Guideline

Bicycle activated warning signs

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Queensland Government

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1 Purpose and scope of this section

This is supplementary material to the Austroads *Guide to Traffic Management Part 10 Transport Control – Types of Devices Section 7.6.9 Vehicle activated intersection and road geometry signs*.

Permanent static hazard warning signs and pavement markings may lose credibility if the location is infrequently used by people riding bikes, to the point that motorists who use a location regularly may not be expecting to see people riding bikes. 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-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.

These devices should 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 3 Part 5 *Design Guide for Roadside signs*
- Queensland Department of Transport and Main Roads, Queensland *Manual of Uniform Traffic Control Devices* (MUTCD), Part 9 *Bicycle Facilities*
- Queensland Department of Transport and Main Roads Technical Note TN160 *Vehicle Activated Signs*

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 tested and found not to be sufficiently effective in warning drivers to modify their behaviour so that people riding bikes can safely negotiate the hazard(s). These traditional warning signs and pavement markings are especially likely to be ignored if people riding bikes are relatively rare, such as on rural routes with fewer than 100 people riding bikes a day.

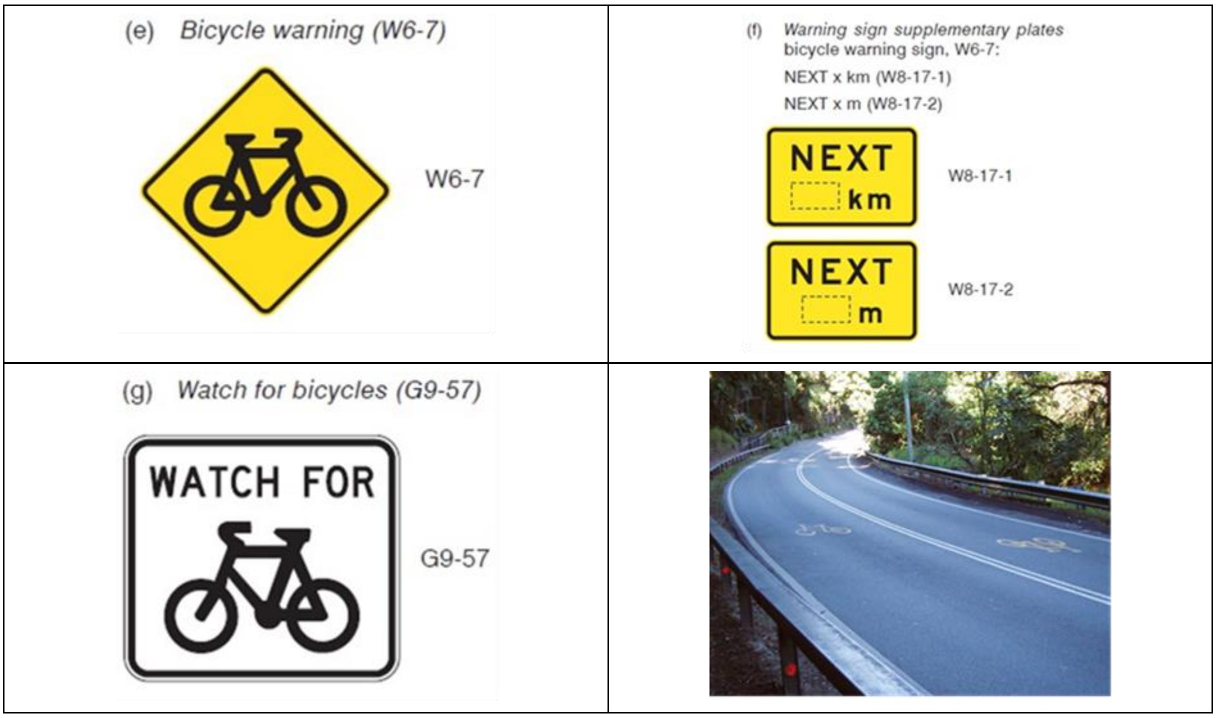
BAWS, when used, are intended to meet the following objectives:

- to highlight and draw drivers' attention to the presence of people riding bikes 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 people riding bikes are 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:

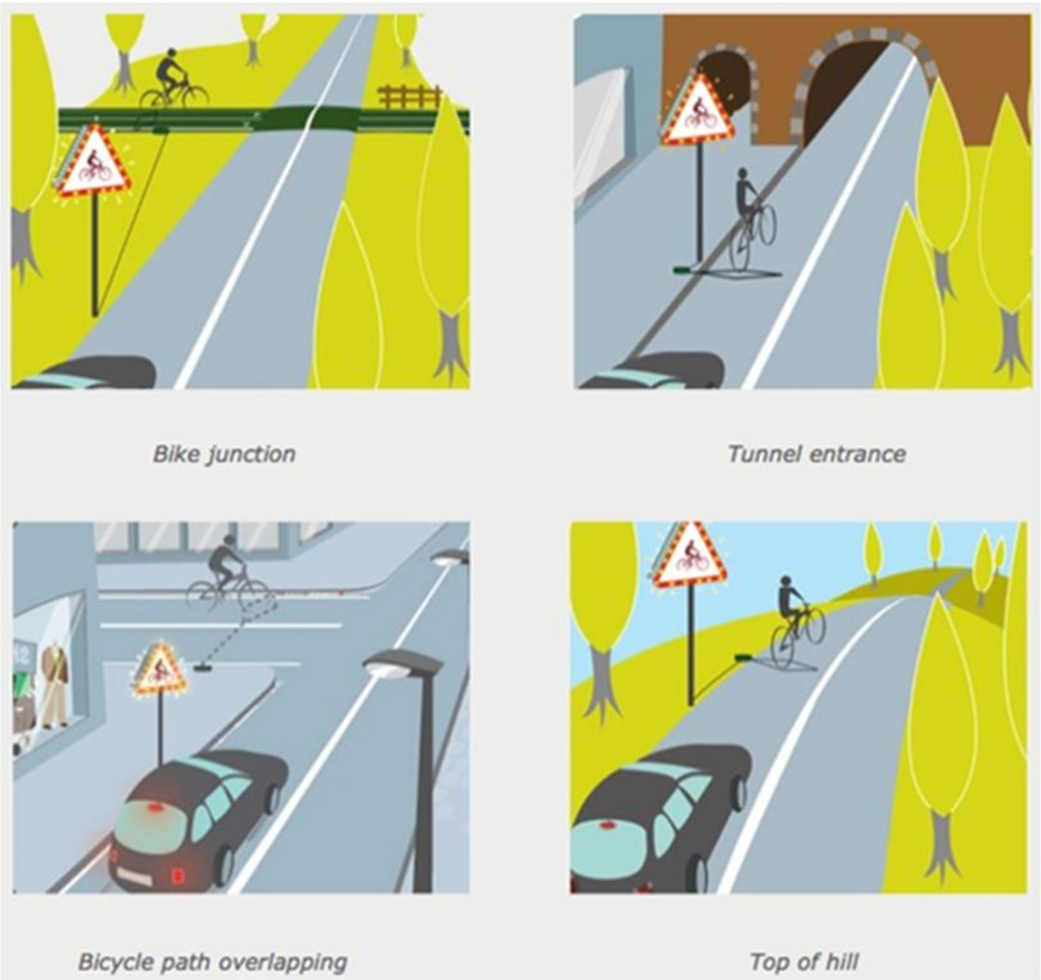
- there is a permanent feature of the road that is a hazard (especially one that is not obvious or apparent to the driver of a motor vehicle), and
- where people riding bikes are infrequent (or present only at irregular times of the day).

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 people riding bikes 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 people riding bikes are present in the 'hazardous' section of road, to inform motorists of the presence of people riding bikes 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 people riding bikes. 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 people riding bikes.

Risk of lack of activation

The sign must also be activated by people riding bikes 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, people riding bikes may fail to activate the sign. If people riding bikes deliberately fail 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 people riding bikes (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 average annual daily traffic (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 people riding bikes 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 confidence of people riding bikes 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 Queensland Manual of Uniform Traffic Control 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

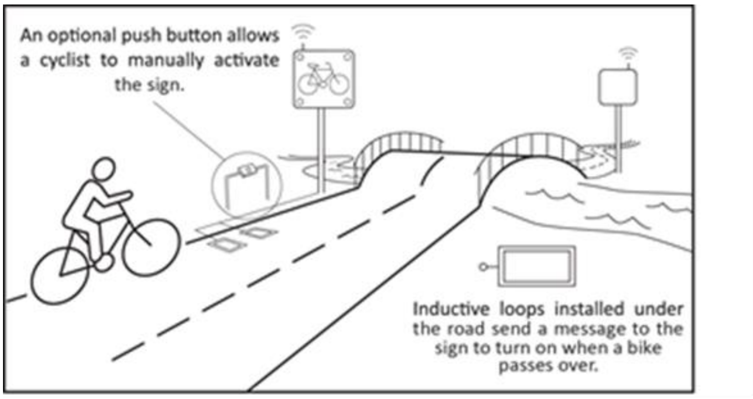


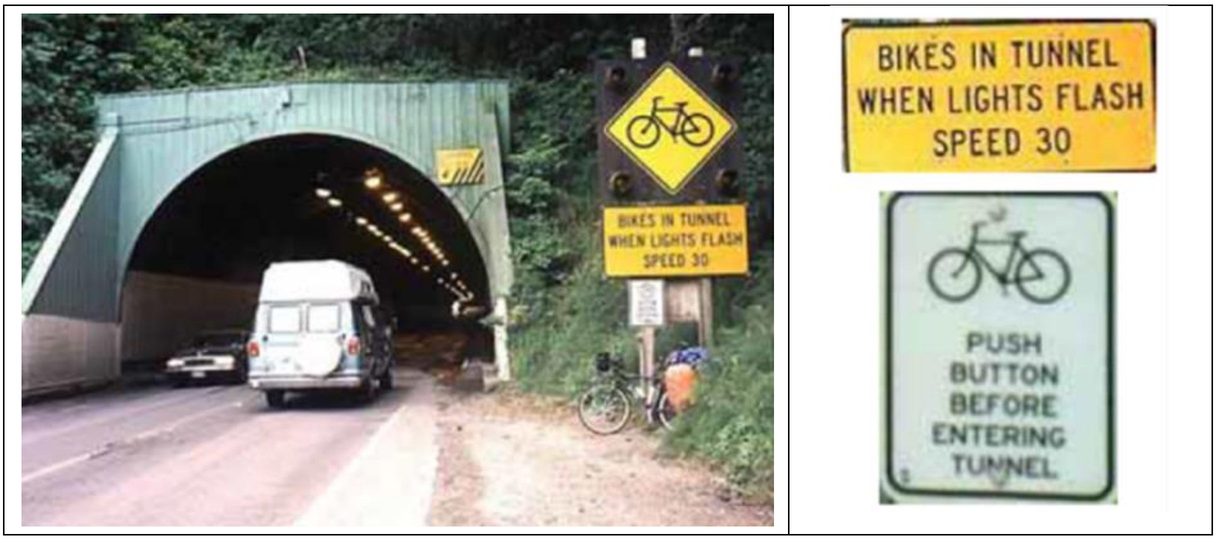
Figure 6(c) – Active warning sign on a narrow winding road near Steamboat, Colorado

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(d) – Mad River Bridge, California

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(e) – 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 (refer to Transport and Main Roads Technical Note TN160 Vehicle Activated Signs (VAS)):

- on roads with a 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, in accordance with the requirements of the Queensland MUTCD Part 4 *Speed Controls* and a VAS installed)
- on roads with more than two lanes in each direction
- on approaches to hazards with vertical or horizontal curves or gradients (external radars may be more effective on such approaches)
- in areas with a dense canopy of trees (option to locate solar panel remotely)
- on roads with a limited forward visibility, and
- on roads with an overtaking lane (speeding vehicles are often obscured by larger vehicles on the nearside lane).

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 (see Technical Note TN160)

Criteria	Considerations
Crash history	Review crashes that have occurred at the location related to people riding bikes. Did vehicles wanting to overtake people riding bikes in narrow spaces 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:

Activation of the sign by people riding bikes

- What is the likely path of the people riding bikes?
- Is the likely path of people riding bikes 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)?

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 people riding bikes 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 a 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 people riding bikes will reliably activate them. A separate signed manual activation button is also recommended to build confidence of people riding bikes 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 the Queensland MUTCD Part 1 Sections 1.12.3.2 and 1.12.3.3. Similarly, the mounting height of BAWS must be determined in accordance with the Queensland MUTCD Sections 1.12.3.4 and 1.12.3.5.
Operation	The sign LED colours must replicate the sign display (design and colour) in the Queensland MUTCD or TC sign 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 Queensland MUTCD or TC sign designs (design and colour must be replicated) and must not contain any non-standard pictograms or messages.
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 bicycle-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 people riding bikes 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 people ride bikes over the loops, they 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 people riding bikes 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 bicycle-activated flashing LED panel associated with a static warning sign is activated when people riding bikes citybound (westbound) approach the intersection. The purpose of the signage is to warn eastbound motorists queuing to turn right at the intersection into Ngapipi Road that people riding bikes are approaching from the opposite direction.

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

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 people riding bikes 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 people riding bikes, when the dynamic sign was activated. Early braking was also employed by drivers once the dynamic sign was activated even when people riding bikes were not visible to drivers. Drivers also gave people riding bikes 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 people riding bikes legally permits crossing the double lines, providing it is safe to do so. The treatment also had positive influences on perceptions of safety by people riding bikes.

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 demand by people riding bikes in locations with physical constraints and engineering challenges, for example, high bridge widening costs.