WAKA KOTAHI
NZ TRANSPORT AGENCY

ELECTRONIC SIGNS – VMS, MVMS and LCS

Intelligent transport systems (ITS) design standard

24 MAY 2024
0.3

DOCUMENT STATUS: DRAFT

New Zealand Government

Disclaimer

NZTA has endeavoured to ensure material in this document is technically accurate and reflects legal requirements. However, the document does not override governing legislation.

NZTA does not accept liability for any consequences arising from the use of this document. If the user of this document is unsure whether the material is correct, they should refer directly to the relevant legislation and contact NZTA.

More information

If you have further queries, contact the Intelligent Transport Systems Standards and Specifications (ITS S&S) team via email: itsspec@nzta.govt.nz

More information about ITS is available on the NZTA website at https://www.nzta.govt.nz/its

This document is available on the NZTA website at https://www.nzta.govt.nz/itsspecs

Template version

2.0, 02/02/2024

Contents

1 Overview and outcomes 7
1.1 Purpose 7
1.2 Overview 7
Definitions 7
1.2.1 7
1.2.2 NZTA ITS class 8
1.3 Scope 8
Outcomes 9
1.4 9
Operational 9
1.4.1 9
1.4.2 For users of the transport network 10
1.4.3 For road controlling authorities and transport operations centres 10
1.5 One Network Framework road classification and Concept of Operations requirements 10
2 Design for operation – Fixed VMS 12
2.1 Selection of VMS as a solution 12
2.1.1 Motorway and expressway VMS 12
2.1.2 Regional VMS 12
2.1.2.1 High-volume urban VMS 12
2.1.2.2 Regional State Highway VMS 12
2.1.3 Minimum distance from key intersections 13
2.1.4 Turn around and pullover areas 13
2.1.5 Other VMS uses 13
2.2 Standard VMS types 14
2.2.1 Character height 14
2.3 VMS Visibility and Road Environment 15
2.3.1 Clear sight distance and recognition time 15
2.3.1.1 Motorway and Regional VMS sight distance 15
2.3.1.2 Urban Type D VMS sight distance 15
2.3.2 Road angle vertical and horizontal alignment 15
2.3.2.1 Vertical Alignment 15
2.3.2.2 Horizontal Alignment 16
2.3.3 Downstream road geometry 17
2.3.4 Presence of other signage 17
2.4 Civil Requirements and Support Structures 17
2.4.1 Interface between VMS and LCS and the support structures 17
2.4.2 Foundation conditions 17
2.4.3 Mounting to the support structure 18
2.4.4 Road Safety Barriers 18
2.4.5 Cabling and Ducting 18
2.5 Power Requirements 18

2.5.1 VMS uninterruptible power supply (UPS) 19
2.6 Communications to site 19
2.7 Roadside cabinets 20
2.8 Environmental and planning requirements 20
2.8.1 Environmental impact and public consultation 20
2.8.2 Urban design, environmental planning, site services and land issues 20
2.8.2.1 Urban design requirements 20
2.8.3 Environmental planning 21
2.8.3.1 Outline plan 21
2.8.3.2 Resource consents 22
2.8.3.3 Assessments of environmental effects 22
2.8.4 Land issues 22
3 Design for operation of MVMS 23
3.1 Selection of MVMS as a solution 23
3.2 Site Selection for MVMS 23
3.2.1 Appropriate MVMS sites 23
3.2.2 Drainage clearance 23
3.3 Positioning 24
3.3.1 For Approaching Motorists 24
3.3.2 Road Types 24
3.3.3 Road alignment 24
3.3.4 Traffic Volumes 24
3.3.5 Route Advisory Messaging 25
3.3.6 Clear Sight Distance 25
3.3.7 Avoiding Sunlight Glare 25
3.3.8 Road geometry 25
3.4 Alignment 25
3.5 Presence of Other Signage 26
3.6 Avoid Creating a Hazard or Hindrance 27
3.7 Messages 27
3.8 Deployment 27
3.8.1 General Requirements 27
3.8.2 In Windy Conditions 27
3.9 Communications Coverage 28
4 Design for operation – LCS 29
4.1 Concepts 29
4.1.1.1 LCS site 29
4.1.1.2 LCS system 29
4.1.1.3 LCS operation modes 29
4.2 LCS site selection consideration 30
4.3 LCS placement 30
4.3.1 Longitudinal placement 30
4.3.1.1 Integrated lane and speed management mode 30

4.3.1.2 Speed management operating mode ... 32
4.3.2 Horizontal (lateral) placement ... 32
4.3.2.1 Integrated lane and speed management mode ... 32
4.3.2.2 Speed management operating mode ... 33
4.3.3 Vertical placement ... 33
4.3.3.1 Integrated lane and speed management mode ... 33
4.3.3.2 Speed management operating mode ... 33
4.3.4 Over dimensional routes ... 33
4.4 Civil requirements and support structures ... 33
4.4.1 Integrated lane and speed management mode ... 33
4.4.2 Speed management operating mode ... 34
4.5 Power Requirements ... 34
4.5.1 LCS UPS ... 34
4.6 LCS site communications infrastructure ... 34
4.7 Roadside cabinets ... 35
5 Design for safety ... 36
5.1 Health and safety ... 36
5.1.1 Health and safety in design ... 36
5.2 Safety outcomes ... 36
5.2.1 Space to ensure safety conformance – motorway and expressway ... 36
5.2.2 Space to ensure safety conformance – Regional State Highways ... 36
5.2.3 Site access static locations ... 37
5.2.4 Site access MVMS ... 37
5.2.5 Safe Parking ... 37
5.2.6 Safety issues – above and below ground ... 37
Electrical Safety ... 38
5.2.7 38
5.2.8 Electrical surge protection ... 38
5.3 Site assessment ... 38
5.4 Site audit ... 38
5.5 System-specific safety requirements ... 39
6 Design for maintainability ... 39
6.1 Maintenance outcomes ... 39
6.1.1 System-specific inspection and maintenance requirements ... 39
6.1.2 Maintenance Responsibility ... 39
6.1.3 Site access ... 40
6.1.4 Maintenance access to structures ... 40
6.1.5 Extreme weather or other environmental conditions ... 40
7 Design for security ... 41
7.1 Security outcomes ... 41
7.2 System-specific security requirements ... 41
7.2.1 LCS and Fixed VMS Gantry physical security ... 41
7.2.2 MVMS ... 41

8 Integration, Testing, Commissioning and Handover 42
8.1 Testing Requirements 42
8.2 Commissioning and Handover 42
9 References 43
9.1 Industry standards 43
9.2 NZTA standards, specifications and resources 43
9.2.1 Standards and specifications 43
9.2.2 Resources 43
9.3 Legislation 44
9.4 Other resources 44
10 Terminology used in this document 45
11 Content to be redirected 48
12 Document control 49
12.1 Document information 49
12.2 Document owner 49
12.3 Document approvers 49
12.4 Full version history 50

List of figures

Figure 3. Cone of visibility alignment for a straight approach to a roadside sign 16
Figure 4: Alignment of a Roadside MVMS (Straight Road) 26
Figure 5: Optimum Alignment for Straight and Curved Road 26
Figure 1. Integrated lane and speed management operating mode 29
Figure 2. Speed management operating mode applied to a whole carriageway (gated) 30
Figure 6 LCSs usage to manage lanes and speed 31
Figure 7. LCS gantry spacing 31
Figure 8. LCSs on a gantry spanning motorway 32

List of tables

Table 1.Summary of electronic sign use requirements 11
Table 2. VMS minimum character heights related to typical locations and ONF category. 15

1 Overview and outcomes

This section defines the operational outcomes for Electronic Signs with respect to the transport network.

1.1 Purpose

The purpose of this document is to specify the Electronic Signs (ES) design requirements for operation, physical layout, safety, maintainability, and security. These include Variable Message Signs – fixed (VMS), mobile Variable Message Signs (MVMS) and Lane and Carriageway Signs (LCS) on the roading network by the Client. The Client can be New Zealand Transport Agency Waka Kotahi (NZTA) or other Clients. This design standard ensures compliance with NZTA operational and asset management systems.

The consideration of how the design meets the Concept of Operations (ConOps) is an important component of the design process.

1.2 Overview

This standard seeks to define best practice on the approach to design of Electronic Signs

This is to be read in conjunction with:

i. the Notes to Electronic Signs design standard;
ii. the latest version of ITS delivery specification: Variable Message Signs – Fixed;
iii. the latest version of ITS delivery specification: Mobile Variable Message Signs;
iv. the latest version of ITS delivery specification: Lane and Carriageway signs (LCSs).

1.2.1 Definitions

The term 'Electronic Signs' had been defined to aggregate several ITS assets that have a similar purpose and NZTA ITS classification under class 001 – Class 'Signs' Class Definition.

Content covered in this document:

i. Mobile Variable Message Signs mounted on trailers
ii. Fixed Variable Message Signs
iii. Lane and carriageway Signs

Content not covered in this document:

i. Vehicle mounted Variable Message Signs
ii. Speed activated Signs and Safety Signs
iii. Parking Displays
iv. Advanced Warning Sign
v. Changeable Message Sign
vi. School Zone Sign
vii. Wrong Way Driver Beacon
viii. Speed Indication Device

ix. Bend Warning Sign
x. Variable Mandatory Speed Signs

Electronic Signs is the umbrella term that brings together the following:

Type	Anacronym	Asset
Electronic Sign	**VMS**	**Variable Message Sign**
	LCS	**Lane and Carriageway Signs**
	MVMS	**Mobile Variable Message Sign**
	CMS	Changeable Message Sign
	AWS	Advanced Warning Sign
	SCHOL	School Zone Sign
	WWDB	Wrong Way Driver Beacon
	SID	Speed Indication Device
	BEND	Bend Warning Sign
	EJT	Estimated Journey Time Sign
	VMSS	Variable Mandatory Speed Signs
	VSS	Variable Speed Signs

The need for electronic signs is described in the general requirements for ITS under which these signs are suitable for use are described in Requirements for Intelligent Transport Systems (ITS-01-000-202302-STD-RITS) where they are referred to individually rather than in the aggregate.

1.2.2 NZTA ITS class

001 Signs. Equipment which provides visual messages or warnings to users of the transport network.
Class definitions

1.3 Scope

This document provides design requirements for the delivery of electronic signs.

Accordingly, the scope of this document has been defined as follows:

i. site selection
ii. requirements for support structures
iii. design for road safety
iv. criterion for determining the visibility requirements, for example, font size and sight lines
v. power and communication services
vi. post deployment audits.

Electronic signs covered in this design are:

i. motorway/expressway VMS which encompass VMS for motorways and expressways with more than one lane in the direction of travel
ii. regional VMS which encompass:
iii. high-volume urban (HVU) VMS
iv. rural VMS.
v. LCS
vi. MVMS

This document sets out the requirements the designer shall address:

i. design requirements for a VMS, MVMS, and LCS site layout.
ii. design requirements for an LCS system (i.e. several operationally linked LCS sites) which is aimed to assist in managing a given length of road or a tunnel.
iii. design requirements for support structures.
iv. design requirements for maintainability.
v. design requirements for road safety.
vi. design requirements for power and communication services for a VMS, MVMS, and LCS site.

The scope of this document does not cover:

i. the interface between an electronic sign and ATMS.
ii. dynamic lane system or reversable lanes system.
iii. electronic sign integration and commissioning. Note: for tunnels - additional controls and integration will also be required through the Tunnel PMCS as well as the ATMS.
iv. mounted on vehicles for MVMS
v. AWRS

1.4 Outcomes

1.4.1 Operational

The intended operational outcomes of this design standard are to:

i. Provide a safer roading network by reducing roadside hazards and improving maintenance access.
ii. Provide a safer roading network by more efficiently alerting road users to downstream incidents where they are required to take action.
iii. Improve utility of assets by locating VMS in optimal locations.
iv. Increase road user acceptance and understanding of the information supplied by improving the visibility, location, and operation of the VMS.
v. Reduce wasted journey and travel time by improving the location of VMS to indicate accessible detour routes and to limit the distance travelled before road users are advised of road closures.
vi. Manage traffic flow more efficiently and safely using dynamic speed limits and managing lane availability.
vii. Be able to execute traffic management plans in response to planned or unplanned events across coordinated groups of LCSs.
viii. Ensure the equipment is available for use (reliability of the equipment and ease of maintenance shall ensure that operational availability requirements are met)

1.4.2 For users of the transport network

i. Provide advance warning to the road user of any changes to the road network due any upcoming road closures, changing weather conditions, heavy traffic volumes, accidents, road works, travel times and any other incident which requires driver notification.
ii. Give users a clear, intuitive advanced message warning of anything which requires them to take action such as a detour route, reduce speed or prepare to stop and turn around.
iii. Give users the ability to recognise and understand the instructions relating to lane use and/or speed management in advance of any activities on the road network under all expected operating conditions.
iv. Provide information about upcoming lane availability and mandatory speed limit.
v. Have sufficient time to react in a safe manner in accordance with lane status and/or speed management instructions.
vi. Achieve consistent customer experience and compliance when travelling along the New Zealand road network and encountering lane and/or speed management instructions.
vii. Improve the traffic flow by enabling authorities to respond to events and congestion

The desired outcome is to improve the safety of road users, minimise return travel times and keep traffic moving around the network (reducing congestion).

1.4.3 For road controlling authorities and transport operations centres

i. Electronic signs are tools that enable the Client and Traffic Operation Centres (TOCs) to manage traffic on their network and warn of any changes to the road network.
ii. VMS can also provide locations of other electronic network devices such as cameras to assist the Client with traffic monitoring and management.
iii. Improve safety of road users and road workers by managing traffic speeds and lane availability.
iv. Reduce construction and maintenance costs by having standardised installations along network infrastructure.
v. Support temporary traffic management functions.
vi. Manage the traffic demand and respond to congestion.
vii. Improve capability to respond to planned or unplanned events across coordinated groups of LCSs.
viii. Reduce the impact of planned and unplanned events.
ix. Reduce the likelihood of a secondary crash associated with an event on the road network.
x. Achieve consistency in managing lane use and variable speed limits.
xi. Standardise and reduce the number of traffic management plans required.
xii. Enable and support managed motorway implementation – to manage incidents and optimise efficiency
xiii. To manage traffic flows and reduce crash rates to within the safety profile in and around tunnels.

1.5 One Network Framework road classification and Concept of Operations requirements

Before project design can be carried out, an understanding of why the asset is needed and what outcomes are intended must be understood by the designer. The high-level requirements of a project are described in the project's Concept of Operations (ConOps). Among many others, ConOps defines project requirements for road user information, corridor and incident management, including requirements for LCS, VMS and MVMS use where applicable. These requirements will differ from project to project. The consideration of how the design meets the ConOps shall be an important component of the design process. A site assessment shall be undertaken to affirm the intent of the ConOps during the design process.

The designer shall also refer to the latest version of the ITS core requirements guideline: Requirements for intelligent transport systems to assess the requirements for use of electronics signs for each One Network Framework (ONF) road classifications. The table below summarises the requirements for use of VMS, MVMS and LCS signs on different type of roads based on requirements for ITS guideline and project's ConOps. Refer to ITS-SPEC-VMS-FIXED-202402 for ETJ.

ONF road classifications	VMS	MVMS	LCS
Transit corridor	VMS (Motorway VMS) and EJT signs must be used	As per ConOps	Required
Interregional connector	VMS and EJT signs must be used	As per ConOps	As per ConOps
Urban connectors	VMS and EJT signs must be used	As per ConOps	As per ConOps
Main streets	EJT signs must be used	As per ConOps	As per ConOps
Activity streets	EJT signs must be used	As per ConOps	As per ConOps
Rural connectors	VMS should be considered	As per ConOps	As per ConOps
Peri-urban roads	VMS and EJT signs should be considered	As per ConOps	As per ConOps

Table 1.Summary of electronic sign use requirements

2 Design for operation – Fixed VMS

This section defines the functionality required to achieve successful operation of the VMS.

2.1 Selection of VMS as a solution

2.1.1 Motorway and expressway VMS

Motorway and expressway environments are characterised by high volumes, multiple lanes, limited access/egress points, and may be subject to congestion. Motorway/expressway VMS have the following features:

- display text with 400mm character height.
- have 3 lines of text with minimum 18 characters per line.
- mounted on overhead gantries to ensure all lanes of a multi-lane environment can view the message.

2.1.2 Regional VMS

Regional VMS encompass high-volume urban (HVU) and Rural State Highways.

Regional VMS have the following features:

- display text with either 200mm or 300mm character height.
- have 4 lines of text of with a minimum 16 characters per line.
- are mounted on roadside supports located on the left side of the highway within the road reserve, or sometimes on private land.

2.1.2.1 High-volume urban VMS

High-volume urban (HVU) VMS have similar functional applications to motorway/expressway VMS but are located in lower-speed environments that are either single or multi-lane.

The HVU VMS displays may have a smaller character size of 200mm, and a correspondingly smaller display size based on road and speed environment. The signs may be positioned on the left side of the highway, rather than overhead on a gantry.

2.1.2.2 Regional State Highway VMS

The rural VMS application is characterised by significantly larger geographic coverage of the NZTA network, and low-volume uncongested roads.

- Located on lower volume roadways typically consisting of one lane in each direction, where motorists can slow down or pull out of the traffic flow while they consider their response to the VMS message.
- Located in advance of travel decision points.
- May be sited in isolated rural locations where there are minimal competing artificial light sources.
- May be located long distances from critical incident locations, or alternative routes (50–100km is not uncommon).
- Often have cross-regional function, in that the messages displayed may also have relevance in adjacent NZTA region(s).

- The isolated nature of some sites may mean that access to mains power, and fixed line and cellular communications systems, is not readily available.

2.1.3 Minimum distance from key intersections

If the VMS is intended to advise route diversions, the sign shall be located sufficiently in advance of the alternative route intersection to allow the road user to assimilate the message and react accordingly, including changing lanes if necessary.

Motorway/expressway VMS should be placed a minimum distance of 1500m prior to the exit/diversion point. This distance provides the motorist with roughly 50–60 seconds from the time they have read the message until they reach the access/diversion point. In practice, this is difficult to achieve in urban areas where interchanges are closely spaced. If the motorway/expressway has two or three lanes in the direction the VMS is indicating, this can be reduced to a minimum of 800m. Alternatively, if two exits are closely spaced, the VMS can be in advance of the first exit. No motorway/expressway VMS shall be installed within 300m of the end of an upstream merge taper.

On high-volume urban (HVU) roads, the distance is dependent on considerations such as the speed limit, local factors and right-of-way constraints.

On a rural single-lane roadway, with no need to change lanes, but acknowledging the complexity of some decisions and the route choices, a distance equating to at least 1000 metres in a 100km/h zone, or a proportionally reduced distance in lower-speed zones, is suggested.

2.1.4 Turn around and pullover areas

Rural VMS with low traffic volumes (eg 2000 AADT) may display a message advising motorists to turn back due to commonly occurring or expected road closure, such as at an alpine pass. In these circumstances consideration should be given to choosing a site that:

- has a pullover/turning area just after the sign for travellers to turn around.
- is located near the exit to the adjacent town or village, covering all exit routes from the town possible.
- is ideally visible from the low speed 50km/hr section.
- has a pullover area or turning area for HGVs prior to the road closure location.

With higher traffic volumes in a high-speed environment, a level (~10,000 AADT) is reached where pulling over or turning around is unsafe. Under normal circumstances, the VMS will be placed in advance of the decision/alternative route point, so turning around will be unnecessary.

2.1.5 Other VMS uses

VMS are used in other systems, such as Over Height Detection Systems (OHDS), Weigh in Motion (WiM) and Tunnel systems.

In general, designs will follow this standard for sign type, roadside location and sight distance. However, some design requirements will differ and be highly site or project specific, such as distance to downstream hazard or distance to pull off location to Commercial Vehicle Safety Centre.

These systems will require their own project specific ConOps to inform many of the design decisions. It is recommended designers seek specialist input for these types of uses.

2.2 Standard VMS types

NZTA have defined a selection of standard VMS sizes to be used in each roading environment. See the latest version of ITS design standard: Variable Message Signs Fixed.

Designers should assess the proposed location and choose the most suitable VMS size. Some variation will be allowed depending on physical site constraints and other restrictions.

These sign sizes are determined by character heights and corresponding font width.

2.2.1 Character height

NZTA have developed a variety of sign types with prescribed minimum character / font heights for use across the network. Minimum character height is fixed for each VMS type based on road type and posted speed limits.

The standardised font heights and VMS types are:

VMS Type	Lines of text	Character height (mm)	Typical use location	ONF Category examples	Speed Environment (km/hr)
Motorway	3	400	• Urban Motorways • Expressway – multiple lanes, high speed, high volume.	• Transit Corridors • Urban Connectors • Inter-regional Connector	100+
Regional Type A	4	300	• Expressways – single lane • Rural state highways	• Transit Corridors • Urban Connectors • Inter-regional Connector • Peri Urban Roads • Rural Connectors	70-100
Regional Type C	4	200	• Rural state highways • Urban roads / local roads	• Inter-regional Connector • Peri Urban Roads • Rural Connectors	60 or less
Urban Type D (EJT)	3	200	• Local roads • Local road approaches to motorway interchanges • High volume urban roads	• Urban Connectors • Main Streets • Activity Streets	60 or less

Table 2. VMS minimum character heights related to typical locations and ONF category.

In some instances, a smaller character height VMS can be used due to road reserve space restrictions as the overall width of the VMS is dependent on character height. For example, Regional Type C VMS can be used in 100km/hr zones where shoulder space is limited.

2.3 VMS Visibility and Road Environment

2.3.1 Clear sight distance and recognition time

The recognition time, necessary to read and understand a message, is typically given in a range of at least 4 to 6 seconds.

Ideally designers will ensure that drivers approaching the sign at the maximum appropriate/legal approach speed should be able to read the message(s) for at least 6 seconds for a single page of text.

Sign placement should be checked for horizontal and vertical alignment to ensure drivers stay within the readability cone of the VMS for the longest possible time.

Signs should be visible to drivers at a greater distance to the maximum legibility distance to allow drivers to observe the sign is activated and anticipate a message.

2.3.1.1 Motorway and Regional VMS sight distance

The designer should look for sites that allow drivers clear sight distance to the sign of at least 375m for 300mm to 400mm character height, and at least 250m for 200mm character height, when travelling at 100km/h. In lower-speed environments the distances can be reduced proportionally.

2.3.1.2 Urban Type D VMS sight distance

Urban Type D VMS are designed for lower speed environments where the sight distance can be reduced proportionally. Designers should allow for a clear sight distance of at least 150m. It is understood however that lower speed urban environments there will be many other signs and distractions that compete for drivers' attention as well as a greater amount of other infrastructure which may limit available sight distances.

2.3.2 Road angle vertical and horizontal alignment

The designer must take into account the viewing angle of the LEDs when locating the VMS both horizontally and vertically.

2.3.2.1 Vertical Alignment

The VMS must be positioned above or to the left of the approaching motorist.

Correct alignment is important to ensure approaching motorists will remain within the cone of illumination for as long as possible. Typically, supplied VMS will have a -5deg vertical cone (B6 LED).

The ability to optimally align the VMS in the vertical plane must be considered when the approach is up a steep hill, or if the VMS is unusually high above the road.

2.3.2.2 Horizontal Alignment

In virtually all situations, it is considered unsafe to position a VMS on the right-hand side of approaching traffic because it may confuse motorists' point of reference under night-time conditions and lead to a head-on collision.

Typically supplied VMS (with B6 LED) will have a 30deg (15deg each side) horizontal cone and are aligned at a 10 to 15deg angle perpendicular to the road edge line refer figure 3.

For VMS mounted beyond a left or right-hand curve, alignment can be modified to maximise the time that drivers remain within the cone of visibility, as detailed in the latest version of ITS design standard: Civil and structural requirements.

The horizontal alignments for straight and curved approaches are detailed in the latest version of ITS design standard: Civil and structural requirements.

For curved approaches, the VMS must be aligned to ensure:

- at the maximum reading distance, the inside edge of the curve is within the cone of visibility.
- approaching the VMS, the outside edge of the curve remains within the cone of visibility for as long as possible.

See the latest version of ITS design standard: Civil and structural, for these diagrams:

- Optimum alignment for regional VMS on roadside support structure
- Optimum alignment for motorway VMS on overhead gantry.

Ensure that roadside trees or other structures will not obscure the sign. Ensure that requirements for trimming or other activities to maintain clear line of sight in the foreseeable future can be legally enforced.

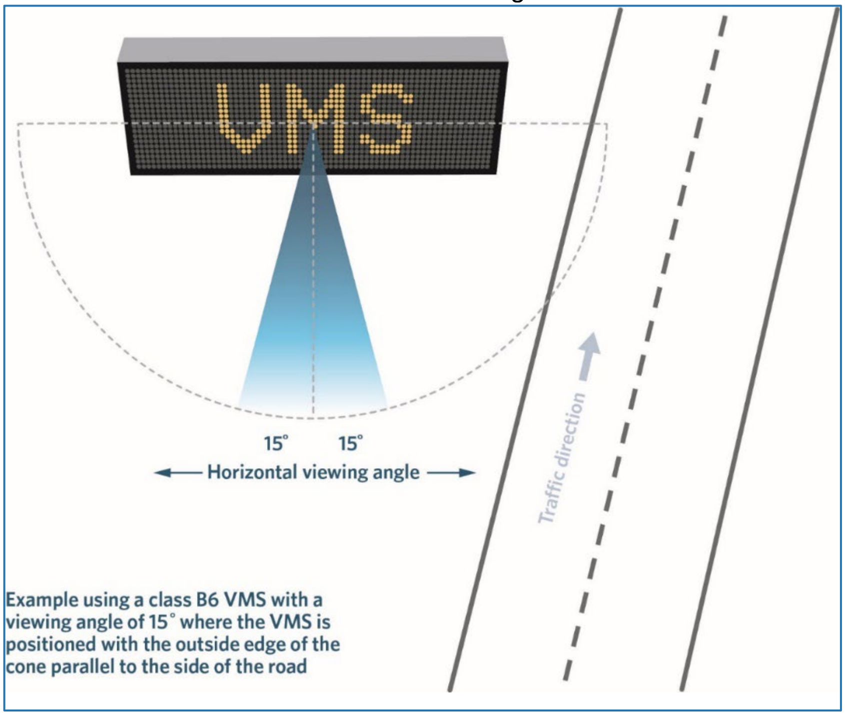

Figure 1. Cone of visibility alignment for a straight approach to a roadside sign

2.3.3 Downstream road geometry

Avoid positioning a VMS immediately before a sharp bend, blind crest or intersection, where the VMS may distract attention at a critical moment and could lead to loss of driver control.

The VMS must not be positioned where the display may be seen from a neighbouring road if this will result in motorists receiving confusing or conflicting information.

2.3.4 Presence of other signage

VMS should not compete with other existing signs and/or strong light-emitting sources or interfere with traffic control devices. The designer must review all signs and traffic control devices both proceeding and beyond the potential site. Based on this review, existing signs may need to be moved to accommodate the VMS placement.

Typically, the minimum distance between signs is calculated as ($0.6V_{85}$) where V_{85} is the 85th percentile speed of traffic, in km/hr, at the sign location. For more information on the longitudinal spacing of signs refer to the latest version of the TCD manual Part 1 General requirements for traffic signs.

VMS and static signage may be co-located on the same gantry structure. For more information on mounting VMS and static signs on the same gantry refer to the Austroads report AP-R485 15 Ability to Absorb Information Through Electronic and Static Signs.

2.4 Civil Requirements and Support Structures

2.4.1 Interface between VMS and LCS and the support structures

Where the electronic signs and the civil works are procured through separate contracts, the interface or integration between the VMS enclosure and the support structure must be closely managed by NZTA or our appointed representatives.

The appointed Project Manager is responsible for ensuring the design requirements for the contract are met, including:

- determining the sign dimensions, weight and method of attachment to the support structure with the contractor supplying the sign. A clear distinction must be made between the dimensions of the enclosure plus tolerance that are required for connection to the support structure, and the dimensions of the enclosure plus the surrounding border (which may be bolted to the enclosure) that are relevant for wind-loading calculations.
- coordinating design for attachment of the sign to the support structure
- communicating this information to the appointed Engineer(s) responsible for the sign and for the civil works.

2.4.2 Foundation conditions

The foundations for large motorway, single pole, cantilevered and other VMS structures outside the standard rural type designs require a detailed geotechnical assessment of the ground conditions.

The regional VMS two-post support structure standard designs, and the single-post centre-mounted support structure standard designs, include foundation designs for a specified envelope of wind and ground conditions. To reduce the risk to the client from the contractor encountering unforeseen ground conditions, the designer shall carry out appropriate investigations before a site is recommended. The results of these investigations shall be used to determine whether the standard designs may be adopted. If ground conditions are poorer than the specified criteria at any site, then either an alternative foundation design must be provided in the tender, or enough information must be included to enable tenderers to submit foundation designs for approval.

2.4.3 Mounting to the support structure

The sign enclosure shall include structural attachment points, bolts and clamps to mount the VMS on the support structure.

Often, VMS will be retrofitted to existing structures when renewing older signs as they come to end of life. Designers need to be aware that different suppliers will have mounting points at different locations on the VMS and LCS enclosures. Comparison of the manufacturers shop drawings, review of structural as-built drawings and site measurements should be undertaken to determine if new brackets or mounting structures are required.

Size and weight of the new VMS will need to be taken into consideration as this may result in the need for a complete check of the existing structure for capacity.

2.4.4 Road Safety Barriers

Typically, most new installations will require an appropriate road safety barrier design as they create a hazard for road users.

2.4.5 Cabling and Ducting

At a minimum all signs will require a duct for data and power cabling from the ITS cabinet to the sign.
For regional VMS all ducting should be contained within the structure where possible to minimise vandalism and damage. All ducts should be external rated UV resistant conduit.

For Gantry mounted signs the conduits should be contained in secure galvanised ducts bolted to the vertical support legs. Where these ducts reach the horizontal walkway, the conduit should be attached to approved cable trays to the sign.

2.5 Power Requirements

See the latest version of the ITS core requirements guideline: Requirements for intelligent transport systems for VMS power supply requirements for each ONF road classification.

Most VMS will be mains powered and as such a key design consideration will be the availability of power at the roadside. Designers must engage with local power suppliers as the cost may be prohibitive.

If the power supply must come from the other side of the roadway, trenching across the state highway is not acceptable, an aerial cable may also not be acceptable, and thrust boring may be the only option.

2.5.1 VMS uninterruptible power supply (UPS)

All VMS shall be equipped with a UPS facility, housed in a cabinet adjacent to the VMS, not within the VMS enclosure itself.

Power to the VMS controller and communications equipment shall be routed via the UPS to ensure a clean and stable power supply.

Batteries shall be of a deep discharge, low-maintenance gel type and automatically charged from the mains power supply.

For regional / remote sites the back-up power facility shall be capable of providing a minimum of seven hours of full VMS operation including pixel lighting in normal daytime mode, communications, and controller under normal operational conditions.

For motorway and expressway sites, or urban locations where the power network is considered extremely reliable, UPS are not generally required.

2.6 Communications to site

A communications link is required to connect the VMS to the NZTA national control system. NZTA has national communications agreements in place with One NZ. One NZ are to be engaged to investigate the most appropriate option for each site. These may be:

- Existing NZTA backbone fibre communications network.
- Leased lines from commercial providers dark fibre or ADSL.
- Cellular communications.

One NZ will provide the router / modem for each site including aerials if required.

Depending on the communication system selected, there may be a need to arrange cabling/trenching to the site. As with the power requirements, consideration should be given to tasking a telecommunications contractor with arranging cabling to the site.

Note that consent from NZTA is required before cabling installation is undertaken in the road reserve.

Where the VMS is to be connected via fibre designers shall reference the latest versions of:

i. ITS Design Standard Optical Fibre - ITS-01-008-202006-STD-CABLE-FIBRE
ii. ITS Design Standard Ducts - ITS-01-010-202008-STD-DUCT
iii. ITS Design Standard Jointing chambers and pull pits - ITS-01-010-202006-STD-CHMBR

Where the VMS is connected to mains power and a copper communication cable, there must be appropriate separation. Where power and communication cables are laid in the same trench for up to 200m, separation of >200mm is required.

The installation (capital) cost, operating cost and fitness for purpose of the communications options must be established.

2.7 Roadside cabinets

Refer to latest version of ITS-SPEC-CAB-202405

2.8 Environmental and planning requirements

2.8.1 Environmental impact and public consultation

Potential costs and delays arising from environmental planning and consent requirements must be considered when assessing a site, as a large VMS and its support structure may be visually intrusive on the surrounding area.

As a minimum there is a requirement to consider the need to consult with nearby residents, particularly those within the LED illumination cone, as the light emitted at night may create adverse effects.

Professional judgment must be exercised as to the likely requirement for a consultation process, and the range of likely risk to the project in terms of community sustainability, time and cost. Depending on the outcomes of these considerations, alternative sites may need to be considered.

2.8.2 Urban design, environmental planning, site services and land issues

2.8.2.1 Urban design requirements

As a signatory to the New Zealand Urban Design Protocol, NZTA has a role to ensure that VMS respond to and enhance the environment in which they are placed.

VMS can potentially add to the visual clutter on the roadside. It is important that VMS are located in relation to other elements in the visual field of view and that the design of support elements is not neglected and unrelated to other roadscape elements.

Whilst the design of the VMS is constrained due to safety reasons etc, their size, placement, support structures and related elements, including rear surfaces, can often be modified to improve the visual quality of roads and surrounding areas without compromising the sign's purpose or road user's safety.

Key strategies and actions for VMS include:

- Design VMS as a vital element of the visual experience of the road and a possible means of reducing the number of signs.
- Ensure coordination and possible collocation of VMS with other roadscape elements.
- Ensure that the local character of an area is not adversely impacted by unnecessarily large and poorly located VMS.
- Design support structures and related signage hardware to be integrated with other elements such as lighting, bridge and guard rails, emergency phones, advertising etc.
- Where VMS are to be located on overbridges, integrate them into the design of these structures if possible so that they do not appear as add-ons.
- Explore ways to improve the appearance of the rear of the VMS.

2.8.3 Environmental planning

2.8.3.1 Outline plan

Where VMS are to be located within the boundary of a road designation, the territorial authority (city or district council) may require an outline plan for the works. It is recommended that discussions be held with the appropriate territorial authority early in the project to determine their requirements.

Where a road designation is in place, resource consent will not be required to install a VMS. Works in accordance with the designation will override the District Plan rules. An exception to this would be if there were conditions on the roading designation relevant to the VMS such as sign height, sign area, character size or illumination. If a VMS exceeded the relevant conditions, resource consent would be required. However, conditions on roading designations relating to signage are uncommon and many District Plans provide for traffic management signs on roads as permitted activities. A check should be made as to whether the sign would be a permitted activity.

Section 176A of the Resource Management Act 1991 (RMA) requires an outline plan for works that are on designated land and are in accordance with the designation, to be submitted to the territorial authority. Section 176A (3) of the RMA states:

"An outline plan must show—
(a) the height, shape, and bulk of the public work, project, or work; and
(b) the location on the site of the public work, project, or work; and
(c) the likely finished contour of the site; and
(d) the vehicular access, circulation, and the provision for parking; and
(e) the landscaping proposed; and
(f) any other matters to avoid, remedy, or mitigate any adverse effects on the environment."

An outline plan for VMS need only include the information listed above, which is relevant to the particular proposal.

Territorial authorities do not have the discretion to approve or decline an outline plan. Their sole discretion is to request changes to an outline plan prior to commencement of the work. The authority responsible for the road designation, ie NZTA, may then accept or reject the recommendation of the territorial authority in full or in part.

In the early discussion with the territorial authority it would be appropriate to enquire whether they require an outline plan of works. Section 176A (2) of the RMA lists the following exceptions to the general rule:

"An outline plan need not be submitted to the territorial authority if—
(a) the proposed public work, project, or work has been otherwise approved under this Act; or
(b) the details of the proposed public work, project, or work, as referred to in subsection (3), are incorporated into the designation; or
(c) the territorial authority waives the requirement for an outline plan."

In the past a number of territorial authorities have, upon enquiry from the road authority or its agent, not required an outline plan of works given the minor nature of the VMS.

2.8.3.2 Resource consents

Where VMS are to be located outside the boundary of a road designation, a land use consent may be required from the territorial authority. An assessment under the relevant rules of the District Plan will be necessary to determine whether the VMS needs a resource consent.

2.8.3.3 Assessments of environmental effects

Where NZTA is required to apply for a resource consent to locate a VMS, an assessment of environmental effects must be undertaken. This would require a more extensive and detailed assessment than for an outline plan.

The actual or potential effects being assessed will need to be tailored to the circumstances of the VMS proposed. In most situations, the main effects that will be considered are visual and traffic safety effects. The visual effects could include matters such as sign height, size, location or amenity. The traffic safety effects could include the benefits to traffic safety as a result of the sign or any potential driver distraction considerations. Site, location and sign design plans and information on how the sign will be operated and serviced should be included with the application. It would also be helpful to include visual imagery that demonstrates the appearance of the sign and the highly directional nature and narrow illumination cone of the display elements.

Where a VMS requires a resource consent, written approval to the proposal from the affected party, ie the landowner concerned, will be necessary. It is important to note that written approval of the VMS cannot be subject to conditions. The affected party either approves or does not approve the VMS. If the affected party has particular conditions they would like addressed, these should be incorporated into the proposal or through private contract with NZTA. If the resource consent application requires amendment due to the affected party's concerns, then the application should note that the proposal has been amended to address the concerns of the affected party and that the affected party has provided written approval to the amended proposal.

2.8.4 Land issues

There are normally distinct advantages in having:

- the VMS site, and
- the line of clear sight to the VMS sign over the entire legibility distance, and
- trenched or overhead services to the sign

completely within the legal boundary of the road reserve or land owned by the Crown, to avoid landowner negotiations, compensation, legal issues and potential delays.

This section is intended to flag the importance of ensuring any agreements with landowners are placed on a formal legal basis if encroachment into neighbouring land is going to occur. It does not address details of such legal instruments as Easements, Land Plans, Land Entry Agreements, Full and Final Agreements, and compensation for landowners, which may be required if encroachment occurs. For specialist advice, the NZTA Property Consultant should be approached.

3 Design for operation of MVMS

This section defines the functionality required to achieve successful operation of the MVMS.

3.1 Selection of MVMS as a solution

MVMS are located to allow the service user of the road to and consideration of how this will be achieved must be considered before this solution is chosen

Hazard warnings – communicate information about unusual or hazardous driving conditions (e.g. planned maintenance activities).

Event notifications – communicate information on future events such as major sporting/cultural events and planned road closures or diversions these events may require.

Route advisory – provide guidance on alternative routes where applicable.

Travel time information – provide information on travel times to locations further downstream when there is prior knowledge available of possible delays.

Incident management – communicate advance warning to motorists of incidents including crashes and non-recurrent or unusually severe congestion (when there is sufficient time to deploy them).

Safety advisory notices – generic safety messages that have been sanctioned by Waka Kotahi, as part of an approved safety campaign.

The required outcome of the use of a MVMS must be understood before installation or deployment of any assets.

3.2 Site Selection for MVMS

There are multiple factors that must be considered while selecting a site for MVMS to be placed.

3.2.1 Appropriate MVMS sites

The appropriate MVMS sites shall be:

i. Incident management sites
ii. Special events
iii. Extreme weather or environmental events
iv. Route advisory
v. Travel time information
vi. Safety advisory notices

These include both urban and rural environments.

3.2.2 Drainage clearance

MVMS shall be positioned to avoid any obstruction to drainage or flow of water.

3.3 Positioning

For position requirements information on the ConOps shall be developed in accordance with the below sections.

3.3.1 For Approaching Motorists

Unless there are operational requirements that necessitate variations, the MVMS must be positioned to the left of the approaching motorist.

In virtually all situations it is considered unsafe to position a MVMS on the right hand side of approaching traffic because it may confuse motorists' point of reference under nighttime conditions and lead to a head on collision.

3.3.2 Road Types

Motorways and Expressways:

MVMS positioning on the motorway must consider the speed environment to ensure that there is sufficient visibility for messages to be read. Positioning must also allow for decision time ahead of interchanges if providing route information. Any deployment must consult with relevant professionals from managing organisations such as duty engineers and safety engineers.

Urban/arterial roadway:

The distance may vary dependent on the speed limit, local factors, and right-of-way constraints. Location of MVMS shall be reviewed and approved by the Client prior to locating on site.

Rural single lane roadway:

On a rural single lane roadway, with no need to change lanes, but acknowledging the complexity of some decisions and the route choices, appropriate positioning particularly in a 100 km/h zone must be carefully considered.

3.3.3 Road alignment

Straight alignments are preferred to ensure a clear sightline is maintained and the drivers are provided with enough time to recognise the message.

3.3.4 Traffic Volumes

For low traffic volumes (e.g. 2,000 AADT) where the MVMS may display a message advising motorists to turn back, consideration should be given to choosing a site that has a suitable pull over / turning area just after and within view of the sign for map reading / turning around.

With high traffic volumes and a high-speed environment, a level is reached where pulling over or turning around is unsafe. Therefore, consultation with a Suitably Qualified Professional shall be undertaken to exercise as to where the pull over / turning areas are appropriate.

3.3.5 Route Advisory Messaging

If the MVMS is intended to advise route diversions, the sign should be located sufficiently in advance of the alternate route intersection to allow motorists to assimilate the message and respond accordingly, including changing lanes if necessary.

3.3.6 Clear Sight Distance

In motorway and high volume urban (HVU) settings there are typically many other signs and distractions that compete for motorists' attention. Visibility and impact, proportional to the environmental context, are particularly important considerations of site selection.

For roadways with a speed environment of 100kph, sites that allow motorists clear sight distance to the sign of at least 300 metres should be sought. In lower speed environments the distances can be reduced proportionally.

Ensure that roadside trees or other structures will not obscure the sign.

3.3.7 Avoiding Sunlight Glare

If possible, avoid positioning the MVMS directly in front of a rising or setting sun as this may significantly reduce its effective visibility. Similarly, reflections of the sun on the display face may reduce its legibility.

Where these display visibility factors cannot be mitigated by e.g. taking advantage of a natural backdrop of a hill or trees, or a downhill slope, then the use of a hood or louvers should be considered to shield the display.

3.3.8 Road geometry

Avoid positioning a MVMS immediately before a sharp bend, blind crest, or intersection, where the sign may distract attention at a critical moment and could lead to loss of driver control.

Also, the MVMS must not be positioned where the display may be seen from a neighbouring road if this will result in motorists receiving confusing or conflicting information.

3.4 Alignment

Figure 4 and Figure 5 illustrate the optimum alignment of the illumination cone for a MVMS on straight and curved sections of road. When aligning a MVMS, the total cone width is 20 degrees. I.e. 10 degrees either side of the optical axis. The right side of the LED cone (looking towards the approaching motorist) should be aligned to run along the road reserve parallel with the road, while the left side of the LED cone will follow a tangent across the road. This alignment maximises the distance that an approaching motorist will spend within the LED cone.

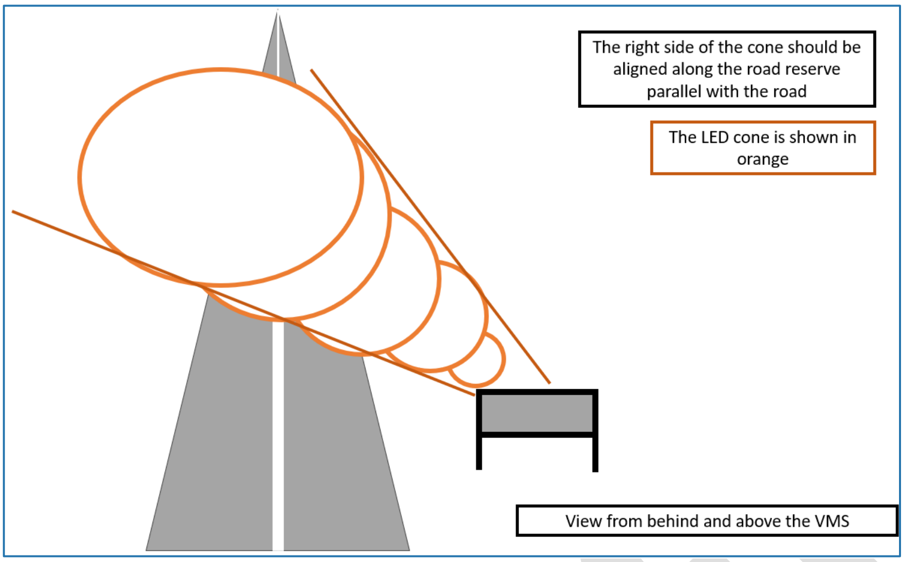

Figure 2: Alignment of a Roadside MVMS (Straight Road)

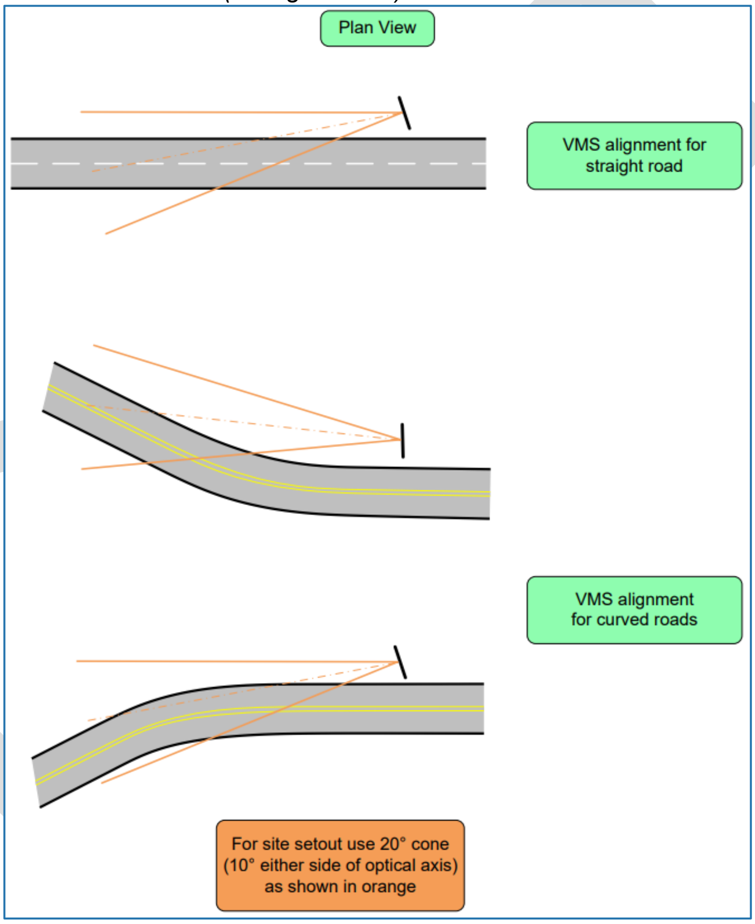

Figure 3: Optimum Alignment for Straight and Curved Road

3.5 Presence of Other Signage

MVMS should not compete with other existing signs and or strong light emitting sources or interfere with traffic control devices both proceeding and beyond the site.

As a guide, TCD requires different signs to be located a minimum of ($0.6V_{85}$) apart, where V85 is the 85th percentile speed of traffic, in km/h, at the sign location.

3.6 Avoid Creating a Hazard or Hindrance

In the Motorway context, MVMS will normally need to be positioned behind barrier protection.

In the HVU and Rural context, for speed environments at or above 70kph, MVMS should be sited outside the clear zone or behind barrier protection.

For speeds below 70 km/h MVMS should be located as far from the road edge as practicable.

Consideration must be given to visibility, illumination, and safety under nighttime or adverse weather conditions.

Placement of MVMS must not impede pedestrian footpaths or cycle lanes.

3.7 Messages

Messages posted on MVMS shall comply with the standard message design processes outlined in the NZTA National VMS Operating Procedures, and where possible shall utilise the standard messages provided in this document.

Inconsistent or contradictory messages may arise between MVMS and Fixed VMS. To ensure road users receive consistent information, the appropriate Traffic Operation Centre must be made aware of the proposed MVMS message before it is displayed.

3.8 Deployment

3.8.1 General Requirements

When deploying a MVMS, operators shall ensure:

- The rear of the trailer faces oncoming traffic
- The handbrake is on
- The wheel clamps are fitted and locked
- The stabiliser legs are extended firmly to the ground

3.8.2 In Windy Conditions

The “sail area” of the raised display will exert large overturning forces on the trailer in moderate to high winds. Consideration must also be taken of the design limits for any MVMS which may limit the locations where a MVMS can be deployed.

In addition to the requirements listed in Section 3.8.1, operators shall also employ some, or all, of the following measures if there is a risk of overturning in high wind:

- Use the lash down straps provided, to anchor the trailer to the ground or some other fixed object. The most important lash down points are those on the windward side.
- Only raise the display to the lowest operational configuration. (However it must be noted that a fully raised display provides better visibility in moderate to high traffic volumes).
- If very high winds are expected, the display should be placed in transportation mode, or the MVMS moved to a position of safety until the winds abate.

3.9 Communications Coverage

If messages for the MVMS are to be controlled remotely, the site must have the appropriate communication system coverage.

4 Design for operation – LCS

This section defines the functionality required to achieve successful operation of the LCS.

4.1 Concepts

4.1.1.1 LCS site

LCS site is the defined location on the given carriageway where orthogonal array of LCSs is installed across the carriageway or in a tunnel.

4.1.1.2 LCS system

An LCS system includes several logically linked LCS sites used to manage a part of a road corridor or a tunnel.

4.1.1.3 LCS operation modes

LCSs operate across a group of lanes along the length of a carriageway. LCSs are operated in one of these modes:

i. integrated lane and speed management mode (regulatory).
ii. speed management mode (regulatory).
iii. Information and warning mode (advisory).

In the integrated lane and speed management operating mode, LCS signs have a one-to-one direct correlation with a lane and are installed on an overhead gantry as shown in Figure 1.

Figure 4. Integrated lane and speed management operating mode
Source: VicRoads 2013

In this mode, LCSs are used only on expressways/motorways with 2 or more lanes in each direction for the purpose of:

i. closing a lane or lanes and managing traffic flow around closed lane(s),
ii. closing a carriageway and managing diverted traffic off the carriageway, across multiple lanes onto alternative routes.
iii. speed management for incidents, congestion and events.

Under the speed management operating mode, displayed speed signs apply to a whole carriageway (gated), depending on the configuration as shown in Figure 2. In this operating mode LCSs on carriageways with up to three lanes shall be installed on vertical poles (Vicroads 2013). On three lane carriageways with the percentage of trucks more than 5%, LCS gantry mounting shall be considered to alleviate visibility restrictions. For carriageways with four or more lanes LCSs shall be installed on gantries.

In the Information and warning mode, pictograms or symbols with visual messages may be used to inform or warn users. For example, roadworks preceding speed reduction - or wind warnings pictograms or no use of high sided vehicle in lanes.

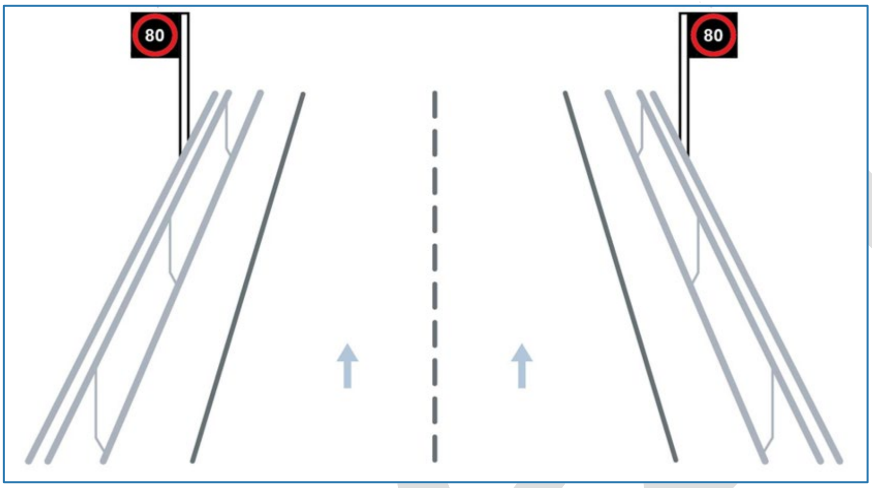

Figure 5. Speed management operating mode applied to a whole carriageway (gated)

4.2 LCS site selection consideration

Among others, design considerations shall be given to the following conditions at each site:

i. visibility - carriageway curves and bends – sight distances.

ii. specific designs and application needs at tunnels and approaches

4.3 LCS placement

4.3.1 Longitudinal placement

4.3.1.1 Integrated lane and speed management mode

As described in section 1.2.1.1, LCS for this mode shall be installed on gantries.

General LCS gantry design layout principles:

i. the number of lanes needed to be closed (n) requires n+2 gantries to safely manage the traffic. So when one lane is blocked, a total of three LCS gantries are required (refer *Figure 6*) to divert traffic; two blocked lanes require a total of four LCS gantries to divert traffic.

ii. one LCS array shall be visible from the previous.

iii. interchanges may be very closely spaced, so the number of gantries between them may be less than n+2 for motorway closure at the downstream exit. In situations like this the speed reduction and/or lane closures for the downstream exit shall begin upstream of the first exit. LCS is a linear management tool and not an exit management tool.

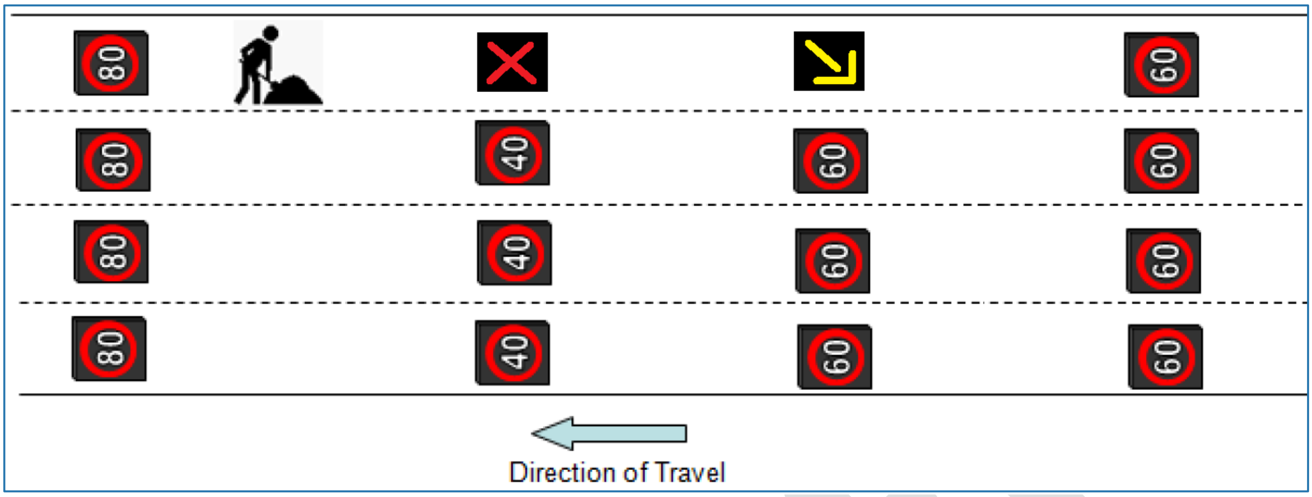

Figure 6 LCSs usage to manage lanes and speed
Source: Austroads 2016

Gantry spacing along an expressway/motorway is affected by many factors. Due to the need for other infrastructure, combined with the need for user safety (e.g. the ability to see one gantry from the previous), gantry spacing may vary. The other important factors that influence the spacing of the gantries and shall be considered, are operating speed and the complexity of the road environment (Austroads 2009).

The desired schematic layout of LCS gantry spacing in relation to off- and on-ramps and other signage is shown in *Figure 7*.

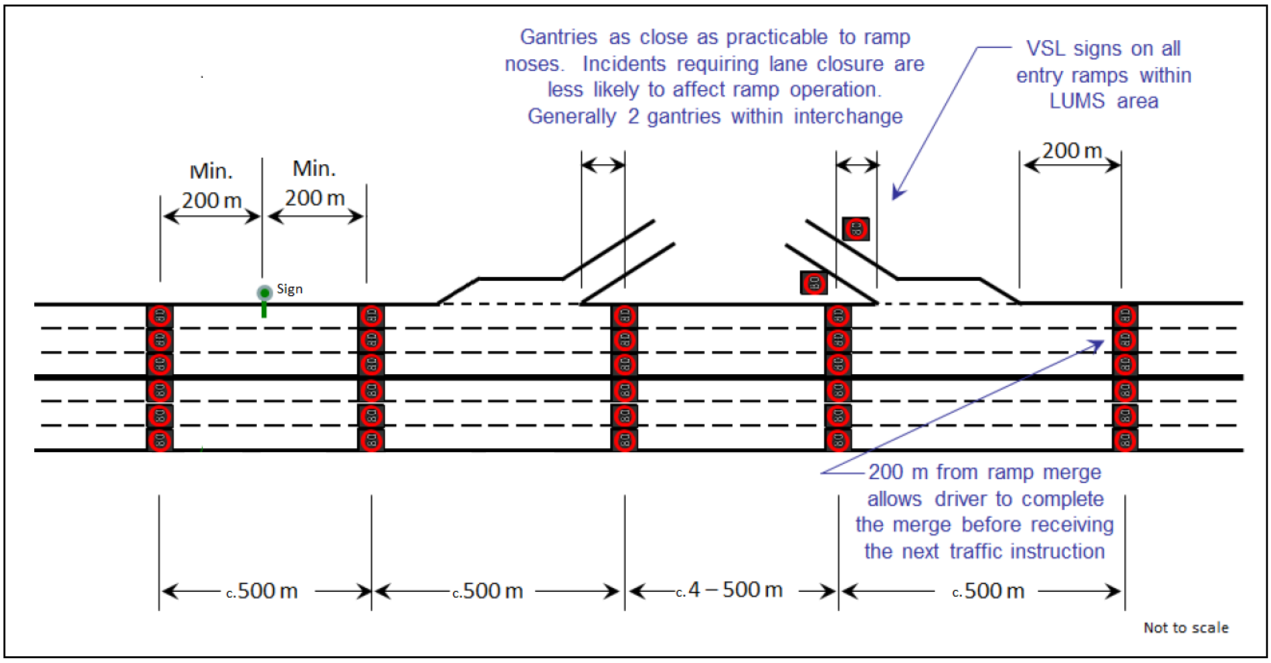

Figure 7. LCS gantry spacing
Source: VicRoads 2013

On-ramp LCSs shall be located at the top of the ramp within 30m of the legal speed limit change. On a single lane ramp only one LCS is required unless physical constraints dictate otherwise. Where there are two or more lanes on an on-ramp LCS installation shall be gated.

In tunnels, LCSs in this operating mode shall be typically spaced between 100 to 200m (VicRoads 2013).

4.3.1.2 Speed management operating mode

On motorways and expressways LCS in this operating mode shall be installed on both sides of the carriageway, typically at 500m spacing with maximum 800m spacing (VicRoads 2013).

Spacing must meet the stated operational outcomes (consistency of messaging). E.g. for managed motorways the gantries distance shall be considered closer to 500m.

In tunnels LCS in this operating mode shall be typically spaced a maximum of 500m intervals (VicRoads 2013).

4.3.2 Horizontal (lateral) placement

4.3.2.1 Integrated lane and speed management mode

LCS positioning (see Figure 8 as an example) shall adhere to the following rules:

i. be positioned centrally over each lane.
ii. be located above off-ramps, either over the painted nose, gore or physical nose with signals over the main carriageway lanes and the exit lane(s).
iii. have one signal per lane at the start of every on-ramp.

iv. not be positioned over a merging or diverging lane.
v. gantries are always perpendicular to the carriageway.
vi. LCS shall be aligned to maximize visibility.

The gantry shall span both carriageways of a motorway/expressway in locations where:

i. both carriageways require LCSs. or
ii. a narrow median restricts gantry leg installation.

The gantry shall span each carriageway of a motorway/expressway:

i. where carriageways for different directions are at different elevations.
ii. where LCS for different directions are not required to be positioned at the same location.

Figure 8. LCSs on a gantry spanning motorway

4.3.2.2 Speed management operating mode

For side mounted LCS installations, other signage shall not be installed on the same pole as the LCS. The distance between the side mounted LCS and other non-related signage should not be less than 200 m.

4.3.3 Vertical placement

4.3.3.1 Integrated lane and speed management mode

The minimum vertical clearance to the gantry and LCSs shall be minimum 6m, but no more than 8m.

LCS site design shall consider if LCSs can be co-located with destination signage (lane specific) and VMS when it is not possible to space destination signage and VMS gantries using required distances.

4.3.3.2 Speed management operating mode

The mounting height (measured from the underside of LCS) for an LCS installed on the top of a pole on the side of a road shall be minimum at:

i. 2.5m minimum when installed on the left-hand side of a one lane carriageway (TCD).
ii. 4.3m when LCS are gated or when an LCS is proposed to be located in the median on two or three lane carriageway. This requires only the sign support to cater for barrier deflection and truck rollover requirements as the sign itself is above the maximum vehicle height. It can also reduce median widening costs and disruption.

Refer section 1.2.1.3 for standard details of mounting poles.

4.3.4 Over dimensional routes

LCS site design shall consider if a site is located on a vehicle over dimension route. These routes require a 'design envelope' clearance minimum 10m wide x 6m high as per the NZTA Bridge Manual. If the wider clearance envelope of 11.5m wide and 6.5m high can be accommodated this is preferred by the New Zealand Heavy Haulage Association.

Specific designs and application shall be given at tunnels and approaches to them.

4.4 Civil requirements and support structures

The design shall comply with the requirements detailed in the latest version of the ITS Core Requirements Standard: Commissioning and Handover Requirements.

4.4.1 Integrated lane and speed management mode

A truss gantry shall be used wherever possible to allow maintenance of LCSs without the need of a TMP.

Refer to the latest version of NZTA ITS standard drawings for LCS mounting and gantry details:

i. 00-0000-0-7104-60 for the latest details of LCS gantry.
ii. 00-0000-0-7104-58 for the latest details of LCS gantry backing boards.

4.4.2 Speed management operating mode

A pole holding an LCS shall conform to the latest versions of NZTA ITS standard drawings:

i. 000-0000-0-7104-20 for the latest details of a pole with shear base.
ii. 000-0000-0-7104-21 for the latest details of a ground plant pole.

A bracket holding an LCS on a pole shall be designed similar to the mounting bracket as per the latest version of ITS standard drawing 000-0000-0-7104-22. For the required type of LCS see the latest version of ITS delivery specification: Lane and Carriageway Signs (LCSs).

4.5 Power Requirements

See the latest version of the ITS core requirements guideline: Requirements for intelligent transport systems for LCS power supply requirements for each ONF road classification.

LCSs will be mains powered and as such a key design consideration will be the availability of power at the roadside. Designers must engage with local power suppliers as the cost may be prohibitive.
Permanent reticulated power supply shall be provided to a cabinet forming part of an electronic sign site.

If the power supply must come from the other side of the roadway, trenching across the state highway is not acceptable, an aerial cable may also not be acceptable, and thrust boring may be the only option.

4.5.1 LCS UPS

A UPS shall be provided inside an LCS site cabinet and be able to supply power to an LCS site field controller, all LCSs at full intensity and any other components that are necessary to maintain communication with a TOC for a period of four hours.

4.6 LCS site communications infrastructure

See the latest version of the ITS core requirements guideline: Requirements for intelligent transport systems for requirements on communications infrastructure for each ONF road classification.

A communications link is required to connect an LCS site to the NZTA national control system.

Depending on location there are a range of communications options that can be utilised, including:

- Use of any existing NZTA backbone fibre communications network.
- Leased lines from commercial providers dark fibre or ADSL.
- Cellular communications. NZTA has national communications agreements in place with a commercial provider.

Depending on the communication system selected, there may be a need to arrange cabling/trenching to the site. As with the power requirements, consideration should be given to tasking a telecommunications contractor with arranging cabling to the site.

Note that consent from NZTA is required before cabling installation is undertaken in the road reserve.

Where and LCS site is connected to mains power and a copper communication cable, there must be appropriate separation. Where power and communication cables are laid in the same trench for up to 200m, separation of >200mm is required.

The installation (capital) cost, operating cost and fitness for purpose of the communications options must be established.

4.7 Roadside cabinets

For details of roadside cabinet which forms an LCS site refer to NZTA ITS Cabinets Standard (ITS-02-04)

5 Design for safety

This section defines the requirements to ensure the Electronic Signs can be operated and serviced safely.

5.1 Health and safety

All ITS equipment must be designed to ensure installation and maintenance in accordance with the Health and Safety at Work Act 2015.

5.1.1 Health and safety in design

Health and safety in design must be undertaken to identify any hazards and the appropriate interventions. See the latest version of the NZTA Health and safety in design minimum standard (ZH/MS/01).

5.2 Safety outcomes

5.2.1 Space to ensure safety conformance – motorway and expressway

Health and safety in design principles must be undertaken to determine the appropriate space required to operate safely within the VMS or LCS site The space must accommodate an LCS gantry or a pole, a cabinet with an apron and safety interventions (such as barrier protection if required), safe maintenance vehicle parking, and it must allow additional distance to the edge of the live lane in a higher speed environment.

In the motorway and expressway context, gantry support structures will normally require barrier protection which will in turn provide protection for maintenance technicians. Where safety barriers or guardrails are provided to protect the VMS or LCS support structure and any associated equipment, refer to the section titled Safety Barriers in the current version of ITS design standard: *Civil and structural requirements.*

Barrier designs are required to be undertaken by a suitably qualified Installation Designer, using the latest version of Austroads *Guide to Road Design Part 6 Roadside Design Safety and Barriers and the latest version of NZTA Specification M23 (Road safety hardware)*.

5.2.2 Space to ensure safety conformance – Regional State Highways

For regional VMS, the width of the left-hand road reserve is a crucial determinant in the decision process. The space must accommodate the width of the proposed sign, space for barrier protection if required, and allow a further distance to the edge of the live lane dependent on speed environment.

Consideration should be given to natural protection afforded by positioning signs on top of cuttings or beyond culverts, providing the other site selection requirements can be met.

For speed environments at or above 60km/h, structures must be frangible or protected.
Below 60km/h there is no requirement to protect non-frangible signs, but the supports should be located as far from the road edge as practicable.
Where a guardrail is being considered, the needs of pedestrians, cyclists and turning vehicles shall be considered.

5.2.3 Site access static locations

The site must allow reasonable vehicle access for erection, and for reactive and routine maintenance. The site shall be accessible, and the sign shall be maintainable, without the need for temporary traffic management (TTM). The design should:

- allow safe access to the sign for maintenance vehicles
- minimise the exposure to hazards posed between maintenance vehicles and personnel, and traffic in the live lane(s)
- facilitate effective traffic control for any maintenance work above the carriageway.

5.2.4 Site access MVMS

The arrangements to access the sign need to be fully reviewed by client and Suitably Qualified Professional to ensure safe arrangements have been made available. The requirements for safe site access will vary depending on the road environment. Individuals that do access the site need to be suitably qualified.

5.2.5 Safe Parking

The design shall allow a maintenance vehicle to decelerate to a crawl in the left lane of the road in order to pull out of that lane and then reverse into the paved maintenance bay. The maintenance bay shall be located behind a barrier or positioned within a safe distance from the road.

Parking areas should allow for clear line of site for safe entry and exit and be sealed. Access from off the State Highway from local roads should be considered if achievable.

For reversing vehicles, rubber wheel stops or bollards must be installed where there is a risk of a vehicle hitting a gantry leg, a pole, a cabinet or other assets.

For regional sites – sight rails may be used to reduce the chance of vehicles dropping into culverts, unrecoverable swales or other hazards.

5.2.6 Safety issues – above and below ground

The top of the sign shall not be located any closer than 2m to overhead low-voltage power lines, and not closer than 4.5m for high-voltage lines. However, some power companies may require slightly greater separation distances. For safe distances from low- and high-voltage power lines, refer to the latest version of the NZECP 34:2001 New Zealand Electrical Code of Practice for Electrical Safe Distances.

Note should be made if the site is under power lines low enough to interfere with erection of the support structure and this information should appear in the tender documents.

Note that a check must also be made for the presence of underground services before digging or testing with a Scala penetrometer or other geotechnical investigation equipment.

5.2.7 Electrical Safety

All ITS equipment to be installed in accordance with AS/NZS 3000 known as the Australian/New Zealand Wiring Rules.

Each installation will have an Electrical Certificate of Compliance (COC) and Record of Inspection (ROI).

5.2.8 Electrical surge protection

All display equipment shall be internally protected against damage resulting from:

- lightning strikes near the VMS/LCS/gantry/roadside cabinet
- electrical transients on power cabling
- electrical transients on internal and external signal wiring
- electromagnetic interference
- static electrical discharge.

A lightning protection system shall be installed in accordance with AS/NZS 1768:2021 Lightning protection (AS/NZS 1768). The system shall consist of:

- an air termination to intercept lightning discharges directly.
- down conductors to connect the air terminal to earth terminals. Note that it is possible that these down conductors can be formed from reinforcing steel that may be used in concrete support structures (as applicable).
- earth terminations to discharge the lightning currents into the general mass of earth. Note that this may in part, or in full, consist of the foundations for the support structure, depending on the calculated required maximum earthing resistance.
- equipotential bonding between the lightning earthing system and any other earthing systems for personal and equipment protection.

Multi-stage surge diversion shall also be provided on the incoming power circuits and communication circuits. Surge diverters shall be field replaceable without the need to disconnect wiring and they shall have integral indicators to show when they have blown (as applicable). A preferred option is to have an auto-reset function which negates the need for an actual site visit.

5.3 Site assessment

All site designs are required to be reviewed by the NZTA regional safety team once the design is up to a suitable stage.

Each site shall be designed in accordance with NZTA Safe System principles and the overall project shall be subject to the NZTA Safe System Audit process.

5.4 Site audit

Each ES site shall be designed in accordance with NZTA Safe System principles and the overall project shall be a subject to the NZTA Safe System Audit process.

5.5 System-specific safety requirements

To be defined

6 Design for maintainability

This section defines the requirements to ensure the Electronic Signs can be maintained.

6.1 Maintenance outcomes

i. The design shall deliver the following maintenance related outcomes:
ii. complies with the requirements of the main design outcomes in Section 2
iii. minimise maintenance costs
iv. improves safety of maintenance crew
v. improves safety of road users
vi. minimises traffic disruption during maintenance activities

6.1.1 System-specific inspection and maintenance requirements

The design and layout must allow inspection carrying out without the need for additional temporary traffic management (TTM).

The design and layout shall facilitate planned inspections and reactive maintenance (repair) with the minimum of equipment, in the shortest time and with minimum impact to traffic.

6.1.2 Maintenance Responsibility

Following successful completion of all installations will be handed over to the National ITS Maintenance contractor or Regional Maintenance Contractor (ASM, WTA etc), part of this handover is supply of relevant documentation

Any equipment faults within the Defects Liability Period will be the responsibility of the equipment supplier.

The Relevant ITS Maintenance Contractor will be responsible for the maintenance and monitoring of the Electronic Sign and all associated equipment.

Minor structures, guardrail, vegetation control will be the responsibility of the local NOC, while larger structures such as gantries need to be handed over to the Regional Structural Bridge Maintenance Contractor.

The Engineer is responsible for collating the required information for each of these organisations in the form of RAMM data and as-built information.

6.1.3 Site access

Refer to the latest version of ITS design standard: Civil and structural requirements where structures are relevant.

6.1.4 Maintenance access to structures

Refer to the latest version of ITS design standard: Civil and structural requirements for typical maintenance access and typical maintenance bay drawing (where structures are relevant).

6.1.5 Extreme weather or other environmental conditions

Avoid sites prone to flooding where possible. If necessary, use a tall traffic signal-type roadside cabinet ensuring its position does not offer vandals a platform to reach the Electronic Sign. Consideration must be given to extreme or unusual conditions at each site that will require upgrading of part of the design.

Obvious examples include:

- extreme winds that are more likely >500m altitude, on a ridge or cutting, or in a lee effect multiplier zone, affecting foundations and structural support design
- corrosive environments requiring enhanced coating systems.

Another less obvious example is the need to protect exposed equipment in alpine locations from wildlife.

7 Design for security

This section defines the requirements to ensure the Electronic Signs can be secured and maintain integrity.

7.1 Security outcomes

i. The Electronic Sign design must deliver the following security related outcomes:
ii. complies with appropriate Specification security requirements, site networking equipment security
iii. requirements), as well as with the requirements of section 5.2.
iv. meets all relevant NZTA security procedures and protocols.
v. passes all security audits / assessments of installed ITS equipment.

7.2 System-specific security requirements

7.2.1 LCS and Fixed VMS Gantry physical security

For physical security requirements refer section 2.8 of the latest version of ITS design standard: Civil and Structural Requirements.

For details of gantry access ladder, hoop, vandal barrier and gate refer the latest version of NZTA ITS standard drawings:

i. 000-0000-0-7104-56 for details of access ladder and hoop
ii. 000-0000-0-7104-57 for details of vandal barrier and gate

7.2.2 MVMS

It is most likely that the signs will be left unattended on the roadside. So, security requirements prevent:

i. Removal of the complete unit from site
ii. Removal of major components, e.g. wheels, solar panels, etc
iii. Dismantling of the equipment
iv. Operation of the equipment.

8 Integration, Testing, Commissioning and Handover

8.1 Testing Requirements

Refer to latest version of ITS-01-012-202303-STD-VLSI for Integration and Testing Requirements.

8.2 Commissioning and Handover

For Handover and Commissioning, refer to latest version of ITS-01-000-202302-STD-CMH Commissioning and handover requirements.

9 References

This section lists all external and NZTA references included in this document.

9.1 Industry standards

Standard number/name	Source
AS/NZS 1768:2021 Lightning protection	https://store.standards.org.au/product/as-1768-2021
AS/NZS 3000:2018 Electrical installations – Known as the Australian/New Zealand Wiring Rules (AS/NZS 3000)	https://www.standards.govt.nz/shop/asnzs-30002018/
Health and Safety at Work Act 2015	https://www.legislation.govt.nz/act/public/2015/0070/latest/DLM5976660.html
NZECP 34:2001 New Zealand Electrical Code of Practice for Electrical Safe Distances	https://www.worksafe.govt.nz/dmsdocument/1565-new-zealand-electrical-code-of-practice-for-electrical-safe-distances-nzecp-34-2001

9.2 NZTA standards, specifications and resources

9.2.1 Standards and specifications

See the NZTA website for the latest versions of the ITS S&S listed below.

Document name
ITS core requirements guideline: Requirements for intelligent transport systems
ITS core requirements standard: Commissioning and Handover
ITS delivery specification: LCS (Lane and Carriageway Signs)
ITS design standard: Civil and structural requirements
ITS design standard: Roadside Cabinets
ITS delivery specification: Variable message signs – fixed
ITS Design Standard Optical Fibre
ITS Design Standard Ducts
ITS Design Standard Jointing chambers and pull pits

9.2.2 Resources

Document name/code	NZTA website link
Health and safety in design minimum standard (ZH/MS/01)	https://www.nzta.govt.nz/assets/resources/contractor-health-and-safety-expectations/ZHMS-01-Health-and-safety-in-design-minimum-standard.pdf

Document name/code	NZTA website link
Bridge Manual (SP/M/022)	https://www.nzta.govt.nz/resources/bridge-manual/bridge-manual/
Land Transport Rule: Traffic Control Devices 2004 Rule 54002/2004 Updated 19 May 2022 (TCD rule)	https://www.nzta.govt.nz/assets/resources/rules/docs/traffic-control-devices-2004-as-at-19-may-2022.pdf
Traffic control devices manual (TCD manual)	https://www.nzta.govt.nz/resources/traffic-control-devices-manual/
Safe System Audit	https://www.nzta.govt.nz/resources/safe-system-audit-guidelines-for-transport-projects/
NZTA M23:2022 Specification and guidelines for road safety hardware and devices	https://www.nzta.govt.nz/assets/resources/road-safety-barrier-systems/docs/m23-road-safety-barrier-systems.pdf

9.3 Legislation

Name	Website link
Health and Safety at Work Act 2015	https://www.legislation.govt.nz/act/public/2015/0070/latest/DLM5976660.html

9.4 Other resources

Name	Website link
Guide to Smart Motorways (Austroads 2016) Austroads - Guide to Smart motorways	Austroads - Guide to Smart motorways
Managed freeways handbook for lane use management, variable speed limits and traveller information (VicRoads 2013)	VicRoads - handbook for lane use management, variable speed limits and traveller information
Freeway design parameters for fully managed operations (Austroads 2009)	https://austroads.com.au/publications/road-design/ap-r341-09
Austroads report AP-R485 15 Ability to Absorb Information Through Electronic and Static Signs.	https://austroads.com.au/publications/traffic-management/ap-r485-15
Austroads Guide to Road Design Part 6: Roadside Design, Safety and Barriers	https://austroads.com.au/publications/road-design/agrd06

10 Terminology used in this document

Term	Definition
DRAFT	The document is being written and cannot be used outside of NZTA.
FINAL DRAFT (pending ratification)	The document has been finalised and is pending approval and ratification by NZTA. It can be used for procurement at this status.
RATIFIED	The document is an official NZTA document. NZTA projects and other road controlling authorities connected to NZTA back-end systems must include this document in the contracts. The obligation to follow the requirements in this document would come from the inclusion of the S&S document in the contract.
RETIRED	The document is obsolete, and/or superseded.
ITS	Intelligent transport system(s)
NZTA	NZ Transport Agency Waka Kotahi
S&S	Standards and specifications
AADT	Annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
AC	Alternating current
ADSL	Asymmetric digital subscriber line
AS	Australian standard
AS/NZS	Australian/New Zealand standard
ASM	Auckland System Management
ATMS	Advanced traffic management system
Barrier protection	Generic term covering various roadside protective barrier systems including rails, fences and crash cushions, which are designed to restrain vehicles that are out of control
Border	Border surrounding an active display matrix on an electronic sign or signal
Character height	Height of an upper-case character expressed in millimetres
Character spacing	Horizontal spacing between individual characters on the same line of a message, expressed as a ratio of stroke width
COC	Electrical Certificate of Compliance and Electrical Safety Certificate
ConOps	Concept of Operations
EJT	Estimated journey Time
Enclosure	Housing for electronics systems to protect against environmental conditions
Expressway	High-speed roads, which may include well-spaced at-grade intersections – which means they often have accesses and driveways onto them and sometimes traffic signals or roundabouts
FAT	Factory acceptance testing

Term	Definition
FCD	Field controller device
Frangible	Performance capability of structures, which are designed to shear or collapse when struck by a vehicle, minimising the impact hazard to the vehicle’s occupants
Gantry	Support structure spanning a carriageway for the purpose of supporting electronic signs and signals
High-voltage lines	Lines carrying electrical current greater than 1000 volts AC or 1500 volts DC
HVU	High-volume urban. Refers to non-motorway, generally high-volume roads, in urban environments
ITS	Intelligent transport systems
LCS	Lane and carriageway sign
LED	Light-emitting diode
Line spacing	Vertical space between lines of text, expressed as a percentage of the upper-case font height
Low-voltage lines	Lines carrying electrical current less than 1000 volts AC or 1500 volts DC
Luminance ratio	Ratio of light emitted from the active display area, to that of the inactive display area when illuminated by an external light source
Motorway	Access-controlled, high-speed roads that normally have grade-separated intersections – which means they have overbridges (or underpasses) so road users don't have to stop at traffic lights
MOTSAM	Manual of traffic signs and markings
NZTA	New Zealand Transport Agency
ONF	One Network Framework
Pixel	Smallest controllable element of a display matrix for an electronic sign or signal
Pixel pitch	Distance between centres of adjacent pixels
PMCS	Plant Management and Control System
RAMM	Road Assessment and Maintenance Management system
Road reserve	Corridor of land owned by the Crown, which is designated for roading infrastructure
ROI	Record of Inspection – of high risk prescribed electrical work
Rural	In the context of ITS, rural refers to low-volume uncongested roadways in non-urban environments
SAT	Site acceptance testing
Scala penetrometer	Test equipment used to determine the penetration resistance of soil
Slip base	Shearing system for support structures involving upper and lower base plates clamped together by slip bolts in slots that are tightened to a prescribed torque

Term	Definition
Stroke	Width of a character
S&S	Standards and specifications
TCD manual	Traffic control devices manual
TCD Rule	Land Transport Rule: Traffic Control Devices 2004
TIM	Travel Information Management – operational system which sends EJT messages to the VMS.
TMP	Traffic management plan
TOC	Transport operations centre
TTM	Temporary Traffic Management
UPS	Uninterruptible power supply
VMS	Variable message sign
WTA	Wellington Transport Alliance

11 Content to be redirected

This section records any circumstances where content from this document will be reclassified and moved into future documents. This table is then updated with a reference to the new location.

Section reference	Section name	Future document	Class

12 Document control

12.1 Document information

Document number	ITS-STND-ESIGN-202405
Previous document number/s (if applicable)	ITS-01-001-202105-STD-VMS-FIXED
Document status DRAFT | FINAL DRAFT | RATIFIED | RETIRED	DRAFT
[IF RETIRED] New document details	
Online ISBN	
Document availability	The controlled version of this document can be accessed from https://www.nzta.govt.nz/roads-and-rail/intelligent-transport-systems/standards-and-specifications/its-current-interim-and-legacy-standards-and-specifications/https://www.nzta.govt.nz/resources/intelligent-transport-systems/its-standards-and-specifications/

12.2 Document owner

Role Platform Lead, Digital Transformation

Organisation NZTA

12.3 Document approvers

This table shows a record of the approvers for this document.

Approval date	Approver	Role	Organisation
DD/MM/YYYY			

12.4 Full version history

This table shows the full history of changes made to this document, both minor and major, in chronological order, since the document was first authored.

Minor versions are numbered 0.1, 0.2 etc until such point as the document is approved and published, then it becomes 1.0 (major version). Subsequent edited versions become 1.1, 1.2 etc, or if it's a major update 2.0, and so on.

Version	Date	Author	Role and organisation	Reason
0.1	April 2024	Richard Quinney James Ellison Kirill Yushenko	VMS, Senior Specialist MVMS, Principal LCS, Principal Consultant	Initial Drafts for expert panel
0.2	07/05/2024	James Ellison Richard Quinney Kirill Yushenko Allan Arora Catherine Rochford	MVMS, Principal VMS, Senior Specialist LCS, Principal Consultant Transport Engineer Senior Associate – Project Manager	Documents merged in to Electronic Signs Standard document. Draft for expert panel
0.3	27/05/2024	James Ellison Richard Quinney Kirill Yushenko Allan Arora Catherine Rochford	MVMS, Principal VMS, Senior Specialist LCS, Principal Consultant Transport Engineer Senior Associate – Project Manager	After expert panel
0.4				After industry