WAKA KOTAHI
NZ TRANSPORT AGENCY

RAMP METER SYSTEMS

ITS Design Standard

14 AUGUST 2020
1.1

New Zealand Government

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More information
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Contents

1 DOCUMENT CONTROL

1.1 Document information

Document number	ITS-01-003-202006-STD-RMS
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1.2 Document owner

Role ITS Document Review Panel

Organisation Waka Kotahi

1.3 Document approvers

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

Approval date	Approver	Role	Organisation
DD/MM/YY		Design Engineer	Waka Kotahi
		Product Manager	Waka Kotahi
		Asset Manager	Waka Kotahi
		Safety Engineer	Waka Kotahi
		Security Specialist	Waka Kotahi
		Technical Specialist (Technology Operations)	Waka Kotahi
		Procurement Manager	Waka Kotahi
		Journey Manager (Transport Operations)	Waka Kotahi

1.4 Version history

This table shows a record of all changes to this document:

Version	Date	Author	Role and organisation	Reason
0.1	01/09/15	Kirill Yushenko	Consultant, AECOM	Fundamental update, split into requirements and layout parts
0.2	08/05/20	Final Word	Editorial services	Transferring draft document to latest ITS design standard template
0.3	11/05/20	ITS Document Review Panel	Waka Kotahi	Checking this draft in the new template, redirecting content, addressing queries
1.0	30/06/20	ITS Document Review Panel	Waka Kotahi	Interim draft issued
1.1	14/08/20	ITS Document Review Panel	Waka Kotahi	Diagrams resized

2 TERMINOLOGY USED IN THIS DOCUMENT

Term	Definition
DRAFT	The document is being written and cannot be used outside of Waka Kotahi
PENDING	The document has been approved and is pending ratification by Waka Kotahi. It can be used for procurement at this status
RATIFIED	The document is an official Waka Kotahi document. Road controlling authorities are obliged to follow a document with this status
RETIRED	The document is obsolete, and/or superseded
AASHTO	American Association of State Highway and Transportation Officials
ADSL	Asymmetric digital subscriber line
AS/NZS	Australian and New Zealand standard
AWS	Advanced warning signs
EJT	Estimated journey time
EN	European standard
LED	Light-emitting diode
MOTSAM	Manual of traffic signs and markings
NCHRP	National Cooperative Highway Research Program
RCA	Road controlling authority
RSS	Ramp signalling system
SCATS	Sydney Coordinated Adaptive Traffic System
SRMS	SCATS Ramp Metering System
SHGDM	State highway geometric design manual
TCD	Traffic Control Devices Rule
TIM	Travel/traveller information manager
TOC	Traffic operations centre
VMS	Variable message signs

3 OVERVIEW AND OUTCOMES

This section defines the operational outcomes for intelligent transport systems with respect to the transport network.

3.1 ITS design standard definition

Design assurance is delivered through a series of design standards. The standards ensure road network level operational outcomes and design for safety, security and maintainability are accounted for in solutions being delivered to Waka Kotahi. Design standards address risks typically generated at the front end of roading or infrastructure projects. Their objective is to ensure solutions address the correct operational need and solutions are fit for purpose.

3.2 System overview

This document outlines a formal methodology to be followed when implementing ramp signalling systems (RSS); the ITS equipment that contributes to improved efficiency and safety both in the local area and the wider motorway network. With so much at stake, the standards recommended in the following sections will ensure that the implementation of all ramp signalling equipment is consistent and continues to provide strong value for money.

Ramp signalling is a tool used around the world to regulate the flow of vehicles entering a motorway according to existing traffic conditions in order to smooth and optimise traffic flows.

In a typical RSS, vehicle detectors report the flow of vehicles to a computerised system which then uses the data, in conjunction with algorithms and stored plans, to control the flow of traffic entering the motorway.

Standard traffic signals are generally installed at the intersection of the arterial road and the start of the motorway on-ramps to control the flow of vehicles. Typically, the ramp signals operate a short cycle allowing one vehicle per lane to join the motorway traffic at each green period. The duration of the red period within the signal cycle varies depending on the density of traffic in the adjacent motorway lanes. As the flow on the motorway becomes denser, the red period increases, thus reducing the incoming flow rate from the on-ramp.

Ideally, a successful ramp signalling implementation can be described as follows:

- installed minimally, only in places where real benefits identified prior to design can be demonstrated after commissioning
- highly efficient in terms of operational energy use and information delivery
- low maintenance with ready access when maintenance is required
- equipped with automated fault reporting to enhance availability and reduce the need for physical checks
- interoperable, plug and play, regardless of vendor, enabled by excellent object-oriented specification.

In New Zealand, Waka Kotahi has standardised on the Sydney Coordinated Adaptive Traffic System (SCATS) for the overall control and coordination of traffic signals at intersections and has standardised on the SCATS Ramp Metering System (SRMS) for ramp signals on motorway on-ramps. SRMS may use arterial road SCATS detectors for queue and count purposes.

3.2.1 System definition

A ramp meter is tactical traffic demand management system. They are used to manage or regulate a traffic flow, in response to measured local traffic conditions, at a merge point where the traffic flow enters the main line traffic of a motorway or expressway. A typical ramp meter site will have a set of detection devices, signalling equipment and a local controller associated with each site. A group of sites can be coordinated to provide corridor level demand management. This requires a back office supervisory system, to which each coordinated site is connected. An example of this is SCATS.

3.2.2 System class

003 Signs.

3.3 Scope

This document establishes the layout requirements for RSS equipment. The intent here is to show the typical layouts of interchanges and installation positioning of inductive loops, cabinets, electronic signs, static signage etc, which are typically an integral part of RSS. The layouts are intended for designers, manufacturers, RSS installation contractors and suppliers while being sufficiently comprehensive to perform design, selection and installation of equipment, and final acceptance testing.

This document applies to all new or reconstructed sites. The layout requirements of this document are not intended to be retrospectively applied to existing ramp signal sites until that site is modified or replaced.

3.4 Applicable legislation

To be defined.

3.5 Outcomes

To be defined.

3.5.1 Operational

To be defined.

3.5.2 For road users

To be defined.

3.5.3 For road controlling authorities

To be defined.

4 DESIGN FOR OPERATION

This section defines the functionality required to achieve successful operation of the intelligent transport system.

4.1 RSS geometry and components layout

4.1.1 Ramp storage needs

Ideally, vehicles should be able to be stored on the ramp and the queue should not spill back onto the arterial system when the ramp meter is operating. At least four minutes of peak traffic flow should be able to be stored on the ramp and two storage lanes provided if the flow is expected to exceed 600 vehicles per hour. Where four minutes' storage on the ramp is not achievable, eg on an existing ramp in a constrained environment, the remaining storage should be allowed for on the arterial where it does not interfere with other movements. The relevant RCA (ie operations team or traffic operations centre [TOC]) should be consulted should this requirement be unable to be met.

The table below illustrates the linear lane storage requirements for a range of design flow rates. This requirement is broken down into one, two and three-lane storage requirements. Therefore, the storage per lane requirement is the length of the ramp from the back of queue to the stop line. The total length of ramp, to the physical nose, can be calculated by adding a 100m acceleration length to the one-lane ramp, a 100m merge and acceleration length to the two-lane ramp and a 200m double merge length to the three-lane ramp. All these values are based on four-minute storage and an average road occupancy length per vehicle of 8.5m.

The ramp shall be designed to a minimum six-second cycle time. Italic figures in the shaded area of the table below are for capacity information purposes only.

Design flow (vph)	Storage required (m)	Storage per lane (m)	Average cycle time(s)	Storage per lane (m)	Average cycle time(s)	Storage per lane (m)	Average cycle time(s)
		One lane		Two lanes		Three lanes	
500	283	283	7.2	142	14.4	–	–
600	340	340	6	170	12	–	–
700	397	*397*	*5.2*	198	10.3	–	–
800	453	*453*	*4.5*	227	9	151	13.5
900	510	*510*	*4*	255	8	170	12
1000	567	–	–	283	7.2	189	10.8
1100	623	–	–	312	6.5	208	9.8
1200	680	–	–	340	6	227	9
1300	737	–	–	*369*	*5.5*	246	8.3

Design flow (vph)	Storage required (m)	Storage per lane (m)	Average cycle time(s)	Storage per lane (m)	Average cycle time(s)	Storage per lane (m)	Average cycle time(s)
1400	793	–	–	*397*	*5.2*	264	7.7
1500	850	–	–	*425*	*4.8*	283	7.2
1600	907	–	–	*454*	*4.5*	302	6.8
1700	963		–	*482*	*4.3*	321	6.4
1800	1020	–	–	*510*	*4*	340	6
1900	1077	–	–	–	–	*359*	*5.7*
2000	1133	–	–	–	–	*378*	*5.4*
2100	1190	–	–	–	–	*397*	*5.2*
2200	1247	–	–	–	–	*416*	*4.9*
2300	1303	–	–	–	–	*435*	*4.7*
2400	1360	–	–	–	–	*454*	*4.5*

Table 1. Ramp storage needs

4.1.2 Site geometric layout

The geometrical shape of all ramps where an RSS is installed shall follow safety and storage requirements set in the latest versions of State highway geometric design manual (SHGDM), Manual of traffic signs and markings (MOTSAM), AASHTO and this document.

4.1.2.1 Limit line

The limit line is the point at which vehicles are brought to a halt by the ramp signal on the on-ramp prior to being released onto the motorway; it shall be set as follows:

- The limit line shall be located 6m up the ramp from the traffic lantern poles or gantry.
- For one-lane ramps, the limit line shall be located a suitable acceleration distance from where the ramp merges with the mainline flow in order to allow vehicles to safely reach the left lane cruising speed at the merge point (where the merging lane is 3.5m wide). This will typically mean that the limit line is at least 100m from the physical nose, although this will depend on the geometry of the ramp.
- For two-lane ramps, the limit line shall be located a suitable acceleration distance from where the ramp merges with the mainline flow in order to allow vehicles to safely reach the left lane cruising speed at the merge point (where the merging lane is 3.5m wide). The two-to-one merge will have a minimum length of 100m and is to be complete before or at the physical nose of the on-ramp. The two-to-one merging distance may be reduced to between 75mm and 100m only following the written sign-off from the relevant Waka Kotahi Safety Engineer.
- For three-lane ramps, or two-lane ramps with a priority vehicle bypass lane, the limit line shall be located a suitable acceleration distance from where the ramp merges with the mainline flow in order to allow vehicles to safely reach the left lane cruising speed at the merge point (where the merging lane is 3.5m wide). The limit line will typically be located a minimum of 200m upstream of the physical nose of the on-

ramp. This distance is comprised of two consecutive 100m merge lengths. One or both of these merge lengths may be reduced to between 75m and 100m only following the written sign-off from the relevant Waka Kotahi Safety Engineer.

- The positioning of all vehicle detectors on an on-ramp shall be based in relation to the location of the limit line.

4.1.2.2 Standard ramp signal entrance

See the latest version of ITS standard drawing 000-0000-0-7104-10-RX.

4.1.2.3 Two lanes ramp signal – side mount option

See the latest version of ITS standard drawing 000-0000-0-7104-11-RX.

4.1.2.4 Two lanes ramp signal – gantry option

See the latest version of ITS standard drawing 000-0000-0-7104-12-RX.

4.1.2.5 Two lanes ramp signal – plus bypass lanes

See the latest version of ITS standard drawing 000-0000-0-7104-13-RX.

4.1.2.6 Motorway to motorway – signal locations

In certain circumstances and where traffic volumes dictate, ramp signals may be used on motorway-to-motorway intersections.

The location of the limit line and traffic signals follows the same methodology already detailed in this standard.

Queue loops will be set back from the limit line in 100m intervals until the previous merge point, as detailed in drawing Entry Ramp Signalling System Motorway to Motorway attached in section 1 layout drawings of the NZTA's ITS specification: Ramp signalling system standard drawings (ITS-05-03).

Enlarged advanced warning signs (AWS) will be used, details of which can be found in Appendix D, to inform motorist of ramp signal operation.

The type A sign shall be located on the previous motorway in a location prior to the lane split in order for road users to make an informed decision on the route they take.

As with standard ramp signal installations, the type B sign shall:

- be located on the ramp itself, depending on the length of the motorway-to-motorway ramp
- not be located any more than 150m upstream of the limit line.

All rules regarding static signage and road marking still apply.

See the latest versions of ITS standard drawings 000-0000-0-7104-14-RX and 000-0000-0-7104-15-RX.

4.1.3 Ramp signals

The ramp signal LED traffic signal heads shall either be pole mounted or attached on an overhead gantry, typically for single and two-lane on-ramps, without any priority bypass lanes shall have post-mounted signal heads installed. Three lane on-ramps and on-ramps installed with priority bypass lanes shall be installed on an overhead gantry.

Regardless of the ramp configuration, the ramp signal traffic signal heads shall be located 10m downstream of the limit line.

4.1.4 Location of the ramp signal controller

The ramp controller's location shall be selected according to the following principles:

- The ramp controller shall be mounted in a signal control cabinet installed, where possible, adjacent to the ramp network communications cabinet to facilitate the communications connection.
- The location of the signal control cabinet shall be selected to provide the best overall solution for the following:
  - ease of access for maintenance
  - to reduce the need for traffic management during installation and maintenance
  - to provide the onsite technician with a direct line of sight to the traffic signals when working on the controller
  - not to exceed the maximum distance of 500m from a vehicle loop detector (unless an external detector is used)
  - where it will not be prone to damage caused by moving traffic or maintenance activities
  - where road user intervisibility is not interfered with
  - where personnel will not be subjected to adverse safety, such as behind a crash barrier, where vehicle speeds are low or sufficiently far from the kerb line or carriageway
  - where pedestrians will not be unnecessarily inconvenienced or endangered.

4.1.5 Inductive loop types and locations

4.1.5.1 Standard loop configurations

For loop dimensional details, see the latest version of ITS standard drawing 000-0000-0-7104-08-RX.

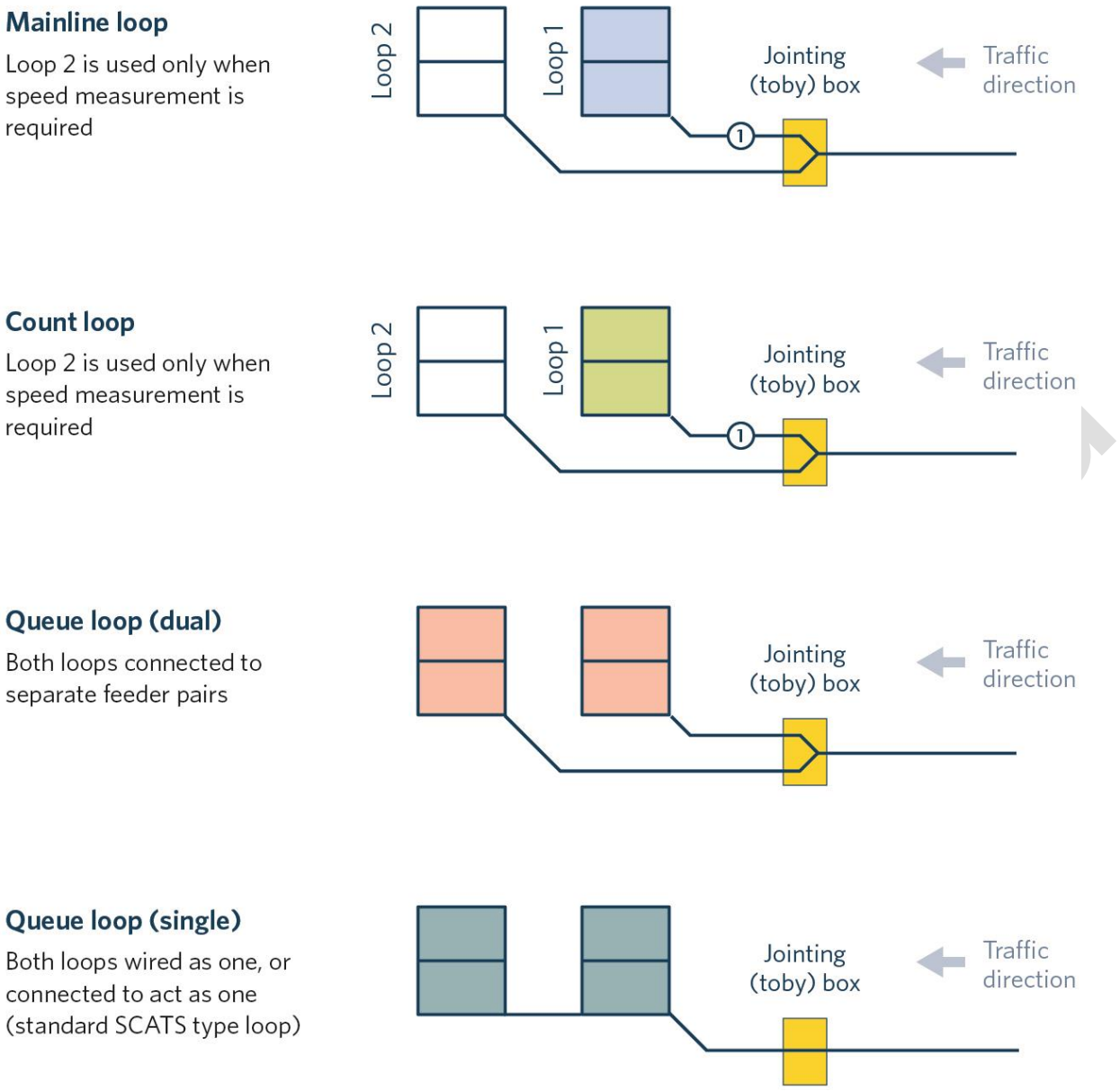

Figure 1. Standard ramp meter loop configurations

4.1.5.2 Detector locations

Detector loop locations have been developed over a number of years using the knowledge gained from designing and operating the RSS.

Detectors on the ramp are dependent on whether the ramp is long and/or busy.

At least one set of queue/count detectors shall be provided per ramp. Where the ramp length exceeds approximately 120m, two sets of detectors should be provided; the first back from the limit line as a 4.5m SCATS loop and the second (outer) detector as a queue/count detector. The first (inner) detector is to be installed at 60 per cent of the distance from the limit line to the outer detector.

See the latest version of ITS standard drawing 000-0000-0-7104-11-RX.

Where queuing is likely to extend onto the arterial road, further queue/count detectors may be installed to allow the measurement of queues. These may be linked to the local SCATS intersection controller if there is insufficient input space within the ramp signal controller to house them.

There are times when special requirements apply. These will generally be dictated by the TOC. The designer should always consult with the TOC when designing detector locations.

A count loop is required for every on-ramp and off-ramp. These loops are to be positioned where all traffic passes over the detector, which is generally in the vicinity of the physical nose. Some ramps have two lanes on or off, in which case the ramp count detectors must be adjacent to each other.

The count loops shall be installed as follows:

- At all on-ramps, count detectors shall be located at the end of the merge, where the lane is 3.5m wide and only one vehicle is detected at a time. This is generally at the physical nose of the onramp.
- At two-lane on-ramps, the count detector shall be located at a point after the vehicles have merged, which is generally at the physical nose:
  - when the merge is downstream of the on-ramp, the detector shall be located just after the merge
  - at on-ramps with a bypass or priority lane, two detectors shall be located; one after the two general traffic lanes have merged and the other adjacent to it, in the bypass lane.
- At all off-ramps, detectors shall be located in the area of the physical nose.

The queue detectors shall be installed as follows:

- At on-ramps, at the beginning of the ramp.
- In adjoining arterial roads, at designated locations where deemed necessary.
- At motorway-to-motorway ramps, set back from the limit line in 100m intervals until the previous merge point.
- Intermediate queue detector(s) shall be provided at a point 60 per cent along the ramp from the limit line to the detector at the start of the ramp. Short ramps of approximately 120m or less between the start of the ramp and the limit line do not require intermediate queue detection.

Mainline loops are often provided at mid-block locations. Coverage of detectors every 500m is the gold standard, but economics generally dictate that they are installed at such centres in only the busiest urban environment. The designer should aim for no more than 1km spacing elsewhere.

Mainline loops shall be provided in numerous locations:

- At each off-ramp, generally adjacent to the physical nose. This allows a shared feeder cable to be used with the off-ramp count detector.
- For merge on-ramps, two sets of detectors located:
  - one 20m beyond the end of the painted nose where the painted gap is 1.8m, or where the gap is smaller, the loops shall be located 20m past the point where the lines are 1.8m apart.
  - at the end of merge taper.
- For lane gain on-ramps, one set of detectors located 50m beyond the end of the physical nose.
- As required for intermediate SRMS count stations.

Where a lane drop in the form of a recovery lane exists, it is good practice to place a set of mainline loops at the start of the merge taper and another set at the end.

4.1.5.3 Ramp layout examples

Following are examples of ramp layouts from which any layout can be derived.

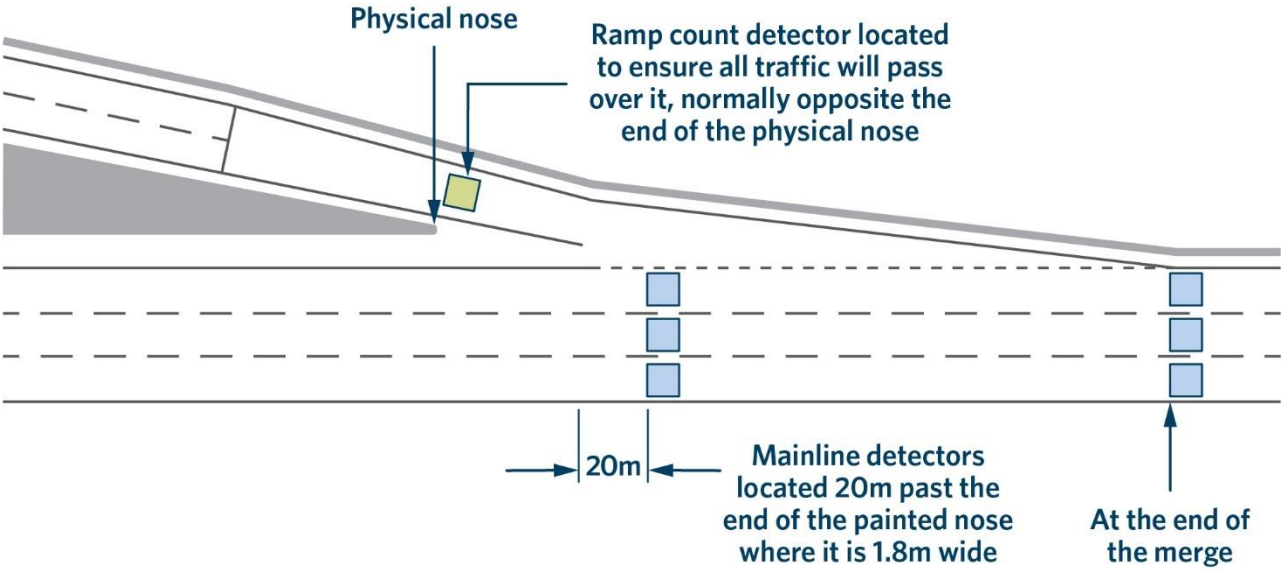

Figure 2. On-ramp merge

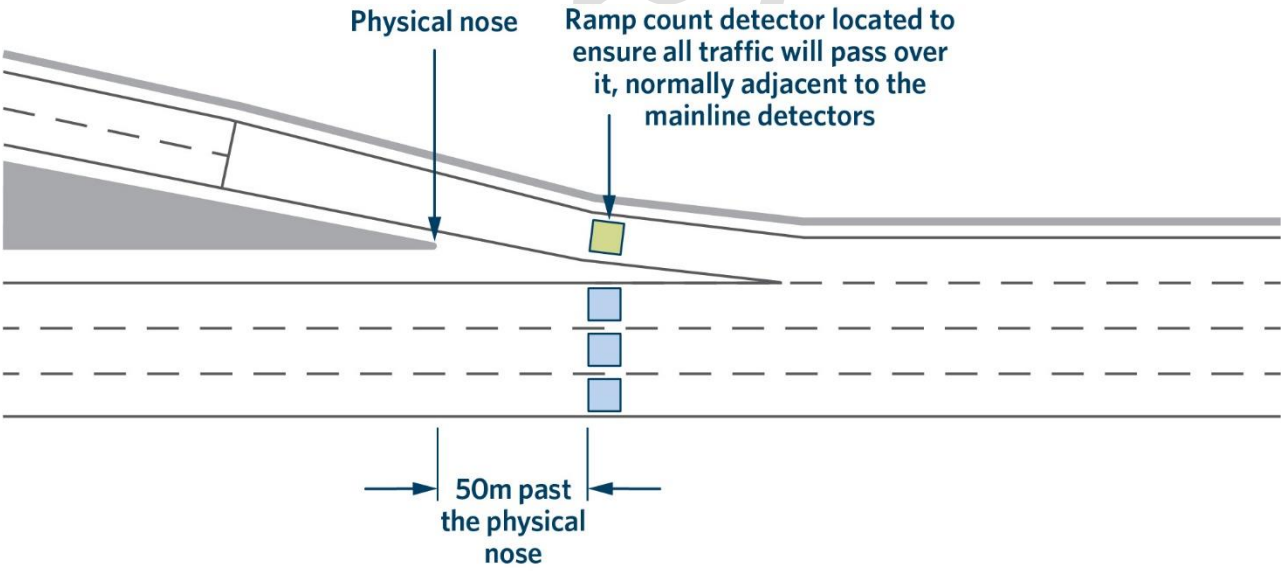

Figure 3. On-ramp lane gain

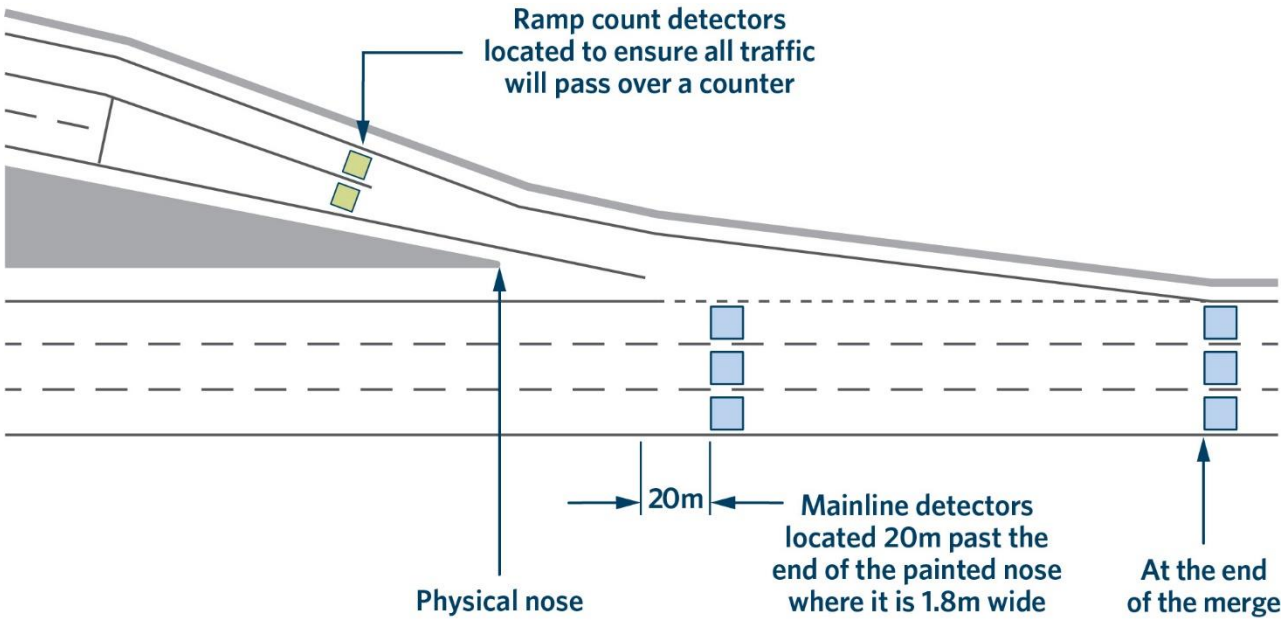

Figure 4. On-ramp merge with bypass lane

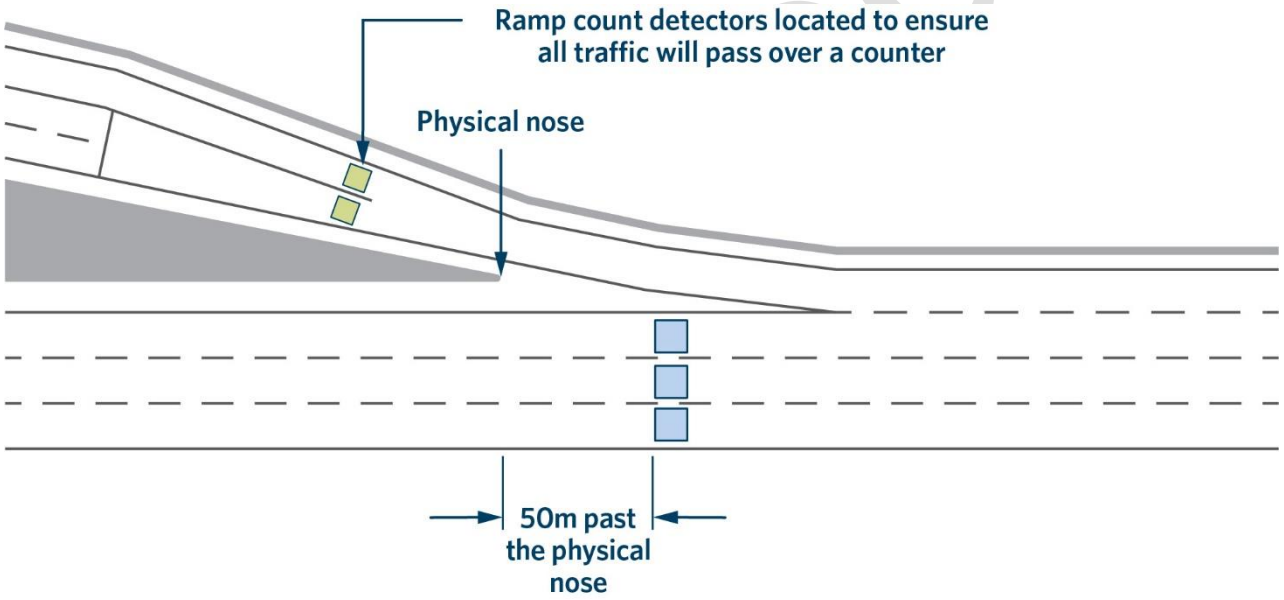

Figure 5. On-ramp merge with lane gain and bypass lane

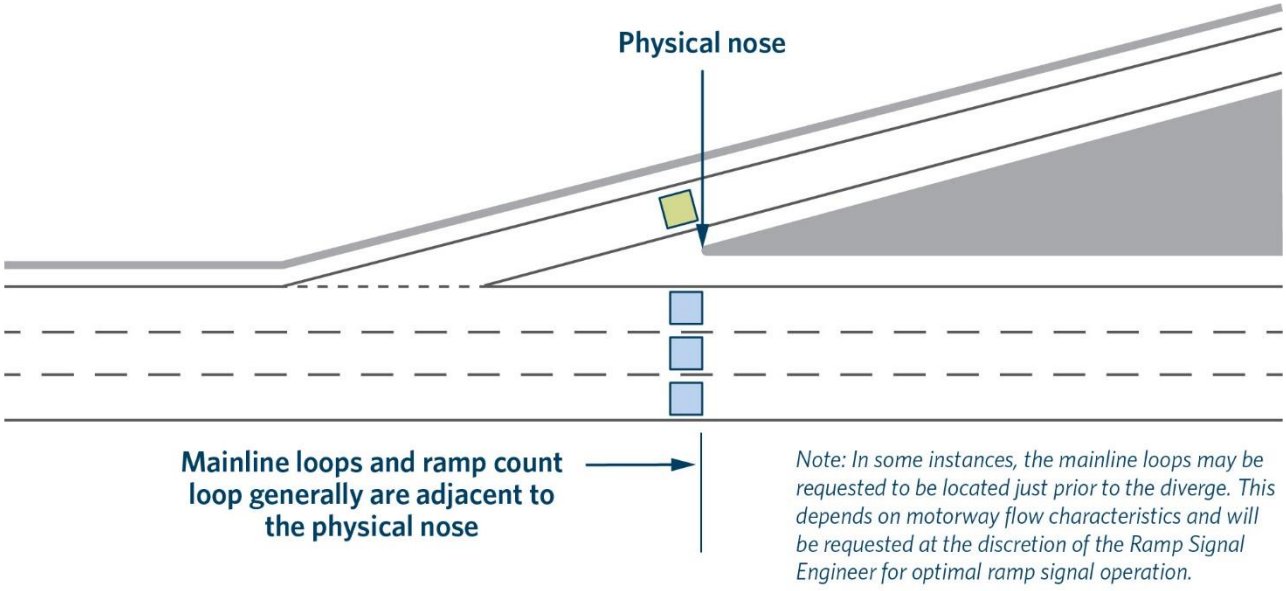

Figure 6. Off-ramp diverge

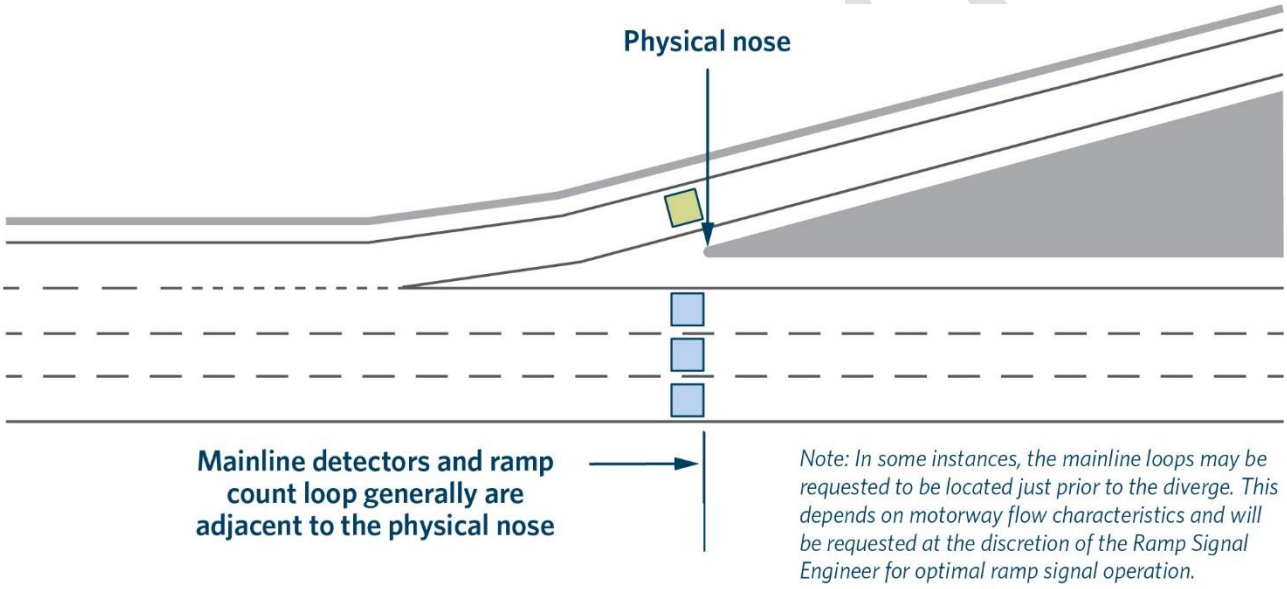

Figure 7. Off-ramp diverge lane drop

4.1.6 Inductive loop numbering

Detector numbering is required to standardise the look of a ramp on SCATS. The numbering is also used in the controller information sheets. Numbers radiate out from the signal controller cabinet (shown as ‘cabinet’ in the examples below) according to detector function.

Below are numerous examples of varying count station and ramp layouts. Sites vary considerably in what is attached to the on-ramp controller. The examples shown below should allow the designer to specify any detector permutation.

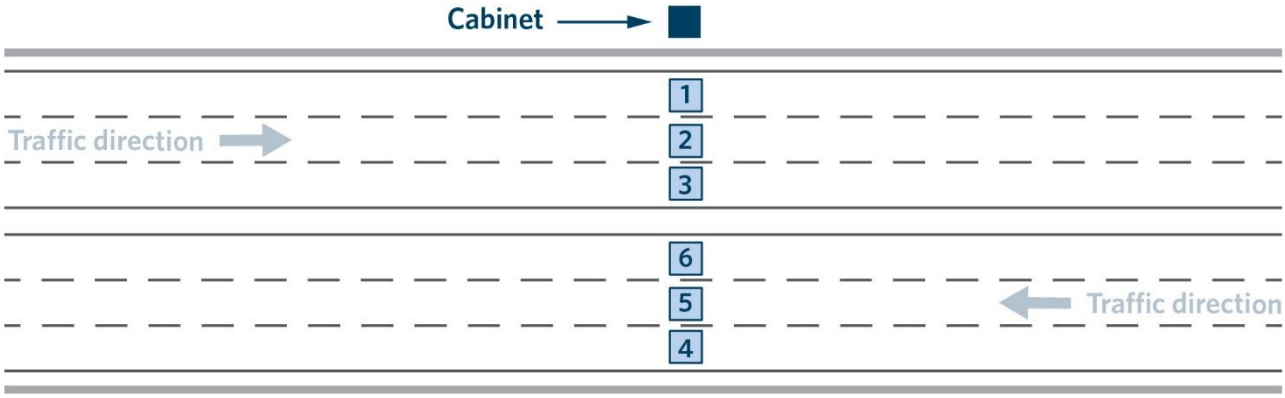

Figure 8. Count site with one set of detectors

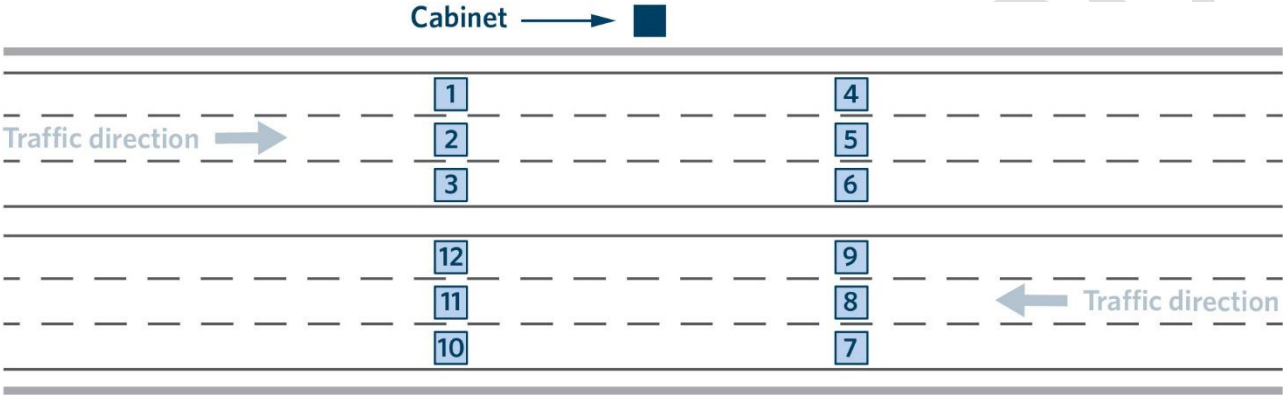

Figure 9. Count site with more than one set of detectors

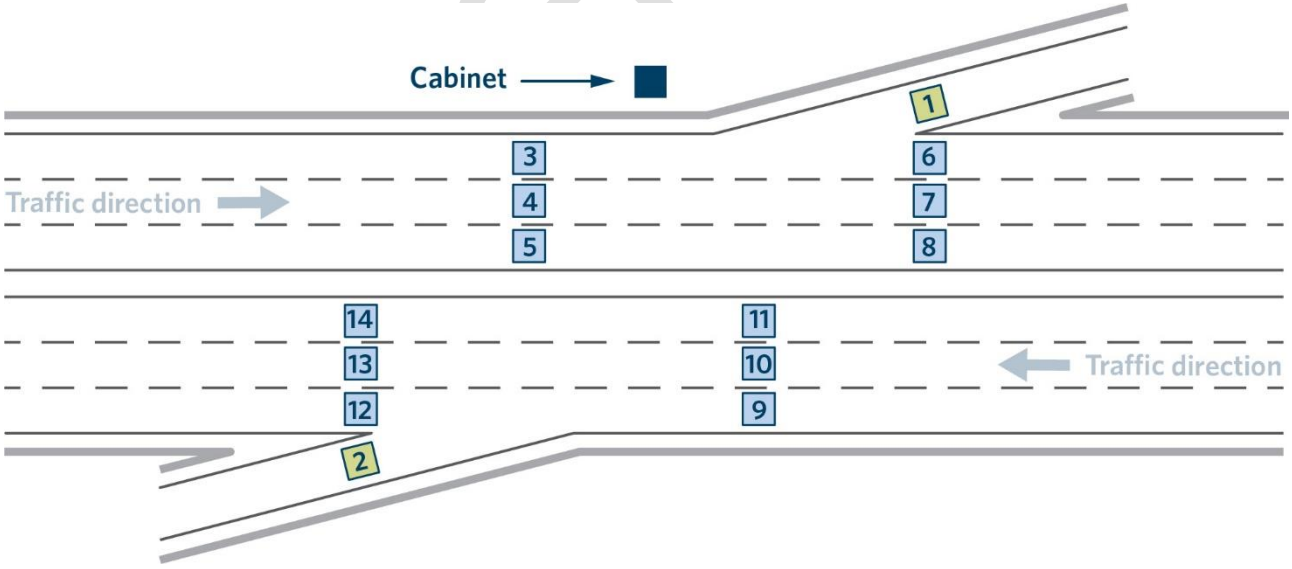

Figure 10. Count site with off-ramp loops

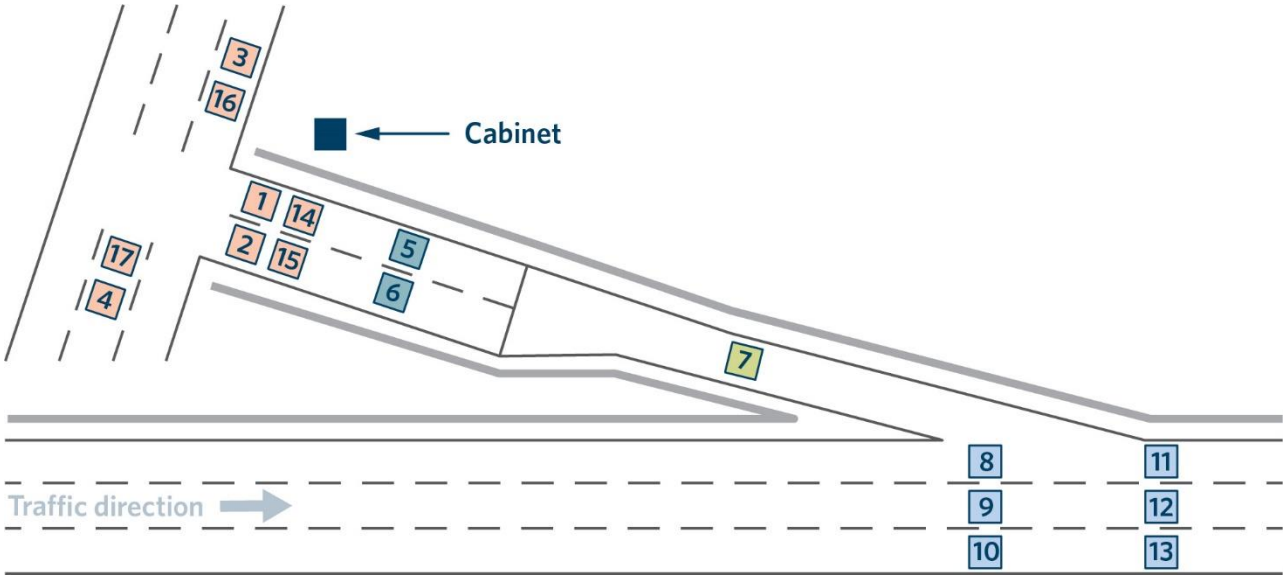

Figure 11. Standard on-ramp detectors

If the ramp is sufficiently long to hold the expected queue length, all of the count and queue loops may be positioned only on the ramp.

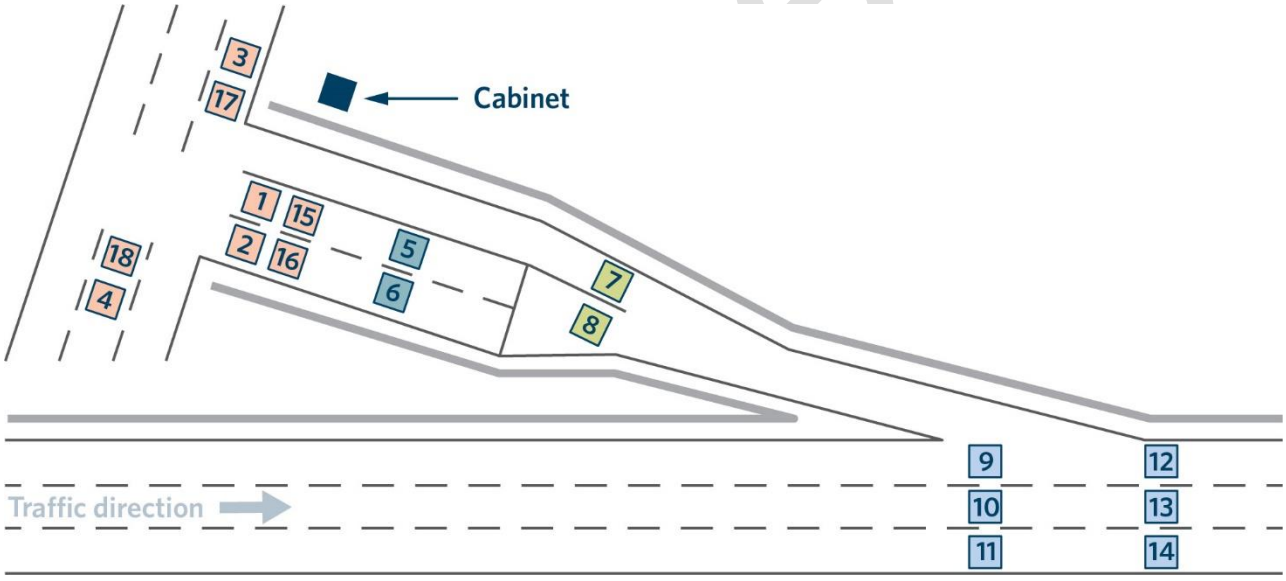

Figure 12. On-ramp with bypass lane

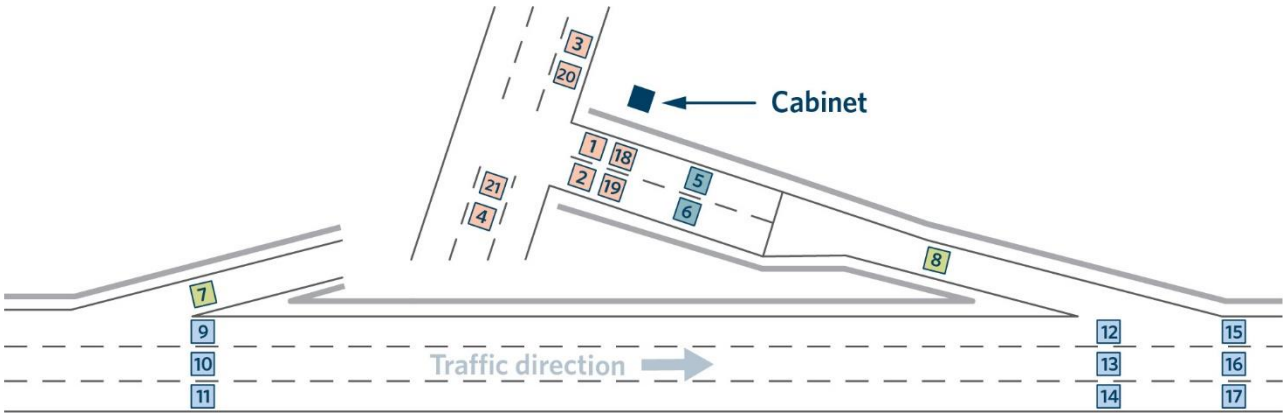

Figure 13. On-ramp with preceding off-ramp

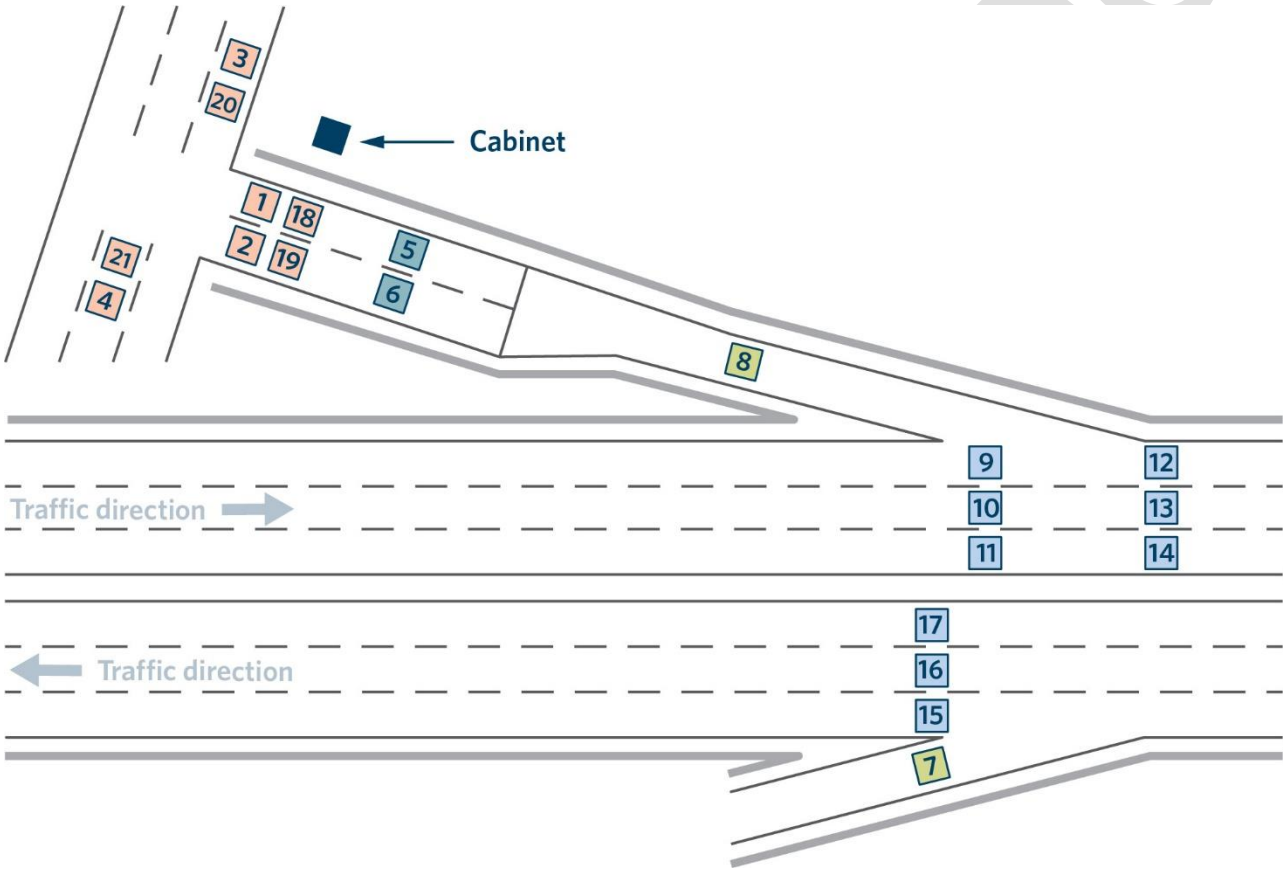

Figure 14. Site with detectors and ramps on both sides of the motorway

4.2 Advanced warning signs

4.2.1 Function of AWS

AWS shall be installed as part of the RSS to notify road users of major motorway events and whether the RSS is operational.

Type A AWS shall be installed on the arterial road at the decision point on the approach of the on-ramp to advise motorists of major motorway events and whether the ramp signals are in operation.

Type B AWS shall be installed at the on-ramp itself to advise motorists of an impending limit or that the ramp signals are not operating.

The installation of type B AWS at RSS on-ramps is not mandatory. Waka Kotahi mandates that type B AWS shall be installed on motorway-to-motorway ramps and where the signals cannot be seen from the top of an on-ramp.

4.2.1.1 Type A AWS

Type A AWS shall be installed:

- on arterial roads on the approach to a motorway on-ramp
- in a position that can be clearly seen by motorists and located to allow the motorist to choose whether to use the on-ramp or not
- at a maximum distance of 75m from the start of the on-ramp.

The type A AWS display shall be 'blank' when the RSS is switched off.

Type A AWS shall:

- display the message 'Ramp Signal ON' when the RSS is in operation
- be capable of displaying the following messages upon receiving a corresponding code from the ramp signal controller (note: the screen is blank for messages 1 and 3, and all pixels are switched on for message 10):
  - Message 1 – [Blank]
  - Message 2 – Ramp Signal ON
  - Message 3 – [Blank]
  - Message 4 – Motorway Closed
  - Message 5 – On-ramp Closed
  - Message 6 – Incident on Motorway
  - Message 7 – Works on Motorway
  - Message 8 – Queue on Motorway
  - Message 9 – Reduce Speed
  - Message 10 – [All pixels on]
- If the direction of the intended message displayed on the type A AWS is unclear, a supplementary plate (approved by the relevant Waka Kotahi Sign Engineer) indicating its intended direction may be mounted on the AWS pole.
- AWS shall have the capability to operate amber flashing lanterns located centrally top and bottom to the sign. Two amber flashing lanterns shall be installed where approach speeds are likely to exceed 70kph (Traffic Control Devices Rule 54002) and on motorway-to-motorway links.

4.2.1.2 Type B AWS

Installation of the type B AWS at an RSS on-ramp is not mandatory. The type B AWS shall be installed on all motorway-to-motorway high-speed ramps and on-ramps where the signals cannot be seen from the top of the ramp.

The type B AWS shall be installed at on-ramps according to the following principle:

- **Single lane:** One (1) type B AWS installed on the left-hand side of the on-ramp.
- **Two lanes:** Two (2) type B AWS installed, one on the left of the left lane and one on the right of the right lane.
- **With priority bypass lane:** One (1) type B AWS installed on the right-hand side of the right lane.

At motorway on-ramps, all type B AWS shall be installed at a maximum distance of 90 per cent of the distance between the limit line and the primary set of queue detectors at the start of the on-ramp.

Type B AWS shall:

- display the message 'Ramp Signal OFF' when the RSS is switched off
- display the message 'Prepare to Stop' when the RSS is in operation
- have the ability to have no pixels displayed (blank message) for test purposes
- have the ability to have all pixels on for test purposes.

A W10-4 Traffic Signals Ahead static warning sign shall be mounted on the top of all the type B AWS.

4.2.1.3 Motorway-to-motorway AWS

AWS with 250mm character height shall be used at motorway-to-motorway links.

All motorway-to-motorway AWS design details shall conform to the latest versions of ITS standard drawings 000-0000-0-7104-14-RX and 000-0000-0-7104-15-RX.

The motorway-to-motorway type A AWS shall be installed on the motorway or ramp which contains the ramp signals at a point after the last upstream exit.

One flashing lantern centrally mounted on top of the AWS and one flashing lantern centrally mounted beneath the AWS shall be used on motorway-to-motorway type A AWS and type B AWS. They are detailed in TCD Rule 6.2.20(b) – 2014 Addendum.

The motorway-to-motorway type B AWS shall be installed on the ramp between the motorways. See the latest versions of ITS standard drawings 000-0000-0-7104-14-RX and 000-0000-0-7104-15-RX.

All static signage and road markings related to motorway-to-motorway AWS installations shall be implemented in accordance with MOTSAM.

4.2.1.4 Mounting of AWS – poles

AWS shall be mounted in such a way that they will not be hit or damaged by passing or turning traffic.

The type of pole used for mounting each AWS shall be dependent on the conditions of the site and the installation constraints.

The standard AWS pole used at all RSS sites shall be a 3.9m hot-dipped galvanised steel pole; enabling a 2.5m ground clearance after installation.

For special conditions, where viewing height is needed or ground conditions dictate, a 4.9m hot-dipped galvanised steel pole shall be used instead; enabling a 3.5m ground clearance after installation.

The AWS poles shall be ground planted or shear based (bolted to a ground-mounted stub).

The selection of ground planted or shear-based poles shall be based on the following principles:

- AWS installed behind a barrier – ground planted.
- AWS without barrier protection – shear base.
- AWS in areas where vehicle speed limit exceeds 50kph – shear base.

All AWS poles shall conform to the latest versions of ITS standard drawings 000-0000-0-7104-20-RX, 000-0000-0-7104-21-RX, 000-0000-0-7104-22-RX and 000-0000-0-7104-23-RX.

For mounting brackets, see the latest version of ITS delivery specification: Ramp meter systems.

4.2.1.5 Foundation design

The criteria used for the design of AWS foundations shall conform to the following standards:

- AS/NZS 3101.1&2:2006 Concrete structures standard
- AS/NZS 4203 General structural design and design loadings for buildings

The foundation design shall be based on soil parameters determined from:

- geotechnical investigations conducted as part of the pavement design, and other investigations if visual inspections reveal unsuitable material
- relevant earthworks and/or pavement specifications
- quality assurance testing of fill material
- undrained shear strength of 50kPa where foundations are in natural ground (unless investigations reveal otherwise).

Two foundation options shall be available for each AWS, namely a pile foundation and a shallow-pad foundation for situations where the pile foundation cannot be installed.

4.3 Static signs

4.3.1 Ramp signal signage

The static signage installed for all RSS traffic signals shall display the message ‘One Vehicle per Green’.

In a two or three-lane configuration, the above signage shall be supplemented by the additional message ‘Each Lane’.

The location of these signs shall be dependent on the design of the on-ramp and both pole and gantry-mounted traffic signals shall conform to the latest versions of ITS standard drawings 000-0000-0-7104-14-RX and 000-0000-0-7104-15-RX.

The static signage installed for all RSS shall comply with Traffic Control Devices.

4.3.2 Traffic signal sign

A W10-4 traffic signal sign shall be installed on top of each type B AWS to notify motorists of the presence of traffic signals. Where no type B sign exists, the W10-4 sign shall be mounted on a suitable frangible pole if not protected by a barrier.

4.3.3 Priority bypass lane sign

All priority bypass lanes shall have static signage installed detailing the constraints of that lane.

The signage information displayed at priority bypass lanes shall be restricted to vehicles allowed to use that lane.

The location of these signs shall be dependent on the message displayed but shall conform to MOTSAM part 3, section 11: Miscellaneous signs.

Signs detailed in the TCD R4-13 and R4-13.1 and in the latest versions of ITS standard drawings range 000-0000-0-7104-24-RX to 000-0000-0-7104-33-RX shall apply.

4.3.4 Line markings

All line markings shall be in accordance with MOTSAM part 3, section 12: Road markings and delineation.

All limit lines shall be in accordance with MOTSAM part 2, section 3.06: xxxxx.

Centre lines installed on two-lane on-ramps from the limit line shall be in accordance with MOTSAM part 2, section 3.02: xxxxx

4.4 Journey time information, type D sign

In addition to the AWS, each ramp signal installation shall be complimented with additional message signs detailing estimated journey time (EJT) in minutes.

The type D signs are variable message signs (VMS) controlled independently of the RSS and shall comply with the technical requirements of the latest version of ITS delivery specification: VMS – Fixed.

Type D VMS shall be located:

- on the arterial roads that lead directly to the motorway on-ramps
- in a manner that clearly defines the direction they feed.

In installations where a congestion of type D signs are present the direction the sign feeds shall be attached to the VMS pole via a metal cardinal plate, refer to drawing 000-0000-0-7104-34-RX in section 4 Static signs of the NZTA's ITS specification: Ramp signalling system standard drawings (ITS-05-03).

All type D signs shall communicate with the Waka Kotahi journey time information system, TIMS. Connections will be via multimode fibre cable as detailed in the latest version of ITS delivery specification: VMS – Fixed. If direct connection the Waka Kotahi fibre network is not possible, ADSL or other suitable methods of communications may be considered.

4.5 Installation

To be defined.

5 DESIGN FOR SAFETY

This section defines the requirements to ensure the intelligent transport system 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.

5.2 Safety outcomes

5.2.1 Design safety

Peer reviews shall be conducted to evaluate the design, construction, operation/maintenance, decommissioning/deconstruction and disposal safety aspects of all RSS prior to implementation. Minutes of the peer reviews and a list of risks shall be officially recorded and supplied with the project documentation.

5.2.2 Mechanical safety

All RSS enclosures and equipment shall have no sharp edges or protrusions liable to cause injury and no catching edges.

Cables shall not hinder access to RSS equipment or become trip hazards onsite.

Levels, trips and undergrowth shall not hinder access to RSS equipment.

5.2.3 Electrical safety

All RSS electrical equipment shall be installed by a licensed electrician, inspected and certified. Certificates of electrical compliance and other related inspection documentation shall be prepared and issued to Waka Kotahi on the day the work is officially completed.

5.3 Site assessment

To be defined.

5.4 Site audit

To be defined.

5.5 System-specific safety requirements

To be defined.

5.5.1 Barriers

A safety barrier shall be installed where a non-frangible hazard is located where it could reasonably be hit by an errant vehicle.

The design of new barriers shall be completed in accordance with the latest relevant standards and guidelines adopted by Waka Kotahi, which include but are not limited to:

- Bridge manual (SP/M/022)
- AS/NZS 3845.1:2015 Road safety barrier systems
- Specifications and notes for road safety barrier systems on state highways (NZTA M23)
- AASHTO Manual for Assessing Safety Hardware (MASH)
- SHGDM

5.5.2 Regulatory speed signs

An R1-5.4 motorway begins threshold sign (MI 33.2 MOTSAM) or an R1-1.1 (100kph) or R1-1 (if the speed limit is less than 100kph) regulatory road speed sign shall be installed on either side of the on-ramp at or within 30m of the start of motorway regulations. As a general rule, this is at the start of the ramp.

All regulatory speed signs shall conform to the latest versions of TCD Rule 54001 and MOTSAM.

5.5.3 Road narrows signs

At all on-ramps that merge into a single lane prior to the motorway, a W13–1.3 road narrow sign shall be used.

Each W13–1.3 road narrow sign shall be located beyond the limit line and prior to commencement of the merge into one lane.

6 DESIGN FOR MAINTAINABILITY

This section defines the requirements to ensure the intelligent transport system can be maintained.

6.1 Maintenance outcomes

6.1.1 Pits and chambers

For pits and chambers, please refer to the latest version of ITS design standard: Jointing chambers and pull pits.

6.1.2 Supply

A recommended spare parts list for first-line maintenance shall be provided by the RSS installation contractor.

The spare parts list shall also indicate standard delivery times and repair times for spare parts where applicable.

7 DESIGN FOR SECURITY

This section defines the requirements to ensure the intelligent transport system can be secured and maintain integrity.

7.1 Security outcomes

To be defined.

8 APPENDIX A – <TITLE>

9 APPENDIX B – <TITLE>

10 REFERENCES

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

10.1 Industry standards

Standard number / name	Source	Licence type and conditions
AS 1650-1989 Hot-dipped galvanised coatings on ferrous articles		
AS/NZS 1768:2007 Lightning protection		
AS 1939 Degrees of protection provided by enclosures for electrical equipment (IP code)		
AS/NZS 2053 Conduits and fittings for electrical installations		
AS/NZS 2144:2002 Traffic signal lanterns		
AS/NZS 3000 Electrical installations		
AS/NZS 3100 Approval and test specification – General requirements for electrical equipment		
AS/NZS 3101.1&2:2006 Concrete structures standard		
AS 3147 Approval and test specification – Electric cables – Thermoplastic insulated for voltages up to and including 0.6/1 kV		
AS/NZS 3845.1:2015 Road safety barrier systems		
AS/NZS 4203 General structural design and design loadings for buildings		
AS/NZS 4251.1 Electromagnetic Compatibility – Generic Emission Standard – Residential, commercial and light industrial		
AS/NZS 4680:2006 Hot-dip galvanised (zinc) coatings on fabricated ferrous articles		
AS/NZS 4791:2006 Hot-dip galvanised (zinc) coatings on ferrous open sections, applied by an in-line process		
AS/NZS 4792:2006 Hot-dip galvanised (zinc) coatings on ferrous hollow sections, applied by a continuous or specialised process		
AS/NZS 5000.1:2005 Electric cables – Polymeric insulated – For working voltages up to and including 0.6/1 (1.2) kV		
CP 33:1996 Code of Practice for Lightning Protection		

Standard number / name	Source	Licence type and conditions
EN 12966-1 Road vertical signs. Variable message traffic signs		
National Traffic Signal Specification 2013 Revision 1		
NCHRP Report 350: Recommended Procedures for the Safety Performance Evaluation of Highway Features		
SAA HB59-1994: Ergonomics—The human factor		
AASHTO Manual for Assessing Safety Hardware (MASH)		
Health and Safety at Work Act 2015	NZ Legislation website	Public

10.2 Waka Kotahi standards, specifications and resources

10.2.1 Standards and specifications

See the Waka Kotahi website for the latest versions of the ITS design standards, delivery specifications and core requirements listed below.

Document name
ITS delivery specification: Ramp meter systems
ITS delivery specification: VMS – Fixed
ITS design standard: Jointing chambers and pull pits

10.2.2 Resources

Document name / code	Waka Kotahi website link
Manual of traffic signs and markings (MOTSAM)	https://www.nzta.govt.nz/resources/motsam/part-1/
Specifications and notes for road safety barrier systems on state highways (NZTA M23)	https://www.nzta.govt.nz/resources/road-safety-barrier-systems/index.html
Bridge manual (SP/M/022)	https://www.nzta.govt.nz/resources/bridge-manual/
State highway geometric design manual (SHGDM)	https://www.nzta.govt.nz/resources/state-highway-geometric-design-manual/shgdm/
Traffic Control Devices Rule 54002	https://www.nzta.govt.nz/resources/rules/traffic-control-devices-index/

10.3 Drawings

See the Waka Kotahi website for the latest versions of the ITS standard drawings listed below.

Drawing number
000-0000-0-7104-08-RX
000-0000-0-7104-10-RX
000-0000-0-7104-11-RX
000-0000-0-7104-12-RX
000-0000-0-7104-13-RX
000-0000-0-7104-14-RX
000-0000-0-7104-15-RX
000-0000-0-7104-20-RX
000-0000-0-7104-21-RX
000-0000-0-7104-22-RX
000-0000-0-7104-23-RX
000-0000-0-7104-24-RX
000-0000-0-7104-25-RX
000-0000-0-7104-26-RX
000-0000-0-7104-27-RX
000-0000-0-7104-28-RX
000-0000-0-7104-29-RX
000-0000-0-7104-30-RX
000-0000-0-7104-31-RX
000-0000-0-7104-32-RX
000-0000-0-7104-33-RX
000-0000-0-7104-34-RX

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
4.2	Advanced warning signs	Advanced warning signs delivery specification	001 Signs