

Technical Specification

**Transport and Main Roads Specifications
MRTS233 Roadway Flood Monitoring Systems**

July 2017

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1 Introduction

This Technical Specification defines the design, supply, installation, testing and commissioning, performance, documentation, training and maintenance requirements for roadway flood monitoring systems (RFMS).

The RFMS is intended to supplement an overall weather monitoring system strategy to improve incident response and driver safety.

The basic RFMS is an electrically powered (mains or solar) system consisting of a flood level sensor, data logger/controller, antenna and communications equipment tilt pole support structure and some means of backhaul communication (usually wireless) to a remote head end Traffic Management Centre (TMC) to enable monitoring of roadway flood height data, and optionally roadway flood monitoring imaging.

Auxiliary devices or systems connected to the basic RFMS include Road Condition Information Signs (RCIS) and CCTV cameras with or without infra-red illumination for night viewing.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements* and other Technical Specifications as appropriate.

The Principal may elect an outright purchase model or a lease type model for all or part of the RFMS specified in this Technical Specification.

This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

2 Definition of terms

The terms defined in Clause 2 of MRTS01 *Introduction to Technical Specifications* and MRTS01 *Introduction to Technical Specifications* apply to this Technical Specification. Additional terminology relevant to this Technical Specification is defined in Table 2 below.

Table 2 – Definitions

Term	Definition
BoM	Bureau of Metrology
DOD	Depth of Discharge
FAT	Factory Acceptance Test
FP	Field Processor
GUI	Graphical User Interface
HRC	High Rupture Capacity
IP	Internet Protocol
IPRT	Internet Protocol Remote Telemetry (the department's core ITS Network supplied by Telstra)
ITS	Intelligent Transport System
PLC	Programmable Logic Controller
PV	Photo Voltaic (solar array)
RFMS	Roadway Flood Monitoring System(s)

Term	Definition
RPEQ	Registered Professional Engineer of Queensland
STREAMS	The Principal's traffic management system and primary user interface to ITS field devices
TMC	Traffic Management Centre
TRUM	Traffic Road Use Manual

3 Reference documents

The requirements of the referenced documents listed in Table 3 of MRTS201 *General Equipment Requirements* and Table 3 below apply to this Technical Specification. Where there are inconsistencies between this Technical Specification and the referenced MRTS (including those referenced in MRTS201 *General Equipment Requirements*), the requirements specified in this Technical Specification shall take precedence.

Table 3 – Referenced documents

Document ID	Document Name / Description
AS 1768	<i>Lightning protection</i>
AS/NZS 3000	<i>Electrical installations (known as the Australian/New Zealand Wiring Rules)</i>
AS/NZS 3100	<i>Approval and test specification - General requirements for electrical equipment</i>
AS 4070	<i>Recommended practices for protection of low-voltage electrical installations and equipment in MEN systems from transient over-voltages</i>
AS/NZS 4509.1	<i>Stand-alone power systems - Safety and installation</i>
AS/NZS 4509.2	<i>Stand-alone power systems - System design</i>
AS/NZS5033	<i>Installation of photovoltaic (PV) arrays</i>
AS 60529	<i>Degrees of protection provided by enclosures (IP Code)</i>
MRTS50	<i>Specific Quality System Requirements</i>
MRTS61	<i>Mounting Structures for ITS Devices</i>
MRTS91	<i>Conduits and Pits</i>
MRTS201	<i>General Equipment Requirements</i>
MRTS225	<i>Imaging</i>
MRTS231	<i>Provision of Road Weather Monitors</i>
MRTS232	<i>Provision of Field Processors</i>
TRUM Manual	<i>Traffic and Road Use Management Manual</i>
MUTCD	<i>Queensland Manual of Uniform Traffic Control Devices</i>

4 Quality system requirements

The quality system requirements defined in MRTS201 *General Equipment Requirements* apply to this Technical Specification. Additional quality system requirements relevant to this Technical Specification are defined in Table 4. There are no Milestones defined.

Table 4 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
13.2	1. Certified Electrical wiring diagram		
15	2. Inspection of mounting surfaces	1. After installation of the cables, the conduits shall be sealed to prevent vermin entry.	
16	3. Testing and commissioning		
17	4. Documentation		

5 Functional requirements

The RFMS shall transmit water level information to stations designated by the Principal, for the purpose of incident management and monitoring.

The RFMS shall also be able to send signals to local roadway signage to alert motorists of water over the road.

Where a weather monitor system is already installed at the site, the RFMS may be installed as part of the weather monitor system as described in MRTS231.

6 RFMS components

A typical RFMS shall include:

- a) a flood level sensor (Section 8)
- b) RFMS controller (Section 11)
- c) RFMS communication equipment (Sections 11,14)
- d) imaging equipment, where required (Section 10)
- e) co-located STREAMS field processor, where required (Section 11)
- f) enclosures (complying with MRTS201 *General Equipment Requirements*) to house all control and communications equipment associated with the RFMS
- g) column/mounting support and footings (Section 12)
- h) power supply, including solar power (Section 13)
- i) roadway warning signals and displays, where required (Section 9), and
- j) where the warning signals and display enclosure is located above the road surface, a maintenance gantry that complies with MRTS201 *General Equipment Requirements*.

7 Operational requirements

The operational requirements defined in MRTS201 *General Equipment Requirements* apply to equipment provided under this Specification. Additional operational requirements are described below.

The RFMS shall support remote TMC head end flood height backhaul data within Transport and Main Road's Traffic Management System - STREAMS - to enable departmental operators to centrally

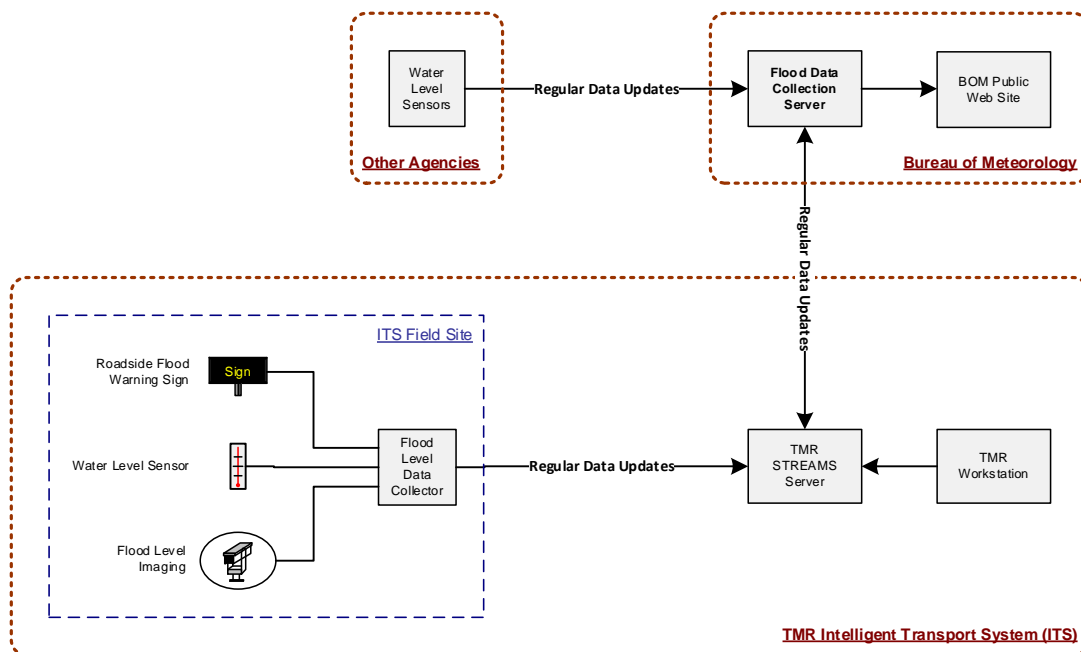
monitor Transport and Main Roads RFMS sites directly via the STREAMS interface, rather than by separately viewing Third Party hosted web sites to monitor these RFMS sites.

This preferred arrangement means that the communications between the RFMS sites and the TMC's are generally provided by the department's own internal ITS communication network (IPRT or Transport and Main Roads 'private' wireless networks) rather than Third party provisioned backhaul communications networks.

For RFMS sites supporting remote flood level backhaul data and monitoring via STREAMS, but also requiring low speed flood monitoring images then these images should be integrated within STREAMS via the department's default video management system (DVTel).

It is planned that in future the department will send roadway flood level data collected from ITS Field sites to the Bureau of Metrology (BoM) as per the diagram below and also receive selected relevant flood data from BoM.

The departmental roadway flood data captured in STREAMS would be transferred to BoM for use in the BoM public database and website. Reciprocal flood data sharing arrangements of data collected directly by BoM (and other agencies supplying data to BoM) will be of direct benefit to the department for roadway flood height measurement and prediction. The department's flood data captured in STREAMS has the advantage of the normal STREAMS full support and maintenance arrangements.



Where the integration of potential departmental RFMS sites into STREAMS or the department's existing ITS network is not technically possible, a number of Third Party RFMS solutions are available which provide tested and mature flood monitoring solutions, including satellite backhaul capability where 3G or 4G coverage is not available at the RFMS site.

7.1 Security requirements

Physical security of the equipment and equipment shelter will be in accordance with MRTS201, as this will secure access controls for authentication and authorisation of users connecting to the RFMS.

8 Flood level sensor requirements

The RFMS shall have the ability to support a diversity of water level sensor technologies including the following which have been successfully used in departmental RFMS sites:

- a) radar type sensor
- b) ultrasonic type sensor
- c) conductive probe tube sensor, and
- d) gas bubbler sensor (Industry "standard" - widely used throughout Queensland).

The sensors for the RFMS shall be easy to install and maintain. All sensors shall meet the environmental, performance and technical requirements as outlined below.

The choice of appropriate Flood Water level sensors should be carefully selected depending on the specific flood monitoring site physical environment.

8.1 Environmental requirements

The sensor (or system of sensors) shall:

- operate normally at temperatures of 0 - 70°C
- have ability to operate without an air drying unit
- be suitable for use in very contaminated waters and resistant to damage due to freezing, and
- withstand extended periods of exposure to dry river bed conditions (for sensors that measure water level insitu).

8.2 Performance requirements

The sensor (or system of sensors) shall:

- have a measurement range of 0 to 10 m H₂O
- be accurate to within 0.25% of full scale
- drift stabilisation to at most 0.2% per annum, and
- have a maximum warm-up time of 150 ms.

8.3 Electrical requirements

The sensor (or system of sensors) shall:

- operate normally for voltage variation of between 10-30V dc. System voltage shall be 12V dc
- have reverse polarity protection
- have current output of 4-20 mA over the operating range
- have zero offset of no more than 0.1 mA, and
- withstand voltage spike of up to 600 V.

8.4 Mechanical/material requirements

The sensor (or system of sensors) shall:

- have an IP rating IP68 or better
- have a minimum 10 year life span
- be made of corrosion resistant material, stainless steel grade 316 as minimum, and
- be of compact design with a minimum of moving parts.

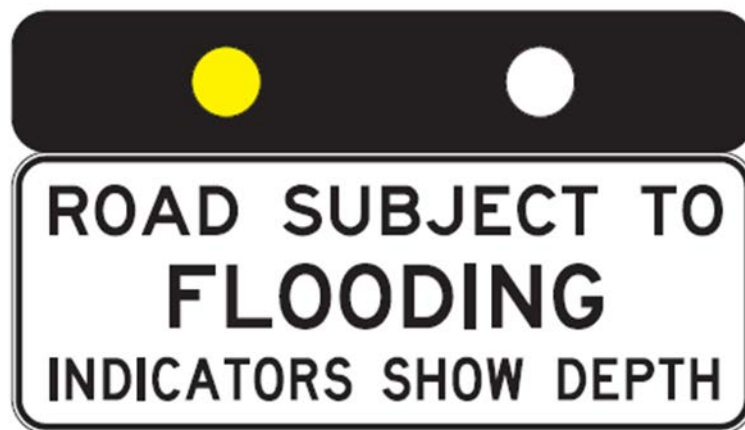
9 Road signage

Where specified in the contract, the RFMS roadway sign face shall be as outlined in TC 1768 (Figure 9). Full drawings for TC 1768 are attached in Appendix A.

The flash rate for the flashing lights shall be configurable locally or remotely by the user, and shall initially be set to 50/50 (lit/unlit) with a cycle time of one second.

Frangible post or slip base construction shall be used in high speed environments for mounting the signs. The decision to use slip base or frangible posts shall be made by an engineer with the appropriate RPEQ qualification.

Figure 9: RFMS signage showing advanced warning flooding warning lights - TC1768



10 Imaging equipment

Where specified in the contract, the provision of imaging equipment shall be as per the implementation guidelines for internet enabled video cameras defined in the TRUM Manual.

11 Control system

The control system requirements defined in MRTS201 *General Equipment Requirements* apply to equipment provided under this Technical Specification. Additional control system requirements for equipment provided under this Technical Specification are described below.

11.1 General

For new systems unable to be integrated into STREAMS as per the Operational Requirements listed in Section 7, the RFMS control system shall as a minimum:

- a) retrieve and communicate, automatically or on-demand, in near real-time, the flood levels and other related system information, including images, system status and/or faults, from multiple flood monitoring stations/sensors to STREAMS and/or a server nominated by the Principal
- b) where it performs local calculations based on sensor inputs, transmit both raw data and calculated data to STREAMS and/or a web-server nominated by the Principal
- c) activate other ITS devices such as road signage or other monitoring devices, as required
- d) provide capability for both local and remote fault diagnostics, system monitoring and configuration of the entire flood monitoring system components
- e) be of a latency such that the effect of commands issued by the operator (either from STREAMS or server nominated by the Principal), must be observed by the operator within 200 msec, and
- f) be housed in an enclosure with an IP68 rating to AS60529.

11.2 STREAMS device driver

Where STREAMS device drivers do not already exist, the contractor shall engage Transmax and provide a device driver compatible for interfacing with the STREAMS field processor meeting the requirements of MRTS232. STREAMS currently supports weather stations capable of communicating using a protocol which includes a "Water Level" value.

Future versions of STREAMS (STREAMS Atlas, and later versions) will utilise the inherent generic PLC integration capability via Modbus TCP as a standard feature.

11.3 System local control

The RFMS shall allow local control via a maintenance communications port using a laptop or a handheld device. Local control shall be gained using the diagnostic software. The system shall provide secure access to the RFMS equipment and prevent unauthorised access to the signs.

All system diagnostics and configuration parameters able to be changed in the field shall be accessible when the sign is selected for local control. Remote control of the RFMS shall be disabled when the RFMS is selected for local control.

Disconnection of a laptop or handheld device shall cause the controller to revert to autonomous operation.

Ending of the maintenance session shall not require further interaction from the user, nor in anyway interrupt operation or require rebooting of the RFMS but immediately let the RFMS to revert to autonomous operation.

11.4 System remote control

A remote management system must be supplied. The remote sign management software shall:

- Detail the location and current status of all RFMS sites (operational, idle, fault condition).

- Show RFMS on an interactive GUI.
- Request passwords as part of the access and configuration authorisation process.
- Implement multiple levels of user access such as:
 - administrator
 - maintenance
 - standard user, and
 - read only.
- Allow querying of events according to set criteria such as by site, time, date, event type, or by duration.
- Poll the RFMS in the field every 24 hours to verify the communications link and that the system has not failed. Failure of the remote management system to gain a response from the sign shall result in an event being logged in the system that highlights that the sign status is unknown and possibly failed or damaged.
- Be compatible with the department's standard operating environment Microsoft Windows® operating system environment, Windows XP, Windows Vista, Windows 7, and those industry standards current at the time of delivery. Any software provided shall be capable of operating on all such operating systems, and
- Support remote connectivity to the RFMS via Satellite, 3G, 4G, GPRS, ADSL, or any telecommunications network nominated by the Principal.

11.5 Internal clock

An internal clock shall be provided in accordance with MRTS201 *General Equipment Requirements*.

11.6 Communication protocol

Communication with the RFMS shall be in accordance with a protocol accepted by the Principal's Representative and the requirements of MRTS201.

The RFMS controller shall connect to STREAMS using the currently available generic PLC interfacing capability, using the Modbus TCP protocol.

The current version of STREAMS uses the specific implementations of Modbus TCP to facilitate integration of:

1. Campbell Scientific Data loggers, and
2. RMTek Data loggers.

One important advantage of this arrangement is that the STREAMS Field Processor (FP) normally required at the RFMS site can be relocated to head end TMC's in cases where RFMS sites are solar powered.

12 Mechanical and physical requirements

The mechanical and physical requirements of the RFMS equipment shall be as defined in MRTS201 *General Equipment Requirements*.

The enclosures used for housing any of the RFMS equipment including the controller shall be in accordance with MRTS201 and IP rated to at least IP68 in accordance with AS 60529-2004.

Mounting structures shall be as per the requirements defined in MRTS61 *Mounting Structures for ITS Devices*. Frangible post or slip base construction may be used in high speed environments for mounting the RFMS equipment and the signage. The decision to use slip base or frangible posts shall be made by an Engineer with the appropriate RPEQ qualification.

13 Electrical

13.1 General

Options to energize the RFMS shall include Mains power and/or solar power. The electrical requirements defined in MRTS201 *General Equipment Requirements*, apply to equipment provided under this Technical Specification. Additional solar power requirements relevant under this Technical Specification are described below.

13.2 Solar power requirements

The total warranty for the solar power system shall be at least five years. The solar power system shall be capable of operating the RFMS without recharge for a minimum period of seven days throughout the entire warranty period.

Power supply and control wiring connection/disconnection shall be designed without requirement for personnel to be holders of an electrical licence to perform this task. This will generally require the use of modular type connections.

Electrical Protection, Switching and Isolation and Lightning Protection shall be provided in accordance with AS 4509.2. High Rupture Capacity (HRC) fuses only shall be used for circuit protection. The power board shall be labelled with nominal voltage and current, DC or AC as well as the requirements of Fire Emergency Information required by AS 5033.

An electrical wiring diagram shall be provided in each enclosure, with details specific to each installation. Detailed designs of the electrical wiring including the solar power and charging assembly shall be reviewed and signed by the Contractor's RPEQ. They shall then be submitted and approved by the Principal or their delegate for verification and acceptance. **Hold Point 1**

13.2.1 PV module

The choice, configuration, installation and testing of PV modules shall be consistent with AS 4509.1, AS 4509.2 and AS/NZS 5033.

PV module(s) shall be mounted at a height of no less than 4.5 metres. The PV module angle of elevation shall be adjustable in order to optimise performance at the latitude where the RFMS is to be installed. The design of the solar modules shall include a deterrent mechanism for stopping birds from resting on the solar module structure. The solar module and mounting structure shall be fitted with anti-vandal features.

All PV module fittings and adjustments shall be designed, manufactured and tested with appropriate theft prevention methods.

13.3 Batteries

The selection of the batteries to be used with solar power shall be consistent with AS 4086.1 and subject to the following additional conditions:

- the secondary battery technology shall have a minimum 3000 cycles to 20% Depth of Discharge (DOD) and of a low-maintenance type
- in the absence of solar charging, the battery must be able to handle levels DOD of up to 80%
- the battery shall be of the type suitable for charging by solar cells
- batteries with liquid electrolytes shall NOT be used, and
- the batteries shall have a minimum lifespan of five years.

Batteries shall be installed such as to minimise risk of:

- impact by a motor vehicle
- theft or vandalism, and
- explosion.

13.3.1 Battery enclosure and installation

Batteries shall be installed in an enclosure rated to IP 56 in accordance with AS 60529. Arrangement shall be made to avoid vandalism and prevent access by unauthorized persons. Battery enclosures shall be in accordance with provisions in AS 4509.2. All battery enclosures shall have natural or forced ventilation and ventilation rates, method of ventilation and sizing of ventilation apertures shall meet the provisions of AS 4086.2.

Installation of the batteries shall be in accordance with the provisions in AS 4086.2 and the relevant installation requirements in AS/NZS 4509.2.

Installation of the battery protection equipment shall meet the requirements of AS 4509.1.

13.4 Electrical safety

The electrical equipment and associated wiring within the RFMS shall comply with the relevant requirements of AS/NZS 3100.

All electrical cabling within the RFMS shall comply with the relevant requirements of AS/NZS 3000, and MRTS91 *Conduits and Pits*.

The RFMS site works incorporating conduits for power and telecommunications cables shall comply with the requirements of the *Electricity Act* and AS/NZS 3000.

13.5 Protection against electrical transients and over-voltage

If the flood-prone site is assessed to AS 1768 to also be susceptible to lightning, the RFMS shall incorporate measures to protect against electrical transients and over-voltage. The installation shall follow the recommended practices for MEN systems, specified in AS 4070 for protection of low-voltage electrical installations and equipment from transient over-voltages.

The RFMS installation shall follow the general guidelines for the protection of persons and property from hazards arising from exposure to lightning in accordance with AS 1768.

The enclosure housing the data processing/control equipment shall also include the necessary devices to protect all equipment being housed in the enclosure from electrical transients and over-voltage.

The contractor shall ensure that all other equipment connected to the enclosure housing the data logger, are suitably protected to prevent transients and over-voltages entering the installation.

14 Telecommunications requirements

The telecommunications requirements defined in MRTS201 *General Equipment Requirements* apply to work under this Technical Specification. Additional requirements are as shown below:

Remote departmental RFMS sites need to communicate data within STREAMS back to Transport and Main Roads TMC's unless their RFMS management systems are hosted on Third party Internet sites.

In order of priority, the telecommunications backhaul links from RFMS sites to head end monitoring sites should be implemented as listed below:

1. connection via the department's own existing private telecommunications networks using copper, fibre or point to point, or point to multipoint wireless systems back to the department's TMC's
2. connection via the department's default ITS network using departmental IPRT Network to connect to the department's TMC's using IPRT ADSL , Next G (3G) or 4G if available, and
3. connection via Third party provided by satellite link backhaul from Third party RFMS sites where no Telco provided mobile coverage is available.

15 Installation requirements

The sensors and associated infrastructure shall be installed at locations shown on the design documentation. The contractor shall allow access for inspection of all mounting surfaces by the Administrator prior to installation. **Hold Point 2**

After installation of the cables, the conduits shall be sealed to prevent vermin entry. **Witness Point 1**

16 Testing and commissioning

The testing and commissioning requirements defined in MRTS201 *General Equipment Requirements* apply to work under this Technical Specification. In addition, test sheets shall demonstrate compliance with the technical requirements of this Technical Specification prior to the delivery of the equipment to site. **Hold Point 3**

17 Documentation

The documentation requirements defined in MRTS201 *General Equipment Requirements* apply to work under this Technical Specification.

Additional documentation requirements relevant to this Technical Specification are defined below.

Prior to the commencement of manufacturing works, the Contractor shall prepare and request approval of the Principal/Administrator of three copies of the following documents:

- a) fabrication and assembly drawings, detailing all of the components to be installed

- b) manufacturer's specifications of the RFMS and of all major components detailing ratings and performance characteristics
- c) a schematic layout of components, building details and interconnection diagrams
- d) system operating manual
- e) recommendations for routine maintenance tasks, and
- f) recommendations on spare parts holdings.

Hold Point 4

The Contractor shall provide to the satisfaction of the Principal/Administrator, the following documents prior to the delivery and acceptance of the RFMS to site:

- a statement confirming the warranty provisions associated with the RFMS and associated equipment
- full set of installation as-constructed drawings
- compliance details of all components as required or implied under this document
- records of tests conducted by the Contractor to demonstrate compliance to this Specification, and
- project asset data in a format suitable for entry to the department's "Queensland Asset Data Format Version 2.0". The department will supply relevant spreadsheet/template.

Hold Point 4

Prior to issue of Practical Completion, the Contractor shall provide a laminated A3 sized copy of the "As Constructed" telecommunications and electrical schematics and wiring diagrams, together with all FATs, Commissioning and Operating/Maintenance documentation, as appropriate, to the satisfaction of the Administrator. **Hold Point 4**

18 Training

The training requirements defined in MRTS201 *General Equipment Requirements* apply to work under this Technical Specification.

19 Maintenance

The maintenance requirements defined in MRTS201 *General Equipment Requirements* apply to work under this Technical Specification.

20 Handover

The handover requirements defined in MRTS201 *General Equipment Requirements* apply to work under this Technical Specification.

Appendix A

Typical set up example

Colour Legend

- Retroreflective white
- Black
- Yellow flashing lights

Notes

1. This warning light panel may be used in conjunction with advanced guide sign G9-21 when particular attention will be required to notify the possibility of the road ahead being subject to flooding.
2. The conspicuity devices (flashing lights) shall meet the requirements of AS2144 for 200mm diameter signal lanterns.
3. Stiffener rails used on the light panel should be "Type 1" and spaced so as not to interfere with light assembly.
4. Flashing light separation is designed to suit 2 x 65 NB posts spaced at 1290mm (non slip base -1500 mm to underside of sign) or 2 x 80NB posts spaced at 1520mm (slip base - 2200 mm to underside of sign).
5. For the post design example details of non slip and slip base options see page 2 and page 3 respectively.

Queensland Government		ADVANCED WARNING FLOODING WARNING LIGHTS	
Network Operations & Road Safety Division Traffic Engineering & Road Safety Section		<u>APPROVED AS OFFICIAL TRAFFIC SIGN</u>	
Designed TV 06/09	Checked DJ 06/09	Scale Not to Scale	<div style="text-align: center;"> PRINCIPAL ENGINEER (Traffic Engineering) </div> <div style="text-align: right; margin-top: 5px;"> 24/06/09 Date </div>
			TC1768 Page 1 of 3
			A

24/06/2009		Traffic Sign Structures - Design Form		Page 1				
Job : Flood		Section : Lights		Sign Pos : 1				
Location Details			Slope Details					
Wind Region	Region C		<u>Segment</u>	<u>Length</u>				
Exposed Terrain	No		1	5000				
Risk Category	Low Impact Risk			<u>Height</u>				
Foundation Soil	Firm to Stiff Clay Soil			0				
Side of Road	Left							
Distance from carriageway	1000							
Road Height	1500							
Sign Face Details								
<u>Detail</u>	<u>Front Lower</u>	<u>Front Upper</u>						
Sign Code	11	12						
Sign Width	2150	2150						
Sign Depth	800	400						
Legend Class	Various	Various						
Legend Colour	Various	Various						
Background Class	Various	Various						
Background Colour	White	Brown						
Sign Separation	0	0						
Sign Stiffener Details								
<u>Detail</u>	<u>Front Lower</u>	<u>Front Upper</u>						
Stiffener Type	1	1						
Number of Stiffeners	3	2						
Stiffener Spacing	375	350						
Number of Brackets	6	4						
CHS Steel Design Details								
<u>Support Details</u>								
Number	2							
Spacing	1290, Standard							
Kerb Post Length	3400							
Post 2 Length	3400							
Post 3 Length	0							
Post 4 Length	0							
Stub Length	0							
Post Dimensions	65 NB							
Post Wall Thickness	3.2							
Post Grade	C350							
Slip Base Required	No							
<u>Footing Details</u>								
Diameter of Hole	300							
Depth of Hole	700							
			ADVANCED WARNING SUPPORT DESIGNS - NON SLIP BASE					
Network Operations & Road Safety Division Traffic Engineering & Road Safety Section			<u>APPROVED AS OFFICIAL TRAFFIC SIGN</u> PRINCIPAL ENGINEER (Traffic Engineering)					
Designed TV 06/09	Checked DJ 06/09	Scale Not to Scale	24/06/09 Date	TC1768 Page 2 of 3				
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24/06/2009		Traffic Sign Structures - Design Form		Page 2
Job : Flood		Section : Lights		Sign Pos : 2
Location Details			Slope Details	
Wind Region	Region C	<u>Segment</u>	<u>Length</u>	<u>Height</u>
Exposed Terrain	No	1	5000	0
Risk Category	High Impact Risk			
Foundation Soil	Firm to Stiff Clay Soil			
Side of Road	Left			
Distance from carriageway	1000			
Road Height	2200			
Sign Face Details				
<u>Detail</u>	<u>Front Lower</u>	<u>Front Upper</u>		
Sign Code	11	12		
Sign Width	2150	2150		
Sign Depth	800	400		
Legend Class	Various	Various		
Legend Colour	Various	Various		
Background Class	Various	Various		
Background Colour	White	Brown		
Sign Separation	0	0		
Sign Stiffener Details				
<u>Detail</u>	<u>Front Lower</u>	<u>Front Upper</u>		
Stiffener Type	1	1		
Number of Stiffeners	3	2		
Stiffener Spacing	375	350		
Number of Brackets	6	4		
CHS Steel Design Details				
Support Details				
Number	2			
Spacing	1520, Variable			
Kerb Post Length	3400			
Post 2 Length	3400			
Post 3 Length	0			
Post 4 Length	0			
Stub Length	825			
Post Dimensions	80 NB			
Post Wall Thickness	3.2			
Post Grade	C350			
Slip Base Required	Yes			
Footing Details				
Diameter of Hole	300			
Depth of Hole	900			
		ADVANCED WARNING SUPPORT DESIGNS - SLIP BASE		
Network Operations & Road Safety Division Traffic Engineering & Road Safety Section		APPROVED AS OFFICIAL TRAFFIC SIGN		TC1768
Designed TV 06/09	Checked DJ 06/09	Scale Not to Scale	 PRINCIPAL ENGINEER (Traffic Engineering)	24/06/09 Date
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