in the 'door zone', with symbol set into an edge line adjacent to parking (Richmond Road, Morningside).

3 Design and implementation of Bicycle Awareness Zones

All issues and options for a particular link or site should be evaluated and documented before concluding that a BAZ is a suitable treatment. BAZ are used to advise cyclists regarding their travel position within the lane and, therefore, it is essential that all options are evaluated to ensure that this treatment is an improvement on a 'do nothing' option.

3.1 Assessment and selection process

BAZ shall only become an option once the three-step assessment process following determines that safer facility options are not feasible. The reasons why safer facility options cannot be provided shall be documented. The assessment steps are:

1) Route investigation – understand existing road space and how it is used. Section 5 *Bicycle lane design worksheet* is provided to document the existing road environment.
2) Identify all practical options – assess the site to determine the preferred treatments. Section 5 *Bicycle lane design worksheet* details options to find space to achieve Austroads-compliant facilities. Table 4(A) and Table 4(B) provide guidance on the choice of appropriate cycling treatments given varying road environments. These treatments are shown diagrammatically in Figure 4 and Figure 4.1.1(A), Figure 4.1.1(B) and Figure 4.1.1(C). Table 4(B) also includes an example of how to achieve an Austroads-compliant bicycle lane in lieu of BAZ.
3) Identify the preferred option – from among the preferred treatments identified in Step 2, evaluate these against considerations such as construction cost, difficulty of construction,

impact on other stakeholders, level of service and consistency along the route. Document the preferred option using the Section 5 *Bicycle lane design worksheet.*

3.1.1 Documentation and approval

Section 5 *Bicycle lane design worksheet* must be completed for every BAZ treatment and signed off by an RPEQ.

3.1.2 Design audit

The design audit is a risk assessment to be carried out pre-installation to identify any additional factors or problems that might make the proposed location unsuitable for installation of a BAZ.

3.1.3 Post-installation audit

A post-installation audit should be undertaken by a qualified road safety auditor to identify any safety issues in the operation of the BAZ. Austroads *Guide to Road Design* Part 6A (Appendix D) outlines an example of a Bicycle Safety Audit checklist – this should be used as the basis for the whole-of-route bicycle safety audit. Further information can be obtained from the Austroads *Guide to Road Safety* Part 6: *Road Safety Audit*.

3.1.4 Education

In order to enhance road users' understanding of the role of BAZ, a local education campaign targeted at motorists and cyclists should be implemented following the infrastructure works.

4 Bicycle Awareness Zones lane configurations and pavement marking layouts

This section outlines the lane width requirements and pavement marking layouts required. All dimensions shown are for a single lane of traffic. In some instances, it may be necessary to relocate the centreline to accommodate both parking and safe advisory treatments for cyclists – for example, providing parallel parking on only one side of the road.

Table 4(A) – Lane configurations without parking

Total lane width	Vehicle lane width	Cyclist facility	Comments
2.8 m to 3.6 m	2.8 m (min) to 3.6 m	BAZ (without edge line) See Figure 4	Not recommended on ascending (uphill) lane
3.7 m to 3.9 m	3.7 m to 3.9 m	Wide kerbside lane BAZ (with edge line) See Figure 4.1.1(C)	
4.0 m or greater	2.8 m vehicle lane width (min)	1.2 m bike lane achieved (min)	

Figure 4 – Dimensions for Bicycle Awareness Zones without edge lines and without parking

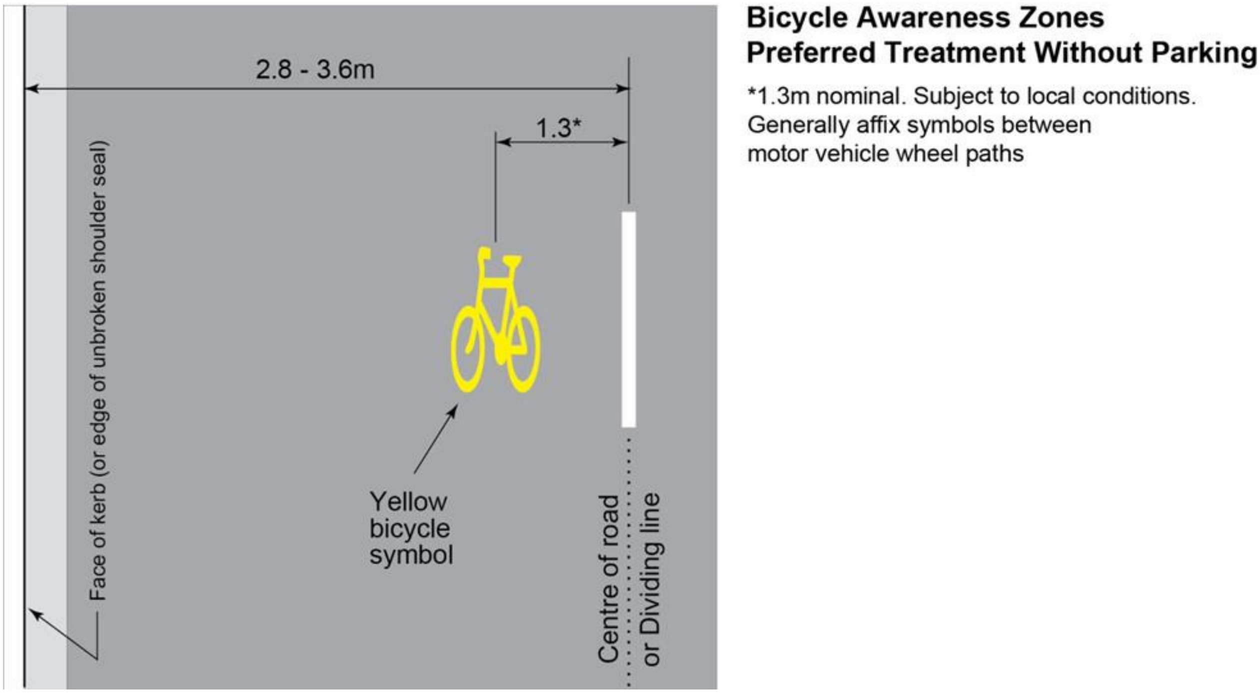


Table 4(B) – Lane configurations with parallel parking

Total lane width	Vehicle lane width	Shared cyclist/parking facility	Comments
Less than 6 m		Parking not recommended	
6 m to 6.6 m	3.2 m to 3.6 m	BAZ (without edge line) (2.3 m (min) parking bays with 0.5 clearance required)[8]	Not recommended on ascending (uphill) lane
6.7 m to 6.9 m	3.7 m to 4.1 m	BAZ (with edge line) See Figure 4.1.1(C) (2.3 m (min) parking bays with 0.5 clearance required)[9]	
7 m or greater	4.2 m	1.2 m bike lane achieved (min)	

Where on-street parking cannot be provided in compliance with AS 2890.5, it should be removed. Provision of disabled parking bays is not recommended in a parallel parking configuration due to the risk posed by passing traffic.

4.1.1 Important note on parking restrictions to reduce car turnover and increase cyclists' safety

Although these width and line marking requirements encourage motorists to park as close to the kerb face as possible, there is still a risk for cyclists riding in the 'door zone' because some motorists may park well clear of the kerb. A vehicle parked on the kerbside only presents a car 'dooring' risk when an occupant enters or leaves that vehicle[10]. As such, the nature of the parking provision must be

8 Refer to Australian Standard *AS 2890.5*, Section 2.4(a) and Table 2.1
9 Refer to Australian Standard *AS 2890.5*, Section 2.4(a) and Table 2.1
10 CDMR 2012. *Bicycle Rider Collisions with Car Doors*. Report prepared for the Road Safety Action Group. CDM Research. Melbourne, Victoria.

assessed to determine the risk to cyclists' safety. If the number of events (that is, the number of times a door is opened) can be reduced, then the risk of conflict would also be reduced[11]. By reducing vehicle turnover, the risk to cyclists of a 'dooring' crash will decrease proportionally.

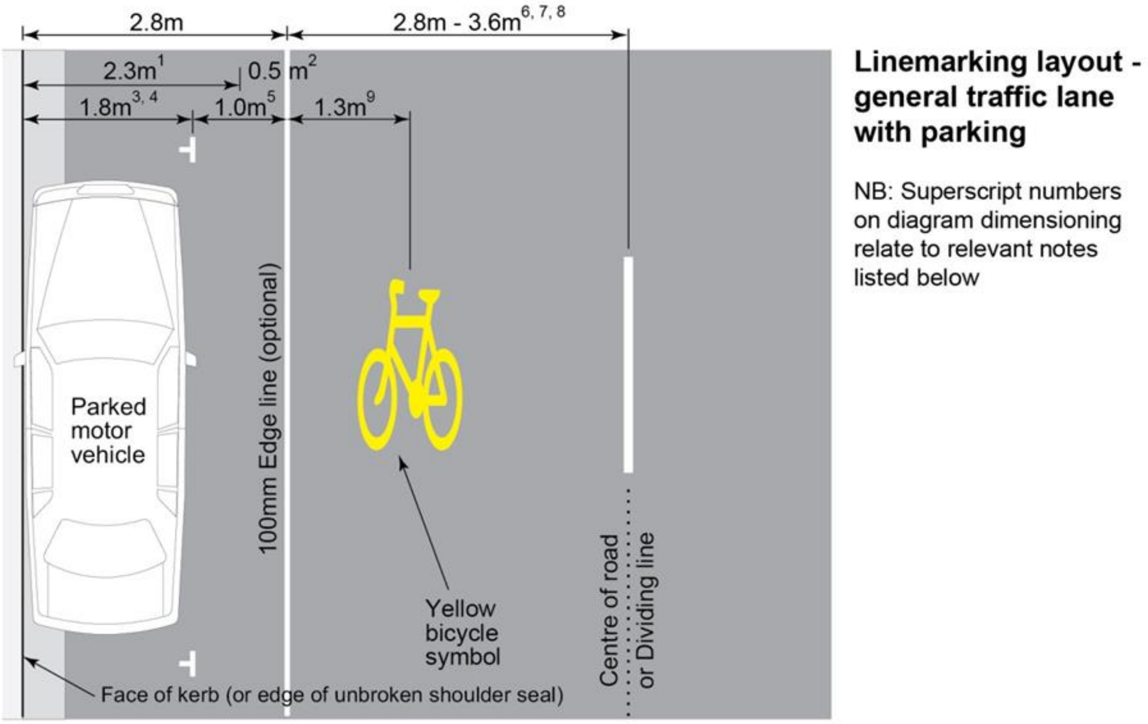
Different types of parking zones will also have different rates of turnover; for example, loading zones and taxi zones, by their very nature, will attract vehicles that are constantly opening their doors and will have short parking times, resulting in a high rate of vehicles entering and exiting the parking spaces.

In constrained lane-width environments, where there is a need to place an advisory treatment for cyclists' safety, it is recommended that parking allocations and time restrictions be reviewed also, with a preference given to longer time period parking restrictions and residential or commuter parking.

It is acknowledged that this is a site-specific decision and will likely be affected by the destinations that the parking serves; for example, a retail precinct with service outlets, such as supermarkets, milk bars or newsagents, will probably generate far more parking turnover events than clothing stores[12].

11 CDMR 2012.
12 CDMR 2012.

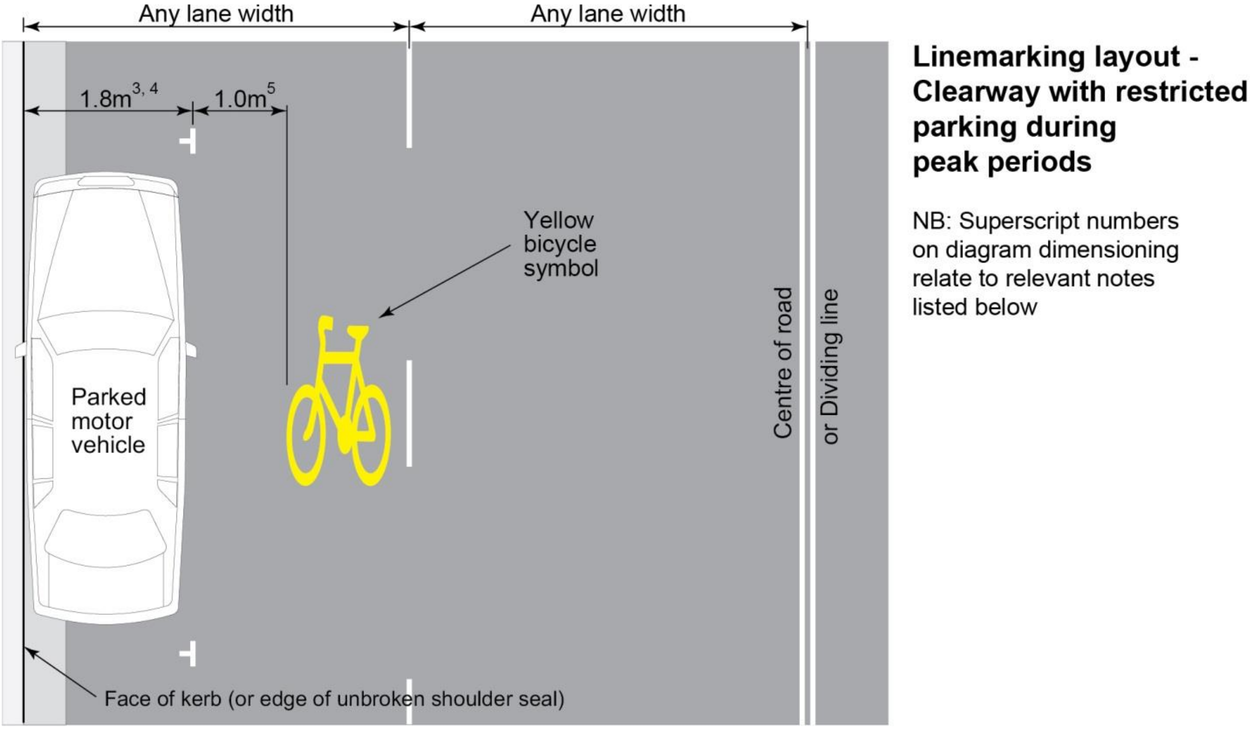
Figure 4.1.1(A) – Dimensions for Bicycle Awareness Zones on a two-lane, general traffic road with parallel parking



Notes for Figure 4.1.1(A)

1. AS 2890.5 requires 2.3 m width for parking space for cars and light commercial vehicles.
2. AS 2890.5 requires 0.5 m clearance from the nearest moving traffic lane, in a traffic speed environment <60 km/h. Additional 1 m clearance required for every additional 10 km/h to a maximum of 3 m.
3. As per AS 2890, in Australia, 85 per cent of cars have width dimension less than 1860 mm.
4. As per the research report (CDMR 2012), it is required to ensure road space is most effectively used by marking parking bays that are no wider than absolutely necessary in order to encourage parking discipline as close to the kerb as possible.
5. The bicycle rider collision with car doors research report states that cycling within a distance of 1 m from a kerbside parking space, places cyclists at risk should a car door open.
6. In instances of general traffic lane widths of <3.6 m, there is insufficient space for a car to safely pass a bicycle. In these instances, the bicycle should occupy the middle of the lane to improve visibility to motorists and to clearly communicate to motorists that it is unsafe to attempt to pass the cyclist while remaining in the lane.
7. In instances of general traffic lane widths between 3.7–3.9 m, there is sufficient space for a car to safely pass a bicycle.
8. In instances of general traffic lane widths >4 m, there is sufficient space for a bicycle lane.
9. Symbol should be paced between wheel paths, notionally 1.3 m subject to local conditions.

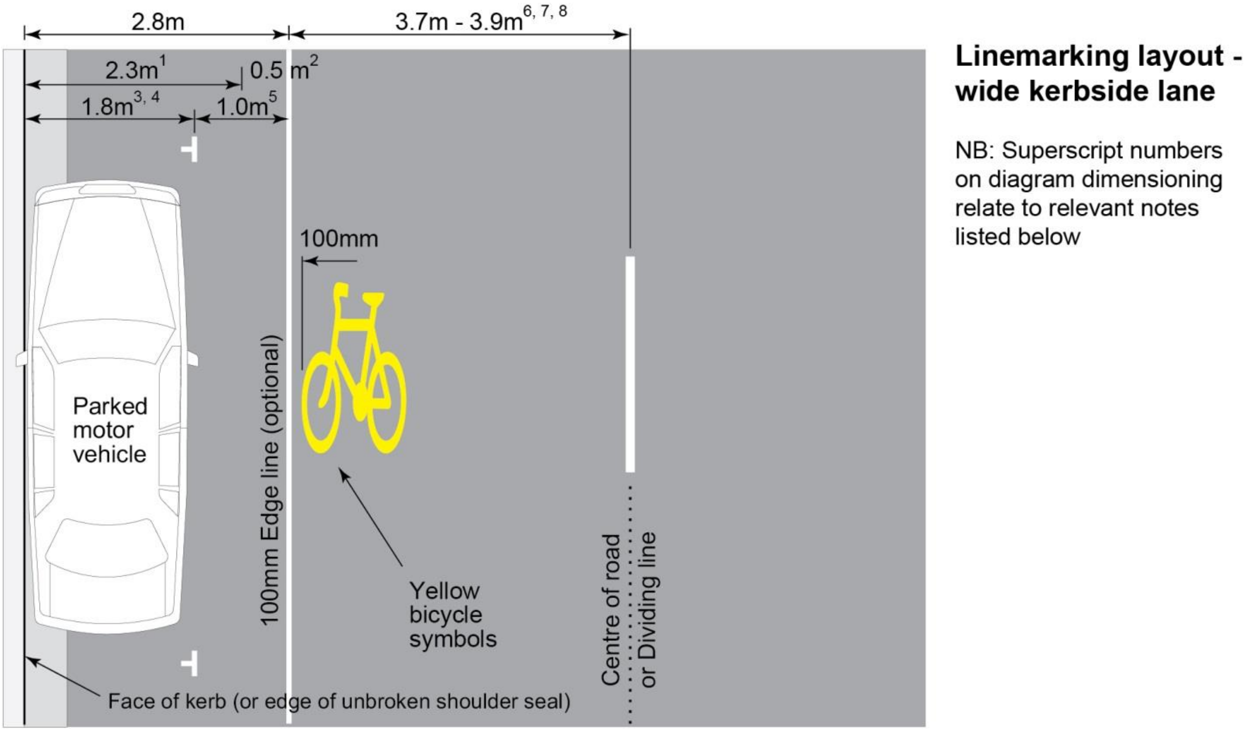
Figure 4.1.1(B) – Dimensions for Bicycle Awareness Zones on a multi-lane, general traffic road with parallel parking



Notes for Figure 4.1.1(B)

1. AS 2890.5 requires 2.3 m width for parking space for cars and light commercial vehicles.
2. AS 2890.5 requires 0.5 m clearance from the nearest moving traffic lane, in a traffic speed environment < 60 km/h. Additional 1 m clearance required for every additional 10 km/h to a maximum of 3 m.
3. As per AS 2890, in Australia, 85 per cent of cars have width dimension less than 1860 mm.
4. As per the research report (CDMR 2012), it is required to: ensure road space is most effectively used by marking parking bays that are no wider than absolutely necessary in order to encourage parking discipline as close to the kerb as possible.
5. The bicycle rider collision with car doors research report states that cycling within a distance of 1 m from a kerbside parking space, places cyclists at risk should a car door open.
6. This scenario assumes that the parking spaces are only unoccupied during the peak hours of a single direction of flow of traffic (for example, 7am–9am inbound or 4pm–6pm outbound). The majority of time the cyclists will be required to travel clear of the door zone for their own safety. During peak times, cyclists are expected to comply with the road rule (S129) requiring road users to keep as the far-left side of the road as practicable.

Figure 4.1.1(C) – Dimensions for Bicycle Awareness Zones in a wide kerbside-lane lane with parallel parking



Notes for Figure 4.1.1(C)

1. AS 2890.5 requires 2.3 m width for parking space for cars and light commercial vehicles.
2. AS 2890.5 requires 0.5 m clearance from the nearest moving traffic lane, in a traffic speed environment < 60 km/h. Additional 1 m clearance required for every additional 10 km/h to a maximum of 3 m.
3. As per AS 2890, in Australia, 85 per cent of cars have width dimension less than 1860 mm.
4. As per the research report (CDMR 2012), it is recommended to ensure road space is most effectively used by marking parking bays that are no wider than absolutely necessary in order to encourage parking discipline as close to the kerb as possible.
5. The research report (CDMR 2012) also states that cycling within a distance of 1 m from a kerbside parking space, places cyclists at risk, should a car door open.
6. In instances of general traffic lane widths of <3.6 m, there is insufficient space for a car to safely pass a bicycle. In these instances, the bicycle should occupy the middle of the lane to improve visibility and to clearly communicate to motorists that it is unsafe to attempt to pass the cyclist, while remaining in the lane.
7. In instances of general traffic lane widths between 3.7–3.9 m, there is sufficient space for a car to safely pass a bicycle.
8. In instances of general traffic lane widths > 4 m, there is sufficient space for a bicycle lane.

5 *Bicycle lane design worksheet*

Project Name / Number				
Existing environment				
Section description Street				
from				
to				
Posted speed limit				
Vehicles Per Day (VPD)				
Traffic mix (% HGV / LGV / cars)				
Describe how proposed connection contributes to an identified cycle route.				
Potential cyclists				
Expected cyclist volume (hourly)				
Likely cyclist type (commuter, occasional, recreational)				
Existing road layout				
Side 1				
Parking turnover (high, med, low)				
Parking restrictions				
Existing lane widths Parking				
Bike				
Traffic				
Traffic				
Side 2 Existing lane widths Traffic				
Traffic				
Bike				
Parking				
Parking restrictions				
Parking turnover (high, med, low)				
Increasing road space options	Consider and comment on options to increase road space, Refer Section 6			
Option				
Remarking traffic &/or parking lanes				
Sealing shoulders				
Indenting car parking				
Rationalising car parking				
Road widening at the median				
Road widening (in direction of travel)				
Removing a motor vehicle lane				
Transitioning to path				
Using existing service roads				
Combinations of above options				

Proposed bicycle facility	Determine the treatment using the three-step process in TRUM Volume 1, Part 10 Section 3, TRUM Volume 1, Part 8 and Transport and Main Roads guideline *Selection and design of cycle tracks*.			
Treatment Side 1: (circle chosen treatment)	No treatment BAZ (without edge line) BAZ (with edge line) Cycle street Advisory Bicycle Lane Bicycle lane Cycle track	No treatment BAZ (without edge line) BAZ (with edge line) Cycle street Advisory Bicycle Lane Bicycle lane Cycle track	No treatment BAZ (without edge line) BAZ (with edge line) Cycle street Advisory Bicycle Lane Bicycle lane Cycle track	No treatment BAZ (without edge line) BAZ (with edge line) Cycle street Advisory Bicycle Lane Bicycle lane Cycle track
Treatment Side 2: (circle chosen treatment)	No treatment BAZ (without edge line) BAZ (with edge line) Cycle street Advisory Bicycle Lane Bicycle lane Cycle track	No treatment BAZ (without edge line) BAZ (with edge line) Cycle street Advisory Bicycle Lane Bicycle lane Cycle track	No treatment BAZ (without edge line) BAZ (with edge line) Cycle street Advisory Bicycle Lane Bicycle lane Cycle track	No treatment BAZ (without edge line) BAZ (with edge line) Cycle street Advisory Bicycle Lane Bicycle lane Cycle track
Width Side 1 Proposed lane widths Parking				
Bike				
Traffic				
Traffic				
Width Side 2 Proposed lane widths Traffic				
Traffic				
Bike				
Parking				
If BAZ is the chosen treatment, describe how an Austroads compliant facility could be provided in the future.				
Comments:				
Signed off by:				

6 *Ways to gain on-road space to make provision for on-road cycling (derived from VicRoads 2001)*

Space finding techniques	**Definition / opportunities to implement**	**Benefits / advantages**	**Other considerations**
Re-marking traffic and/or parking lanes	When traffic and parking lanes are wider than necessary (for example, wider than the minimums given in the Transport and Main Roads RPDM and/or *Austroads Guide to Road Design* Part 3), lane markings can be removed and repainted to allow for an exclusive bicycle lane or wide kerbside lane.	Relatively low-cost treatment. Can be undertaken during maintenance (for example, of line marking or as part of road resurfacing). Causes minimal disruption to other road users.	May limit lane widths for other road users. Widths should not be reduced below minimums given in the relevant guidelines. Also refer Transport Planning and Coordination Regulation 2005 Part 2, Section 5. May reduce the capacity of the road and so possibly increase congestion. May increase ‘friction’ between through motorised traffic, cyclists and parked vehicles.
Sealing shoulders	Some roads in outer suburban and regional areas have long lengths of continuous unsealed shoulders that could be sealed to provide bicycle lanes for bicycle riders (providing shoulder materials are pavement quality).	Increased road safety for all road users. Less road maintenance – reduction in edge breaks and ravelling of surface. Access to funding from road safety and maintenance programs.	Shoulder should only be sealed if shoulder materials / pavement suitable to serve as a pavement and suitable for sealing. In such cases, the shoulder should not be sealed unless the shoulder material is removed and replaced with pavement materials complying with a certified design. Need to ensure shoulders remain free of debris. Adopt a maximum 10 mm chip size on shoulder seals within a 20 km radius of towns (refer Austroads *Guide to Road Design* Part 3, Table 4.5)
Indenting car parking	Indenting parking frees up space that can be used to make provision for on-road cycling. Car parking can be indented on both sides of the road or on one side only.	Maintains some car parking on one or both sides of the road. Efficient use of available space.	Need to control parking between indented areas. Possibly reduced car parking capacity. Reducing footpath width may affect Public Utility Plant (PUP), road lighting poles and/or stormwater (for example, pits / gullies). May be a costly option due to relocation of PUP, road lighting poles and/or stormwater (for example, pits / gullies) subsurface drainage and pavement widening. Unsuitable in areas of high pedestrian activity (unless footpaths are wide).

Space finding techniques	Definition / opportunities to implement	Benefits / advantages	Other considerations
Rationalising car parking	On many roads, parallel parking is permitted on both sides of the street – even where there is off-street parking available or there is insufficient demand for the volume of on-street parking provided. In these situations, it may be possible to prohibit parking on one side of the road, or perhaps on both sides, to create sufficient space to make provision for on-road cycling.	Relatively low-cost treatment. Rationalised volume of available parking corresponds to forecast demand or may be used as a travel demand management measure.	Reduced car parking capacity, which may affect residents and businesses. May require changed line marking and signage. This may add to cost. Need to enforce changes.
Road widening at the median	In some cases, it may be possible to widen the road by reducing the width of the median strip. Median strips may offer a cost-effective space for widening of a road as they often contain minimal amounts of stormwater drainage and services. It is important to ensure that medians are wide enough to accommodate turning lanes, traffic signals, PUP, lighting poles, safety barriers, pedestrians, and so on, as required.	May minimise disruption to drainage and services.	May be a high-cost treatment, requiring extensive traffic management. May reduce landscaping opportunities. Removal of a table drain may require installation of underground stormwater systems. Relocation of PUP, road lighting poles and/or stormwater (for example, pits / gullies) may be required which may increase costs. Safety barrier may need to be installed or existing safety barriers may need to be relocated.
Road widening at the left-hand side (in direction of travel)	On roads that do not have a median strip or that have a median strip that cannot be reduced further, it may be possible to widen the road by reducing the width of the footpath / nature strip or cutting back protruding traffic islands.	Increased road safety for all road users.	May be a high-cost treatment. May be appropriate where the footpath is wider than necessary or where there is little pedestrian activity / demand. Important not to reduce useable footpath space for pedestrians if there is reasonable pedestrian activity / demand. Relocation of PUP, road lighting poles and/or stormwater (for example, pits / gullies) may be required which may increase costs. Footpath may need to be reinstated. May reduce landscaping opportunities.

Space finding techniques	**Definition / opportunities to implement**	**Benefits / advantages**	**Other considerations**
Removing a motor vehicle lane	It may be that a road is either too wide and/or contains too many traffic lanes for the volume of traffic that it carries or will carry in the future. It may be possible to introduce a tidal flow lane arrangement or a centre turning lane to manage peak hour traffic volumes. The resulting space may be sufficient so that adequate provision for on-road cycling can be made.	Typically, a low-cost treatment requiring only changes to line marking. Tidal flow can have high construction and operation costs.	Poorer level of service and consequent reduction in motor vehicle capacity (that is, greater congestion). Need to consider forecast traffic demand and implications of removing lane. Potential Travel Demand Management measure. Two-way right-turn lane treatments may reduce congestion and improve safety.
Transitioning to path	Where a sufficient verge corridor width is available, and the adjacent road environment is highly constrained.	Path construction is typically less costly than road pavement widening. Limits rider exposure to vehicular encroachment on tight corners. Caters for a wide range of cyclist competencies.	Deficient property access, vegetation and location of footpath furniture must be modified to ensure safe operations. Relocation of PUP, road lighting poles and/or stormwater (for example, field inlets) may be required which may increase costs. Path surfaces must be even, refer Austroads *Guide to Road Design* Part 6a, Section 5.10, may require reconstruction of existing footpath facilities. Consider bus stops and volume of pedestrian movements; for appropriate path layout and width, refer to Austroads *Guide to Road Design* Part 6A, Section 5.1.3. Lack of priority at intersections will reduce proportion of riders using the facility. Consider priority crossings at low order side roads. Transition back to on-road where road width permits, treat as an added lane to protect reintegration of riders on-road.

Space finding techniques	Definition / opportunities to implement	Benefits / advantages	Other considerations
Using existing service roads	Many arterial roads have parallel service roads. Service roads provide an ideal opportunity for the provision of on-road cycling. Route continuity and providing for bicycle riders at intersections are important factors to consider. For this reason, checks involving detailed design of intersections are required to ensure that acceptable provision is made for bicycle riders (for example, marked stand-up lanes).	May be a low-cost treatment. Bicycle riders are exposed to lower motor vehicle volumes and speeds than they would be on arterial roads. Typically, less complex intersections than on arterials. Access to local destinations and services for bicycle riders.	May require changes to existing intersections. Should changes to intersections be required, the cost of this option may be substantially increased unless coordinated with other planned works. May involve changes to line marking and signage. Local area traffic management and new path construction may be required to improve connectivity, directness and safety. Riders will be less likely to use the arterial if the service road is as fast as convenient and less stressful.
Combinations of the above	Some measures may be combined to make space (for example, indent parking and the remark of lane lines). Refer to discussion of each treatment.	Refer to discussion of each treatment.	Refer to discussion of each treatment.

6.6 Use of coloured pavements

6.6-1 Coloured surface treatments for bicycle lanes

1 Introduction

This supplement provides guidance on the use of green-coloured surface treatments.

Green-coloured surface treatment is an advisory treatment only and does not define a bicycle lane by itself. Green-coloured surface treatment must only be used on bicycle lanes or bicycle paths.

To accommodate different materials and varying conditions, an approximate colour match to one of the following three AS 2700 greens is permitted – G13 Emerald, G16 Traffic green or G23 Shamrock. Approximate colour match is determined in accordance with AS/NZS 1580.601.1.

A consistent green colour should be provided along a route or within a given locality.

2 Use green-coloured surface treatments selectively

Green-coloured surface treatments can assist in increasing driver and cyclist awareness of the areas designated for bicycle use.

To maintain visual impact effectiveness and minimise costs associated with coloured surface treatments, they should be used selectively and only in busy or higher volume locations where the road layout has unusual features or where driving decisions are more complex, refer Section 4 *Locations where a green-coloured surface treatment may be used* for further details. Coloured surface treatments should not be used on long lengths of bicycle facility where the cross-section is constant and there are few conflict, compliance or crash issues involving cyclists.

3 Effectiveness of green-coloured surface treatments

The AGTM10(2016) statement

> *Austroads (2011) noted that the provision of coloured cycle lanes of good width leading from the transition to the advanced limit lines of signalised intersections improves bicyclist perceptions of safety to a greater extent than the improvement in actual crash risk. As such facilities improve bicyclists' perceptions, their use encourages more to ride.*

should be replaced with:

Austroads report AP-R380/11 found

> *Better driver behaviour was observed in previous studies at coloured cycle lanes. This study shows that the provision of coloured cycle facilities results in substantially safer outcomes.*

Meldrum 2011[13] performed a before-after evaluation of a number of green-coloured surface treatment sites in Cairns, Queensland and found

> *A significant increase in the lateral distance between motor vehicles and cyclist and bicycle lanes was observed at a majority of the sites after the installation of the treatment. At a roundabout where motorist encroachment was measured, there was a significant reduction*

[13] Meldrum, Thomas, Review of current Australian use of green bicycle lanes; evaluation of mass implementation in Cairns, 2011

> *in both the total percentage of motor vehicles encroaching as well as the mean encroachment distance.*

Other treatments such as turn restrictions or physical lane dividers may be more effective safety interventions than coloured surface treatments. Considering the needs of cyclists at all stages of design can help to achieve road and intersection treatments that:

- provide clear guidance to all road users
- reduce the potential for conflict between motor vehicles and bicycles, and
- avoid the need for extensive use of green coloured surfacing.

4 Locations where a green-coloured surface treatment may be used

Green-coloured surface treatments may be considered as a supplementary treatment to highlight potential for conflict where other users are expected to cross a bicycle facility.

Typical situations where a green surface treatment may be used to highlight potential for conflict include:

- on sections of bicycle lanes with a poor safety record
- on the approach and departure of a busy or complex intersection, or one with uncommon layout or alignment features (refer Figure 4(A) for example)
- where large numbers of vehicles change lanes or turn across a bicycle lane, including, for example, across commercial property accesses into high turnover car parks
- where a bicycle lane crosses a free-flowing merge or diverge lane (refer Figure 4(B) for example)
- for a bicycle lane adjacent to a bus lane, busy loading zone or high turnover kerbside parking lane
- for a contraflow bicycle facility
- at other locations, where other road users may not expect to encounter cyclists – for example, where cyclists using an off-road path, service road or local street enter an on-road bicycle lane
- to discourage driver encroachment into a bicycle lane near an intersection or within a bicycle storage box or hook turn space.

Figure 4(A) – Coloured treatment where the intersection layout and traffic movements are complex and large numbers of vehicles cross the bicycle lane

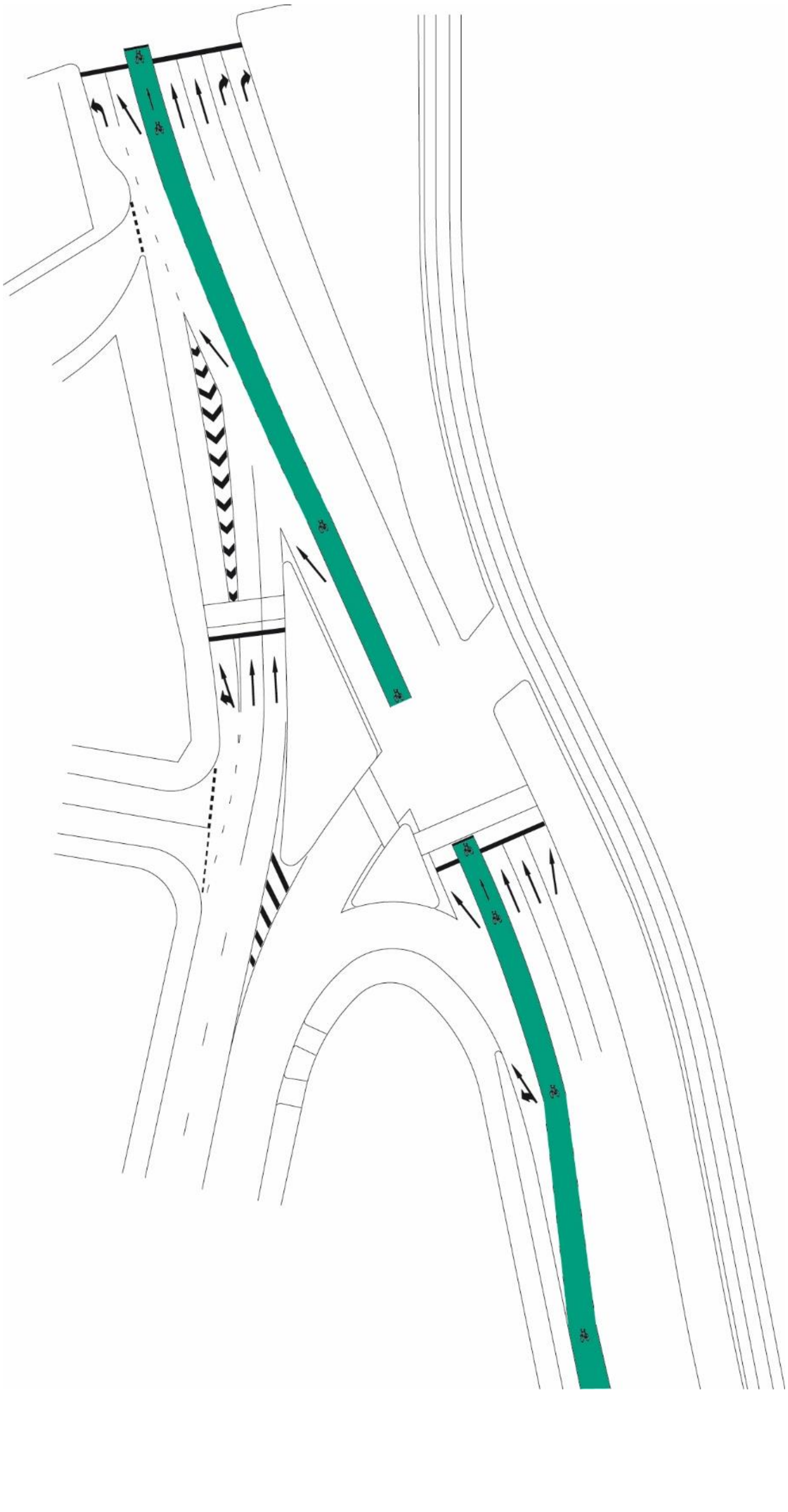
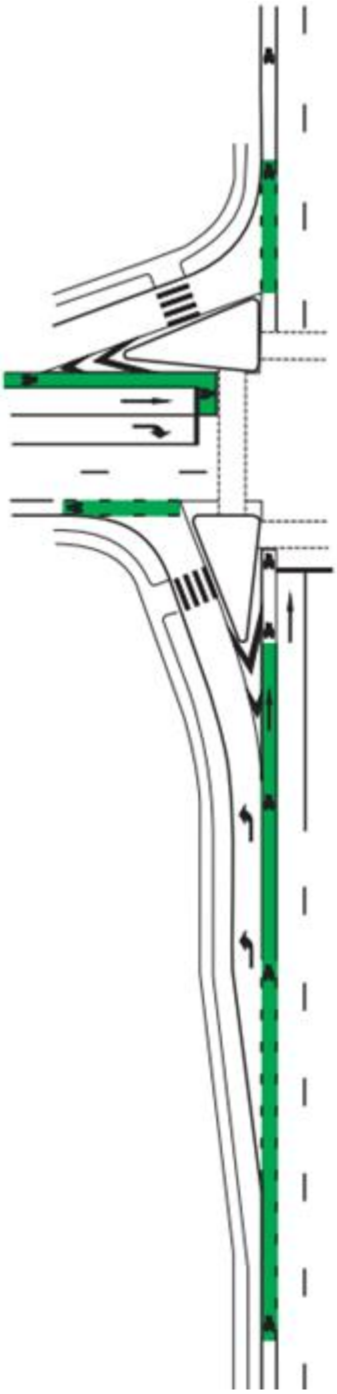


Figure 4(B) – Coloured treatment a bicycle lane passes through an intersection which has a high volume turning movement



Note: The green treatment does not need to extend beyond the conflict zone, unless there is a particular safety issue)

5 Warrants for use of coloured surface treatment

The Australian Capital Territory has developed a points system to determine locations where a coloured surface treatment is justified. Transport and Main Roads has adopted this system for use in Queensland. The warrant system incorporates an Excel spreadsheet (available on the Transport and Main Roads website), in which the treatment being assessed is selected along with relevant criteria particular to that site. 'Weightings' and 'ratings' are allocated to the various criterion options selected for the site and a score for the location is calculated by multiplying the weight by the rating for each separate criterion. All relevant criteria points are totalled to give a final score for the site. A score of 400–420 is an objective indicator that coloured pavement treatment may be justified at the site.

This warrant should be used to assist in exercising judgment and not as a substitute for it. It is intended to assist assessors in ensuring that the major relevant factors have been considered in the selection process. The warrant system is intended as a guide only and is no substitute for judgment based on local knowledge and past experience; for example, coloured surface treatments may be justified at sites that do not meet the warrant but have a poor crash history.

6 Factors to consider when choosing coloured surface treatment materials

A coloured surface treatment must be designed to function like any other road surfacing, providing a sound, durable surface layer, which maintains the required texture and skid resistance for its design life.

The design and specification of a coloured surface treatment for bicycle lanes should:

- ensure the suitability of the existing surface to support and bond with the colour treatment
- provide a surface texture and skid resistance suitable for bicycle use, including in wet conditions, and
- limit differential skid resistance between the bicycle lane and adjacent traffic lanes.

The coloured binder and any coloured surface coating on the aggregate will wear and expose more of the base aggregate colour over time. Use of a product incorporating a clear synthetic aggregate with coloured surfaces can enhance colour retention.

7 Maintenance considerations

As the coloured surface treatment is a supplemental treatment some amount of wear loss may be acceptable if the treatment still largely performs the function of highlighting the conflict zone. Determination of acceptable wear should be a site-specific engineering judgement. Ideally, the treatment should be as durable as surrounding pavement delineation, so they are aligned on the same maintenance schedule.

6.7 Raised pavement markers

6.7.2 Raised retroreflective pavement markers

6.7.2-1 Fire hydrant indication system

1 Introduction

This supplement provides a consistent approach to road marking for indication of fire hydrants. It gives guidance in the use of raised pavement markers and associated road furniture, number and location, installation, removal and costs associated with provision of such a system on unsealed roads and on sealed roads (with or without road centreline markings).

2 Fire hydrant indication system

2.1 General

A fire hydrant indication system may be provided where it is desired to enhance or supplement an existing fire hydrant marking system. Where it is proposed to install a fire hydrant indication system in new subdivisions, the system is used in lieu of existing marking systems.

Prior to installation of a fire hydrant indication system, consideration should be given to the additional costs associated with installation and ongoing maintenance of such a system.

2.2 Road markings and application

Road marking for the fire hydrant indication system is divided into the following categories:

i) unsealed road (gravel, dirt, sand)

ii) sealed road (without pavement marking), and

iii) sealed road (with pavement marking).

Fire hydrants on unsealed roads are located using a fire hydrant marker post with blue delineators. On sealed roads with, or without, pavement marking, hydrants are located using blue fire hydrant pavement markers supported, where necessary, with a fire hydrant marker post (and delineators).

Blue fire hydrant pavement markers are installed opposite the fire hydrant and on the same side of the line marking (or road centreline where line marking is not provided) as the hydrant. On divided roads, the pavement marker indicating a fire hydrant on the right-hand side of the carriageway, is located adjacent the median. Fire hydrant marker posts, delineators and blue fire hydrant pavement markers must be in accordance with the requirements specified in Section 3 *System components* of this supplement or relevant Transport and Main Roads standards.

In addition, power poles, trees or similar other roadside objects are not normally used as fire hydrant marker posts. Where it is necessary to erect a delineator adjacent the guardrail, a separate fire hydrant marker post is used for this purpose and installed behind the guardrail. Blue delineators are not erected on guardrail.

2.3 Typical arrangement diagrams

Typical arrangement diagrams illustrating the use of fire hydrant marker posts, blue delineators and blue fire hydrant pavement markers are provided in Section 5 *Typical arrangement diagrams*, together with a selection table, Table 4.3, to assist in selecting the appropriate diagram. These include:

- Figure 5(A)
- Figure 5(B)
- Figure 5(C)
- Figure 5(D)
- Figure 5(E)
- Figure 5(F)
- Figure 5(G)
- Figure 5(H).

Each diagram is accompanied by notes providing additional information for the convenience of users.

2.4 Installation procedures

Temporary signing for the installation of blue fire hydrant pavement markers, fire hydrant marker posts and blue delineators on Queensland roads under the control of the Transport and Main Roads should comply with Part 3 of the Queensland *Manual of Uniform Traffic Control Devices*.

3 System components

Specifications for:

a) fire hydrant road edge guide post – in accordance with Standard Drawing 1356 (Queensland Transport and Main Roads Standard Drawings – Roads) and painted white (or other selected colour), near edge of road

b) fire hydrant marker post – in accordance with Queensland Fire and Emergency Services specifications (commonly marked with 'HP').

4 Administration

4.1 General

Approval for installation of a fire hydrant indication system and associated temporary signing on Queensland roads is obtained from the District Director, Transport and Main Roads Regional Offices. For roads not under the control of Transport and Main Roads, approval should be sought from the relevant local authority.

4.2 Cost of fire hydrant indication system

The installation of a fire hydrant indication system is arranged in accordance with the following.

4.2.1 New water mains within new subdivision development

Supply and installation costs of blue fire hydrant pavement markers are borne by the developer. Where needed, costs associated with provision of supplementary devices (that is, fire hydrant marker post, blue delineator) are borne by the developer.

4.2.2 Existing water mains

The local authority is responsible for all costs associated with the provision of a fire hydrant indication system described in this supplement (in lieu of an existing marking system), in conjunction with existing water mains.

The installation of a fire hydrant indication system, or conversion of an existing marking system to this system, should be undertaken on an area- (or sub-area) wide basis, as negotiated with the Queensland Fire and Emergency Services.

4.2.3 Maintenance of fire hydrant indication system

The local authority is responsible for continuing inspection and maintenance of fire hydrant indication systems described in this supplement. This includes hydrant location records. Upon request, Transport and Main Roads would carry out minor maintenance or repairs on Queensland roads, for example, replacement of blue fire hydrant pavement markers. The cost applied is an estimate of the actual cost of the repairs or replacement.

Where roadworks affect part of the fire hydrant indication system, Transport and Main Roads would ensure replacement of the part(s) at its cost.

4.3 Removal

Discussions are to be held with the Queensland Fire Service, prior to the removal of devices installed under the provisions of this supplement. Consideration for removal of such devices would be given where:

i) the site is affected by temporary roadworks, or

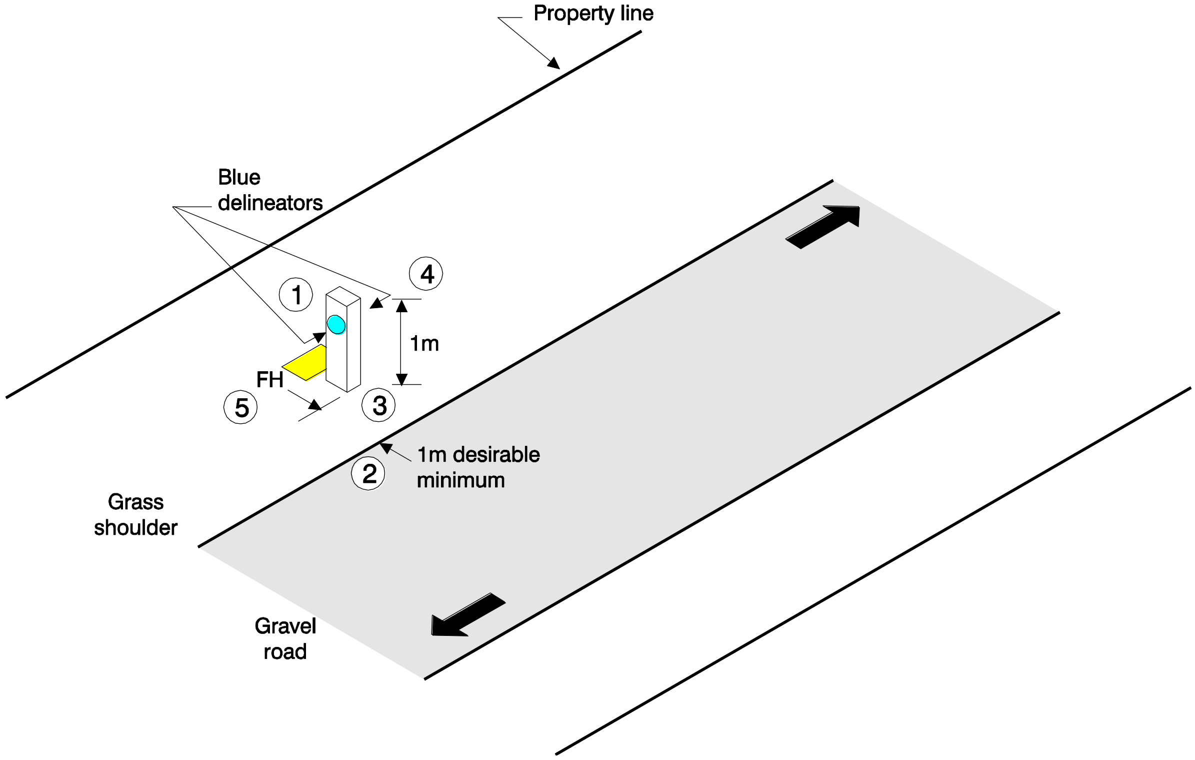
ii) the site is subject to permanent improvements to the road system, for example, construction of an overpass.

Table 4.3 – Fire hydrant marker selection table

Road type	Description	Figure selection
Unsealed road (gravel, dirt, sand)	two-lane, two--way road	1
Sealed road (without pavement marking)	two-lane, two-way road – rural – urban	 2 3
Sealed road (with pavement marking)	two-lane, two-way road multi-lane road divided road – narrow median – wide median	4 5 6 7

5 Typical arrangement diagrams

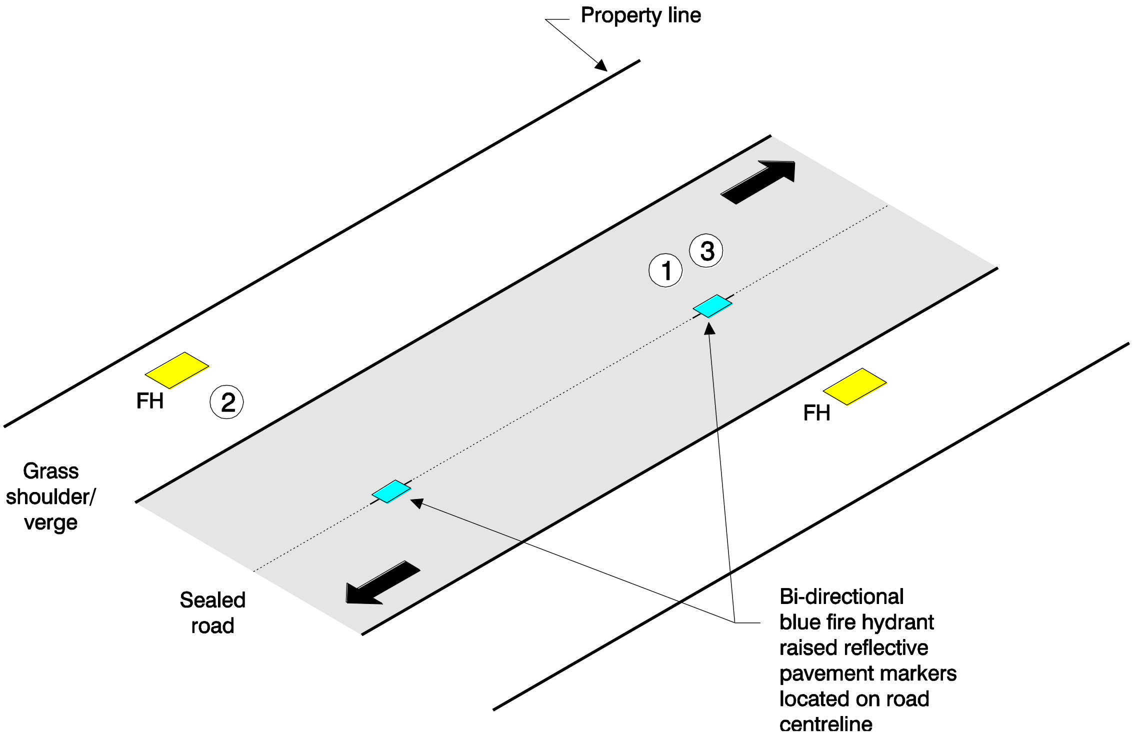
Figure 5(A) – Unsealed road – dirt, gravel, sand



Notes

1. Fire hydrant road edge guide post and delineator to comply with requirements specified in Clause 3 of this section.
2. This distance may be reduced where road edge guide posts along the road are located closer to the gravel/dirt / sand surface.
3. The fire hydrant road edge guide post is erected directly in line with, and on the same side of the road as, the fire hydrant (that is, at right angles from the road edge).
4. Where the road reserve is wide, provision of a fire hydrant distance sign may be considered. This sign is positioned on the front of the fire hydrant road edge guide post (that is, side closest to the roadway) and indicates the distance to the fire hydrant. See Figure 5(H).
5. Where visibility to the fire hydrant may be obstructed, for example, grass, steep batter, and so on, provision of a fire hydrant marker post (facing the road) may be considered.

Figure 5(B) – Sealed road – without pavement marking (rural areas)

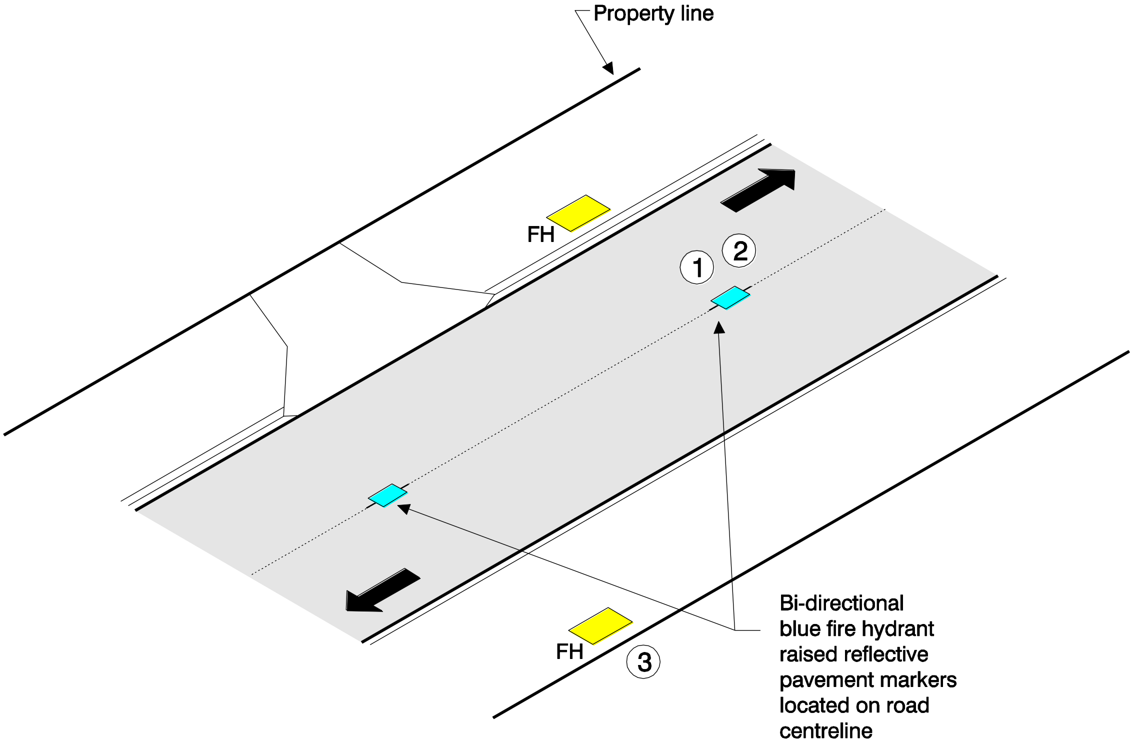


Notes

1. Fire hydrant raised reflective pavement markers to comply with requirements specified in Clause 3 of this section.
2. Where visibility to the fire hydrant may be obstructed, for example, grass, steep batter, and so on, provision of a fire hydrant marker post (facing the road) may be considered.
3. Raised reflective pavement markers are installed on the centre of the road

.

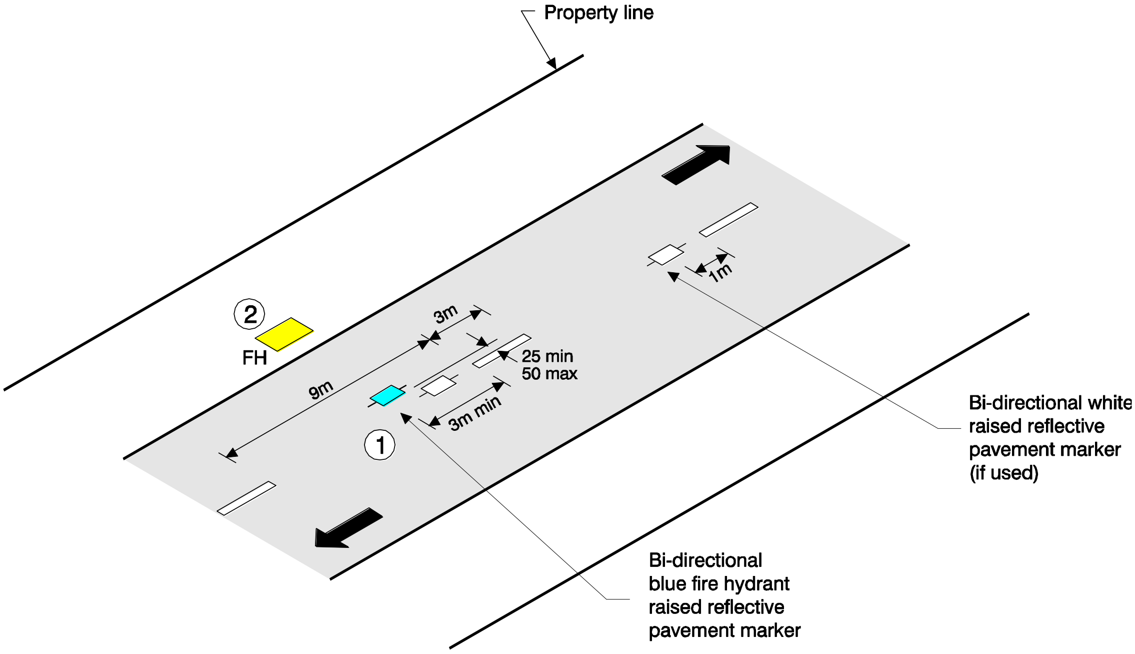
Figure 5(C) – Sealed road – without pavement marking (urban areas)



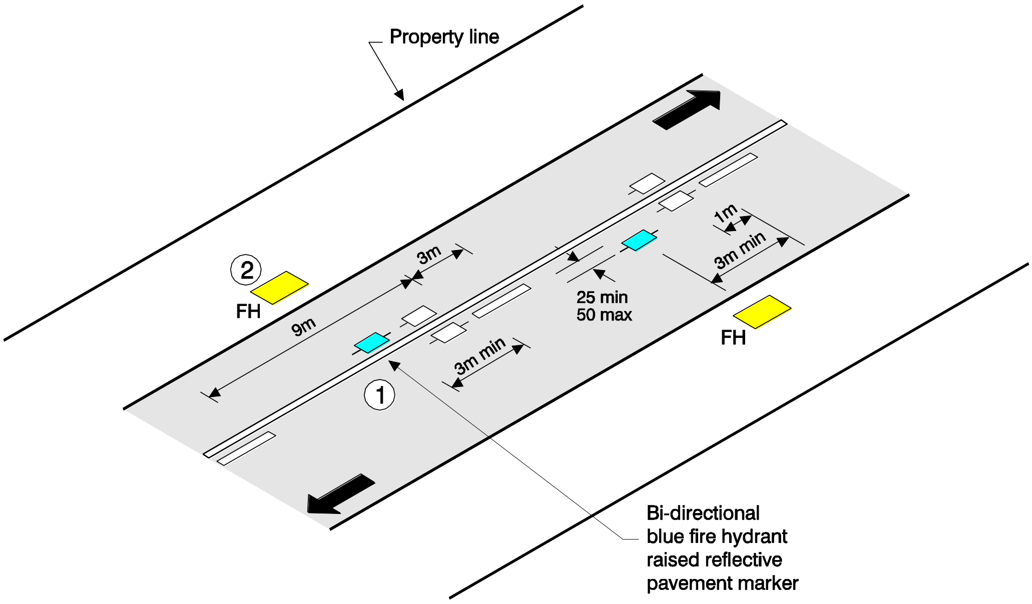
Notes

1. Fire hydrant raised reflective pavement markers to comply with requirements specified in Clause 3 of this section.
2. Raised reflective pavement markers are installed on the centre of the road.
3. Where visibility to the fire hydrant may be obstructed, for example, grass, steep batter, and so on, provision of a fire hydrant marker post (facing the road) may be considered.

Figure 5(D) – Sealed road – with pavement marking (two-lane, two-way road)



(a) Separation Line

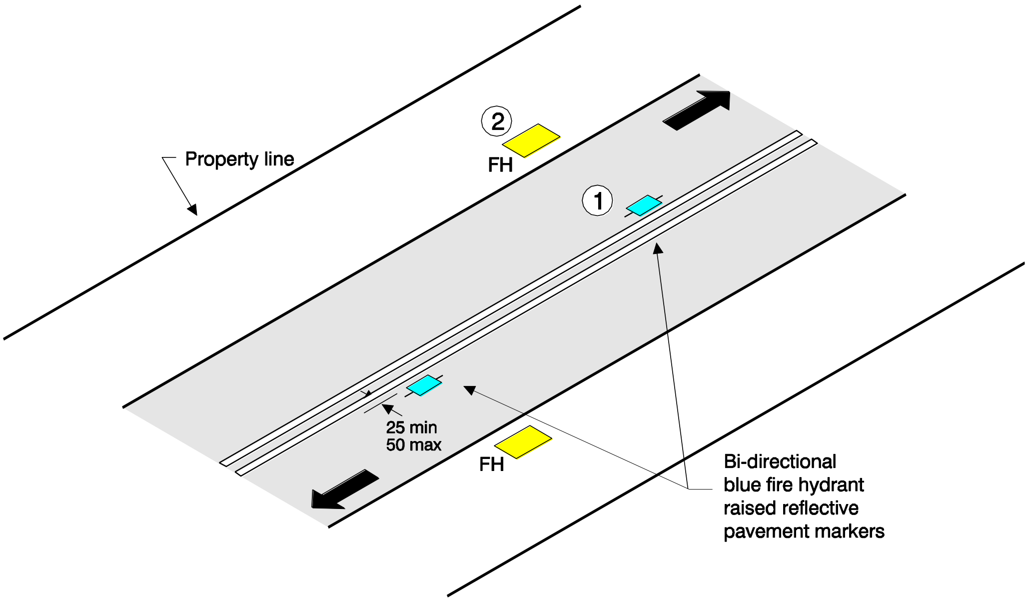


(b) One-Way Barrier Line

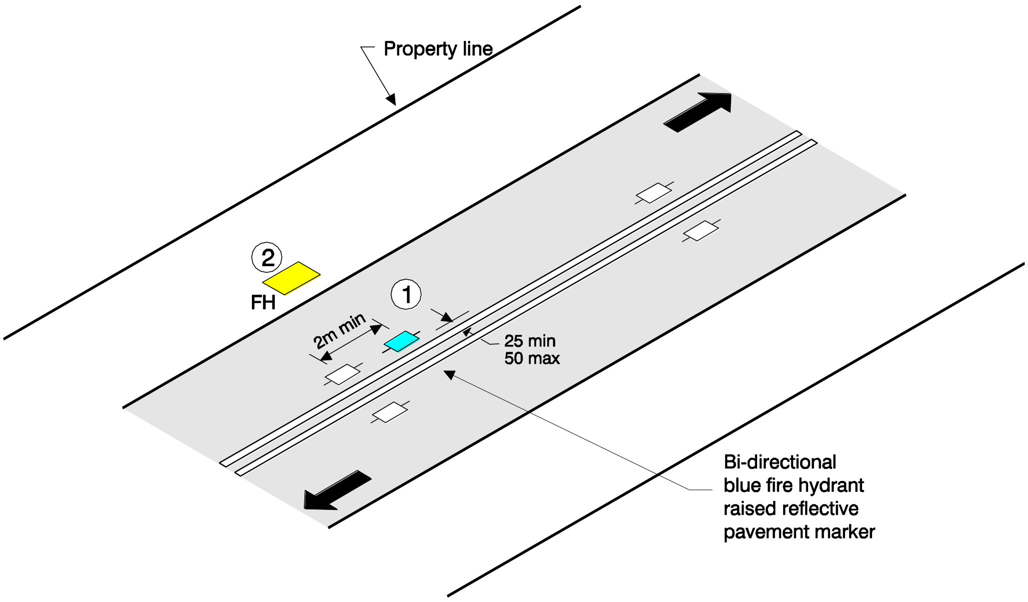
Notes

1. Fire hydrant delineators and raised reflective pavement markers to comply with requirements specified in Clause 3 of this section.
2. Where the road reserve is wide and visibility from the pavement marker to the fire hydrant may be obstructed, for example, grass, steep batter, and so on, provision of a fire hydrant marker post and fire hydrant distance sign (see Figure 5(H)) may be considered. This sign is positioned on the front of the fire hydrant marker post (that is, closest to the roadway) and indicates the distance to the fire hydrant. The fire hydrant marker post is erected along the line of road edge guide posts or the edge of the road formation as appropriate. A blue reflective delineator may be attached to the front of the fire hydrant marker post (that is, closest to the road surface).

Figure 5(D) (cont.) – Sealed road – with pavement marking (two-lane, two-way road)



(c) Two-Way Barrier Line (without raised reflective pavement markers)

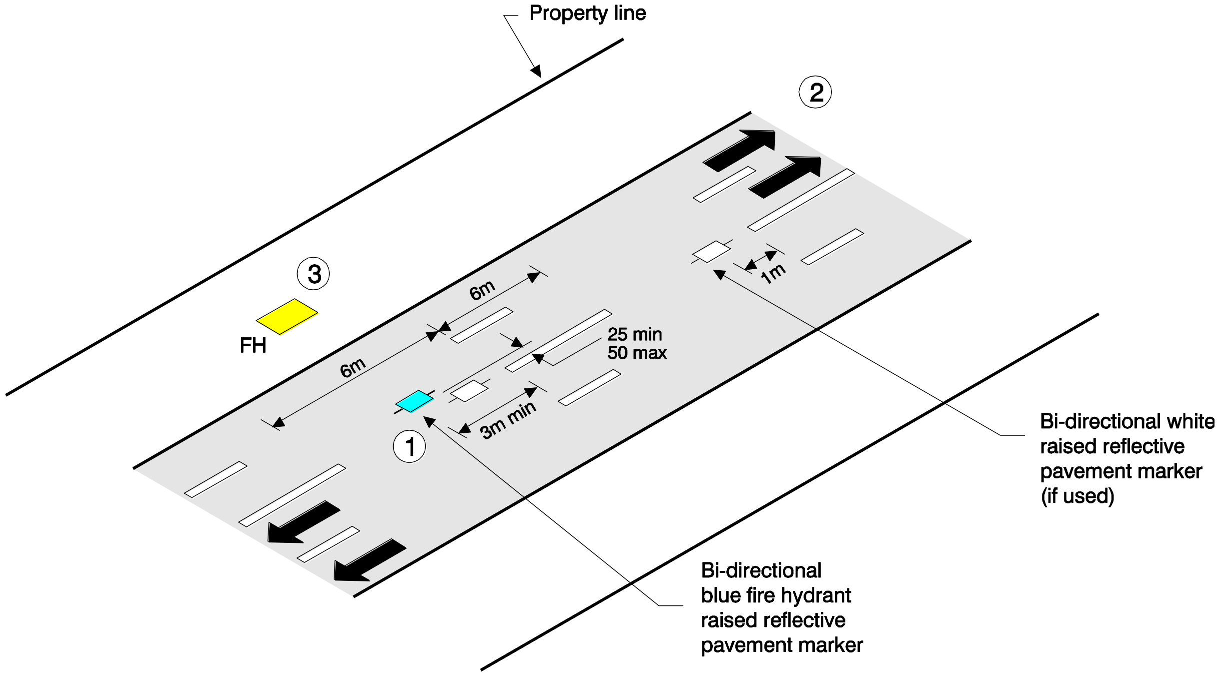


(d) Two-Way Barrier Line (with raised reflective pavement markers)

Notes

1. Fire hydrant delineators and raised reflective pavement markers to comply with requirements specified in Clause 3 of this section.
2. Where the road reserve is wide and visibility from the pavement marker to the fire hydrant may be obstructed, for example, grass, steep batter, and so on, provision of a fire hydrant marker post and fire hydrant distance sign (see Figure 5(H)) may be considered. This sign is positioned on the front of the fire hydrant marker post (that is, closest to the roadway) and indicates the distance to the fire hydrant. The fire hydrant marker post is erected along the line of road edge guide posts or the edge of the road formation as appropriate. A blue reflective delineator may be attached to the front of the fire hydrant marker post (that is, closest to the road surface).

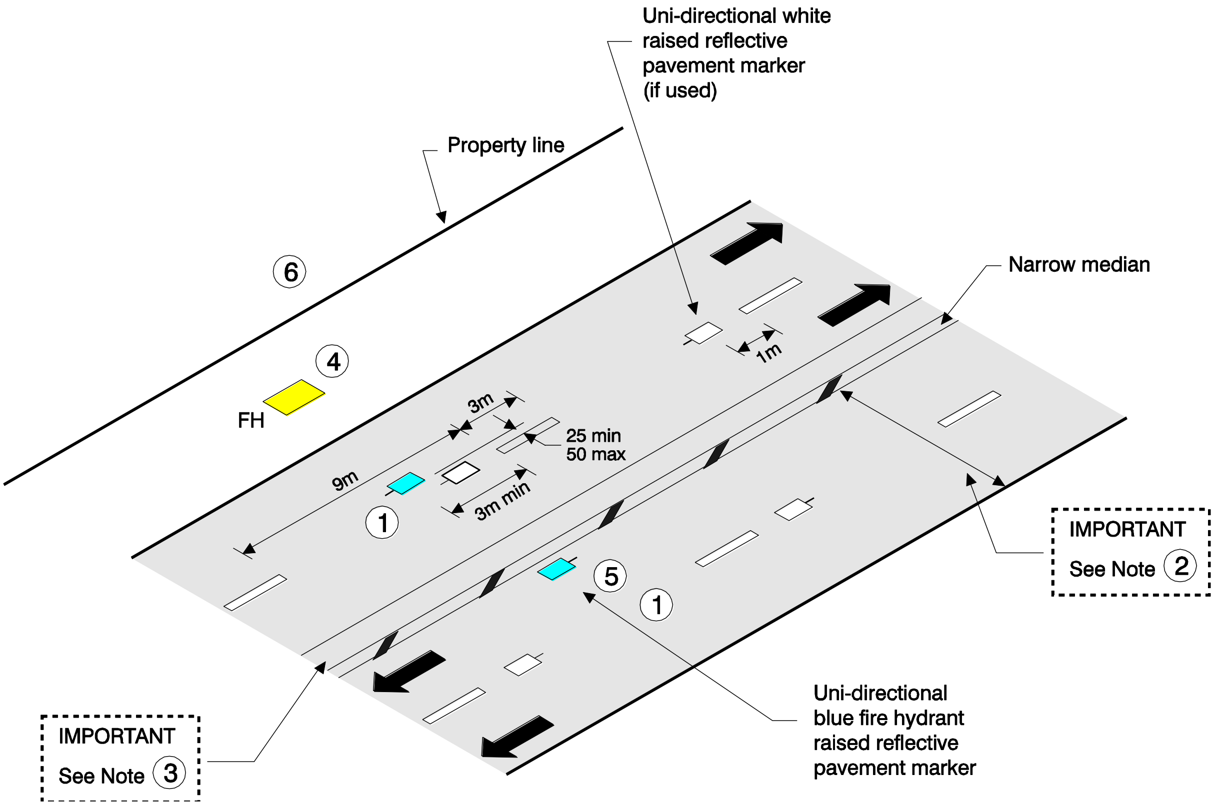
Figure 5(E) – Sealed road – multi-lane road



Notes

1. Fire hydrant delineators and raised reflective pavement markers to comply with requirements specified in Clause 3 of this section.
2. For multi-lane, undivided roads where one-way or two-way barrier lines are used, refer to Figure 5(D) for placement of fire hydrant raised reflective pavement markers and delineators.
3. Where the road reserve is wide and visibility from the pavement marker to the fire hydrant may be obstructed, for example, grass, steep batter, and so on, provision of a fire hydrant marker post (that is, closest to the roadway) and indicates the distance to the fire hydrant. The fire hydrant marker post is erected along the line of road edge guide posts or the edge of the road formation as appropriate. A blue reflective delineator may be attached to the front of the fire hydrant marker post (that is, closest to the road surface).

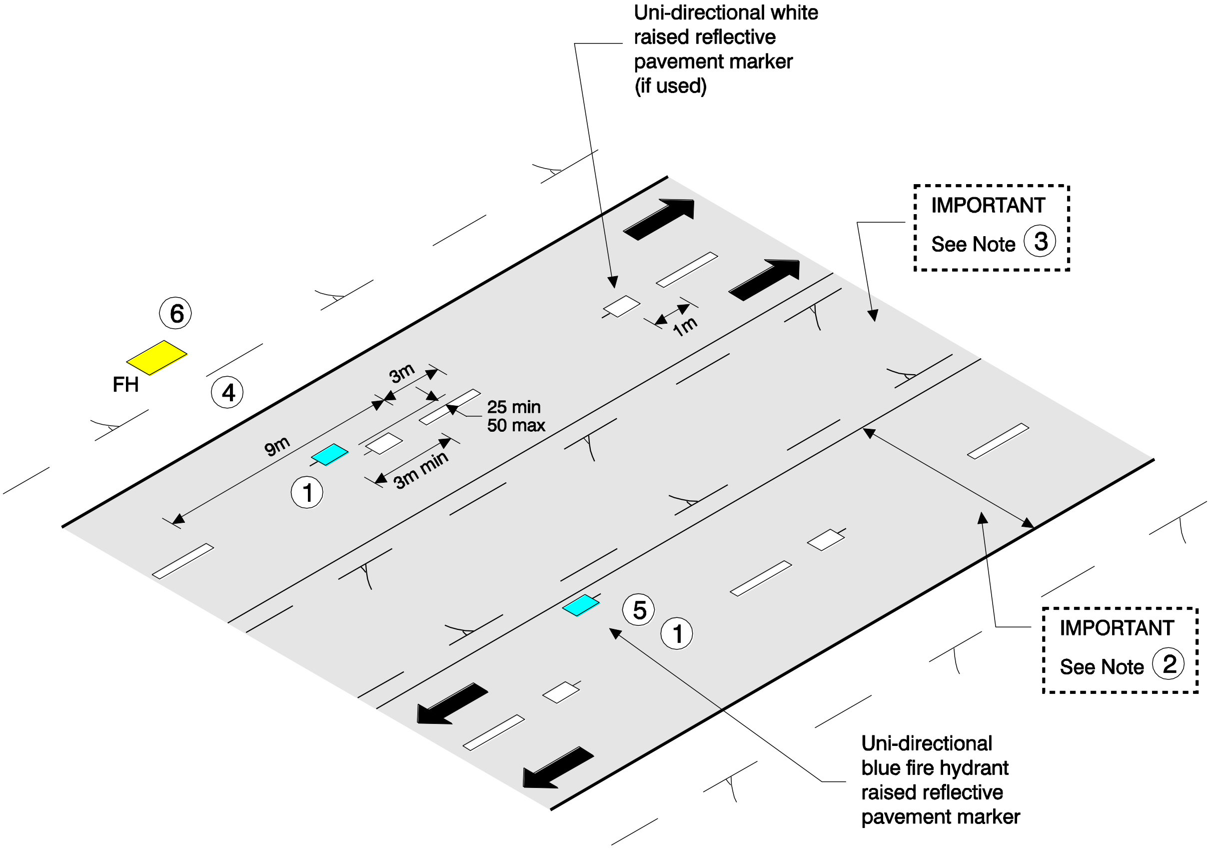
Figure 5(F) – Sealed road – divided road (narrow median)



Notes

1. Fire hydrant delineators and raised reflective pavement markers to comply with requirements specified in Clause 3 of this section.
2. For roads with more than two lanes of travel in one direction, a fire hydrant marker post (and delineators) is erected in the median. In this case, fire hydrant pavement markers are not installed.
3. Where a New Jersey-type structural barrier forms the narrow median on roads with more than two lanes of travel in one direction, a fire hydrant delineator (single-sided) is mounted on top of the New Jersey-type barrier. Fire hydrant pavement markers are not used in this case.
4. Where the road reserve is wide and visibility from the pavement marker to the fire hydrant may be obstructed, for example, grass, steep batter, and so on. provision of a fire hydrant marker post and fire hydrant distance sign (see Figure 5(H)) may be considered. This sign is positioned on the front of the fire hydrant marker post (that is, closest to the roadway) and indicates the distance to the fire hydrant. The fire hydrant marker post is erected along the line of road edge guide posts or the edge of the road formation as appropriate. A blue reflective delineator may be attached to the front of the fire hydrant marker post (that is, closest to the road surface).
5. Where access to a fire hydrant is not available from the opposite carriageway (for example, vertical wall), a fire hydrant pavement marker, or other indication, is not placed for that carriageway.
6. Where the road is a freeway or motorway (with fire hydrants located outside of the road reserve) and it is desired to indicate the fire hydrant, a freeway fire hydrant distance sign (see Figure 5(H)) is attached to the freeway fencing in lieu of the installation of a fire hydrant marker post. An indication of this type is only provided where appropriate access to the hydrant is available for fire fighting vehicles.

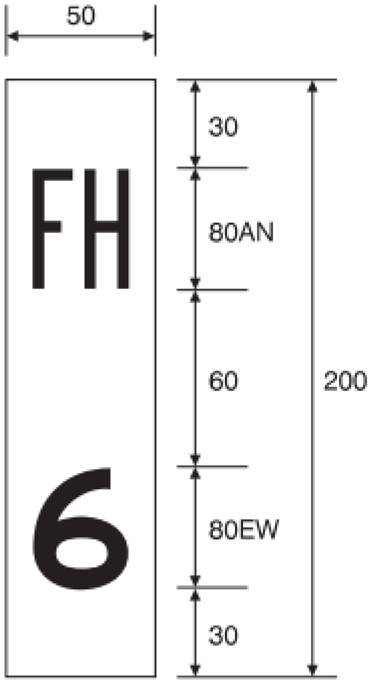
Figure 5(G) – Sealed road – divided road (wide median)



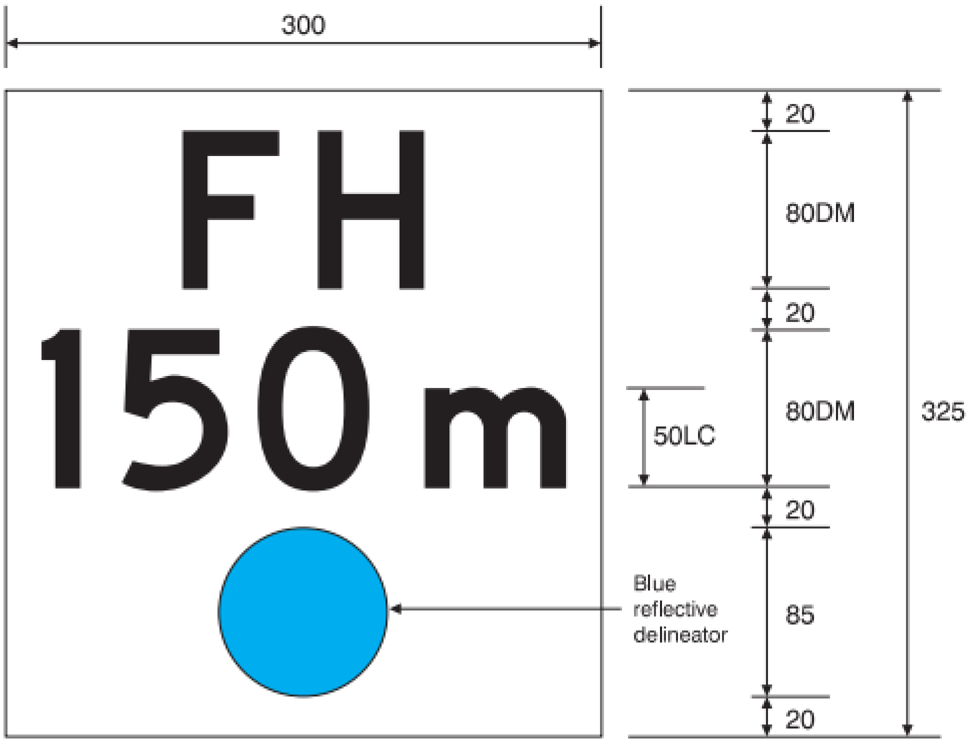
Notes

1. Fire hydrant delineators and raised reflective pavement markers to comply with requirements specified in Clause 3 of this section.
2. For roads with more than two lanes or travel in one direction, a fire hydrant marker post (and delineators) is erected in the median. In this case, fire hydrant pavement markers are not installed.
3. Where a New Jersey-type structural barrier is used on roads with more than two lanes of travel in one direction, a fire hydrant delineator (single-sided) is mounted on top of the New Jersey-type barrier. Fire hydrant pavement markers are not used in this case.
4. Where the road reserve is wide and visibility from the pavement marker to the fire hydrant may be obstructed, for example, grass, steep batter, and so on, provision of a fire hydrant marker post and fire hydrant distance sign (see Figure 5(H)) may be considered. This sign is positioned on the front of the fire hydrant marker post (that is, closest to the roadway) and indicates and the distance to the fire hydrant. The fire hydrant marker post is erected along the line of the road edge guide posts or the edge of the road formation as appropriate. A blue reflective delineator may be attached to the front of the fire hydrant marker post (that is, closest to the road surface).
5. Where access to a fire hydrant is not available from the opposite carriageway (for example, vertical wall), a fire hydrant pavement marker, or other indication, is not placed for that carriageway.
6. Where the road is a freeway or motorway (with fire hydrants located outside of the road reserve) and it is desired to indicate the fire hydrant, a freeway fire hydrant distance sign (see Figure 5(H)) is attached to the freeway fencing in lieu of the installation of a fire hydrant marker post. An indication of this type is only provided where appropriate access to the hydrant is available for fire fighting vehicle.

Figure 5(H) – Fire hydrant indication signs



(a) Fire Hydrant Distance Sign



(b) Freeway Fire Hydrant Distance Sign

6.8 Rumble strips

6.8.1 Types and application

6.8.1-1 Rumble strips

See *Traffic and Road Use Management* manual, Volume 2 *Guide to Road Safety* Part 5 *Road Safety for Rural and Remote Areas*.

7. Guide posts and delineators

7-1 Bicycle lane separation devices

1 Purpose and scope of this Supplement

This supplement has been prepared to provide guidance on preferred treatments and design characteristics of bicycle lane separation devices.

Austroads *Guide to Road Design* Part 6 *Roadside Design, Safety and Barriers*, Section 6.5 addresses road system barriers but adjacent to off-road shared paths rather than for on-road bicycle lanes. Austroads *Guide to Road Design* Part 3 *Geometric Design* Section 4.8 discusses separated bicycle lanes, protected bicycle lanes and supplementary treatments but does not provide specific safety design details about the separation treatment. Transport and Main Roads guideline *Selection and design of cycle tracks* also discuss separation treatments, including widths but does not provide guidance on separation device design considerations.

1.1 Background

Transport and Main Roads supports the implementation of on-road separation between cyclists and motorists. There is currently limited design guidance, however, on how to best implement these separation treatments and to ensure new hazards are not created for cyclists. A number of incidents have been reported (refer to Section 4.1 *Case studies*) that emphasise the importance of ensuring separation treatments are not hazards in their own right.

While separation devices increase the lateral separation between cyclists and motorists, research confirms that some devices and/or treatments are more effective than others.

The degree, and type of separation varies, with separation being provided through road markings, vertical separation, physical barriers, and a combination of devices. This supplement provides a recommendation of preferred separation devices which are suitable for use alongside on-road bicycle lanes.

1.2 Related documents

This supplement should be read in conjunction with the following guidelines:

- Austroads *Guide to Road Design:*
  - Part 3 *Geometric Design*
  - Part 6 *Roadside Design, Safety and Barriers*
  - Part 6A *Pedestrian and Cyclist Paths*
- Austroads *Cycling Aspects of Austroads Guides*
- Queensland *Manual of Uniform Traffic Control Devices:*
  - Part 2 *Traffic Control Devices for General Use*
  - Part 9 *Bicycle Facilities*
- Transport and Main Roads guideline *Selection and design of cycle tracks*.

The documents listed below have been referenced in this supplement but are not listed in related documents:

- Cardno prepared for Department of Transport and Main Roads, *Review of Engineering Treatments for the Separation of Bicycle Lanes*, March 2016
- CARRS-Q prepared for Department of Transport and Main Roads, *Separated Bicycle Lanes – review of literature*, February 2016
- Queensland Government (Department of Transport and Main Roads), *Fact Sheet: Separation Devices on Bicycle Lanes*, September 2016.

2 Preferred separation device

2.1 Device configuration

The preferred separation device configuration is a **vertical delineation device on a separation kerb, within a pavement marked buffer**. The design aspects of the preferred separation device are detailed in Figure 2.1(A) – *Key features of preferred treatment* and Table 2.1 – *Preferred separation device design attributes*.

Figure 2.1(A) – Key features of preferred treatment

Table 2.1 – Preferred separation device design attributes

Preferred safety design features	Function	Considerations
Separation kerb	Provides a safe mounting for vertical delineators and a tactile deterrent to vehicle encroachment. To optimise safety outcomes, the preferred separation device must have the following characteristics: • conspicuous through use of contrasting colours and inclusion of fluorescent and retroreflective elements • slip-resistant wet pendulum >65BPN • semi-mountable on the bicycle side, not incorporating a vertical lip (refer Transport and Main Roads Standard Drawing 1033); a barrier profile may be appropriate on the motor vehicle side to reduce motor vehicle encroachment • continuous treatments are preferred compared to short sections of discrete devices; they should be sufficiently long that they are legible on approach (for example, install the kerbs on the approach to corner of conflict zone such that they reinforce to motorists the desired travel path in their own lane).	• Breaks in the device should be included to remove a 'debris trap' and overland flow / road drainage should not be significantly affected. • Drainage gaps shall incorporate sloped ends no steeper than 1 in 4 on the leading edge. • Avoid short sections of separation kerb as it may appear unexpectedly to cyclists. • Regular monitoring and clearing of debris build-up in the bicycle lane and near the device is required. • The vertical height of the device makes it difficult for vehicles to mount it at reasonable speed and/or comfort and is therefore only suitable where there is no demand for vehicles to cross the device (for example, to access car parking or driveways). • Where access to driveways needs to be maintained, fully-mountable separation kerbs may be used in these sections only (as illustrated in Figure 2.1(B).

Preferred safety design features	Function	Considerations
Vertical delineation device	Improves conspicuity, reduces the likelihood of bicycle wheel strikes and complements the vehicle encroachment deterrent provided by the separation kerb.	• These are effective in improving the legibility and visibility of the installed physical separation kerb. • These are very effective in improving rider safety. They are more effective when installed with other devices (for example, separation kerb) rather than directly into the road surface. • The height should be the equivalent of a road edge guide post. • The device should be installed at the front face of the treatment and at regular intervals. • Additional / more frequently spaced devices may be required based on site characteristics such as horizontal alignment or where there is a lack of or limited street lighting. • Larger gaps in spacing may be considered where there is a need for vehicles to cross the device. • A disadvantage of this device is the potential for impact damage and associated frequent maintenance / replacement costs.
Pavement marked buffer around the separation kerb	Improves delineation and provides the required offset to vehicles and bicycles from the separation device.	Refer to offset requirements to travel lanes specified in the *Road Planning and Design Manual* and Austroads guides.

Figure 2.1(B) – Example of mountable separation kerb for driveway access

2.2 Site design considerations

Site design aspects to be considered when installing bicycle lane separation devices include:

- bicycle lane width and the potential for the device to hinder passing or overtaking within the bicycle lane
- the type of cyclist likely to use the bicycle lane:
  - groups or individuals
  - children or adults, and
  - level of experience
- the likelihood of motor vehicle encroachment, especially at:
  - feeder bicycle lanes to advanced storage areas or advanced stop boxes
  - horizontal curves
  - weaving situations, and
  - intersection auxiliary lanes
- traffic volumes and proportion of heavy vehicles / buses
- locations where there is high vehicle or pedestrian demand across / through the bicycle lane:
  - strong pedestrian desire line along or across the bicycle lane
  - kerbside bus stops (consider bus frequency)
  - kerbside car parking (consider turnover rates and if it is reconfigurable), and
  - driveways at high vehicle trip generators.

Guidance on these issues can be found in:

- Austroads *Guide to Road Design* Part 3, Section 4.8 *Bicycle Lanes*, and
- Transport and Main Roads guideline *Selection and Design of Cycle Tracks*.

3 Historical applications

Figure 3 – Example of historical concrete barrier kerbs

Use of concrete barrier kerbs or 'wheel stops' are common on historical separation treatments, as shown in Figure 3. These treatments are appropriate only if the risk of vehicle encroachment into the bicycle lane is greater than the risk of cyclists and motor vehicle crashes with the device. If used, they must incorporate colour contrast, retroreflection, a pavement marked buffer and vertical delineation devices similar to that detailed in Table 2.1. They must also have a semi-mountable profile facing on the bicycle lane side with ramped ends at the drainage cuts combined with increased width at the entry and distinct delineation on the ends.

4 Background

4.1 Case studies

4.1.1 David Low Way, Bli Bli, North Coast District

Transport and Main Roads' North Coast District was subject to a personal injury claim in December 2016.

As part of a roundabout construction, a developer installed a small concrete island which was struck by a cyclist.

The images following show a concrete island separating the bicycle lane from the road. There are two gaps in the concrete for driveways accessing David Low Way across the bicycle lane. The last photo in Figure 4.1.1 shows the same treatment at the other legs of the roundabout. This continuous separation treatment design was adjusted due to the driveways on the approach to this leg of the roundabout where the incident occurred.

The smaller concrete island was hit by a cyclist who was injured, and subsequently made a personal injury claim against Transport and Main Roads. The concrete island has now been removed.

Lessons learnt: Smaller non-continuous sections of separation devices can be hazardous particularly when installing next to minimum width bicycle lanes. It is preferable to not install short sections of separation; however, if these are to be installed, further delineation of the potential hazard should be incorporated into the design.

Figure 4.1.1 – David Low Way: Showing concrete islands separating the bicycle lane from the road

(Source: Google Street View)

4.1.2 Captain Cook Highway, Cairns, Far North Queensland region

A bicycle lane separation treatment was funded by the *Safer Roads Sooner* program on the Captain Cook Highway in Cairns. It sought to provide a physical separation between cyclists and vehicles on a road with high traffic volumes and speeds and a high proportion of heavy vehicles. The funding business case drew upon a Coroner's findings into a death that had occurred at this location.

The initial treatment (2009) used a low-height plastic kerb and is shown in Figure 4.1.2(A).

Figure 4.1.2(A) – Captain Cook Highway: 2009 separation treatment (plastic kerb with vertical delineators)

Brisbane City Council have used this profile at the separated cycle facility in George Street (Figure 4.1.2(B)), and Transport and Main Roads has installed it on Gympie Road at Kedron Park Road southbound (Figure 4.1.2(C)).

At all locations, and specifically at the Captain Cook Highway, there have been maintenance issues with vehicles striking the kerb (the pinning mechanisms failed on repeated occasions) and the delineator posts were frequently damaged.

Figure 4.1.2(B) – George Street, Brisbane (plastic kerb with vertical delineators)

Figure 4.1.2(C) – Gympie Road at Kedron Park Road southbound, Kedron Park (plastic kerb with vertical delineators)

Considering the maintenance issues and the need to further discourage heavy vehicles from entering the bicycle lane, the Far North Queensland region submitted a *Safer Roads Sooner* funding case to replace it with a concrete, back-to-back barrier kerb, which is still in place (Figure 4.1.2(D)).

Figure 4.1.2(D) – Captain Cook Highway: current separation treatment (concrete kerb)

Design changes included amending the bicycle lane openings to assist in smooth bicycle flow paths and 300 mm vertical delineation devices were installed; however, as per the 2009 project, these were also struck by heavy vehicles' rear wheels and became a maintenance issue (see Figure 4.1.2(D) image with marker lying flat on the ground in front of kerb).

While this has been considerably more effective in achieving the primary goal of preventing vehicles from entering the bicycle lane, there are design elements that could be improved to make it more 'cycle friendly', notably the steep leading edges at the drainage breaks, the entering / exiting alignment, the width at the entry and improved delineation of the end (which would benefit both cyclists and drivers).

The challenge at the Captain Cook Highway roundabouts is to keep vehicles out of the bicycle lane but ensure any new risks for cyclists are not introduced. The barrier kerb on the traffic side appears to have effectively reduced the 'hit by truck' risk but has introduced other hazards that should be able to be mitigated with some design modifications.

> Lessons learnt: The plastic kerb was not suitable for the high traffic and truck volumes (and in particular, the B-double sugarcane hauling trucks) experienced at the Captain Cook Highway roundabouts. A more robust treatment was necessary to keep vehicles out of the bicycle lane. Further improvements could still be considered to reduce risks to cyclists by introducing a semi-mountable profile on the cyclist side with ramped ends at the drainage cuts, combined with increased width at the entry and distinct delineation on the ends, colour contrast, retroreflection, and a pavement marked buffer and vertical delineation devices. In addition, a cyclist rail / post could be included to assist cyclists checking for turning vehicles from behind at GIVE WAY locations.

4.2 Separation device audit

The following table details separation devices currently in place and the findings of the assessment of their suitability as separation treatments for on-road bicycle lanes. This assessment informed the definition of the preferred bicycle lane separation treatment outlined in Section 2.

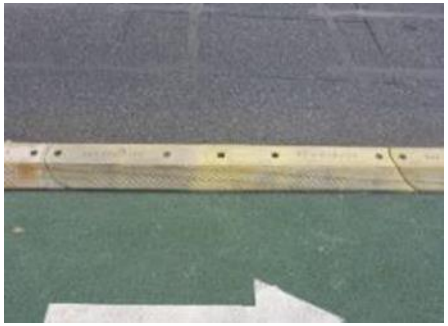
Table 4.2 – Types of separation devices and suitability audit

Device	Examples		Assessment findings
Pavement markings Painted buffer (various line marking arrangement and widths)			• Provision of raised reflective pavement markers (RRPMs) also assisted with this improved perception of safety. • Limited effectiveness in reducing vehicle encroachment.
	Painted 1m chevron traffic island with rumble bars (Chinderah Bay Road)	Painted 2m chevron traffic island with RRPMs at bend (Bennetts Road)	

Device	Examples		Assessment findings
Discrete high-profile devices • armadillos • wheel stops • half wheels • moulded rubber			• Concrete devices were noted as having poor visibility in low light and at night. • All concrete device options, regardless of the angle of the leading and trailing edges were noted as introducing risk to all road users. • Separation between devices varied but did not appear to reduce or eliminate the build-up of debris compared to continuous installations. • There was a lower perception of comfort when driving or riding next to these treatments. Concrete devices, particularly the leading edges, introduced a risk that may have been more significant than that which was being addressed via the installation. • The device, when installed with treatments to address these issues (that is, vertical delineation devices and pavement marked buffers around separation kerbs), provide improved sense of separation compared to being installed by itself.
	Low visibility of older concrete devices	Low abruptness discrete concrete (Helensvale Road)	
			
	Rounded discrete rubber (Somerset Drive)	High abruptness discrete concrete (Somerset Drive)	

<table>
<tr><th>Device</th><th colspan="2">Examples</th><th>Assessment findings</th></tr>
<tr>
<td rowspan="4">Discrete
low / medium profile separators
• audio tactile line markings (ATLMs)
• retroreflective pavement markers
• Riley kerb
• low profile rumble bars</td>
<td></td>
<td></td>
<td rowspan="4">• Studies found that a significant proportion of vehicles travel over the ATLM devices and into the adjacent bicycle lane.
• Typically, the ATLM device is not an effective deterrent for motorists travelling at low speeds (approx. 60 km/h) and does not reinforce or increase separation between vehicles and cyclists.
• Some versions of rumble bars have a relatively high edge and could potentially destabilise a cyclist, should they meet the device.
• In some instances (for example, low-profile longitudinal humps), the low vertical profile could be almost indistinguishable in look or function to surface paint. These devices may prove ineffective as a deterrent to motorists given the very low profile. Additionally, cyclists may not be able to distinguish the device as being slightly raised and may inadvertently ride over it, not expecting there to be a difference in level or surface texture.
• Overall, these devices had a limited effect in reducing the number of vehicle encroachments into an adjacent bicycle lane and were not conspicuous enough.</td>
</tr>
<tr><td>Vehicle encroachment over ATLM (Bennetts Road)</td><td>Low profile rubber rumble bar with RRPM (Chinderah Bay Road)</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Low profile longitudinal humps (Bridge Street, Mackay)</td><td>High profile rumble bar (creating a medium profile separator)</td></tr>
</table>

<table>
<tr><th>Device</th><th colspan="2">Examples</th><th>Assessment findings</th></tr>
<tr><td rowspan="4">Vertical separators
• flexible guide posts
• lane divider flap
• traffic cones
• low impact smart bollard
• plastic flexible bollards</td><td></td><td></td><td rowspan="4">Guide posts can be prone to regular and major damage depending on their location, proximity to the edge of traffic, and fixing / mounting type. Guide posts installed on top of concrete barriers or as an integrated component of a separation kerb are better alternatives based on consideration of the following:
• They appear less prone to initial damage compared to isolated guide post installations.
• When damaged, any remnant part of the guide post fixed to the surface (including the mounting plate) will not be located at-grade, itself becoming an unintended hazard for riders.
• When damaged, there appears an improved chance that some parts of the device mount may be contained within the longitudinal separator.
• Plastic bollard devices are retrofittable and relatively cheap, short enough to not catch on a cyclist’s handlebar and are reflective; however, they can be more prone to vandalism and regular damage by collision.</td></tr>
<tr><td>Damaged delineation post (Tweed Valley Way)</td><td>Plastic bollard device (Grey St)</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Damaged (leaning) bi-directional guide posts (George Street)</td><td>Delineation post on top of concrete barrier (Helensvale Road)</td></tr>
</table>

<table>
<tr><th>Device</th><th colspan="2">Examples</th><th>Assessment findings</th></tr>
<tr>
<td rowspan="4">Separation kerbs
• caterpillar safe cycle (new product and as yet untested)
• rubber separation kerb
• rubber lane maker
• pre-cast concrete</td>
<td></td>
<td></td>
<td rowspan="4">• The rubber devices were robust and generally did not suffer catastrophic failure. Longer-term issues including UV degradation, device separation and cracking are common within an approximate four–six-year post-installation period, depending on site exposure and traffic characteristics.
• The continuous concrete kerb device is very robust; however, as these treatments age, their visibility becomes limited, particularly in low light or darkness. The dimension of the vertical face from the road surface is higher than the rubber device. The profile of the concrete kerb is likely required to reduce edges chipping off. There is the potential for the more significant edge dimension to destabilise a cyclist if he or she was involved in an acute collision with the device.
• Skid resistance needs to be verified.</td>
</tr>
<tr><td>Caterpillar kerb</td><td>Rubber separation kerb (George St)</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">Pre-cast concrete (Maryborough Street – 20+ years old)</td></tr>
</table>

Device	Examples		Assessment findings
Safety barriers (>150mm height) • pre-cast concrete • water filled			• Concrete barriers >150 mm high are typical installations on higher speed road environments, designed to redirect out-of-control vehicles. In this situation, a higher level of separation is preferable. • The devices are installed as interconnected modules which make them difficult to locate within an existing road cross-section in a retrofit situation. • They are also less likely to conform to medium-high radius turns, given their fixed characteristics. • Water filled barriers are typical installations in temporary road works situations and are designed to be used as containment fences or as delineation devices. Similar to the pre-cast concrete barriers, these devices are installed as interconnected modules. Their width would make them difficult to locate within an existing road cross-section in a retrofit situation. The devices can be connected to form medium radius curves, unlike concrete barriers. • A smaller form of device with a lower risk profile is preferred for retrofit situations and lower speed and traffic volume situations.
	Pre-cast concrete with safety fencing	Water filled safety barriers	

<table>
<tr><th>Device</th><th colspan="2">Examples</th><th>Assessment findings</th></tr>
<tr><td rowspan="2">Planter boxes
• plastic / rubber
• pre-cast concrete
• raised gardens</td><td></td><td></td><td rowspan="2">• Planter boxes are large non-frangible devices where the mass and scale of the treatment could represent a hazard to motorists and cyclists on roads that have posted speed limits of 60 km/h or higher.
• The size (width) typical of planter boxes would also make it difficult to locate them within an existing road cross-section in a retrofit situation.
• The available research does not specifically reference planter boxes. The research is clear that any form of separation would deliver perceived and objective benefits to / for riders; therefore, a smaller form of a separation device that has a lower risk profile is preferred. FEMA 430 Section 4.4.2 discusses the use of crash-rated bollards concealed in planters.
• Advantages of these treatments is that they are much more aesthetically pleasing and can be preferable when installed as part of an overall streetscaping / greening / calming project for a particular precinct.</td></tr>
<tr><td>Plastic / rubber planter box</td><td>Pre-cast concrete planter box</td></tr>
</table>

5 Further information

For further information on this supplement, please contact:

Transport and Main Roads – Engineering & Technology Branch
Email: CyclePedTech@tmr.qld.gov.au

10 Communication devices

10.2 Technologies and applications

10.2-1 Implementation of internet-enabled video cameras

1 Introduction

This is a supplement to Section 10.2 of the Austroads *Guide to Traffic Management* Part 10 which specifies practice specific to Queensland state-controlled roads.

The objective of this supplement is to provide guidance in relation to providing internet-enabled cameras for the purpose of traveller information.

2 Key considerations

Before choosing a technology or proposing sites for internet-enabled cameras, the following key considerations are essential:

- purpose
- ensuring privacy
- signage
- copyright requirements
- site and maintenance
- hardware and software, and
- security.

3 Purpose

The purpose of internet-enabled cameras is to provide traveller information to the public. In addition to providing traffic conditions, internet-enabled cameras may have a role in reporting specific road conditions (for example, a camera that provides traveller information in a remote area may monitor a potential flood area).

The images should:

- be wide-angle images not displaying detail but providing an overall view of the traffic, road and weather conditions that may affect travel
- meet all privacy requirements, and
- refresh at an appropriate rate so that motorists can understand the current traffic flow or road condition.

4 Ensuring privacy

The privacy rights of the general public shall be maintained. All images broadcast onto the internet must comply with Queensland Government privacy policies.

Images that are not suitable for the public include but are not limited to:

- police activity
- incidents
- views of adjacent private property, and
- identification of people or vehicles.

Measures to ensure that images are suitable are as follows:

- using special-purpose internet-enabled cameras that have wide-angled lenses and are suitably located
- displaying images with reduced resolution, making it impossible to interpret specific detail (for example, vehicle registration details and identification of people), and
- providing physical ‘block outs’ built in to the camera equipment to limit viewing areas adjacent.

5 Copyright

All images shall be time and date stamped along with the relevant departmental branding.

6 Site and maintenance

6.1 Downtime and availability

Internet-displayed images should be reliable and accurate to reduce downtime and maintain public confidence.

6.2 Access

Camera and associated hardware should be easily accessible for maintenance (refer to the department’s *Road Planning and Design Manual* 2nd edition Volume 5 *Intelligent Transport Systems*).

6.3 Site selection

Consideration to the following is required prior to selecting a suitable site:

- traffic conditions
- road access and condition monitoring (for example, flood monitoring)
- vantage points
- privacy
- communications and power, and
- maintenance access.

6.3.1 Traffic conditions

The intent of the images is to assist in informing how the current conditions (both traffic flow and weather conditions) will affect motorists' travel.

Cameras should be installed at locations determined to have the potential to affect traffic flow.

Examples of these locations are as follows:

- intersections with high peak volumes
- areas of the road network that suffer regular congestion and/or incidents
- areas of the road network that suffer congestion due to planned events
- areas of the road network undergoing significant road works and where delays to motorists are expected (for example, portable camera sites should be considered where applicable at road work sites), and
- important intersections or roadways whereby traffic images will provide useful traveller information, including potential flood locations.

6.3.2 Communications and power

Internet-enabled cameras will need to be connected to a central location for coordinated distribution. The connection must use suitable communications technologies, taking into consideration the camera technology and refresh rate required.

In addition to communications, each camera will require a stable power source.

7 Hardware and software

To provide traffic images onto the internet, the following infrastructure is required:

- cameras and associated hardware
- communication hardware
- site hardware.

It is suitable to install internet-enabled cameras onto existing infrastructure.

8 Security

Internet-enabled camera images should be from a secure or trusted source (for example, the Transmax – ITS Network Distribution server (DISTRO), or a verified local government contact or system) and then delivered to the Qld*Traffic* service.

Appendix C Abbreviations for use on variable message signs

C-1 Abbreviations for use in Queensland on variable message signs

Table C-1 – Approved Queensland-specific variants – abbreviations

Word	Abbreviation
Emergency	EMERGENCY
Highway	HWY
Maintenance	MTCE
Motorway	MWY
Intersection	INTRSECT
Holidays	HOLS

Appendix D Variable message signs statements

Appendix D.1 Recommended variable message signs problem statements

D.1-1 Approved Queensland-specific variants – problem statements

Problem Statement	
CONGESTION DUE TO CRASH (or INCIDENT)	LANE BLOCKED
DANGER	QUEUE
FLAGMAN	ROAD UNDER WATER
FOG	CONDITIONS
GRASS FIRE	WHEN WET
HEAVY TRAFFIC	SMOKE
HIGH CRASH ZONE	SMOKE HAZARD AHEAD
HIGH WIND	VEHICLE BROKEN / DOWN

Appendix D.2 Recommended variable message signs location statements

D.2-1 Approved Queensland-specific variants – location statements

Locations definers	Position definers
EXIT RAMP	AFTER
‘name’ TUNNEL	RIGHT
ON RAMP	LEFT
OFF RAMP	CENTRE
T2LANE	
T3LANE	
TRANSIT LANE	
‘street name’ TO ‘street name’	

Appendix D.3 Recommended variable message signs effect statements

D.3-1 Approved Queensland-specific variants – effect statements

POLICE AHEAD
POLICE CONTROL AHEAD
QFRS AHEAD
QUEUE
SPEED CAMERA AHEAD
SPEED CAMERA NOW ACTIVE
TRAFFIC CONTROL AHEAD

Appendix D.4 Recommended variable message signs attention statements

D.4-1 Approved Queensland-specific variants – attention statements

The attention statement 'ALL TRAFFIC' should only be used where drivers may reasonably expect the message to apply only to a particular group of motorists.

The flashing attention statement CHILD ABDUCTION ALERT TUNE TO LOCAL RADIO can only be used when QPS issue an amber alert direct to TMCs.

VISITORS	T3 VEHICLES
T2 VEHICLES	TRANSIT VEHICLES

Appendix D.5 Recommended variable message signs action statements

D.5-1 Approved Queensland-specific variants – action statements

CRASH AHEAD/DIVERSION IN PLACE	REDUCE SPEED NOW
CRASH AHEAD/REDUCE SPEED	WATCH FOR TRUCKS
SPEED LIMIT REDUCED	

Appendix E Generic message set

E-1 Approved Queensland-specific variants – generic messages

	Screen 1			**Screen 2**		
	Line 1	**Line 2**	**Line 3**	**Line 1**	**Line 2**	**Line 3**
1	CRASH	EXPECT DELAYS				
2	CRASH	PROCEED	WITH CAUTION			
3	CRASH	DETOUR AHEAD				
4	CRASH	PREPARE TO STOP				
5	CRASH	MAJOR DELAYS		FIND	ALTERNATE ROUTE	
6	CRASH	MAJOR DELAYS		PROCEED	WITH CAUTION	
7	CRASH	MINOR DELAYS		PROCEED	WITH CAUTION	