Auckland Transport Operation Centre

Traffic Signals Design Guidelines

Version 5.0

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Document Acceptance

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AT	PDF	AT Urban design Manager
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ATOC	PDF	OD Team

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Appendices

Reference Documents

ATOC would like to highlight the following documents that should be referred to in the process of design of traffic signal facilities in the Auckland Region. Designers should make sure that the most recent versions of these documents are used, direct from the source.

- ATOC Filtered Right Turns at Traffic Signals, Version 4.1, 2016[1]
- ATOC Pedestrian Phase Operation, Version 4.0 2015[2]
- AT Standard Protocol Filter Right Turns, version 3.0 2017[3]
- Auckland Transport's Transport Design Manual (TDM), Version 1
- Austroads Guide to Road Design:
  - Part 4 – Intersections and Crossings: General, 2021
  - Part 4A – Unsignalised and Signalised Intersections, 2021.
- Austroads Guide to Traffic Management:
  - Part 6 - Intersections, Interchanges and Crossings Management, 2020
  - Part 9 - Transport Control Systems – Strategies and Operations, 2020
  - Part 10 – Transport Control – Types of Devices, 2020.
- Creating and Updating Traffic Signal As-built Drawings[4]
- Land Transport NZ RTS-18 New Zealand on road tracking curves for heavy vehicles, 2007
- Land Transport Rule: Traffic Control Devices 2004, Rule 54002C and all relevant amendments
- NZ Transport Agency Manual of Traffic Signs and Markings: Part 1 and Part 2
- NZ Transport Agency Pedestrian Planning and Design Guide, 2009 (Note, a draft of the Pedestrian Network Guidance is now also available at Pedestrian Network Guidance website)
- NZ Transport Agency RTS-14 Guidelines for facilities for blind and vision impaired pedestrians, 2015
- Waka Kotahi's Cycling Network guidance (CNG), cycling-network-guidance
- Waka Kotahi NZ Transport Agency P43 Specification for Traffic Signals (second edition, from 1 June 2020).
- Waka Kotahi NZ Transport Agency Ramp Meter Systems, ITS Design Standard August 2020 (interim).

[1] Available on request from ATOC

[2] Available on request from ATOC

[3] Available on request from Auckland Transport

[4] Available on request from ATOC

- Waka Kotahi NZ Transport Agency Ramp Meter Systems, ITS Delivery Specification June 2020 (interim)
- Waka Kotahi NZ Transport Agency / KiwiRail Design Guidance for Pedestrian & Cycle Rail Crossings, version 1, 2017

Glossary

AGD	Above Ground Detector
ASB	Advanced Stop Box
ATOC	Auckland Transport Operation Centre. This is the unit tasked with managing the flow of traffic throughout the Auckland Region. The centre monitors SCATS and is also responsible for routing all fault calls to the various traffic signal maintenance contractors.
ConOp	Concept of Operations
Controller	The equipment (including the housing) that switches power to signal lanterns and controls the duration and sequence of signal displays as defined by the controller personality.
Controller Information Sheets (CIS)	A hard copy of the information used to make a Controller Personality that is contained within the PROM.
Controller Personality	The unique program stored in the PROM, which configures the controller to the specific operational design of the intersection.
EV	Electric Vehicle
GtRD	Guide to Road Design, Austroads series of documents
GtTM	Guide to Traffic Management, Austroads series of documents
HCV	Heavy Commercial Vehicle
ITS	Intelligent Transport Systems
JUMA	Joint Use Mastarm Pole
JUSP	Joint Use Signal Pole
KJB	Kerbside Junction Box
LoS	Level of Service
OD	Overdimension
PCMCIA (Personal Computer Memory Card International Association) card	A computer card containing the controller personality information housed in the TSC/4 compliant controller. In this document PROM refers to either a PROM or a PCMCIA card.
PROM (Programmable read-only memory)	A computer chip containing the controller personality information housed in the TSC/4 compliant controller.

	In this document PROM refers to either a PROM or a PCMCIA card.
RCA	Road Controlling Authority. In Auckland this is either Auckland Transport, the Waka Kotahi NZ Transport Agency or Auckland International Airport Limited.
SCATS – Sydney Co-ordinated Adaptive Traffic System	A fully adaptive area wide control system for traffic signals that is linked to all of the controllers via telecom lines or fibre optics.
SG	Signal Group
SVL	Special Vehicle Lane
TCD Rule	Land Transport Rule: Traffic Control Devices 2004
TDM	Auckland Transport's Transport Design Manual
TRAFF	RMS software communication protocol that is embedded in SCATS compliant traffic signal controllers
Transport for New South Wales (TfNSW), New South Wales (NSW)	The Authority that is accepted as the basis for the ATOC standards and for product approval. They are also the developers and owners of the SCATS software.
VMS	Variable Message Sign
WinTraff	A software programme used to check the controller information by testing the software of the controller personality.

1. Background and Purpose

ATOC has prepared this document to assist practitioners when designing traffic signal installations in order that the standards used across the region are being utilised consistently. This guideline has been created to make sure that the design of all traffic signal installations are to the highest standard, with variations being the exception rather than the norm. It is important that the information submitted as part of new or modified traffic signal layouts are standardised as much as possible. This will enable any further changes that may result from changing traffic conditions to be quickly and simply implemented.

This document lists the information that ATOC requires to be shown on the drawing for the traffic signal layout plan. The information covers all the basic data required for a contractor to install the traffic signal equipment. The information will also assist ATOC to undertake a design review of the proposed installation or modification, create the CIS and the Controller personality as well as allow ATOC to set up the intersection on the SCATS network and provide good operational performance.

This document covers, in some detail, the requirements for information and plans required as part of any physical works such as existing survey and services, proposed construction or road marking. These are essential to provide as complete a picture as possible. Examples of a typical intersection layout and pictorial examples of the basic details such as pole numbering, signal group numbering and detector numbering are included in the appendices for reference.

It should be noted that this document is a guideline only and all applicable standards and regulations, and the specific requirements of either Auckland Transport (AT), the Waka Kotahi NZ Transport Agency (Waka Kotahi) or Auckland International Airport Limited (AIAL) are to be followed and adhered to when producing a traffic signal design. This document is in place to support these respective requirements in achieving consistent and high-quality designs throughout the Auckland Region.

2. Traffic Signal Documentation Requirements

The following information, dependent upon the stage of design, is required to be submitted to ATOC, via AT, Waka Kotahi or AIAL, by consultants involved in the design of new signalised installations or upgrades to existing signalised sites. When a traffic signal design is undertaken for a client prior to submission to ATOC it is expected that the consultant will produce a detailed traffic signal design report that should contain the following information:

1. Cover Sheet
2. Operations Guidance Note or Concept of Operations (ConOps)
3. Crash Data (where relevant)
4. Traffic Counts (where relevant)
5. Intersection / Corridor Modelling (where relevant)
6. Existing Survey and Services
7. Proposed Construction and Set Out details
8. Proposed Road marking layout and Signage
9. Proposed Street Lighting Plan
10. Tracking Plan(s) (where relevant)
11. Proposed Traffic Signal Hardware Layout (this includes signals, ducting and cabling) and Phasing Plan(s)
12. Standard Traffic Signal Details Plan(s)
13. Traffic Signals Safety Audit Reports, and/or Peer Reviews and Risk Register.

All plans are to be submitted to ATOC electronically and drawings are to be provided in PDF format. This is to make sure that the plans are clear and concise for reviewers and contractors. Plans should be at a scale of 1:200 @ A1 (1:400 @ A3) with a minimum scale of 1:250 @ A1 (1:500 @ A3).

This document deals primarily with the requirements of the Proposed Traffic Signal Plan and Standard Signal Installation Details Plan(s). The requirements for both of these will be detailed more extensively in this document.

2.1 Cover Sheet

This sheet will have the name of the project, a locality plan showing the location of the intersection and a drawing register.

2.2 Background Information

The provision of a design brief or memo outlining the nature and scope of the project, for example a new installation, modification or upgrade, and the reason for the project such as to reduce traffic conflict and delay, road safety, pedestrian improvements, etc. is helpful. This information explaining the proposed operation and purpose will assist when reviewing each project so as the reviewer is aware of the intent and negate any assumptions and / or unnecessary comments.

Information should include details of the proposed operation, particularly where this may be non-standard. Also include any traffic flows and or traffic survey data if available and details such as specific client requirements and / or exceptions being implemented as part of this project. Information on how the proposed site or modifications fits into the wider network with relevance to any Network Operating Plan's or Corridor Management Plans if available will be useful in assessing any designs.

2.3 Crash Data (where required)

Generally, existing crash data for a period of 5 years, or other agreed time period, with a brief analysis of the causes and commonalities is included within an analysis if safety is the trigger for signalisation.

2.4 Traffic Counts (where required)

Classified turning traffic volumes including cars, light vehicles, HCVs and buses, cycles, and pedestrians should be submitted for the following Monday to Friday peak times:

- AM Peak
- Inter Peak
- PM Peak and where necessary
- Weekends:
    - Saturday (09:00 to 18:00hrs)
    - Sunday (09:00 to 18:00hrs).

ATOC notes that the timing of peak periods above will differ on a site-by-site basis and so data submitted should be relevant to the site conditions experienced / expected.

Traffic generation volumes with resultant future turning counts for the year when the signals will be commissioned are also useful as is a brief description of how these were derived. An estimate of the future growth rates for the movements at the intersection will also likely be included.

2.5 Intersection / Corridor Modelling (where required)

Intersection and / or corridor (network) modelling inputs and outputs including assumptions of the models associated with the design options are to be provided. It is expected that each option will have been modelled as a base year and as a future year, with intermediary years included where necessary. The lane arrangement, phasing and time settings of each option must be provided. The model outputs should include a comparison of the following:

- Movement, approach, intersection delay, and Level of Service (LOS)
- Movement and/or approach queue lengths
- Design life results based on a % increase in traffic volumes (sensitivity analysis)
- A summary and recommendation from the modelling.

ATOC may also request the modelling input files from the designer for a more detailed review, particularly for complex, multi-intersection models.

2.6 Existing Survey and Services

This sheet will show the location of all services plotted from the various service authorities plans. In addition, the information collected by any topographical or point cloud survey undertaken such as existing kerbs, driveways, local facilities such as manholes, valves, poles, streetlights and road markings and signs (including Variable Message Signs (VMS)) shall be shown. This should generally also include:

- Road widths
- Special vehicle lanes (SVL) e.g. bus lanes, transit lanes
- Footpaths, shared paths and widths
- On and off-road cycle facilities e.g. cycle lanes, advanced stop boxes, cycleways
- Boundary locations
- Building lines and verandas
- Driveways
- Existing poles (including power poles and streetlight poles)
- Existing services, including manhole covers, boundary plinths / pillars, bus shelters, street furniture etc.
- Drainage
- Trees, garden plots, berms, etc.
- Existing traffic signal and Intelligent Transport Systems (ITS) equipment, e.g. CCTV camera/s.

2.7 Proposed Construction and Set Out

This sheet will show the extent of all new physical works to be undertaken such as kerb relocation, new islands, raised platforms, pram crossings including tactile pavers and where services are being relocated to if applicable. If 3D models (in a suitable format) of the proposed works are available, ATOC will be interested in seeing these as well.

2.8 Proposed Road Marking Layout and Signage

This sheet will show the proposed pavement marking layout with dimensions including the tie-ins with the existing pavement marking at the extent of the physical works. Any proposed signage (including VMS) should also be included on this plan.

2.9 Proposed Street Lighting Plan

This sheet(s) will display the proposed street lighting layouts, particularly with respect to any Joint Use Signal Poles (JUSPs) or Joint Use Mast Arms (JUMA) and highlight whether any existing streetlights can be combined with the modified or new traffic signals.

2.10 Tracking Plan

This sheet will show the tracking of the largest vehicles deemed appropriate for the site. Of particular note should be the left and right turning vehicles with respect to limit line location, cycle ASBs and kerb lines and opposing movements that may run together e.g. the right turn movements in diamond overlap phasing and left / right turn overlaps. For further information see RTS 18 and AT's TDM.

2.11 Proposed Traffic Signal Plan(s)

This sheet(s) will show the proposed kerbs and pavement marking and the location and type of all traffic signal hardware. Also, to be included on this plan are the ducting, cabling, controller and cabinet, access chambers, kerbside junction boxes, relevant static signage and signal phasing diagrams. The plans should be at least a scale of 1:250 at A1 size (1:500 at A3), preferably at 1:200 at A1 (1:400 at A3). An example drawing can be found in Appendix A. Standard traffic signal lantern displays and symbols are included in Appendix F.

The traffic signal and phasing layout plans can be very complex and it is important that they contain all the information required in as clear a format as possible.

The signal and phasing layout plans must encompass all equipment and hardware, e.g. advanced loops. An example of the required layout is attached in Appendix A. In some cases, it may be necessary to split the intersection over two drawing sheets or have the phasing, ducting and cabling on a separate drawing so as to avoid clutter.

2.11.1 Intersection Layout Plan

The intersection layout plan should contain the following information (where relevant):

- Lane configuration including cycle lanes and bus lanes
- Lane widths/carriageway widths (include cycle lanes and advance cycle boxes where applicable).
- Pavement marking Including the following:
    - Lane marking including chevron markings/flush medians, lane arrows, slip lanes and continuity lines
    - Cycle lanes, cycle paths and cycle markings
    - Bus lanes and associated markings
    - Special Vehicle category lanes and markings e.g. T2/3, Bus, HCV and EV
    - Turning bays
    - No-stopping lines, clearways, parking bays etc.
    - Limit lines
    - ASBs and ASLs
    - Bus stops
    - Pedestrian crosswalk lines, shared paths, shared path crossing lines and symbols
    - Zebra crossings and dual zebra crossings.
    - Raised platforms and zig zags / dragon's teeth.
- Street Names

- Property boundaries
- Kerb lines including medians, segregated cycle lane medians, islands, kerb cut-downs and build-outs
- Footpaths, cycle paths, hold rails, shared paths, pram crossings and tactile pavers
- Vehicle crossings
- Raised tables / platforms
- Any prohibited movements should be clearly identified
- ATOC Standard Traffic Signals Legend – corresponding to the symbols and hardware depicted on the drawing
- North Point (Preferably up the page)
- Asset Owners title block (either AT, Auckland Council, AIAL or Waka Kotahi)
- Detector placement and their input numbers, including loops, above ground detectors, video and radar. All detector loops need to be shown i.e. advance loops, SCATS limit line loops, departure loops, cycle loops, count loops, and Ramp Metering loops). Dimensions to advance loops (if any) and any detectors in non-standard locations
- Pole locations with number and type (i.e. 5m outreach mastarm pole, JUSP or JUMA, stub poles, fold down pole etc.)
- Pedestrian and cyclist push buttons and input numbers in the crossing lines adjacent to the button (subject to the controller type being known)
- Controller and cabinet position
- Access chamber locations and their label, such as AC1. At minimum, access chamber labels shall be shown in the ducting and cabling diagrams.
- Kerbside junction boxes (Tobies) and their labels, e.g. TB1. At minimum, toby labels shall be shown in the ducting diagram.
- Pedestrian and cycle lanterns, specifying the movement number P1, P2, C1, C2 etc., adjacent to but outside of the crossing crosswalk lines with the relevant signal group number inside the crosswalk lines.
- Vehicle, cycle lanterns and visors i.e. open or closed, specifying the vehicle lantern. Signal aspects and arrangements are to comply with those permitted in the TCD Rule and are contained in Appendix F of this document.
- Ducting layout
- Other signs, such as RG27, RG7 and RG8, that support the traffic signal design and/or operation
- Other detectors/inputs or facilities such as rail detectors, emergency service inputs, video detectors
- Other ITS equipment such as CCTV cameras, enforcement equipment

- General Notes including reference to standards and technical specifications, details around hardware and pole types, standard details, power connections (when known), SCATS communication facilities etc.

2.11.2 Signal Groups and Phasing Diagrams

It is desirable to have a separate Signal Group Diagram showing vehicle, cycle, bus and pedestrian groups at the intersection.

The phasing diagram should show the following details:

- Each phase in a separate box with the phase label inside the box corner A, F, F1, etc.
- The phases shall be shown in alphabetical order from left to right
- Alternate phases such as B, C, F1 are to be shown one below the other
- Show only the movements that display a green in each phase, the exception being an All-Red phase where all movements are terminated
- The phase sequence, and where applicable the alternative phase sequence, must also be shown on the plan, adjacent to the phasing diagram
- Vehicle movements are to be orientated by a solid line terminating in an arrow pointing in the direction that traffic will travel as indicated on the intersection layout plan. The exception to this is where a left turn movement controlled by a 3-aspect left turn display is turning across a pedestrian movement and so is giving way to pedestrians or in the filtering phase where right turn movement is permitted to filter across through traffic. In this instance the left turn or right turn movement is to be a dotted line terminating in an arrow pointing in the direction that traffic will travel.
- Signal groups shown in a circle at the base of the movement arrow for vehicles, buses and cycles and beside pedestrian movements
- Pedestrian movements are to be shown as a dashed line terminating in arrows at each end
- Cycle movements are to be shown as a solid line alongside any pedestrian movements. The solid line will terminate in arrows at each end.
- Any Special Flags inside the phase box Z-, Z+, etc
- Movements that have priority in the phase are shown with a solid directional arrow and movements that can proceed but must give way to another vehicle movement are shown as a dotted
- Include notes within the Phasing Notes on operational features or information not apparent on the drawing e.g. ‘Rest in A’; ‘Z- allows filter’; pedestrian protection requirements, cycle protection requirements, filter/non-filter etc.
- Special phasing requirements for facilities such as rail e.g. G-phase is the rail phase, detector 28 calls rail phase
- Indicate if filter turn movements are permitted i.e. is default non-filter – include as part of the operational notes.

Refer to Appendix A for an example of a typical phasing diagram and signal group diagram.

2.11.3 Cabling and Ducting Diagrams

Separate cabling diagrams for signal cable and feeder cable as well as ducting diagrams are to be provided. These do not need to be to scale but should show a clear representation of the proposed ducting layout and cable runs.

The ducting diagram is to include:

- Traffic signal controller and cabinet
- Access chambers and labels
- Kerbside Junction Boxes (KJBs) or tobies and labels
- Duct lines (to poles, access chambers and KJBs) so that a complete loop of the intersection is achieved, specifying the size as per the legend and number of ducts in the diagram
- Poles and pole numbering.

The signal cabling diagram is to include:

- Traffic signal controller and cabinet
- Poles and pole numbering
- Access chambers and label
- Signal cable runs from the controller to each pole and run number. Run numbers for signal cable are labelled S1, S2 etc.
- The number of cables on each run and the core size of each signal cable.

The feeder cabling diagram is to include:

- Traffic signal controller and cabinet
- Access chambers and label
- Toby boxes and label
- Feeder cable runs from the controller to each toby box and run number. Run numbers for feeder cable are labelled F1, F2 etc.

Refer to Appendix A for examples of typical cabling diagrams and ducting diagrams.

2.12 Standard Signal Installation Details Plan(s)

This sheet will show the details particular to signal installations specific to the project, such as traffic signal pole footings / foundations, bridge deck and project specific requirements for pole locations (where needed).

Standard signal details provide information for construction of those features particular to signal installations such as traffic signal pole and installation details, overhead mast pole details, stop line loop wiring plan details and installation details and stop line loop plan details. Several of these standard signal details are included in the P43 Specification of Traffic Signals and do not need to be included on the Details Sheet.

Copies of typical details that are more specific to ATOC sites and/ or are not in P43 Specification are attached in Appendix E.

2.13 Road Safety Audits, and / or Peer Reviews and Risk Register

Any road safety audit reports, and/or peer reviews and risk register of the project if available are to be supplied to ATOC to assist with the review and understanding of the design, operation and maintenance.

3. Traffic Signal Layout and Phasing

The traffic signal and phasing layout plans can be very complex, and it is important that they contain all the information required in as clear a format as possible.

The following sections detail the ATOC conventions for the traffic signal layout plans and phasing.

3.1 Hardware and Software Limitations

There are a number of limitations with the signal hardware and software that designers need to be aware of in order for the signals to operate correctly. Limitations of the TRAFF software incorporated in each traffic signal controller currently controls the number of signal groups and detector inputs that are available for use. The current standards are known as VC5 and VC6. The VC6 standard allows for more signals groups and detectors to be used as well as special purpose inputs and outputs.

3.1.1 Number of Phases

Signal controllers can accommodate a maximum of 7 prime phases and up to 4 sub-phases per prime phase (as a practical maximum). Some prime phases (repeat phases) and sub-phases (diamond phase options) are optional phases and are often controlled by FLAGS (e.g. Z-, Z+). If the controller is running in isolated mode, the controller will operate the base phase sequence without SCATS flag optional phases operating. Diamond sub-phases will always operate. Optional phases can be introduced through SCATS Masterlink control or SCATS Flexilink mode.

3.1.2 Signal Groups (Outputs)

Signal Groups are the controller outputs. There is a mixture of controller types and ages on the Auckland network. Those with the TRAFF VC5 software can accommodate up to 16 vehicle groups and 8 pedestrian groups to a maximum of 24 groups. Newer traffic signal controllers with TRAFF VC6 software can accommodate up to 24 vehicle groups and 8 pedestrian groups to a maximum of 32 groups or all 32 groups can be vehicle groups. This is generally sufficient to accommodate the majority of intersections in the Auckland region. Should more than 24 vehicle groups and 8 pedestrian groups be required at a very complex intersection (e.g. a large interchange or off-set T intersections), an additional controller will be required and the intersection run as two intersections.

Note that cycle movements, either on road or off road, when controlled with a 3-aspect cycle symbol lantern are classified as vehicle signal groups, both in practice and in the traffic signal personality software.

3.1.3 Inputs

Inputs at the controller are the detectors of various forms, placing a demand for a particular movement/phase and are grouped into internal inputs and external inputs. Internal inputs are vehicle detectors and external inputs are largely pedestrian detectors, pedestrian push buttons, but can also include the likes of a link from a nearby rail crossing to stop movements at the traffic signals from entering the rail crossing, emergency services hurry calls, external video detectors, etc.

The controller software can accommodate 48 inputs. Where TRAFF VC5 standard is used, only 24 vehicle and 8 external detectors can be monitored. However, the TRAFF VC6 standard accepts up to 48 vehicle detectors as external inputs with 8 reserved for pedestrian push buttons.

Inputs and detectors are discussed further in Section 3.8.

3.1.4 Controller Software

ATOC are responsible for preparing the software for each controller. This requires a period of at least 6 weeks. As such, an early request to ATOC is necessary. This lead-in time is applicable to new signalised intersections, upgrades/changes to the operation of existing intersections, new and upgraded ramp metering installations and / or for temporary arrangements. Software is made up of two components: preparation and checking of the Controller Information Sheet (CIS) and the writing and testing of the personality (sft).

3.2 Pole Numbering

All poles, including stub (short) poles, are numbered in a clockwise direction from the controller cabinet assuming that a line is drawn from the controller to the centroid of the intersection. Refer to Appendix C for pole numbering for a typical intersection design.

Where there is a secondary part to the intersection, such as at interchanges, offset or staggered T intersections, the intersection closest to the controller shall be numbered first then the additional part can be numbered in the same format assuming that a line is drawn from the controller to the centroid of the secondary part of the intersection as shown in Figure3 Appendix C. For an offset/staggered T intersection or interchange layout with poles within the median islands, these poles are numbered as the sequence passes by the adjacent kerb.

If a controller is relocated as part of the works then the poles at the site must be renumbered to comply with this convention.

3.3 LED (Light Emitting Diode) Lanterns

All new installations shall use LED lanterns in accordance with P43 Section 2.4. This includes all vehicle, cycle and pedestrian displays.

The ATOC requirements for the installation of LED lanterns are detailed below:

- Sites in areas with a posted speed limit of 60 km/h or lower, 200 mm diameter LED lanterns are to be used on all signal displays in the low-level position.
- Regardless of the posted speed, 300 mm diameter LED lanterns are to be used on all signal displays in the overhead position.
- Sites in areas with a posted speed limit of 70 km/h or higher, consideration should be given to the use of 300 mm diameter LED lanterns in the low-level position to increase the visibility of the signals. Details of lantern types and sizes should be included in the drawing notes and legend.
- Pedestrian countdown timer lanterns can be used at mid-block pedestrian traffic signals and at intersections where an exclusive pedestrian or Barnes Dance phase operates.

3.4 Access Chambers and Locations

An access chamber is generally required on each corner of an intersection. An additional chamber is to be installed immediately adjacent to the traffic signal controller. This allows for easy installation of cables to the controller, provides more space for maintenance contractors to work and keeps cabling within the controller tidier. Chamber locations should be placed so as not to cause a trip or slip hazard and where practicable outside of any tactile paving and towards the rear of the footpath away from the live lanes. Refer to P43 Clause 4.4.2 for further details of access chamber requirements and locations.

Access chambers are to be numbered clockwise from the controller cabinet (the same as traffic signal poles) with the number preceded with the label AC (Access Chamber), such as AC1, AC2 etc. ATOC preference is have access chamber labels shown on the ducting and cabling diagrams only. This is to maintain clarity and reduce clutter on the layout plan. Including access chamber labels on the layout plan is only to be considered where there are minimal other numbered or labelled features.

Refer to Appendix A that demonstrates the access chamber numbering and arrangement for a typical intersection.

If a controller is relocated as part of the works then the access chambers at the site must be renumbered to comply with this convention.

3.5 Kerbside Junction (Toby) Boxes and Locations

Kerbside junction boxes, commonly referred to as Toby boxes, are required to house the connections between detector loop tails and the feeder cables. They are located, as the name suggests, at the kerbside adjacent to the traffic lanes and close to the stop lines. In circumstances where there are raised medians or islands, particularly triangular islands, but excluding central medians less than 2m wide, the kerbside junction boxes can be placed in these medians/islands.

Kerbside junction boxes should be located as close as possible to the detector loops so as to minimise the length of saw-cuts in the carriageway. Toby boxes that are located in the footpath should be placed so as not to cause a trip hazard and where practicable outside of any tactile paving. Refer to P43 Clause 4.7 for further details of toby box requirements and locations.

Toby boxes are to be numbered clockwise from the controller cabinet, in a similar manner to traffic signal poles, with the number preceded with the label TB (Toby Box) e.g. TB1, TB2 etc. ATOC preference is have toby box labels shown on the ducting diagram only. This is to maintain clarity and reduce clutter on the layout plan. Including toby box labels on the layout plan is only to be considered where there are minimal other numbered or labelled features.

Refer to Appendix A that demonstrates the kerbside junction box arrangement and numbering for a typical intersection.

If a controller is relocated as part of the works then the kerbside junction boxes at the site must be renumbered to comply with this convention.

3.6 Ducts

All ducting should link back to a chamber location at each road crossing and from each pole. The ducting should link all chambers in a complete ring around the intersection to allow for multiple cable route options, for redundancy and future proofing purposes.

A minimum of two x 100 mm diameter ducts shall be provided from the controller cabinet to the first access chamber.

Generally, all road crossings should be a minimum of 2 x 100 mm diameter ducts, possibly more depending upon the number of cables proposed. Note that a single 100 mm diameter duct can comfortably contain 3 x 36 core cables. If more than 3 cables per duct are proposed, consideration to an additional 100 mm diameter duct should be given.

Ducts to poles should be a single 100mm diameter duct from the nearest chamber. Ducting to kerbside junction boxes (Toby Box) should generally be 50 mm in diameter and should terminate at the closet chamber. Feeder cables are then run back to the controller through the 100 mm ducts.

Refer to Appendix A that demonstrates the ducting arrangement for a typical intersection.

3.7 Cable Runs

Signal cable runs should be designed to serve the primary pole first, followed by subsequent poles. In addition, the cable runs should be designed so that if any one pole gets hit, that pole can be isolated and disconnected but the site can remain in operation with a minimum of two vehicle displays on each approach. This makes sure that the intersection can safely continue to operate without the pole and without any temporary traffic management.

This requirement generally results in a separate cable run to each corner and to each median pole. Where there are poles with push buttons only such as a stub pole (i.e. no signal lanterns attached), these poles should be cabled last in the sequence; cables are to run to poles with signal lanterns attached first.

Signal cable run numbers start from the controller, proceeding in a general clockwise direction following pole numbers. The S1 is the cable that services Pole 1, with S2 being the cable that services Pole 2 or the next pole in the sequence.

The number of feeder cables needed will vary depending on the number of detector loops and their locations. Feeder cable runs start from the controller with cable F1 going to TB1, cable F2 going to TB2, cable F3 going to TB3 and so forth.

Refer to Appendix A that demonstrates the cabling arrangements for a typical intersection.

3.8 Detection

Detectors provide the intersection with its ‘eyes and ears’. They allow the controller to register a demand for a movement and so move to service this demand via a green signal. There are many types of detection: vehicle / cycle in-ground loops or cameras and pedestrian / cycle detection by push buttons or above ground detection (AGD) such as cameras or radars.

The requirements for the detector numbering convention are detailed in Sections 3.8.1 and 3.8.2 below. If the controller cabinet is relocated, then all detectors at the site must be renumbered to comply with the standard convention.

For VC5 controllers, SCATS can access a maximum of 24 vehicle detectors (inputs) and 8 pedestrian inputs. The result is that SCATS can receive data up to a maximum of 24 internal (vehicle) inputs and up to a maximum of 8 external (pedestrian) inputs and 8 special purpose outputs per intersection. Note that the combination of internal and external numbers cannot exceed 32 in total and the various combinations are shown in Table 1 on page 13.

In these instances, if any detectors are required for strategic control in SCATS they will need to be located in the range of 1-24. At existing sites, should more than 24 detectors be required for strategic control, the controller will need to be upgraded to VC6.

For VC6 controllers, SCATS can access up to 48 vehicle, cycle or emergency vehicle detectors and 8 pedestrian push buttons. With VC6 controllers SCATS can receive data from more detectors, thereby affording greater control at large intersections.

Subject to the availability of inputs at the controller, 1m loops are to be provided at left turn slip lanes for counting and data collection purposes. In some circumstances a 4.5m SCATS loop may be required in these locations subject to availability of inputs and space so the loop does not encroach on the adjacent approach or exit lanes.

Table 1 Detector Card Configurations for VC5 TSC/4 Compliant Controllers

Detector Card	16 Detectors	24 Detectors	32 Detectors
Internal Detectors (Vehicles)	8 Loops + 8 Push buttons	16 Loops + 8 Push buttons	24 Loops + 8 Push buttons
External Detectors (Loops\Pedestrian)	8 (Loops\Ext) + 8 Push buttons	16(Loops\Ext) + 8 Push buttons	24(Loops\ Ext) + 8 Push buttons

VC6 controllers can be configured to provide combinations (divisible by eight) of internal and external detectors up to a maximum of 56. Note however, up to 48 can be configured as vehicle detectors and up to 8 can be configured exclusively as push button inputs.

3.8.1 Vehicle Detector Numbering

Detectors are numbered anti-clockwise from the controller assuming that a line is drawn from the controller through the centroid of the intersection. Refer to Appendix B for a diagram illustrating this convention. The reason detectors are numbered anti-clockwise is so that an approach will read numerically correct from left to right from the left kerb towards the centre of each approach.

The first numbering sequence are the stop line (including loops in bus lanes) and counting loops and are numbered following the above convention. The stop line and counting loops are numbered sequentially as encountered in the anti-clockwise direction. For an 11m filtering loop (2x 4.5m SCATS loops with a 2m spacing – the approach loop in the traditional stop line location and the departure loop beyond the stop line), the stop line part of the loop is numbered first immediately followed by the associated departure loop. Where a cycle loop exists in an ASB in front of a right turn lane, the departure filter loop will be placed further forward into the intersection, at least 2m from the cycle loop. Refer to Appendix EB for a typical layout example. Numbering for these cycle loops are covered below in the last sequence.

The second sequence of detector numbering is to capture the advance approach detectors, if there are any. Not all intersections will require these loops. Generally high-speed approaches will have advance loops and sometimes they are used for other special operational reasons. The same anti-clockwise numbering convention is to be followed. Advance loops can also serve as queue loops if required. Please consult with ATOC about the need for such loops.

The third sequence of detector numbering is to capture any departure detectors (note this excludes the filtering departure loop). As with advance loops, not all intersections will require departure loops and they should only be provided on an as and when required basis. Please consult with ATOC about the need for such loops. The same anti-clockwise numbering convention is to be followed. Departure loops can also serve as queue loops if required.

The last circuit of detector numbering is for on-road cycle loops. The loops will typically be provided in cycleways or when there are advance cycle stop boxes and / or cycle lanes on the non-main road through approaches, i.e. not on the A phase through movements. The same anti-clockwise numbering convention is to be followed.

Where there is a secondary part to the signals such as at interchanges and offset or staggered T intersections the numbering convention follows the same anti-clockwise circuit with the stop line loops at the secondary part following on consecutively from the stop line loops at the primary part and so forth. When detector loops are located within the mid-block area between the intersections, any internal loops are numbered as the sequence passes by the adjacent kerb.

If video or radar detectors are being used at a site for vehicle detection, these are included as vehicle (external) inputs mapped to logical inputs and are numbered in consecutive order along with normal internal detectors (loops). They are mapped as logical input numbers in the software. If pedestrian / cycle above ground video or radar detectors are being used at a site, these are included as vehicle (external) inputs and are numbered in consecutive order after all of the vehicle loops are completed. They are mapped as logical input numbers in the software.

Push buttons, typically an external input, are commonly used at signalised pedestrian and cycle crossings to place a demand for the pedestrian and cyclist movement/s. Where there are sufficient internal inputs available at the controller, the cyclist call buttons are assigned an external input number that is then mapped to a logical input in the software. The logical internal input number is the next consecutive number after all other vehicle inputs are numbered, and are mapped to the next available external input after all pedestrian buttons have been assigned e.g. at a site where there are 10 vehicle loops and 3 pedestrian crossings, the cycle inputs would be external input 4 that would be mapped to logical input 11.

Note: The preferred placement of road marking for lane arrows should be clear of the detector loops e.g. located approximately 15m from the limit line. This means that any maintenance undertaken such as re-cutting of loops does not affect existing road marking and removal of road markings (via water or sand blasting) does not affect the watertight seal of the loop cuts.

If a controller is relocated, then the site must be renumbered to comply with the standard convention outlined above.

3.8.2 Pedestrian Detectors

Pedestrian detectors are numbered depending upon the detector card in use. First ascertain the number of detectors available at the controller if it is an existing site or determine the requirement if it is a new controller.

The VC5 TSC/4 Compliant controllers come with a 32 input card. This consists of a maximum of 24 vehicle inputs and 8 external inputs or 16 vehicle inputs and 16 external inputs. This will depend on the type of controller and the configuration applied.

Pedestrian push buttons are numbered in descending order from the highest available input switch on the proposed signal controller. The inputs available for the current signal controllers are as follows in Table 2 below.

Table 2 Pedestrian Detectors

Controller Type	Available Number of Inputs
VC 5 QTC	32 (8 pedestrian)
VC 5 ATSC4	32 (8 Pedestrian)
VC5 Eclipse	24 (8 pedestrian)
VC6 all types	56 (8 pedestrian)

For example, in an Eclipse controller, P1 would use Input 24, P2 would use Input 23, etc. and for a VC5 QTC controller, P1 would use Input 32, P2 would use Input 31, etc.

For all controllers, pedestrian push buttons are numbered in descending order from 32 unless using 24 detectors cards are being used, in which case pedestrian push buttons are numbered in descending order from 24. If more than 32 detector inputs (VC6 controller) are being used, they are numbered in descending order from 48.

The pedestrian detectors are numbered from the highest number down as follows in Table 3 and may include more than 4 pedestrian facilities:

Table 3 Pedestrian Detector Slot Numbering (16 Detector)

Pedestrian Number	1 Ped	2 Peds	3 Peds	4 Peds	5 Peds
P1	16	16	16	16	16
P2		15	15	15	15
P3			14	14	14
P4				13	13
P5					12

A similar configuration will apply across the top for 24 and 32 detector cards. For VC6 controllers, a similar configuration will apply using 32 or 48 as required.

3.8.3 Pedestrian In-Ground Call Pads

Other detection facilities include pedestrian in-ground call pads. Currently on the Auckland network there are very few sites that operate with this technology and ATOC, AT and Waka Kotahi no longer support the installation of new such facilities. If required to modify a site that has in-ground call pads and where these will remain, the designers should note that vehicle inputs are used for pedestrian call pad detection.

Designers should also note that the P43 Specification for Traffic Signals states that in-ground call pads are no longer acceptable and should not be used.

3.8.4 Cycle Inputs and Above Ground Detection (AGD) Video

Where call buttons or other AGD devices are used such as video detection for cyclist movements, they are assigned a logical input as described in Section 3.8.1.

Where AGD is used for pedestrian detection, they are assigned an external input number and mapped to a logical input number in the same manner as pedestrian push buttons.

Detection such as loops or radar are to be provided at all ASBs where cyclists will need to call the phase.

3.9 Signal Groups

Details on signal group conventions are detailed in Section 3.10.3. With VC5 TSC/4 compliant controllers the total number of signal groups can range from 4 to 24, in modules of 4 signal groups. With VC6 TSC/4 compliant controllers the total number of signal groups can range from 4 to 32 signal groups.

The total number of signal groups required is determined from the number of vehicle (cyclists, buses and trams included) groups and number of pedestrian groups. For example, a typical T-intersection may require 6 vehicle groups and 2 pedestrian groups, requiring 8 signal groups in total. A more complex cross intersection may require 9 vehicle groups and 4 pedestrian groups, requiring 13 signal groups in total. As signal groups are in modules of 4, a 16-group controller will be required for this example.

Vehicle signal groups start at 1 and increase in their numbering. Pedestrian signal groups start at the highest signal group number available based on the number of modules used and decrease in their numbering. Refer to Sections 3.10.3 to 3.10.6 for details.

3.10 Phasing

In general, all traffic signals shall comply with the TCD Rule and be consistent with the standard TfNSW (RMS) configuration with some NZ exceptions permitted. The choice of signal phasing needs to be determined by an experienced traffic engineer and based on the current and future predicted flows. In general, intersection or corridor modelling needs to be carried out to determine the optimum design. Where standard phasing configurations are not appropriate, due to the site or traffic flow conditions the phasing should be designed to:

- Minimise the number of phases
- Minimise cycle time
- Run as many compatible movements as possible in each phase
- Restrict each phase to non-conflicting movements
- Promote safety, efficiency, consistency and simplicity
- Allow each movement to run in as many phases as possible (preferably allowing as many as possible to overlap from the previous phase or into the following phase (subject to swept path analysis))
- Should be consistent with the standard ATOC configurations (that are based on standard TfNSW (RMS) configurations).

The phasing design should only consider the use of filter right turn movements where there is a justifiable reason i.e. non-filter operation is to be considered the norm, with right turn filtering being the exception.

Refer to the ATOC document "*Filtered Right Turns at Traffic Signals*" or *"AT Standard Protocol Filter Right Turns"* for guidance on when filtering should be considered. The phasing design should provide the most flexible operation that will accommodate changes in traffic conditions without the need to reprogram the controller personality. This may result in a phasing sequence in which not all phases are used initially. An example of this is the inclusion of repeat right turn phases.

The phasing sequence (i.e. the order in which the phases run) should be designed to provide the optimum coordinated flow along a corridor. This may change at different times of the day. Split approach phasing is very inefficient and only used as a last resort when heavy right turn volumes exist and exclusive right turn lanes are not available, where site constraints prevent the diamond movement or when pedestrian / vehicle conflicts are critical. The phase sequence must also be shown on the plan, adjacent to or below the phasing diagram.

Often, alternative movements are allowed in a single phase, dependent on other conditions such as detector demands or pedestrian demands. The most common use of alternative movements is the diamond overlap phasing where either the full diamond or one of the two options is introduced based on which right turn detectors are occupied. The alternative movements are represented by sub-phases, labelled by adding a number to the end of the phase label, e.g. E, E1, E2, where E1 and E2 are referred to as sub-phases. Care should be taken to make sure that they are actually sub-phases and not separate phases.

Examples of phasing options are presented in Appendix D.

3.10.1 Filtering Right Turn Movements

At many intersections right turning traffic that has opposing movements will be provided for by installing a separate signal display giving the right turning motorist a protected turn at some time in the phasing sequence. With the advent of Vision Zero and Safe Systems, there is a growing emphasis on safety at intersections. As right turn filter movements increase the potential for conflict, resulting in serious harm or death, between road users, filter movements are to be avoided. However, under very strict criteria 'filter turn' movements may be permitted in order to improve intersection efficiency. Refer to the ATOC document "*Filtered Right Turns at Traffic Signals*" or AT's *"Standard Protocol Filter Right Turns"* for guidance on when filtering may be considered.

Whilst the provision of filter turns may improve efficiency, it reduces the potential safety as conflicting movements may now occur. In some circumstances the phasing design will have to consider a balance between safety and efficiency, however the guidance in Vision Zero / Road to Zero should take precedence. When considering whether to allow filtering, safety **must** be given a higher weighting in the decision process and give due consideration to pedestrian and cyclist protection.

The phasing design at adjacent intersections should also be considered in order to provide consistency along a corridor and preferably throughout an area/ region.

Where the filter option is included in the proposed phasing, the phasing notes should state if the site is to default to non-filter operation or not.

At AT intersections, 11m filtering loops are only to be provided if there is a filter option in the proposed phasing, regardless of whether the site will filter or not. This allows the filter option to be introduced at a later date without having to change the software. However, at the majority of sites, provision for filtering will not be required. If ASBs and cycle loops are installed in right turn lanes then right turn filtering shall not be permitted.

3.10.2 Repeat Right Turn Phases

A repeat right turn is where a right turn movement at an intersection is introduced for a second time within the same cycle. Repeat right turns can be provided at any site with a right turn phase. Generally, the controller logic will have two phases with exactly the same movements (i.e. for a T-intersection B and D) with one phase only introduced when a special facility signal is activated (normally B using the Z+ flag).

Repeat right turn phasing can only be used under Masterlink or Flexilink control modes (not in isolated mode) and are generally provided at peak times to service a high right turn demand. It is unusual to have a repeat right turn phase operating 24 hours a day.

Repeat right turn phasing is normally used where the single right turn phase does not provide sufficient capacity within a cycle for specific flow periods, or it is necessary for progression within a coordinated system.

A typical use is where a right turn bay is too short to cope with the number of right turning vehicles that arrive within the cycle. This can result in the right turn queue extending into and blocking the adjacent through traffic lane. This reduces the capacity for the through movement and increases the risk of ‘nose to tail’ type crashes occurring. The use of the repeat right turn is particularly important, under these circumstances, where there is only one through lane.

Repeat right turn phasing should only be considered under the above conditions. Generally, where vehicles may queue outside of the through lane (i.e. on a painted median) it is more efficient to provide a longer single right turn phase than two short phases.

3.10.3 Vehicle Signal Group Numbering

Vehicle Signal Groups (SGs) are numbered in the following order, starting at SG1, with no gaps in the numbering sequence:

- SG1 – the through SG for the first main road approach, encountered clockwise from the controller cabinet. The exception is at T intersections where SG1 is the main road through movement adjacent to the main road right turn.
- SG2 – the through SG for the second main road approach opposite SG1.
- SG3 – the right turn SG on the same approach as SG1.
- SG4 – the right turn SG on the same approach as SG2.
- SG5 – the through SG for the first side road approach clockwise from SG1.
- SG6 – the through SG for the second side road approach.
- SG7 – the right turn SG on the first side road approach.
- SG8 – the right turn SG on the second side road approach.
- SG9 – the left turn SG adjacent to SG1.
- SG10 – the left turn SG adjacent to SG2.

- SG11 – the left turn SG adjacent to the first side road SG.
- SG12 – the left turn SG adjacent to the second side road SG.

At sites where there is a second internal stop line such as an interchange, vehicle signal groups are numbered in the following order, starting at SG1:

- SG1 – the through SG for the first main road approach to the outer limit line, encountered clockwise from the controller cabinet.
- SG2 – the through SG for the second (internal) stop line in the same direction as SG1
- SG3 – the through SG for the second main road approach to the outer limit line, opposite SG1
- SG4 – the through SG for the second (internal) stop line in the same direction as SG3
- All subsequent signal groups follow the same sequence as above i.e. main road right turn approaches followed by off-ramp (side road) approaches etc.

Where Bus 'B' aspects are required (Refer Section 4.13) a separate signal group will be necessary for each bus movement. These are numbered immediately after the last general traffic signal group. If there are 'B' signals on multiple approaches, then the same convention as outlined above is to be used.

Examples of Signal Group Numbering are included in Appendix D.

3.10.4 Cyclist Signal Group and Movement Numbering

Cyclist Signal Groups are numbered in ascending order after all motor vehicle groups (including buses) have been numbered with no gaps e.g. if the highest motor vehicle group is SG9, the first cycle group will be SG10 with the next cycle group being SG 11. This is the case whether the cycle movements are on-road or at a crossing.

On-road cycle groups are numbered in a similar sequence to vehicle groups as described in Section 3.10.3 above. At shared / separated crossings or cycle crossings, the cycle movements are numbered in a similar manner to pedestrian movements as described in Section 3.10.6. At a shared / separated crossing C1 would run parallel to P1. Using the example above, C1 would correspond to the first cycle group being SG10.

3.10.5 Pedestrian Signal Group Numbering

Pedestrian movements have Signal Groups numbered in descending order starting with the highest available Output Group in the proposed signal controller. Signal controller Output Groups come in blocks of either 4 or 8, depending on the controller type. The following are the common controller types in the Auckland Region and the number of Output Groups per Board:

- Eclipse – 8
- QTC – 4
- ATSC4 – 4

Pedestrian signal groups in a 16 group controller will be denoted as P1=16, P2=15, P3=14 and P4=13. If only two Pedestrian signal groups are needed then P1=16 and P2 = 15. In an 8 group controller, pedestrian signal groups will be denoted as P1 = 8 and P2 = 7 etc.

The total number of Output Groups to be provided in the controller equals the number of vehicle signal groups plus the number of pedestrian signal groups, rounded up to a multiple of either 4 or 8, depending on the signal controller type as detailed above. For example, if there were 5 vehicle signal groups and 4 pedestrian signal groups required, then the signal controller would need a minimum of 9 Output Groups. The highest Output Group for a QTC or ATSC4 controller would therefore be 12, but the highest Output Group for an Eclipse controller would be 16.

3.10.6 Pedestrian Movement Numbering

Pedestrian Movements are numbered in the following order, with no gaps in the numbering sequence:

- P1 – the pedestrian movement parallel to SG1.
- P2 – the pedestrian movement parallel to SG2.
- P3 – the pedestrian movement parallel to the first side road movement.
- P4 – the pedestrian movement parallel to the second side road movement.
- P5 – the pedestrian movement across the left turn slip lane adjacent to SG1.
- P6 – the pedestrian movement across the left turn slip lane adjacent to SG2.
- P7 – the pedestrian movement across the left turn slip lane adjacent to the first side road approach.
- P8 – the pedestrian movement across the left turn slip lane adjacent to the second side road approach.

If the intersection is designed to operate with a Barnes Dance or exclusive pedestrian crossing phase, then all movements will be numbered the same; P1.

The TRAFF software allows for a maximum of 8 signal groups to be designated as pedestrian groups at an intersection.

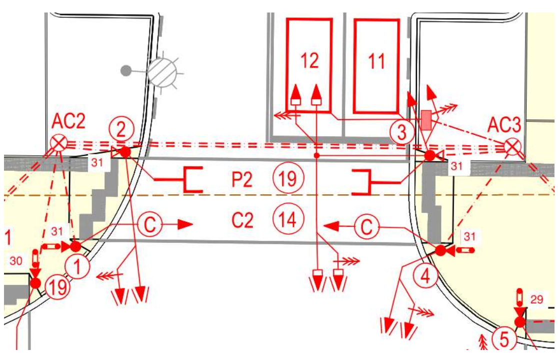


Figure 1: Example Pedestrian / Cycle lanterns, inputs and numbering at a shared crossing.

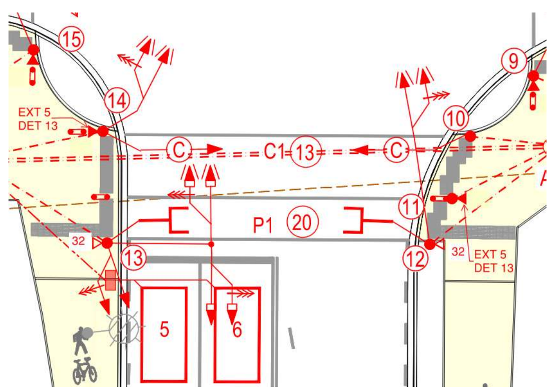


Figure 2: Example Pedestrian / Cycle lanterns, inputs and numbering at a separated crossing.

4. Operational and Geometric and Special Considerations

The following section is designed to provide guidance around operational and geometric considerations and other special considerations that should be taken into account during the design process, where applicable, of traffic signal installations.

4.1 Safety in Design

The NZ Health and Safety at Work Act 2015 became effective on 4th April 2016 with the passing into Law of the Health and Safety Reform Bill. This Act replaces the Health and Safety in Employment Act 1992. A copy of the Act and all associated details can be sourced from the NZ Legislation website.

As part of New Zealand's adoption of this Act, ATOC expects to see an increased awareness of the safety of all people (including members of the public and users) involved with the construction, operation, maintenance and decommissioning of traffic signals. This is to be reflected through good safety in design practice as well as thorough hazard identification, mitigation and minimisation, and a risk assessment associated with all aspects of a traffic signal design.

Hazards should be eliminated through design where at all possible, or at the very least the risk from these hazards minimised as much as is reasonably practical. Any residual risk should be clearly detailed and conveyed to the asset owner and / or operator / maintainer, if different. These risks should then be further eliminated or minimised through operational and maintenance practices and procedures.

A lack of design foresight regarding the full life cycle of the assets in the design process from designers is no longer accepted by ATOC. ATOC supports an open and collaborative design approach to maintain the safety of all personnel involved with the design, construction, operation, maintenance and decommissioning of traffic signals, and encourage early dialogue from designers regarding any issues that arise.

4.2 Vision Zero / Road to Zero and Safe System

Vision Zero is AT's ambitious safety vision that states that there will be no deaths or serious injuries in the Auckland transport system by 2050. No death or serious injury is acceptable. Similarly, Waka Kotahi have a vision of zero deaths and serious injuries on New Zealand roads; one where anyone walking, cycling, driving, motorcycling or taking public transport, can get to where they're going safely. Waka Kotahi have set a target of reducing deaths and serious injuries on our roads by 40% by the year 2030.

Designers are ultimately responsible for the safety of the system, however ATOC has an essential role in how the network operates. On behalf of the parent organisations ATOC has an important role in making sure the transport system is free from death and serious injury.

The safe system approach says that we have the responsibility to make good choices, however we are human and make mistakes. In order to minimise harm, the system should be designed so that if mistakes are made, they will not lead to deaths or serious injuries.

4.3 Network Fit and Integration

In a large and growing city, such as Auckland, an intersection is rarely an isolated facility on the road network. There are often multiple intersections and crossing facilities along a corridor, along with other traffic management and control facilities, which will have some impact on the overall design and modification of any set of traffic signals.

ATOC are continually managing the network in a seamless and coordinated manner as a whole system (One Network approach), rather than its individual parts. In doing so, the design of an intersection becomes critical when viewed as part of this system. The potential effects on the surrounding road network include (but are not limited to) queue lengths, traffic flow, access, coordination with other signals, roundabouts, railway crossings, zebra crossings, cycle facilities and public transport.

4.3.1 Design Considerations

The following are the main design considerations around integrating an intersection within the network:

- The form of control at adjacent intersections. Are adjacent intersections also signal controlled or other forms such as roundabout or priority controlled? Will these intersections impact on the operation of the signals e.g. queues from a roundabout extending back to the signals and vice versa? Will the signals be able to be linked or co-ordinated with adjacent signals?
- Similar to the point above, consider the proximity of the signals to midblock signalised crossings and zebra crossings. Consider whether the signalised intersection and the midblock crossing can be combined into one intersection. If not, can the signals be linked. Will frequently stopped vehicles for the crossings queue back and impact on the operation of the signalised intersection. Similarly, will stacked vehicles at the intersection signals queue back over the crossings and become a safety concern for pedestrians.
- In line with the first two points, include Waka Kotahi’s sites and Ramp Signals within the consideration of the network fit also, recognising the need to balance the performance across both the State Highway and arterial and local road networks.
- At closely spaced signalised intersections the ‘see through factor’ i.e. when a downstream green can be seen by drivers at the upstream limit line, needs to be taken into consideration. Overhead signals may not be required or there may be a need to remove or screen (via louvers) overhead signal displays or consideration given to the use of 200 mm displays (see Section 3.3).
- At closely spaced intersections, consider whether queue loops are required.
- The possible impacts on the network such as, will the signals attract traffic to a particular intersection / route increasing congestion or can they be used to discourage traffic? Will particular movements or side roads / cross routes be penalised / disadvantaged?
- What is happening at the adjacent intersections and how they are operating particularly in terms of phasing, stacking space, queuing, co-ordinated movements etc?
- Apply a consistent approach along a corridor / route in terms of signalised crossing layouts, cycle layouts, bus facilities, right turn bays, filtering, pedestrian protection etc.
- Consider the proximity to and how the signals will integrate with, and the potential impact on nearby or adjacent facilities such as rail crossings, fire stations / emergency services depots and bridges (one lane).

- Where traffic signals are close to fire / ambulance facilities it may be necessary to take precautions so that emergency service vehicles are not blocked by stationary vehicles when trying to exit in an emergency.
- Where lane use control signals are in place or being proposed (i.e. sections of road where traffic flow directions are reversed at certain times of the day e.g. Lagoon Drive / Pakuranga Road, Whangaparaoa Road, Redoubt Road), consider the proximity to or how they will integrate with nearby signals. The traffic signals will need to be aligned with the dynamic/ reversable lane design. In some cases, the signal controller and signal operation may need to be linked to Dynac. Where lane control signals are being considered on the local road network, it is recommended that the design and operation be discussed with ATOC and the Client project team.
- Consider whether the traffic signals are on a public transport route or cycle route. Is the continuation of bus lanes / cycle facilities required? Is specific detection required e.g. cycle loops or are facilities such as lead in lanes, advance stop boxes and special crossings required? Will there be a need for separate movements or phases such as separate bus only movements or a bus only phase or bus head starts / bus gates? Will there be a need for specific instructions / signage such as 'Buses only may proceed straight ahead from left turn lane' in order to provide continuation of a bus lane facility or to promote a particular movement.
- Consider whether the intersection is to be located on an over dimensional load route. Pole placement or pole types will need to be designed to accommodate the over dimensional loads.
- Consider how the placement of other facilities on the network, such as bus stops, fit with the signals e.g. a bus stop close to the limit line on the approach can block access to the lane / loop resulting in the phase not calling or a bus stopped at the bus stop may be stopping on the loop resulting in false calls. Bus stops located within the queuing distance of lanes can cause difficulties for buses crossing to right turn lanes. A bus stop on the departure of an intersection can cause vehicles to queue through an intersection or require a merge within an intersection.
- Consider the impacts of other vehicle access points (other than those mentioned above) and whether they fall within the intersection or are located close to the approaches.
- Consider if the proposed signals integrate with or affect nearby roundabout metering sites or ramp metering sites and vice versa; could the ramp metering / roundabout metering impact on the signals?
- Consider whether the removal of parking or the implementation of clearways is needed. Parking near to the intersection can:
    - Reduce the number of effective lanes on approach and / or departure.
    - Result in false activation of the detectors.
    - Obstruct signal displays and reduce sight distances.
    - Introduce delays as vehicles manoeuvre in / out of the parking spaces.
- Avoid arrangements where 'captured' or 'trapped' lanes may result. This can occur when intersections are closely spaced.
- Consider where or if there are downstream blockages or turning movements that will constrain the operation of a lane.

- Where separate turning lanes are provided adjacent to through lanes, it is important that adequate storage length is provided. Where this cannot be provided, the phasing may need to be modified (e.g. repeat right turn phases). Where a right turn bay is too short to cope with the number of right turning vehicles that may arrive within the cycle it can result in the right turn queue extending into and blocking the through traffic lane. This reduces the capacity for the through movement and increases the risk of 'nose to tail' type crashes occurring. In these circumstances, the use of the repeat right turn phase should be considered. Where vehicles may queue outside of the through lane (i.e. on a painted median) it is generally more efficient to provide a longer single right turn phase than two short phases.
- Consideration for banning particular movements to achieve maximum safety and efficiency in operation.
- With increased focus on safety, the posted speed limits in some areas and along some corridors is being reduced e.g. 30km/h in Auckland's city centre, consideration of the impacts of this on the operation of the traffic signals.
- Similar to the point above, consideration of whether raised safety platforms are required at the signalised crossings or intersections. Will the installation of the safety platform affect the placement and operation of the signal equipment?
- Consideration of user mix at signalised crossings? Is a fully shared pedestrian / cycle crossing appropriate or does it need to be a separated crossing? How wide does the crossing need to be? Can the crossing run in a parallel vehicle phase? Is the treatment consistent with other crossings on the corridor?

4.3.2 Closely Spaced Intersections

A major consideration in the design of signalised intersections is the proximity to an adjacent signalised intersection. Guidance provided in Austroads suggests that intersections should be separated by at least five seconds of travel time at the design speed to provide time for drivers to process information relating to traffic, the road layout and traffic signs. For a 50 kph speed environment this would equate to approximately 70m.

However, Austroads also indicates it is preferable that signalised intersections be separated by a considerable distance. Other sources suggest the minimum distance between signalised intersections should be much higher, in the order of 300-400m. ATOC appreciates the challenges of working on designs within urban areas and that 'ideal' separation distances cannot always be achieved. However, the distance between intersections should be maximised in order to:

- Minimise traffic queues from one intersection backing up through an adjacent intersection and adversely affecting traffic safety or operation (and preserve capacity).
- Minimise inefficiencies that may result from the signal phasing at the intersections having to be interdependent.
- Minimise safety issues arising due to the 'see through effect' where a driver approaching along the main road focuses on green lights at the second intersection rather than red lights at the first intersection. This is outlined previously in Section 4.3.1.

When the spacing between signalised intersections is reduced / too short it can disrupt traffic flow, decrease the throughput of through traffic, decrease travel speeds and increase the likelihood of queues and delays developing.

When two signalised intersections are very closely spaced, the merits and / or dis-benefits of providing one controller (using off-sets achieved through the phasing arrangement) or two controllers (linked through SCATS) needs to be considered.

This typically occurs at staggered T-intersections, motorway diamond interchanges and occasionally where a mid-block signalised crossing is located a short distance from an intersection. To some degree this will be dependent on the number of signal groups and detectors required for strategic control, which are the heavy / critical movements, which are to be the co-ordinated movements, the complexity of the proposed phasing and the resulting cycle times (due to the number of movements / phases). There are a maximum number of phases the controller can accommodate; this is discussed in Section 3.1.1. As such, the phasing arrangement at complex intersections such as these should also take into account the possibility that if SCATS communication is lost the optional or over-lapping phases will not run under isolated mode.

At complex arrangements such as staggered T intersections and diamond interchanges the following needs to be considered:

- There can be unequal lane utilisation due to heavy flows such as the 'S' movement at staggered T-intersections. This should be considered as part of the geometric layout / design and phasing and is usually identified during the traffic modelling stage.
- There is a need to minimise queuing on the internal approaches to avoid blocking of upstream signals. This should be considered in the phasing arrangements and off-sets etc.
- Adequate storage space should be provided on the internal approaches for vehicles turning right onto on-ramps. Stacking and storage space requirements are also part of ramp signal design and where intersection signals feed traffic to a ramp signal these stacking requirements should be accommodated so as to not compromise the operation of ramp signals or the adjacent road network.

Should two signalised intersections be closely spaced, it is desirable that they be co-ordinated to aide congestion management. The potential to be co-ordinated (e.g. via SCATS control) should be confirmed / determined as part of the design process with guidance from ATOC. Co-ordination can improve capacity in these situations as it reduces the number of stops i.e. the stop - start affect, arrival patterns are less random, avoids unnecessary delays to platoons of vehicles and can prevent queues blocking upstream intersections. However, in these situations it is also important to consider that the smaller or minor intersections may run at higher than required cycle times or may need to be double cycled to reduce delays to pedestrians and side road traffic.

4.4 Design Vehicles and Swept Paths

The TDM provides specific requirements about the determination of appropriate design vehicles for an intersection on their network. Waka Kotahi will also specify the design vehicle requirements for interchange and intersection designs on the network. The information contained here is to supplement and support the respective asset owners' requirements with regards to specific considerations for traffic signal intersections.

A ‘design vehicle’ for each site should be identified on an individual intersection basis. The vehicle mix, relative proportions of each vehicle type and the likely frequency of that vehicle using the site is typically considered. Whilst a design vehicle for a particular intersection may not necessarily be the largest vehicle that may operate at that location, it is designed to represent the majority of the vehicles allowed to operate there.

A larger vehicle may not be precluded from the road but may need to operate with reduced clearances or encroach into adjacent lanes. This movement may occur outside of heavily trafficked times, such as overnight or at weekends, depending on the location, vehicle and load concerned.

Once the design vehicle has been determined, the following is to be considered with respect to the intersection layout, geometry and operation:

- When there is a high proportion of larger vehicles (and higher / high-sided vehicles) at an intersection they will require greater clearance to poles / target boards, pedestrian / cyclist facilities etc. Particular attention should be paid to when these vehicles are turning with regards to tail swing, body overhang and leaning over kerbs and or into adjacent lanes.
- As with the above, when there are a high proportion of larger (and higher / high-sided) vehicles at an intersection, these vehicles can mask or obstruct sight lines to the traffic signal displays. Careful consideration should be given to the placement of the signal poles and displays in these circumstances. Additional displays or overhead displays may be required.
- The vehicle mix and proportion of vehicle types at an intersection will determine what design vehicle combinations are appropriate for various turning movement scenarios. Particular attention should be given to opposing right turn movements (i.e. diamond phasing), over-lapping right turn and left turn movements and double right turn or left turn lanes (i.e. two right turn vehicles side by side). The ability to provide diamond phasing or overlapping left and right turn movements generally affords the opportunity to provide more efficient phasing at the intersection.
- The size of the design vehicle will impact on the lane widths and stacking space required i.e. larger vehicles will require wider lanes and longer queuing space. In particular, consider access for vehicles to right turn bays and left turn slip lanes. Stacked vehicles waiting in the adjacent through lane can block access to the turn bay and vice versa, where queued vehicles in the turn bay can block the adjacent through lane. This situation can be exacerbated when there are a high proportion of heavy vehicles using the intersection.
- Within the Auckland Region there are several different sized buses operating on the road network. Confirmation of the likely bus movements at an intersection, the largest bus size to use an intersection and probable changes in route / size in the near future should be sought prior to commencing the design and considered in the signal phasing for diamond and overlap operation. Double decker buses are now in use. Overhanging trees, shop verandas or other street furniture that may cause the buses to come in conflict with will need to be addressed in the signal design.

Drawings showing the swept paths of the largest design vehicles and vehicle combinations deemed appropriate for the site are to be provided. Of particular note should be the left and right turning vehicles with respect to limit line location, ASBs, kerb lines, double turning lane movements and opposing movements that may run together such as the right turn movements in diamond phasing or overlapping right turn and left turn movements. To avoid the risk of vehicle to vehicle conflict and to reduce the chance of vehicles ‘clipping’ the detector loop in another lane as they turn and subsequently calling a phase when it is not needed; this may require the limit line for one lane to be set back some distance from that for the adjacent lane. Documentation detailing the choice of design vehicles, vehicle mix and vehicle combinations should also be provided.

It is generally recommended to keep kerb radii to a minimum in order to reduce turning speeds, minimise clearance times and to optimise signal pole locations. Kerb radii greater than 20m are recommended to be avoided for left turn movements to reduce pedestrian / vehicle conflict and to keep turning speeds down. Vehicle turning speeds have a direct effect on the capacity of an intersection.

The use of larger turning radii (i.e. to accommodate larger vehicles) can lead to:

- Hazards to pedestrians by increased turning speed
- Delays due to increased clearance times as the limit lines are located further from the intersection
- Longer pedestrian crossing distances or deviations from pedestrians' direct route
- Difficulty in achieving optimum lantern positioning and sight lines.

The use of smaller turning radii may result in large vehicles encroaching onto other traffic lanes. This can have implications on the phasing, in particular overlapping movements. This may be acceptable in some circumstances if occurring infrequently. Guidance from either AT and / or Waka Kotahi and ATOC should be sought under these situations.

Appropriate clearance is to be provided between turning vehicles such as opposing right turn movements, overlapping left and right turning movements and vehicles side by side where there is more than one turning lane provided, noting however that larger / longer vehicles may use up to two marked lanes to turn safely. Generally, a minimum 1.0m clearance between vehicles should be provided. Further guidance on recommended clearances can be found in Austroads GtRD Part 4, GtTM Part 10 and Design Vehicles and Turning Path Templates Guide 2020.

When considering signal phasing such as right turn diamond movements or left turn overlaps, if appropriate clearances cannot be achieved between turning movements for the majority of vehicles alternative phasing and / or removing the overlapping movement is to be considered. Where there is insufficient space for a diamond turn the phasing should be altered so that the right turns operate during different parts of the cycle e.g. split approach phasing. Should U-turn movements be permitted (subject to phasing), the vehicle tracking is to enable these movements to be made in one manoeuvre.

The preferred angle at which roads intersect is 90 degrees and generally no less than 80 degrees; refer to AT's TDM and Austroads GtRD Part 4A for further design guidance on this. Very acute angles such as those at Y intersections or multi-leg intersections can be awkward for vehicles to turn through and they will turn at much slower speeds. This needs to be taken into account when determining phase times and phase inter-greens. It can also restrict visibility and care needs to be taken when positioning the signal displays. At multi-leg intersections, the phasing can become much more complex, that in turn can increase minimum cycle times, particularly if all movements are permitted.

4.5 Over Dimension Routes

Over dimensional vehicles will impact on the traffic signal design process, and designers should confirm very early in the design process whether the intersection is situated on an Over Dimension (OD) route in Auckland. This can be determined by checking Waka Kotahi's website for the latest maps of the Over

Dimension routes at Overdimension Route Maps. Alternatively, routes within the Auckland Region can be found in AT's GIS database AT GIS Overdimension Route.

Both AT and Waka Kotahi detail their respective requirements when it comes to OD routes and these should be followed first and foremost. The envelope that designers should cater for to allow OD vehicles to pass through is 6.5m high x 11.5m wide. Further guidance can be found in the New Zealand Heavy Haulage Association's document Road Design Specifications for Overdimension Loads, Version 8. ATOC encourage designers to also consider the impact of the OD routes on the following aspects of traffic signal design:

- The use of hinged or socket planted poles
- The use of mastarms and OD vehicle clearance to any signal lanterns on overhead displays on those mastarms
- Pole location on corners and median islands on OD routes
- Controller location
- Street furniture on islands.

4.6 Lane Arrangements

There are many combinations of lane arrangements that can be used at intersections to provide direction to users. These arrangements can require very different phasing to operate safely and efficiently.

4.6.1 Shared Lanes

On the whole, shared lanes perform well in those situations where the intersection runs a split phase operation, where each approach is signalised to run in its own phase. When split phase operation is not running, operational issues begin to arise when shared through and left or shared through and right turn lanes are proposed.

Designers need to be mindful of the proposed phasing for the intersection when determining the lane arrangements. For example a shared through and right turn lane may operate satisfactorily with low right turn volumes if phased so that the right turn phase leads the through phase so that all right turning vehicles are discharged prior to the start of the through phase. If through volumes are queued however, the through and right turn movement can be extended, reducing the time available for the opposing through movement. A lagging right turn phase may create poor lane utilisation in the shared through and right lane; the designer should consider whether a leading or lagging right turn movement would operate best.

A similar situation arises for shared through and left turn lanes, where the left turn movement is allowed to overlap into another phase. These lanes, generally, are also under-utilised.

While ATOC acknowledges that shared lanes are sometimes unavoidable, with the provision of dedicated lanes not always possible given site-specific limitations and restrictions, designers need to think very carefully about how the best outcome can be achieved both from a safety and operational perspective.

The impact from the level of pedestrian protection required on any parallel pedestrian crossing will also impact the performance of shared lanes and this should be taken into consideration during the design process. Designers should also be cognisant that where cycle movements are running at parallel crossings, that turning traffic is not permitted to filter through the crossing as can occur at pedestrian crossings, i.e. full protection is provided. This can impact the performance of shared lanes.

Careful consideration should also be given to the provision of cycle stop boxes at shared lanes, particularly when the signal phasing allows the movements to run separately. For example, where a cycle stop box is provided at a shared through / left turn lane and a left turn overlap runs, when the green arrow is given to left turners while the through movement is held on red, this will put any through cyclists waiting in that ASB into conflict with those left turners.

4.6.2 Dedicated Lanes

Where space allows, dedicated lanes are preferred as they are generally a safer way of operating the intersection and they allow for greater flexibility of phasing such as overlap movements. Dedicated lanes may increase the size of the intersection and should be considered when turning movements are higher or where there are cycle lanes, cycle movements at parallel crossings or where overlap movements are proposed to operate.

4.6.3 Left Turn Lanes

Generally, a left turn slip lane at a signalised intersection operates more efficiently than a standard signalised; left turning drivers are not held on a red signal being free to turn left whenever there is a suitable gap in opposing traffic, reducing queuing. Similarly, pedestrians/cyclists crossing the left turn lane don't have to wait for a signal, typically reducing delay. However, there are a number of safety issues associated with left turn slip lane arrangements. Particularly during off-peak or lower volumes periods, left turning drivers tend to travel at speed through the lane focussing on finding a gap rather than looking for crossing pedestrians/cyclists and /or on-road through cyclists come into conflict with left turners manoeuvring left across their travel path into the slip lane. Conversely, during busy periods, pedestrians/cyclists trying to cross the slip lane are doing so between queued vehicles.

The standard left turn lane arrangement is generally considered safer, particularly for pedestrians/cyclists, as all movements are catered for in the signal phasing. However, where the signalised crossings are running in parallel to the left turn, there can be delays for left turners and through vehicles if the lane is shared. Left turners are held on a red arrow for part of the crossing time if it a pedestrian only crossing and for the full crossing time if cyclists are using the crossing. Where there is a shared through/left turn lane and a cycle ASB, left turn overlap movements cannot run due to potential conflict with cyclists. Often, with a standard arrangement, the crossing lengths are longer compared to those where there are left turn slips, that in turn can increase overall cycle times.

There is an increasing number of signalised crossings being implemented at single lane left turn slips, particularly at upgrade/ retro-fit sites. In these instances, designers need to be cognisant that under current regulations, the left turn operates as a standard left turn movement where it is under full control of the signals i.e. left turners have to wait for a green signal to proceed, negating some of the efficiency benefits of the slip lane. While provision of a signalised crossing improves safety for crossing users, they have to wait at two crossings, reducing crossing level of service.

When determining the preferred left turn arrangement, designers need to weigh up and provide a balance over efficiency, level of service (including pedestrian/cyclist) and the safety benefits.

4.7 Pole Locations

Traffic signal poles should generally be located on the kerb tangent point. This facilitates lantern visibility and placement of warning tactile paving at pedestrian crosswalks. Poles on median islands should be located so as to avoid strikes / damage from vehicles and on-going maintenance access issues. Waka Kotahi have preferences for 5m poles to be located in dual primary and secondary positions at motorway interchanges and intersections. Mast-arm poles should only be used where forward visibility is deemed to be a problem.

Where geometric layout and signal pole location cannot be designed to adequately cater for high and / or wide loads, removable (socket mounted) or hinged traffic signal poles should be considered as an alternative to maintain the OD corridor envelop. In addition, poles located on bridge decks or other structures should be socket mounted, with appropriate design incorporated into the pre-casting of the bridge structure or other structure. This allows for ease of maintenance and hardware replacement following damage from a road traffic accident or due to age / condition of the pole over time.

Overhead mastarms are generally required on all multilane (normally 3 or more lanes) approaches where an off-side primary pole on a central median cannot be provided. The aim of the mastarm is so as through vehicles have a clear view of the lantern controlling their movement at all times as they approach and pass through the intersection. For this reason, it is considered good design practice to make sure the overhead display is positioned in the centre of the vehicle lane(s) the display is controlling. The locations of mastarms should also be carefully considered with respect to reduced visibility if trees are also present, where high volumes of HCVs or buses on the approach may block visibility of the near-side primary or whether they are located near other overhead obstructions such as power lines or shop verandas.

The preferred location of the mastarm is in the primary location as this provides both good advance warning of the signals and a good mounting position for opposing secondary lanterns. However, mastarms in other positions should be considered if required to facilitate visibility of the traffic signals.

Within the Auckland Region the most common types of mastarm outreach lengths in use are 3m and 5m. Mastarms are also available in New Zealand in outreach lengths of up to 7m. 7m outreach lengths should only be used when absolutely necessary (wide lanes and / or carriageways (4 lanes or more in the direction of travel)) due to the complexity associated with installing these large structures in urban environments. Where considered necessary (higher speed locations), crash protection for mastarms (particularly 7m outreach lengths) should be considered to provide a safer roadside environment.

When using mastarms, consideration should be given to maintaining the OD envelope on those corridors identified as ‘Over Dimensional Routes’ and to the presence of any other overhead structures (including vegetation) and cables.

4.8 Joint Use Poles and Mastarms

Joint Use Signal Poles (known as JUSPs) and Joint Use Mast Arms (JUMAs) are used extensively around the Auckland Region. They provide the ability to combine traffic signal poles with street light columns or CCTV camera columns through the use of specially designed joint use poles to reduce pole clutter.

JUSPs and JUMAs should be considered in all designs in an attempt to reduce both the cost of providing two poles (e.g. street light column and traffic signal pole) and reduce the amount of street furniture installed to maximise the pedestrian environment and clear footpath space. They are particularly useful in space constrained areas. Mastarms should be installed with the spigot so as a streetlight or CCTV camera can be installed in the future.

Spacing of streetlights is done to achieve the required light levels at an intersection or mid-block crossing and sometimes these locations may not coincide with the proposed locations of the traffic signal poles. In these circumstances, the use of JUSPs and / or JUMAs may not be practical.

As previously mentioned in Section 4.7 consideration of overhead structures (including vegetation) and cables should be factored into the design assessment of whether to use JUSPs and / or JUMAs.

AT's TDM and the Transport Agency P43 Specification for Traffic Signals both contain details and requirements for JUSPs and JUMAs in Auckland and New Zealand respectively.

4.9 Location of Traffic Signal Lantern Displays

The location of traffic signal lanterns are classified into 3 positions:

- Primary lantern(s)
- Secondary lantern(s)
- Tertiary lantern(s).

As well as the base classification above, on complex intersections is it possible to have variations of these locations, such as, dual primary, overhead primary, overhead secondary etc. Figure 3 below shows the basic concept of the location of lanterns.

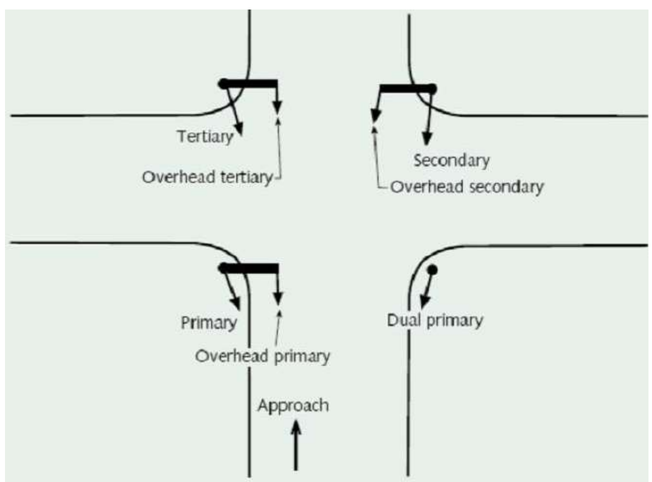


Figure 3: Lantern Face Designations[5]

The function of lanterns in each of the 3 locations is also very different. Lanterns in the primary position (including dual and overhead) will be for an advance warning and stopping function. The lanterns in the secondary and tertiary positions are used for the starting and manoeuvring function.

[5] Diagram taken from Austroads Guide to Traffic Management Part 10.

Each signal group should have an absolute minimum of two lanterns, with most in Auckland typically having 3 lanterns: one in each of the primary, secondary and tertiary locations. In Auckland, a minor signal group, such as single left turn red arrow, will only have two lantern displays. These will be in the primary and tertiary positions. The aim of the designer should be to restrict the number of lanterns to only what is essential for safety and effectiveness. The ideal number is three lanterns per signal group.

4.9.1 Visors

Visors are used to shield the lanterns from the surrounding background light and to provide some restriction to the coverage of the lantern. Visors as classified as either open or closed.

Open visors are used on lanterns where no restriction to the coverage of the lantern is required, normally those on primary poles. Only shielding from background light is provided. Closed visors are used on all secondary and tertiary lanterns where some restriction to the coverage of the lantern is required.

4.9.2 Louvers

Louvers can be fitted to individual signal aspects to further restrict the visibility of that aspect and reduce the intensity. Louvers can be either horizontal or vertical.

Horizontal louvers are generally used when there is a desire to limit the vertical coverage of the aspect and / or lantern. An example of this would be at closely spaced intersections, where the there is a need to restrict the visibility of the lanterns at the secondary intersection from the limit line of the primary intersection, particularly if the lanterns change to green at different times

Vertical louvers are used when there is a desire to limit the horizontal coverage of the aspect and / or lantern, beyond what is possible by the use of visors. The use of this type of louver is less common on the Auckland network presently. They can be used to provide a more targeted visibility of a lantern to particular lanes.

4.10 Staggered Crossing Requirements and Layout

Staggered crossings or two-stage crossings may be used at midblock and intersection locations. The preferred layout for the median stagger is the ‘left right’ movement so as users in the median are facing approaching traffic. As per VicRoads guidance, the minimum recommended stager distance is 6m (the distance between the two internal crosswalk lines). However, there will be some circumstances where these arrangements are not appropriate, particularly at intersections.

The median storage area should be designed to safely accommodate the user demand and user mix and should provide for mobility-impaired pedestrians, pedestrians using mobility devices such as wheelchairs and mobility scooters and pedestrians with prams etc. Where cyclists are using the crossing, sufficient space is to be provided to enable them to safely perform the ‘S’ manoeuvre and to wait in the median without their cycle protruding into the live lanes.

At mid-block staggered crossings the vehicle limit line is located 6m from the crosswalk lines. The primary pole is to be located at or near the vehicle limit line unless there is an ASL or ASB marked. In these instances, the primary pole is located at the ASL/ASB limit line. On multi-lane approaches and / or where the presence of buses and HCVs may restrict visibility of the primary lantern, overhead lanterns are to be considered. Where the median is wide enough, dual primary lanterns should be considered.

Poles within the median stagger area are not to obstruct the travel path through the median or be an obstacle to users. Fencing is required around the stagger area in the median. So as to maintain user access to call boxes, fencing should terminate 400mm from any pole with a call box attached.

Care is required with the phasing at staggered crossings, particularly at intersections, to make sure that both legs of the crossing run at least once, preferably more, in the cycle. This is so users are not left waiting in the median, where they may feel vulnerable, for longer than necessary or become stranded in the median. Where possible, it is desirable that the crossing movements run in sequential phases.

Provision of the call ahead function from the kerbside is to be considered so as to reduce user wait time in the median. The use of AGDs for call cancelling, i.e. when a user pushes the button and then moves from the crossing, should also be considered so that traffic isn't stopped unnecessarily.

4.11 Raised Safety Platform (RSP) Requirements

The installation of raised safety platforms is becoming more common to reduce the operating speed on the approaches to signalised intersections and mid-block crossings.

At RSPs, the vehicle and cycle limit lines should be fully visible to approaching traffic. Limit lines should not be marked on the ramp itself; the preference is for limit lines to either be marked before the approach ramp commences or on the level RSP surface itself. Detector loops should not be placed on or within the RSP.

At intersections, where a crosswalk is marked on the approach, the vehicle limit lines and primary signal poles should be placed at least 2.4 m in advance of the crosswalk but not more than 5 metres upstream of the crosswalk markings.

At midblock crossings, the vehicle limit lines and primary signal poles should not be placed more than 6 metres upstream of the crosswalk markings.

Where there is an ASB on the approach, the ASB limit line is marked 200mm from the crosswalk line. The primary pole is located at the ASB limit line.

The flat section of a RSP must extend a minimum of 6m in length to store a standard passenger vehicle, including when the RSP is used as a pedestrian crossing. A 1m minimum offset is required between the crosswalk markings and the start of each of the entry and exit ramps for safety.

Figure 4: Typical RSP arrangement at signalised mid-block crossing.

Figure 5: RSP at signalised intersection with ASB.

4.12 Street Lighting

Street lighting at traffic signalised intersections and mid-block pedestrian and or cycle crossings should be designed in accordance with AT's TDM Engineering Design Code (for AT intersections) and all other relevant codes, regulations and standards applicable in New Zealand.

The TDM has a clearly defined approach to the design of street lighting for various situations and the outcomes that this needs to achieve based on the type of facility being designed and the classification of the roadway the facility is located on.

When JUSPs / JUMAs are used (detailed in Section 4.8) specific design requirements must be followed with regards to the electrical wiring in the controller. Refer to the Waka Kotahi document P43 Specification for Traffic Signals and to the TDM and the appendix documents associated with this document.

4.13 Bus Facilities and 'B' Aspects

Bus priority, through the provision of bus lanes, separated busways and / or 'B' bus signals, is becoming more common across the Auckland Region to provide a greater level of service and reliability for public transport and in turn encourage use and increase patronage.

On road bus lanes or busways on an approach to an intersection will need a detector as detailed in Section 3.8. In addition, if there is a departure bus lane then a 'B' aspect(s) is not required to provide a 'queue jump' function to allow the bus to progress ahead of the platoon. However, if there is only a bus lane on the approach to an intersection and a bus is required to merge across into a general vehicle lane on the departure side then a 'B' aspect(s) can be useful to provide the bus with an advance start to get ahead of the platoon and make the merge safely.

Where bus lanes are segregated from traffic, such as in a busway environment or bus only road (time restricted or full time), and pass through signalised intersections and / or pedestrian crossings, 3 aspect 'B' signals should be considered to control the movement of buses and to avoid confusion with any roundel or arrow displays used to control general traffic. Careful consideration needs to be given to the use of 'B' signals if emergency vehicles or other vehicles are allowed to also use the busway or bus only road from time to time or at certain times of the day.

‘B’ signals can also be used at an intersection to restrict access to a road or access way to buses only. For example, in Auckland, 3-aspect ‘B’ signals are used at intersections along the AMETI Busway to restrict use to buses only. Use of the ‘B’ signals is reinforced by ‘No Entry Except Buses’ signage. Similarly, ‘B’ signals are used on the entrances to the Grafton Bridge from Park Road and Symonds Street to provide bus only access at certain times of the day, in conjunction with signage advising who can use the bridge and when..

Where ‘B’ signals are used, this requires the allocation of a signal group to each approach using ‘B’ signals. Bus only signal groups are numbered immediately after the last general traffic signal group and if there are ‘B’ signals on multiple approaches then the same convention as outlined in Section 3.10.3 is used to number the bus signal groups.

Bus priority can also be provided via SCATS through several measures and if this is required a discussion with ATOC should be arranged to agree requirements and operation, in conjunction with AT and AT Metro.

4.14 Light Rail (Trams) and ‘T’ Signals

Currently in the Auckland Region the only section of light rail or tram is the Museum of Transport and Technology (MOTAT) tram, known as the Western Springs Tram. However, a wider network of trams or light rail is still a possibility for Auckland in the future and so the following guidance should be noted in the case of traffic signal design with tram or light rail.

As with bus lanes, there are generally two types of application for light rail or trams. One is on-road, using either dedicated tram lanes or sharing with traffic lanes (e.g. Melbourne). The Wynyard Loop tram was an example of an on-road facility sharing with traffic lanes. The other is in a segregated tram or light rail right of way (e.g. Gold Coast), separated from road traffic and generally controlled as such. The MOTAT tram in Auckland is an example of a mostly segregated tram facility.

Where on-road and sharing traffic lanes, light rail or trams will need to be controlled with standard roundel or arrow traffic signals as they will be in the general vehicle mix. For example, this occurs in Melbourne along most of the streets with light rail or trams in the inner suburbs. The second on-road version is where the light rail or trams operate in their own dedicated lanes on the road or within the road corridor; again, this occurs in Melbourne, mostly in the CBD. Depending upon how the light rail or trams are to be controlled and which movements are allowed, either standard roundel or arrow traffic signals can be applied when controlling all road vehicles together or dedicated ‘T’ signals used when wanting to provide direction to light rail or trams only.

In the instance of a dedicated light rail or tram right of way, ‘T’ signals are most commonly used to control and provide direction to these vehicles when inter-acting and / or crossing with road traffic, pedestrians and cyclists. This is the case in the Gold Coast, where the light rail or tram right of way runs down the centre of the Gold Coast Highway and is controlled with ‘T’ signals when crossing an intersection. As with ‘B’ signals, the use of the ‘T’ signal provides specific direction to light rail vehicles or trams and avoids confusion from roundels and arrow displays controlling general traffic.

Light rail or tram priority at traffic signals may also become a reality with any expansion of the Auckland network. In these cases, it is recommended to discuss requirements and options with ATOC, AT and / or Waka Kotahi as required.

4.15 Signals at Cycle Facilities

4.15.1 Cycle Signal

Cyclists, whether on road or off road, are always considered as a vehicle signal group for the purpose of traffic signal design. This is due to the presence of a yellow signal, like that for other vehicles, and this results in the need to operate the movement as a vehicle signal group. Refer Section 3.10.4 for details of signal group numbering for cyclists.

When designing particularly large or complex intersections, such as interchanges or 4 or 5 arm intersections, where there is an existing controller, the allocation of vehicle signal groups can become challenging when there are multiple cycle crossings or cycle movements. Designers should remember that the limitations with the VC5 TRAFF controller software is that it only allows for a maximum of 16 vehicle signal groups. Should an installation require more than 16 vehicle signal groups to provide for the cycle movements, the controller may need upgrading to the VC6 version where up to 32 vehicle signal groups can be provided. Further details are provided in Section 3.1.2.

The above considerations are certainly not exhaustive and as the wider industry becomes more involved with cycle design and facilities for cyclists become part of everyday design, further design issues will continue to arise. A number of trials are underway to address some of these design issues such as the use of 2-aspect cycle lanterns at cycle crossings parallel with pedestrian crossings in Auckland CBD. ATOC suggest advance discussions with AT and / or Waka Kotahi regarding not only the design of such facilities but also the operation of these too.

4.15.2 Separated Cycle Lanes and Cycleways

On-road cycle lanes and cycleways that are separated from vehicle traffic by a physical buffer are becoming more common in Auckland. These can be uni-directional or bi-directional. At signalised intersections the cycle movements will require separate detection and generally their own lanterns.

Sufficient width is to be provided in the separator to safely house signal poles and lanterns. There may also be additional need for overhead lanterns to provide adequate visibility of the lanterns for vehicular traffic. Safely providing for turning cyclists both in the phasing and physically, particularly with bi-directional cycleways, can become complex, often resulting in a ‘cycle only’ phase and / or restricting some turning movements for both cyclist and vehicles. Careful consideration needs to be given to the interaction between cyclists and pedestrians so as cyclists don’t filter through pedestrians using the crossings.

One example would be the Nelson Street bi-directional cycleway. At the Nelson Street / Cook Street intersection, signs and markings indicate cyclists can only perform the through movement (no left turn or right turn movements). The left turn into Cook Street is prohibited for general vehicles on Nelson Street. Three-aspect cycle lanterns are provided for cyclists in both directions of travel and cyclists are provided with their own detectors (via call buttons). The cycle movements only run in one phase, with the parallel general vehicle movement.

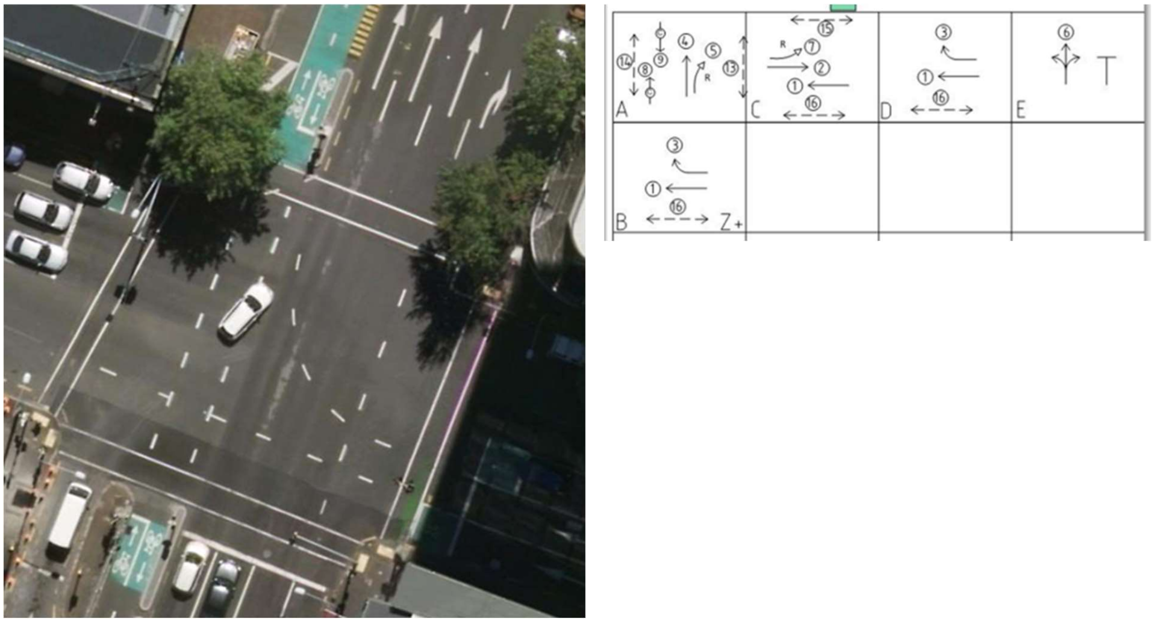


Figure 6: Nelson St / Cook St intersection where on-road cycle facilities are incorporated into the signal operation.

Another example where separated on-road cycle facilities are incorporated into the traffic signal operation is at the Beach Road / Te Taou Crescent intersection. Both east and westbound cycle movements are provided for in a dedicated cycle only phase. A westbound cyclist can also continue west in the general vehicle lane in other phases as well. Six-aspect cycle lanterns, i.e. three of the cycle lanterns incorporate right turn arrows, are being trialled at this intersection. These allow westbound cyclists to turn across the intersection in the dedicated cycle phase or continuing straight through in other phases.

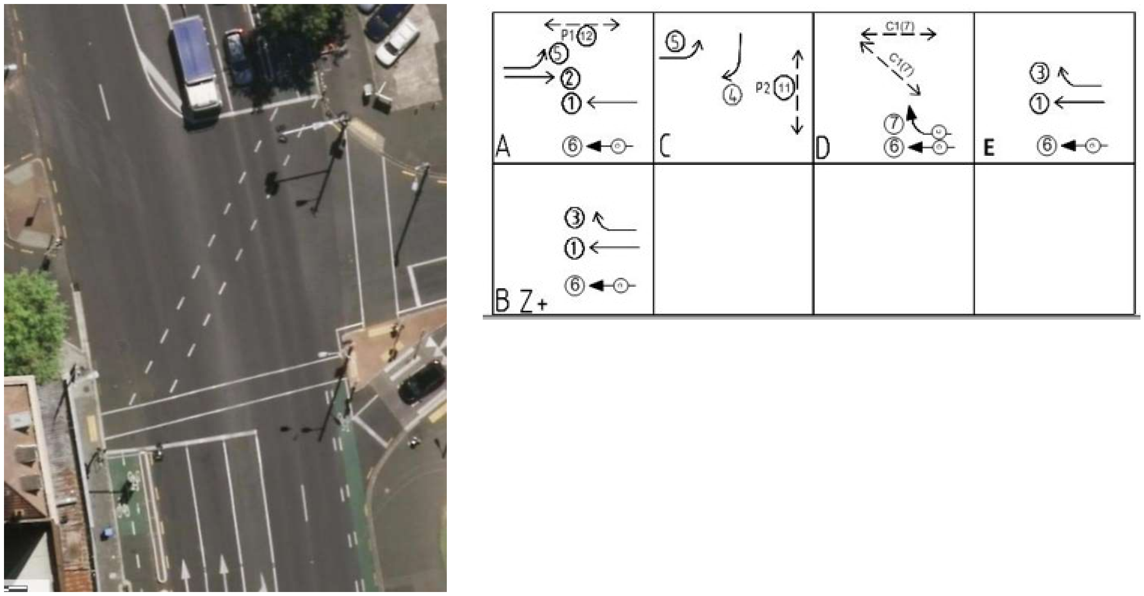


Figure 7: Beach Rd / Te Taou Cr intersection where on-road cycle facilities are incorporated into the signal operation.

4.15.3 Cycle Hook Turns

At busy multi-lane signalised intersections, it may be difficult for less confident cyclists to move to the right turn lane to perform a right turn. While only used very occasionally in Auckland, a hook turn facility may be provided to assist with the manoeuvre, allowing cyclists to make a right turn in two stages:

- The first stage involves moving to the far side of the intersection, keeping as far left as possible.
- The cyclist then waits there (in the hook turn box) until the side street gets a green light and then moves with side street traffic across the intersection.

Figure 8 below illustrates the concept of a hook turn manoeuvre.

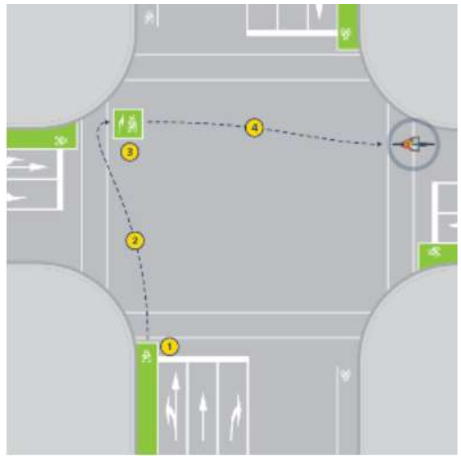


Figure 8: Completing a Hook Turn Manoeuvre[6]

When proposing to use a hook turn feature on an approach at an intersection, designers need to consider a number of factors, these being:

- Detector for cyclists in hook turn box to call the appropriate side street phase
- Operation of phasing, particularly with regards to any left turn overlaps from the side street phase
- Located clear of conflicting through movements
- Of a size suitable for the expected number of cyclists
- Vehicle swept paths
- Proximity of adjacent through lanes.

Safely retrofitting these turns into many existing intersections may not be most appropriate solution. New greenfield developments may be able to be designed satisfactorily, however ATOC suggests seeking early consultation with themselves as well as Waka Kotahi / Auckland Transport / AIAL stakeholders to determine the best approach to using hook turn facilities at an intersection.

4.16 Emergency Vehicle Signals and Operation

Although specific traffic signals solely for emergency vehicles are not used in the Auckland region, facilities to enable a speedier exit from fire stations and ambulance stations are often provided. These facilities take the form of flashing red signals (either horizontally or vertically mounted) with a supplementary PW64 sign sometimes attached and a PW3 sign in advance if required. A PW49 'Fire Station' may also be used in the appropriate location. They provide the ability for emergency services vehicles to exit the station and are activated by the emergency services personnel within the local station. Reference should be made to the Land Transport Rule: Traffic Control Devices for specific details.

In addition to the above or in isolation, a special hurry call phase at an immediately adjacent signalised intersection can be configured to give priority to emergency vehicles through enhanced operation at the intersection as required. This could be to provide no / minimal queue on the approach the emergency

[6] Figure taken from Waka Kotahi: Road Code / Code for Cycling / Intersections

vehicle will be using or to provide a green signal at the intersection to aid them in responding quickly to a call out. This may require additional traffic signal hardware to be installed at the relevant station, with a hardware (or WIFI) connection back to the traffic signal controller.

ATOC would recommend that should hurry call facilities for emergency services at new or existing intersections be required that this is discussed with them early to provide input on the best approach for all concerned.

4.17 Signals at Rail Level Crossings

At grade crossings of railway lines at or in close proximity to traffic signalised intersections require special consideration on a case-by-case basis given the variability of site conditions, operation, train movements etc. In the Auckland region, such facilities are relatively low in number, with most new road / rail crossings being grade separated due to safety concerns. However, there remain existing locations which may require modification over time. The advent of cycle paths and shared paths running alongside the rail corridor has also seen some new signal installations within close proximity to rail level crossings.

Requirements may vary depending on whether the signals are at an intersection or crossing and how far the signals are from the level crossing. However, some key considerations to be mindful of when designing are:

- Queues do not extend back over the rail crossing
- On activation of the rail boom gates no traffic movement is to be given a green signal to enter the midblock between the intersection and the rail crossing.
- Where necessary, provide a clearance phase so that vehicles queued on or near the tracks can start moving before the barrier arms start to fall.
- The signal groups for traffic movements that conflict with the rail line must be interlocked with the railway signals to guarantee they are not showing green when the railway signals start flashing.
- Sufficient rail / train pre-emption time can be provided to service all safety critical timings, minimum greens and clearance times for a vehicle to clear the level crossing, before moving to the ‘rail / train phase’.
- Where a signalised cycle crossing runs parallel to a level crossing, red and yellow arrow lanterns are to be used to prevent cyclists turning across the rail tracks into the path of an on-coming train. Refer also to Waka Kotahi / KiwiRail document *‘Design Guidance for Pedestrian & Cycle Rail Crossings’*, Version 1, 2017.

ATOC recommends discussing any intersection design that proposes or requires the inclusion and / or inter-connection of a rail level crossing with them as early as possible in the design process. Detailed discussions will also be required with KiwiRail with regards to their requirements for the operation of the railway crossing and interfacing between the traffic signal controller and rail signalling hardware. Designers should obtain the latest information from KiwiRail around their interfacing requirements and traffic signal requirements at level crossings as KiwiRail are incorporating new features to improve safety at level crossings. KiwiRail can require significant advance notice upwards of 6 months, in complex cases, involving any design in proximity of a rail crossing.

4.18 Signalised Private Access Way

The signalisation of private access ways into or out of residential or commercial properties is generally not undertaken without a good reason. For the purposes of intersection operational efficiency, it is preferable to **not** signalise these movements because of the additional challenges that are raised certainly with respect to maintenance and access to assets and the precedent that this sets within the community. The movements into and out of these residential properties are typically fewer than 5 vehicles per day and typically fewer than ~20 per day at commercial access ways.

Private access ways that are used more heavily or are located where there is a higher / vulnerable pedestrian use, such as entrances to hotels and intensified residential properties, business premises, community facilities, medical establishments etc. and / or that have particular access issues (sightlines, access onto multi-lane roads) should be considered more carefully for the use of traffic and pedestrian signals. If this is accepted with AT, discussions with the landowner and occupier should be agreed in respect to the access, maintenance and renewal of the traffic signal assets.

Deciding upon whether to signalise a private access way will be part of the overall design process and involve consultation with multiple stakeholders. ATOC would recommend that should the signalisation of a private access way within a new or existing intersection be required that this is discussed with them early to provide input on the best approach for all concerned.

4.19 Roundabout Metering Signals

The use of metering signals is an effective measure to alleviate the problem of excessive delay and queuing that may be experienced at un-signalised roundabout-controlled intersections, especially where there may be heavy and / or unbalanced flows. Although there has been some increase in the use of metering at roundabouts in recent years, they are not used extensively in the Auckland region, they are a valuable operational tool in managing unbalanced flow at certain times of the day. The TCD Rule also permits other uses for roundabout metering signals, mainly around emergency vehicle and rail operation or to improve the safety and efficiency of public transport services. It should be noted that under the same rule there is no mention of the use of metering signals for other purposes, such as at stop or priority-controlled intersections. Metered roundabout signals are not allowed to be part time signals (switched off or blank) under the TCD Rule (i.e. they must remain on unlike ramp signals where they can be off or on).

The metering of roundabout controlled intersections should be selected based on a detailed analysis of the problem and the alternative solutions / options available. It should not be used unless there is an identified and validated problem with unbalanced flows or inadequate gaps in traffic. It should be noted that this does not include ramp signals, which are not metering signals and are implemented under different circumstances to manage other issues.

Any roundabout metering signals proposed should be designed in accordance with the conventions set down in this document and other relevant standards and guidelines as required. Further guidance on roundabout metering can be found in Austroads Guide to Traffic Management Part 10 (2020), section 10.5.6. Figure 9 in Appendix D is an example layout of roundabout metering showing lantern arrangements, detectors and phasing sequence.

4.20 Banned Turns and U-turns at Traffic Signals

The banning of turning movements (including U-turns) at traffic signalised intersections is sometimes required to support a network operating or management approach or to address safety problems and concerns.

Consideration to geometric alignments and physical means to prevent turning movements should be undertaken as a matter of good design practice. In addition to these measures, further reinforcement of the banned turn(s) must be conveyed to users through the placement of either standard no right turn (RG7), no left turn (RG8) or no U-turn (RG15) signs and where there is a need to further enhance the presence of the signs, illuminated no turning signs can be considered.

4.21 CCTV Cameras

AT's minimum requirements include that all new signalised intersections require the addition of at least one CCTV camera and all associated equipment in order to view the operation of and conditions on each approach. In some circumstances, more than one camera maybe required in order to provide sufficient coverage on all approaches to an intersection.

Designers should determine the best location(s) for CCTV cameras and identify the traffic signal pole number on the design plans. Details of any pole type in the location chosen that may require modification should be noted on the design.

Designers should discuss with Waka Kotahi their requirements for CCTV cameras at interchanges and signalised intersections. While some coverage can be provided by the motorway CCTV cameras, additional cameras may be required at interchanges in order to have sufficient visibility of all approaches and exits.

4.22 Utilities and Service Providers

In most urban areas, the ground below roads, footpaths and berms will be congested with service utilities. In addition, the surface will be dotted with chambers and pits providing access to these underground assets. Above ground assets, such as power / telecommunication poles, overhead lines, transformers, switch gears and gas regulator stations are easily visible and so are often taken into account when designing traffic signals. Due diligence by designers around underground assets should also occur.

Discussions with Utility Service Providers (USPs) should always be held during the design stage to determine exactly what assets might be impacted and to agree a mitigation and / or relocation strategy. These requirements should then be factored into the design process to avoid problems and delays during construction.

Some of the common issues occurring with regards to traffic signal assets and USP assets are:

- A chamber lid does not denote the extent of the chamber below the surface. Some chambers below ground can be in excess of 2m x 2m x 2m but only appear to have a minor footprint from the surface. A thorough investigation should be undertaken at the design stage.
- When overhead lines are present, these need to be considered in the design, construction, maintenance and decommissioning of the site. Power providers typically have specific working clearances from power lines and require an envelope of clear space around the lines at all times.

The maintenance procedures for mastarms and overhead lanterns also needs to be considered during the design stage.

- Make sure power / telecommunication poles do not obstruct sight lines to the traffic signals or obscure lantern displays.
- Consider foundation requirements for poles, especially mastarms, and how these will interact with below ground assets. There are products on the market that can help with this issue and / or design solutions that can be adopted.

4.23 Ramp Metering Signals

Ramp Metering Signals are used to manage the flow of traffic on to the motorway and to minimise and delay flow breakdown. This is achieved by breaking up platoons of traffic entering the motorway, providing an easier merge. Ramp Signals are installed on the majority of Auckland on ramps and are linked to detectors on both the motorway and urban arterial in order to manage the on ramps in a coordinated manner. Guidance on ramp metering signals can be found in Waka Kotahi's interim Ramp Meter Systems, ITS Design Standard and interim Ramp Meter Systems, ITS Delivery Specification.

4.24 Design Form

Standardised CAD blocks should be used by all designers based on ATOC's standard Traffic Signals Legend. Examples of the standard signal symbols can be found in Appendix A, Appendix F and the document *"Creating and Updating Traffic Signal As-built Drawings".*

Please refer to the document *"Creating and Updating Traffic Signal As-built Drawings"* for further information regarding the process of providing as-built information to ATOC. Standardised CAD blocks are available and must be used for all Traffic Signal Drawings provided to ATOC for review.

5. Traffic Signal Design Review Process

5.1 Introduction and Purpose

The purpose of this section is to set out the process followed when requested to undertake a Traffic Signal Design Review by either Auckland Transport or Waka Kotahi. When undertaking a Traffic Signal Design Review, it is necessary to refer to the latest versions of the documents outlined at the start of this guideline, under 'Reference Documents'

Traffic Signal Design Reviews are carried out by competent ATOC Traffic Signal Engineers. They are responsible for reviewing, identifying, recording and reporting issues regarding the submitted design back to the RCA.

The key function of a design review is to promote a consistent application of standards across the Auckland Region and to make sure signal designs are to the highest standard, with variations being the exception rather than the norm. It is not the role of ATOC to determine the purpose of the design, this is the RCA's decision and there will be a number of reasons why signals are considered.

ATOC's role when undertaking a Traffic Signal Design Review is to check that safety and efficiency have been considered. They will also consider whether the design presented is appropriate to meet the design requirements and identify areas that need to be re-considered.

As ATOC is a partnership formed between Auckland Transport and Waka Kotahi, these respective RCAs are not obligated or bound by ATOC comments nor does ATOC have the authority to enforce its requirements. Review comments will generally identify areas of concern and ask the designer to consider an alternative option, if and where possible.

5.2 Process

Typically, a request for ATOC to undertake a design review will come via the RCA to the ATOC Optimisation Delivery Manager or appropriate delegate using the following email address: ATOC Design Review atoc.dr@nzta.govt.nz.

The RCA will pass through all information received and relevant for an intersection design, requesting the design be reviewed against this document, the ATOC Traffic Signals Design Guidelines, and other relevant documents.

In order to undertake a thorough and comprehensive traffic signal design review, ATOC has outlined the information expected under Section 2 of this guideline. These sources of information assist with providing a more thorough, comprehensive and useful design review. If minimal or limited information is received to undertake the review satisfactorily, ATOC may request further specific information, via the RCA.

The target response time (to the RCA), is within 5 working days of receipt of the request and appropriate information bring received. However, the size and complexity of the design will dictate how quickly a review can be completed. If a significantly large design is received for review, ATOC will advise of the timeframe in turning around the review due to the complexity. Trying to complete large complex reviews in a short time period increases the risk of missing important issues.

Once a design review is complete, all design review comments are recorded and numbered consecutively for easy reference and included in the ATOC Design Review Response Form. Each design review is submitted to another ATOC engineer for peer review, checking and sign-off prior to issue back to the requesting RCA.

During the process, all correspondence regarding the design review is to be directed through the relevant RCA contact. ATOC does not communicate directly with the designer, unless specifically requested to do so by the RCA. The RCA is responsible for communicating with the designers for further information and to pass on the ATOC review comments.

A copy of the Traffic Signal Design Review Process can be found in Appendix G.

5.3 The Review

During a review of a traffic signal design ATOC will look at the following areas.

5.3.1 General Comments

Under the general comments section, note all general issues identified that are not specific for example:

- No tracking drawings provided
- Appropriateness of tracking
- No street names on the drawing
- Drawing errors such as false or missing references
- Overhead power cables
- Vegetation interfering with the traffic signals.

5.3.2 Geometrics and Layout

Any comments regarding issues relating to geometrics and layout, for example:

- Road marking issues
- Lane allocation issues that might affect efficiency or cause confusion
- Issues relating to dimensions e.g. lane widths.

5.3.3 Operation

Any comments regarding issues relating to the proposed operation, for example:

- Signal group, detector or pole numbering does not follow ATOC conventions
- Phasing notes to explain any special operation required for software generation i.e. pedestrian protection requirements, special logic, phase sequence, special purpose timers, filtering requirements, movement overlaps etc.
- Inefficient phasing or unsafe phase sequence.

5.3.4 Pole and Lantern Layout

Any comments regarding issues relating to pole and lantern layout, for example:

- Pole positions do not conform to standards e.g. primary pole position

- Insufficient number of or no displays for a signal group
- Visibility of lanterns
- Confusing lantern arrangements or alignment
- Information regarding pole and lantern type e.g. JUMA, JUSP, LED, lantern size etc.
- Use of open / closed visors, need for extra-long visors
- Use of mast arms and overhead displays.

5.3.5 Controller, Cabling, Ducting and Chambers

Any comments regarding issues relating to the controller, cabling, ducting and chambers, for example:

- Inappropriate, unsafe or inaccessible controller location
- Controller specification e.g. TSC4 compliant
- Cabling layout, number of cable runs and labelling
- Ducting layout, size and number of ducting runs
- Insufficient or over-use of chambers
- Inappropriate, unsafe or inaccessible chamber locations
- Need for extra chamber next to controller supplied by minimum two ducts
- Positions of kerbside junction boxes
- Access chamber and kerbside junction box numbering.

5.3.6 Detectors

Any comments regarding issues relating to detectors, for example:

- Missing detectors
- Detector positioning
- Detector use e.g. departure loops, queue loops, count loops
- Presence timer requirements
- Cycle loops
- Loops in bus lanes
- Form of detector and their appropriateness to the design and site e.g. video, microwave radar, inductance loops.

5.3.7 Pedestrian Facilities

Any comments regarding issues relating to the pedestrian facilities, for example:

- Inappropriate, unsafe or inaccessible pram ramp locations
- Missing or incorrect layout of tactile paving

- Pedestrian crossings conflicting with cycle movements, vehicle movements, especially right turn filtering
- Crosswalk widths and lengths
- Accessibility of pedestrian bush buttons
- Use of or need for alternative forms of detection such as video pedestrian detectors
- Alignment with RTS-14.

5.3.8 Cyclist Facilities

Any comments regarding issues relating to cyclist facilities, for example:

- Inappropriate, unsafe or inaccessible cycle box locations
- Cycle lane dimensions i.e. widths
- Obstacles along a cycle lane e.g. cesspits
- Cycle detection e.g. cycle loops, video and / or push buttons
- Potential conflict with other user types including pedestrians, vehicles
- Form of facility e.g. on-road or off-road, uni-directional, bi-directional, separated
- Pole and lantern locations relative to the type of facilities
- Information regarding protection requirements e.g. full protection at a cycle parallel crossing.

5.3.9 Shared Facilities

Any comments relating to shared facilities, for example:

- Form of facility e.g. fully shared or separated (pedestrians on one side and cyclists on the other side)
- Missing or incorrect layout of tactile paving or inappropriate layout in relation to the different users
- Potential conflict and / or pinch points between user types using the facility
- Crossings conflicting with other movements, e.g. vehicle movements
- Appropriateness of crossing protection for the user mix
- Crossing widths and lengths
- Accessibility of push buttons
- Appropriateness of detection form relative to the user type
- Use of or need for alternative forms of detection such as video detectors
- Pole and lantern location and type relative the type of facility and user mix.

5.3.10 Street Lighting

Any comments regarding issues relating to street lighting, for example:

- Street light pole positions
- Lack of or excessive street lighting
- Use of joint use poles (JUSPs) and joint use mastarms (JUMAs).

5.3.11 Signs

Any comments regarding issues relating to signs, for example:

- Inappropriate, unsafe, confusing or unreadable sign locations e.g. blocking signal displays
- Signs required to support the operation of the traffic signals e.g. RG-7 “No Right Turn”, RG-8 “No Left Turn”
- Missing signs e.g. RG-27 “Turning Traffic Give Way to Pedestrians” where required.

5.3.12 Special Vehicle Lanes and Facilities

Any comments regarding issues relating to bus, T2/3, HCV, EV or tram / light rail facilities, for example:

- Bus, T2/3, HCV or EV lanes
- Bus or tram displays, and operation within the traffic signal software
- Bus stop locations
- Special vehicle signage relevant to the signal operation e.g. left turn exemption signs to override mandatory left turns.

5.3.13 Safety in Design / Road to Zero / Vision Zero

Any comments regarding safety throughout the life cycle of the signals, for example:

- Safety in design, construction, operation, maintenance and decommissioning
- Potential hazards that do not appear to have been identified or adequately mitigated or minimised
- Potential risks that do not appear to have been addressed
- Safe access to all signal infrastructure and safe work areas during operations and maintenance.
- Consideration of whether the signals are to remain operating during construction and construction staging
- Consideration of reducing operating speeds on all approaches to the intersection or crossing
- Appropriateness of speed reduction means
- What are the consequences if someone makes a mistake?
- Is the space prioritised for people i.e. efficiency and travel time are secondary?
- Is the proposal easy to understand and self-explaining could it be confusing or mis-interpreted? Does it require complex decision making?
- Have the relative speeds, priority and separation of different users travelling in different directions or modes been considered? Are vulnerable users protected?

- Is there a risk of head-ons occurring? Has this been considered? How has it been treated?
- Does the design restrict unsafe movements?
- Which infrastructure is most likely to be hit by errant vehicles, is it protected, frangible or can it be relocated?

Appendix A

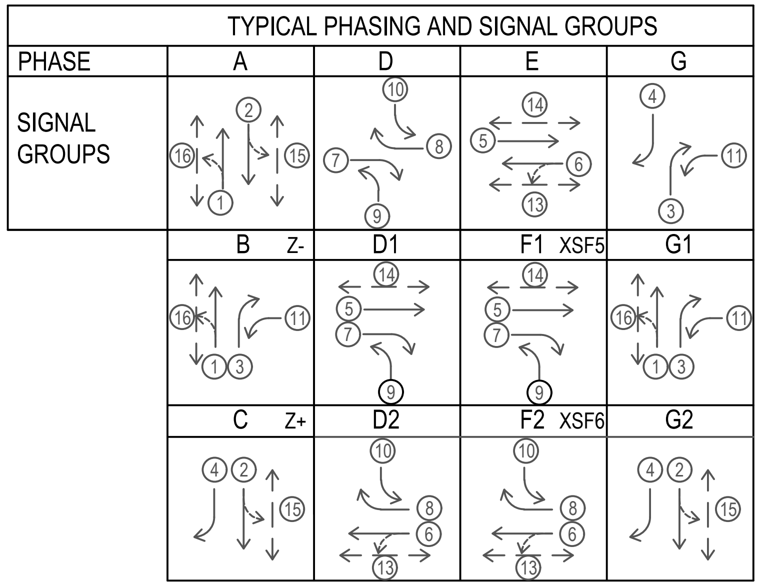
Standard Signal and Phasing Layout Plan

LEGEND

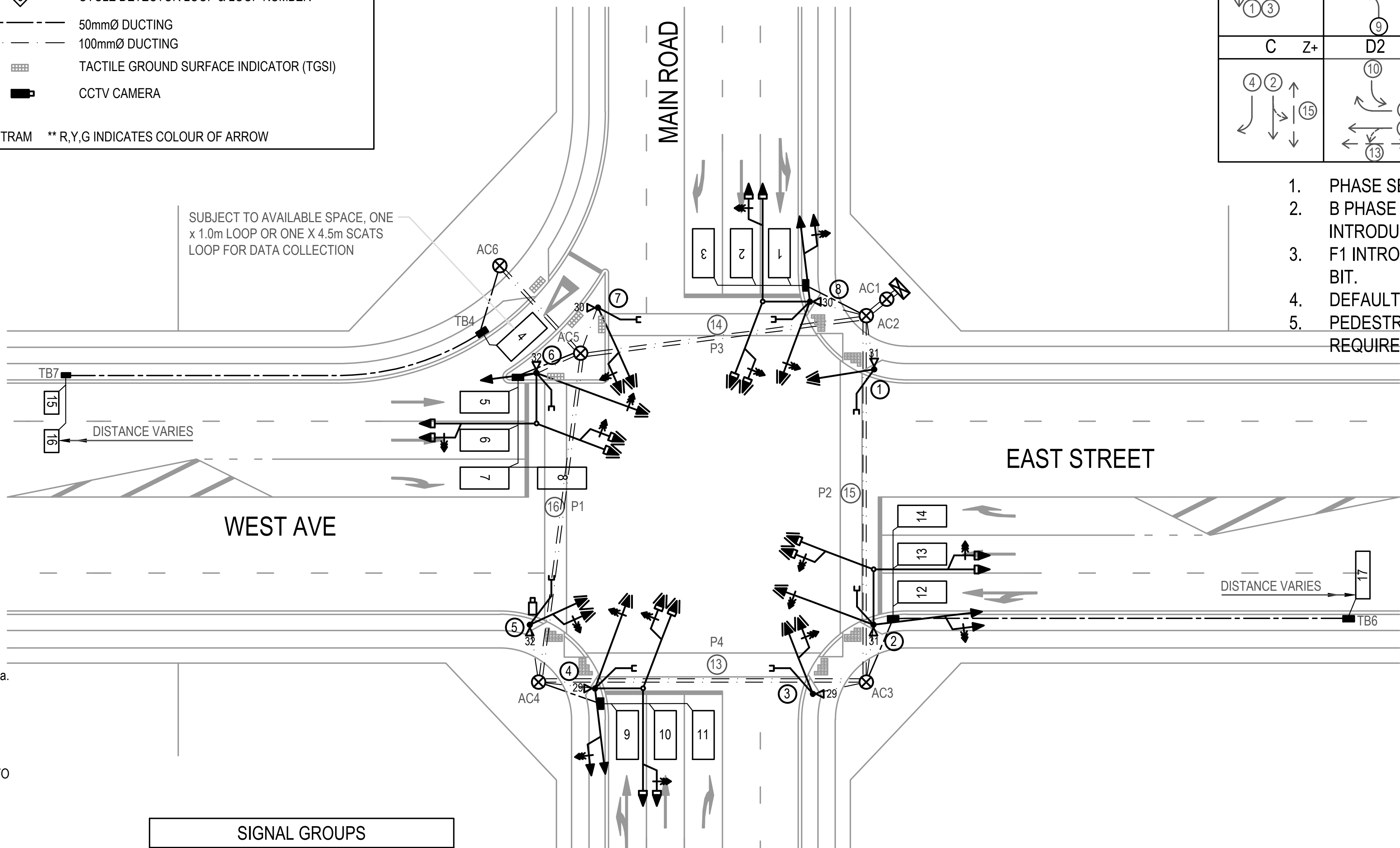
- CONTROLLER
- SIGNAL DUCT ACCESS CHAMBER AND NUMBER (AC6)
- KERB SIDE JUNCTION BOX (KJB) AND NUMBER (TB4)
- POLE AND POLE NUMBER
- POLE WITH OVERHEAD MAST ARM
- 200mm ASPECTS - OPEN VISOR
- 300mm ASPECTS - OPEN VISOR
- ASPECTS WITH CLOSED VISOR
- SINGLE ASPECT SPECIAL VEHICLE DISPLAY *
- 3 ASPECT DISPLAY
- SINGLE COLUMN 4 ASPECT DISPLAY
- 3 ASPECT SINGLE ARROW DISPLAY **
- 3 ASPECT THREE ARROW DISPLAY
- 3 ASPECT DISPLAY WITH SUPPLEMENTARY ARROW DISPLAY **
- 3 ASPECT DISPLAY WITH SUPPLEMENTARY TWO ARROW DISPLAY **
- 3 ASPECT DISPLAY WITH SUPPLEMENTARY THREE ARROW DISPLAY
- PEDESTRIAN ASPECTS
- PEDESTRIAN CALL BOX & INPUT NUMBER (16)
- CYCLE CALL BOX
- DETECTOR LOOP & LOOP NUMBER (6)
- DETECTOR LOOP - ADVANCE LOOP & LOOP NUMBER (12, 11)
- CYCLE DETECTOR LOOP & LOOP NUMBER (6)
- 50mmØ DUCTING
- 100mmØ DUCTING
- TACTILE GROUND SURFACE INDICATOR (TGSI)
- CCTV CAMERA

* B FOR BUSES, C FOR CYCLES & T FOR LIGHT TRAM ** R,Y,G INDICATES COLOUR OF ARROW

TYPICAL PHASING AND SIGNAL GROUPS



1. PHASE SEQUENCE A : D : E : G
2. B PHASE INTRODUCED BY Z- FLAG, C PHASE INTRODUCED BY Z+ FLAG
3. F1 INTRODUCED BY XSF5 BIT, F2 INTRODUCED BY XSF6 BIT.
4. DEFAULT NON-FILTER OPERATION SG7.
5. PEDESTRIAN PROTECTION TO WK/ AT/ AIAL REQUIREMENT



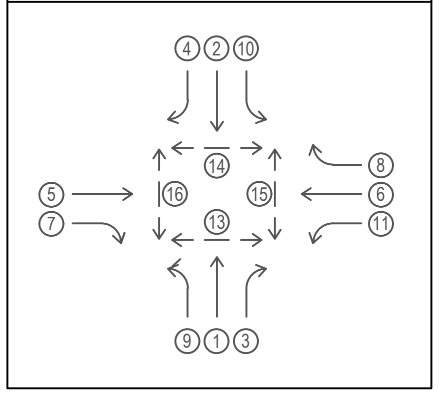
PLAN

SCALE 1:250 @ A1
OR 1:200 @ A1 (PREFERRED)

NOTES

1. FOR DUCTING AND CABLING DIAGRAMS REFER TO FIGURE 1a.
2. TRAFFIC SIGNAL EQUIPMENT AND INSTALLATION SHALL COMPLY WITH WAKA KOTAHI NZ TRANSPORT AGENCY P43 SPECIFICATION FOR TRAFFIC SIGNALS.
3. POLE POSITIONS ARE INDICATIVE ONLY. FINAL POSITIONS TO BE DETERMINED ON SITE AND AGREED WITH THE ATOC TRAFFIC SIGNAL ENGINEER.
4. CONTRACTOR TO LIAISE WITH SERVICE AUTHORITIES FOR LOCATION OF SERVICES BEFORE ANY EXCAVATION.
5. CONTRACTOR TO ALLOW FOR THE INSTALLATION OF THE PROM AND TESTING.
6. DUCTS BETWEEN CHAMBERS SHALL BE 100mm DIA.
7. IF THRUSTED, ONE 100mm DIA DUCT IS TO BE INSTALLED. IF OPEN CUT TWO 100mm DIA DUCTS ARE TO BE INSTALLED.
8. LED LANTERNS SHALL BE USED ON ALL ASPECT DISPLAYS, INCLUDING PEDESTRIAN DISPLAYS.
9. POLES 2, 4, 6 AND 8 ARE JUMAs.
10. CCTV CAMERA MOUNTED ON POLE 5.

SIGNAL GROUPS



ATOC

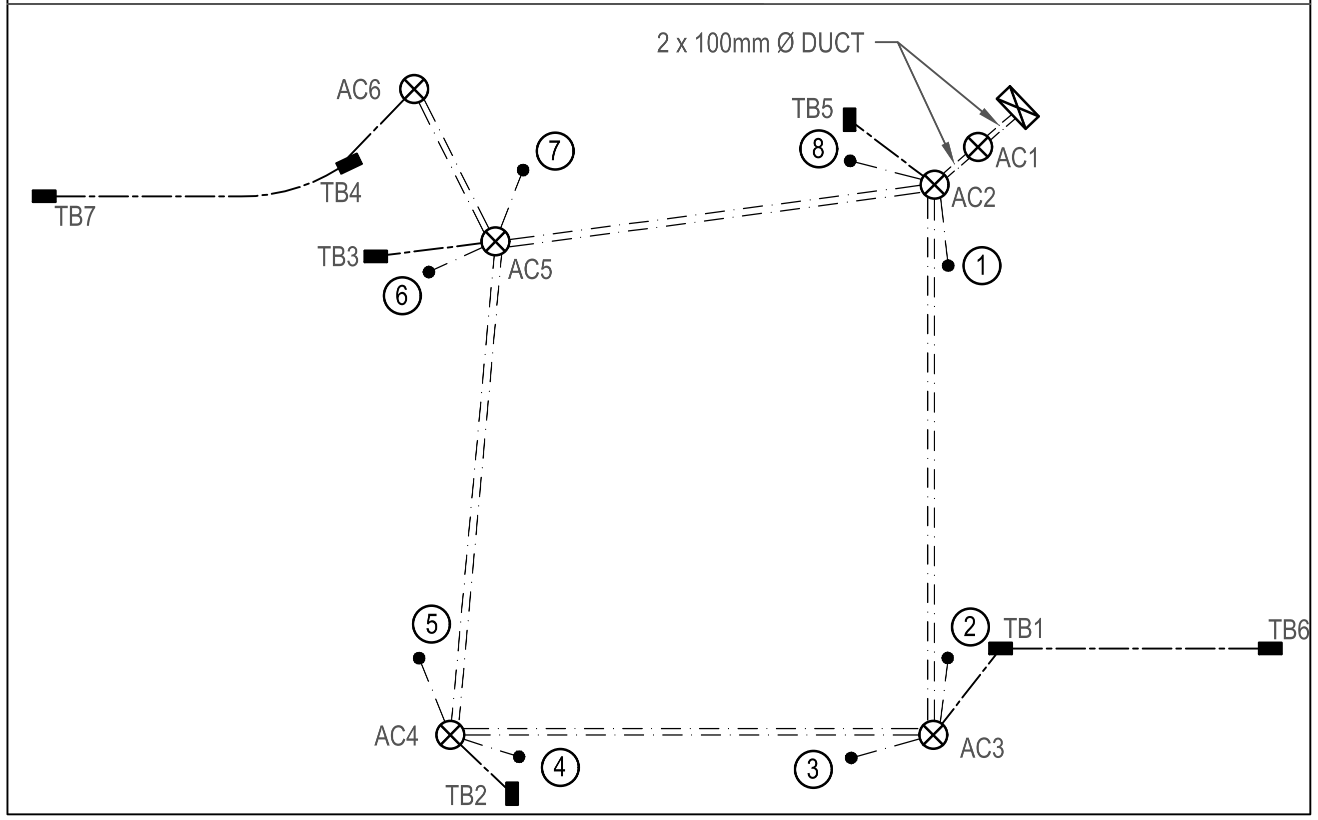
AUCKLAND TRANSPORT OPERATION CENTRE (ATOC)
TRAFFIC SIGNAL STANDARDS

NOT TO SCALE

TRAFFIC SIGNAL LAYOUT AND PHASING PLAN

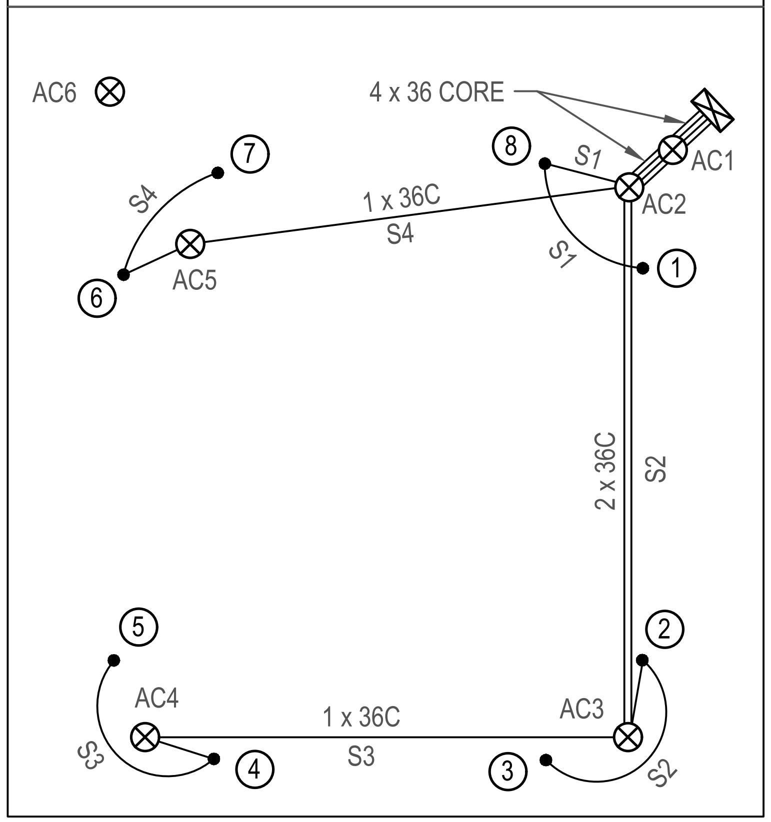
Figure 1

DUCTING DIAGRAM



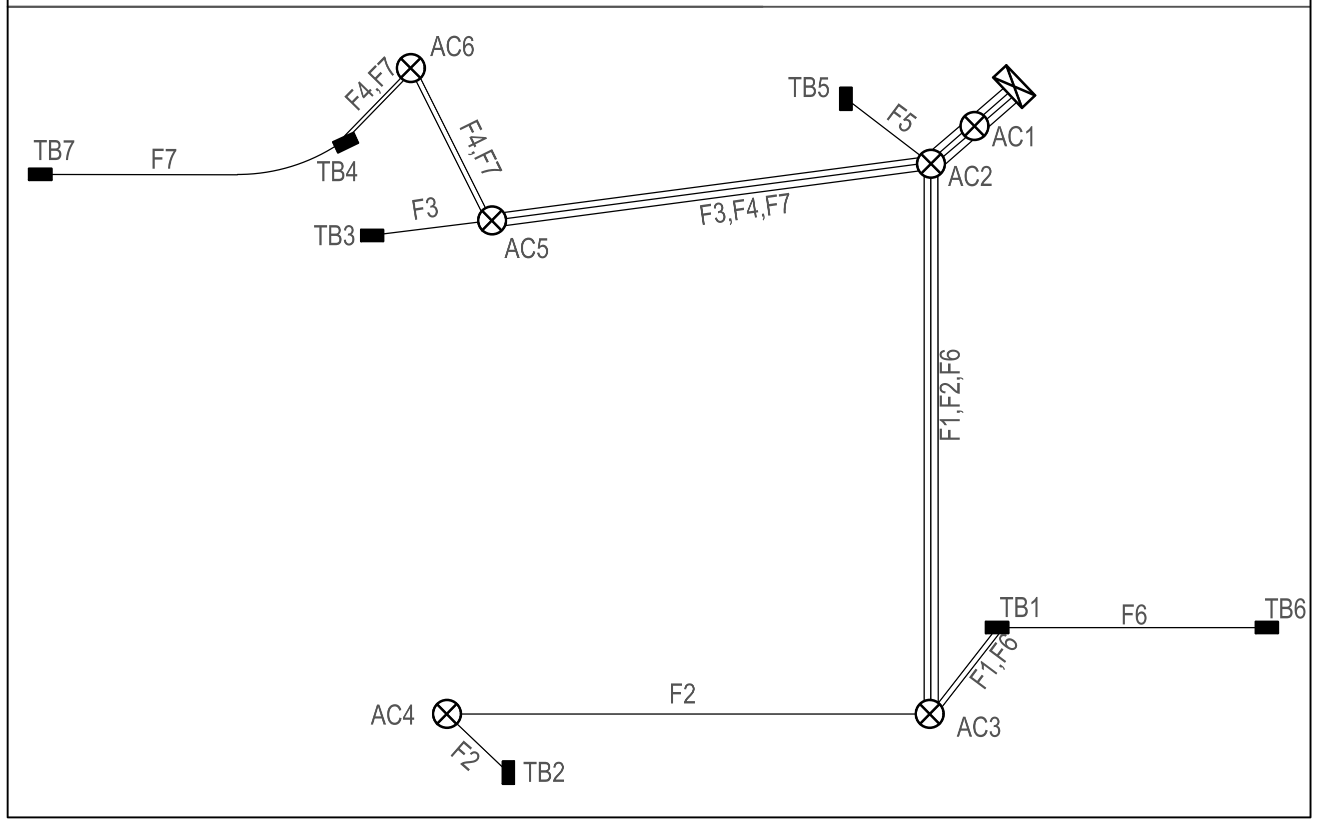
N.T.S

SIGNAL CABLING DIAGRAM



N.T.S

FEEDER CABLING DIAGRAM



N.T.S

ATOC

AUCKLAND TRANSPORT OPERATION CENTRE (ATOC)
TRAFFIC SIGNAL STANDARDS

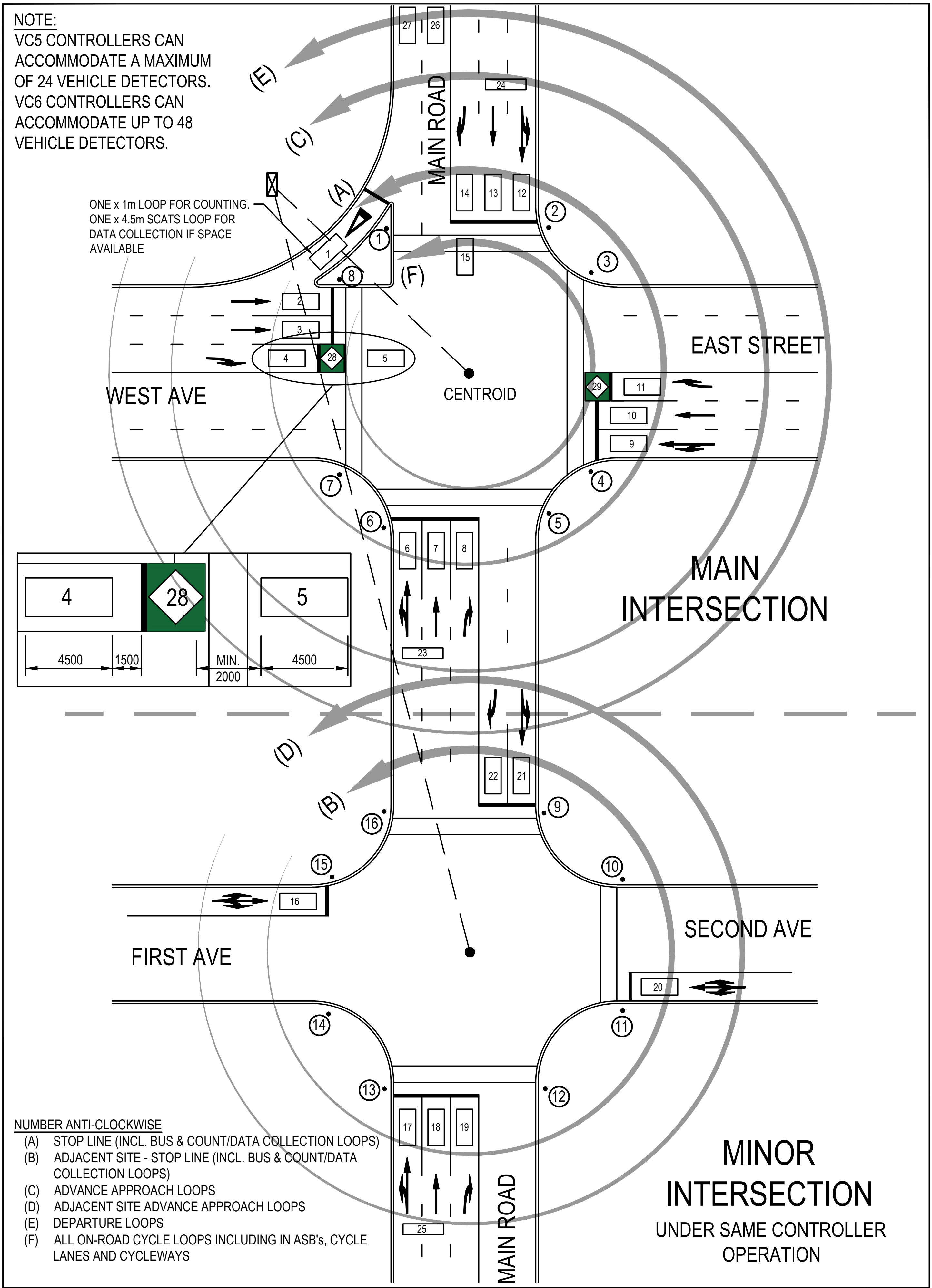
NOT TO SCALE

TRAFFIC SIGNAL CABLING AND DUCTING PLAN

Figure 1a

Appendix B

Example of Standard Detector Numbering



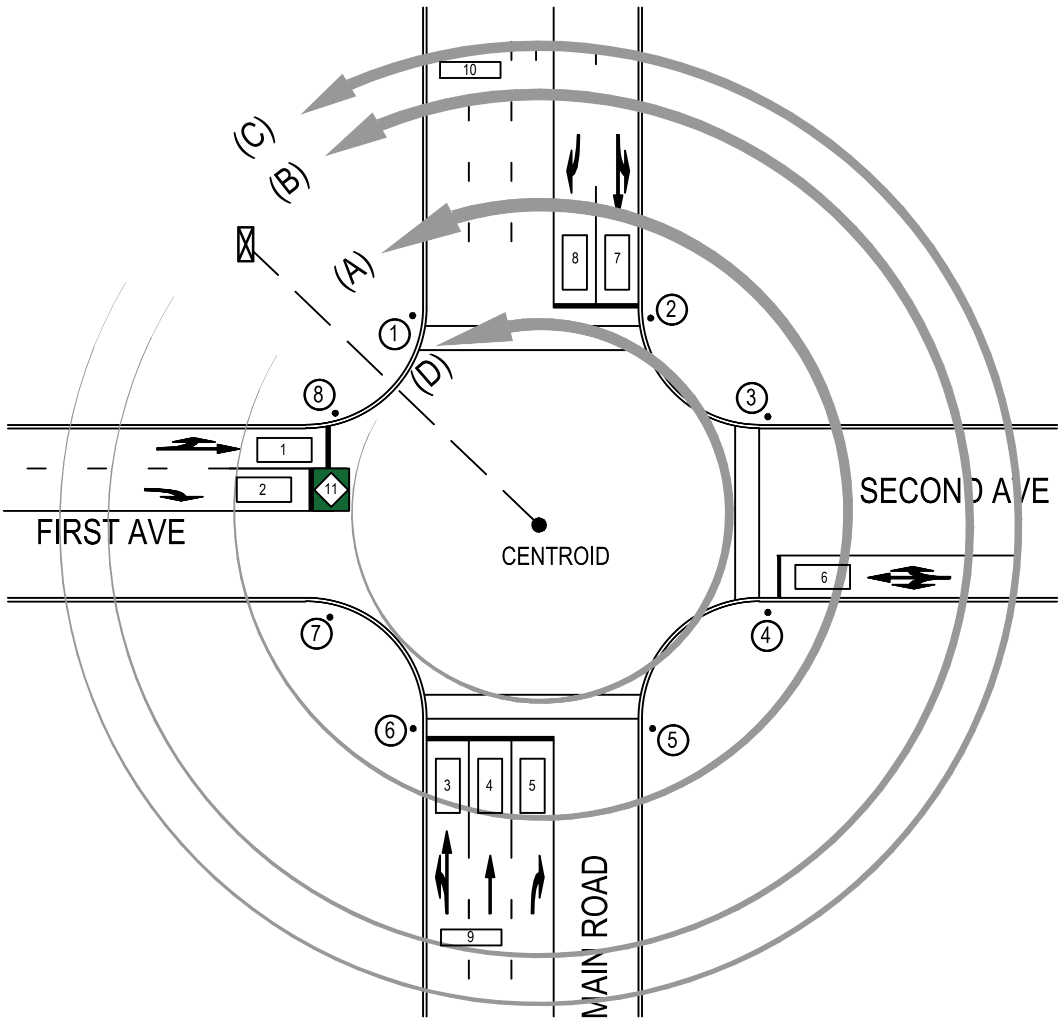
ATOC

AUCKLAND TRANSPORT OPERATION CENTRE (ATOC)
TRAFFIC SIGNAL STANDARDS

STANDARD DETECTOR NUMBERING
MAIN INTERSECTION WITH SECONDARY INTERSECTION
Figure 2

NOT TO SCALE

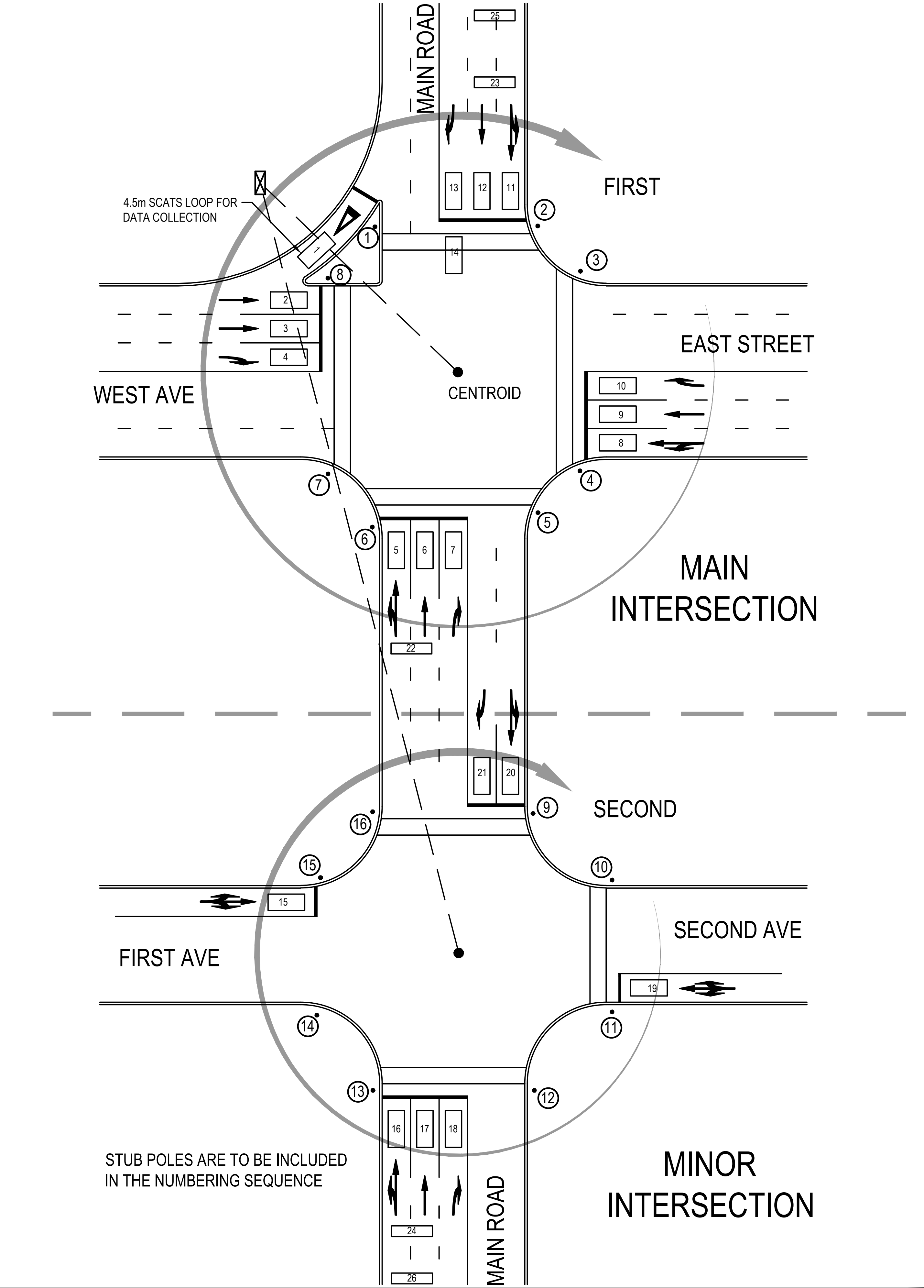
NOTE:
VC5 CONTROLLERS CAN ACCOMMODATE A MAXIMUM OF 24 VEHICLE DETECTORS.
VC6 CONTROLLERS CAN ACCOMMODATE UP TO 48 VEHICLE DETECTORS.



NUMBER ANTI-CLOCKWISE
(A) STOP LINE (INCL. BUS & COUNT/DATA COLLECTION LOOPS)
(B) ADVANCE APPROACH LOOPS
(C) DEPARTURE LOOPS
(D) ALL ON-ROAD CYCLE LOOPS INCLUDING IN ASB's, CYCLE LANES AND CYCLEWAYS

Appendix C

Examples of Standard Pole Numbering



ATOC

AUCKLAND TRANSPORT OPERATION CENTRE (ATOC)
TRAFFIC SIGNAL STANDARDS

NOT TO SCALE

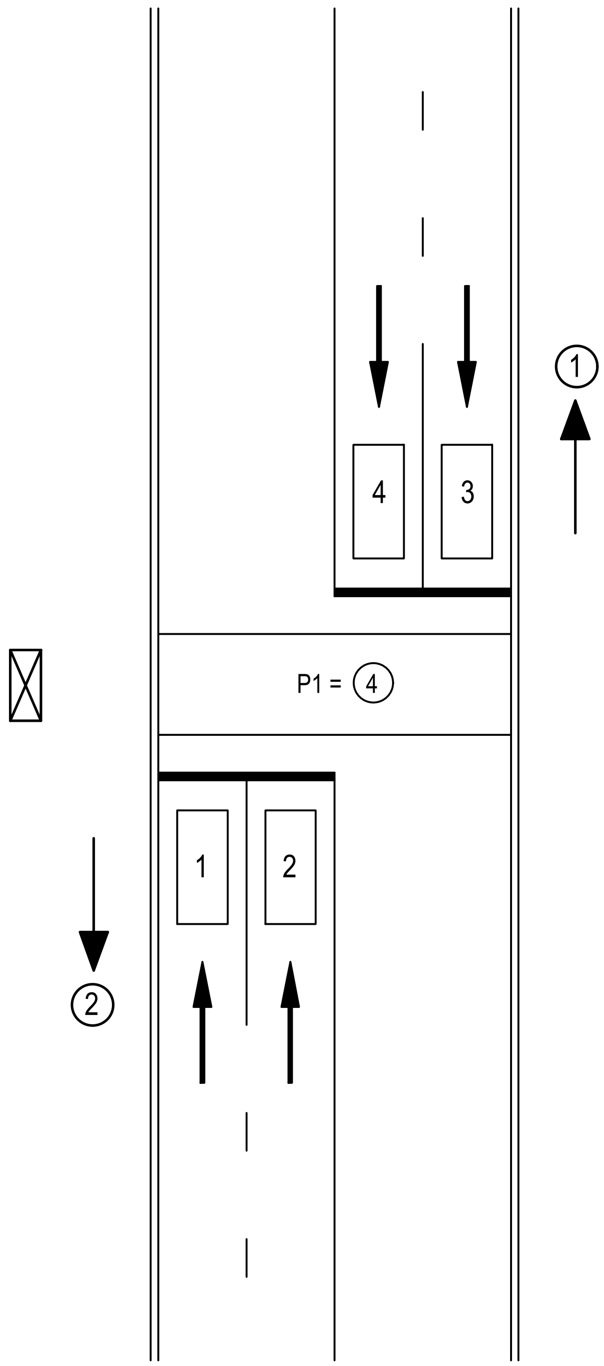
STANDARD POLE NUMBERING

Figure 3

Appendix D

Examples of Standard Signal Group Numbering and Phasing

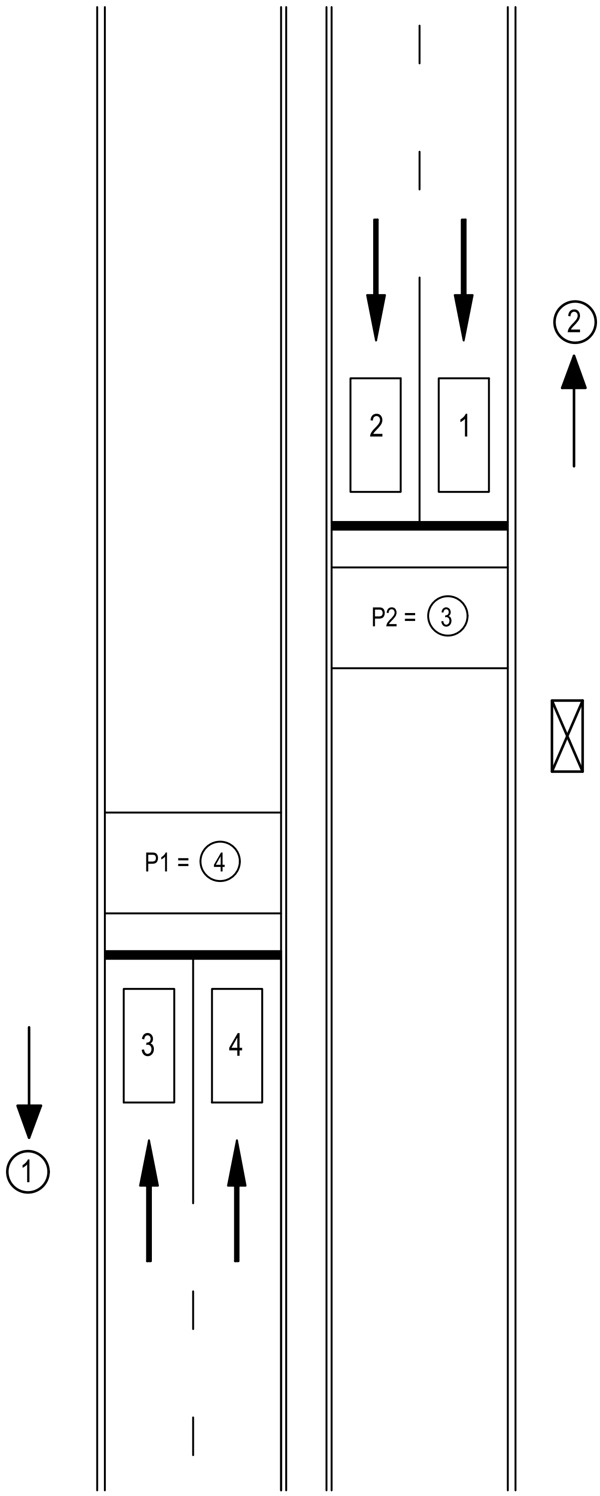
EXAMPLE



TYPICAL PHASING				
PHASE	A	B	C Z+	D Z+
SIGNAL GROUPS	① ↑↓ ②	P1 ④	① ↑↓ ②	P1 ④

PHASE SEQUENCE A : B
ALTERNATIVE PHASE SEQUENCE A : B : C : D

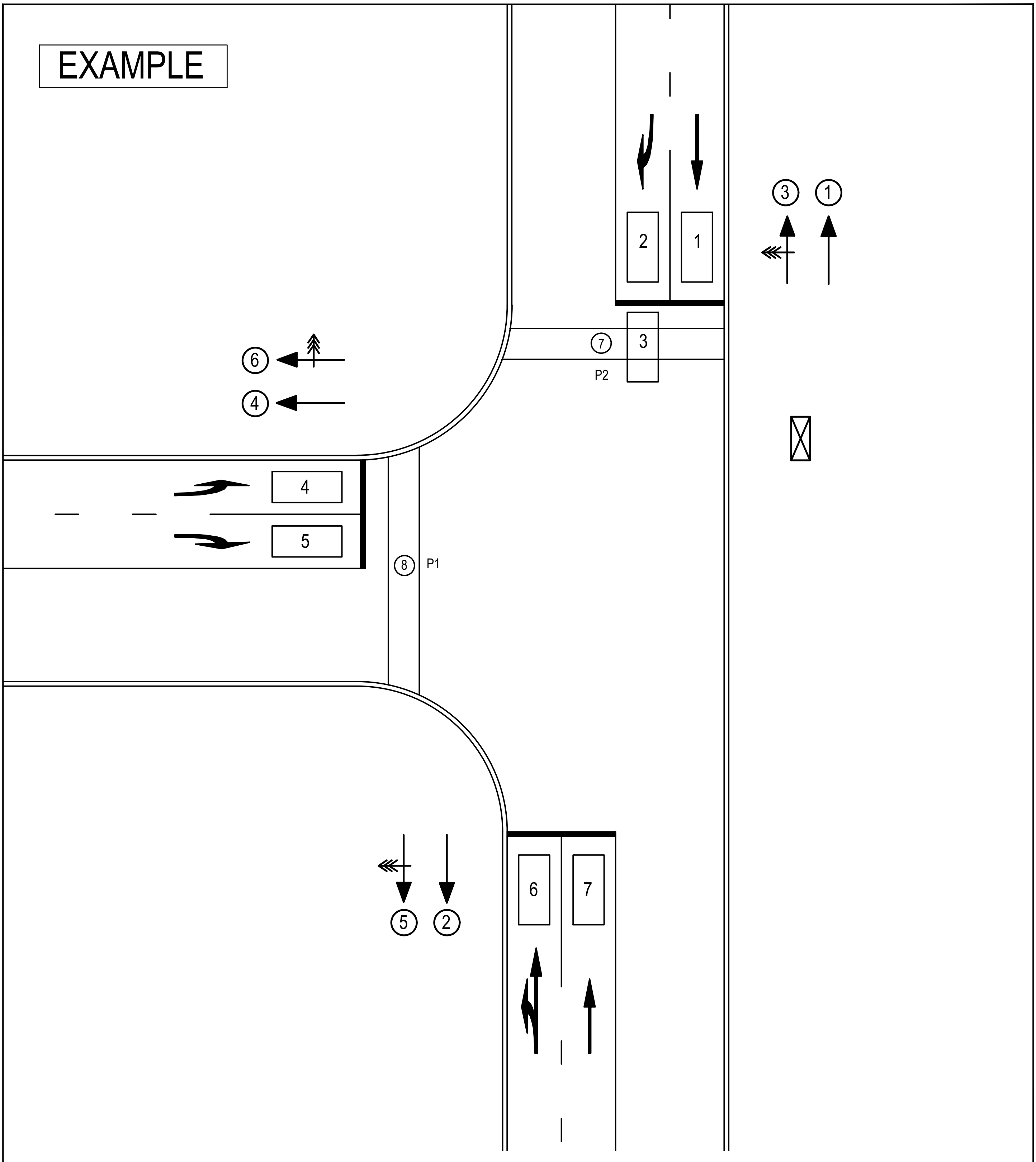
EXAMPLE



TYPICAL PHASING				
PHASE	A	A1	A2	B
SIGNAL GROUPS	1 2	P1 4 2	1 P2 3	USED FOR SCATS PURPOSES ONLY

PHASE SEQUENCE A : B
ALTERNATIVE PHASE SEQUENCE A : B

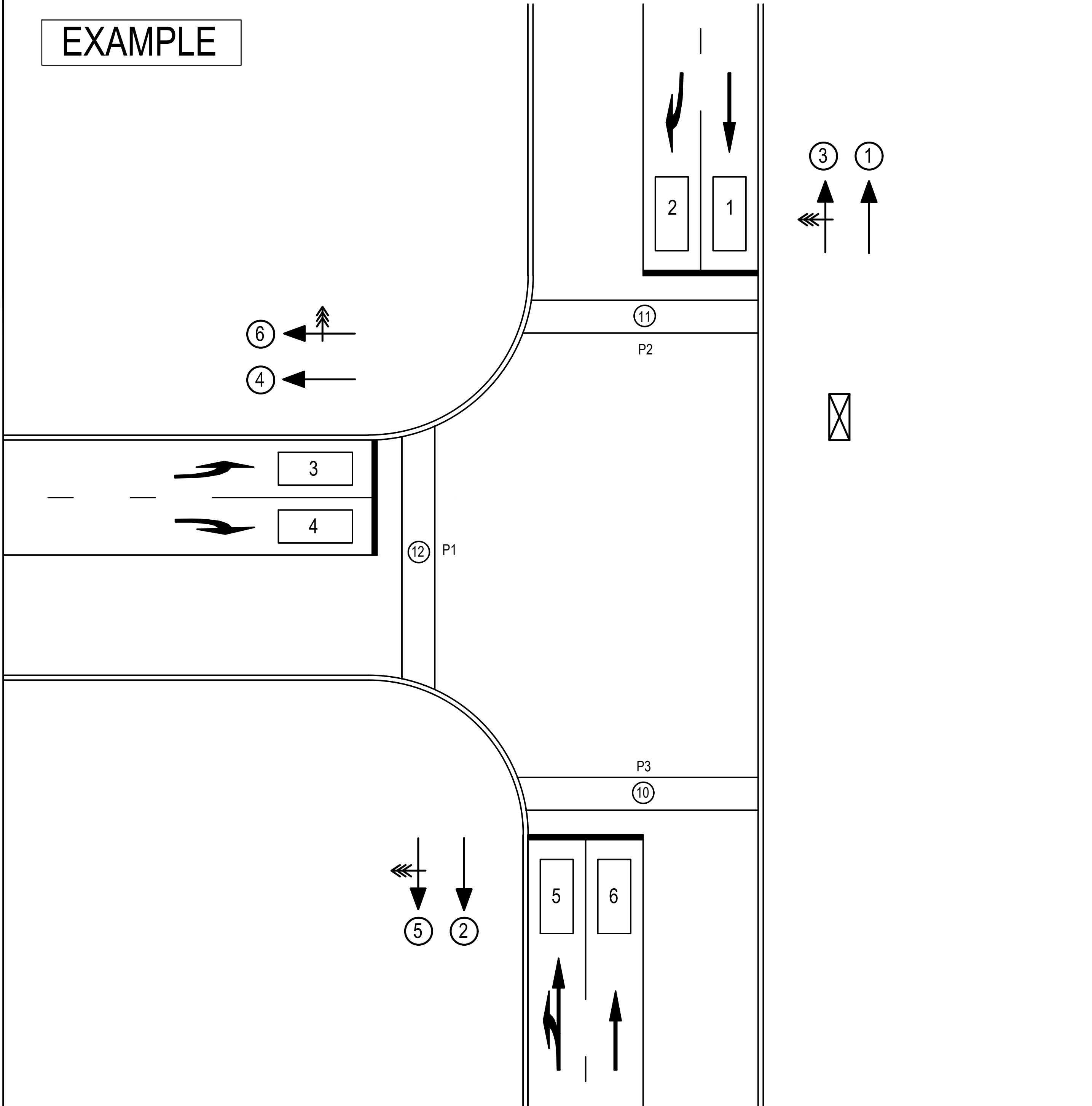
EXAMPLE



TYPICAL PHASING				
PHASE	A	B Z+	C	D
SIGNAL GROUPS	1, 8, 5, 2	3, 1, 6	7, 6, 4, 5	3, 1, 6

PHASE SEQUENCE A : C : D ALTERNATIVE PHASE SEQUENCE A : B : C : D
8 GROUP CONTROLLER ASSUMED

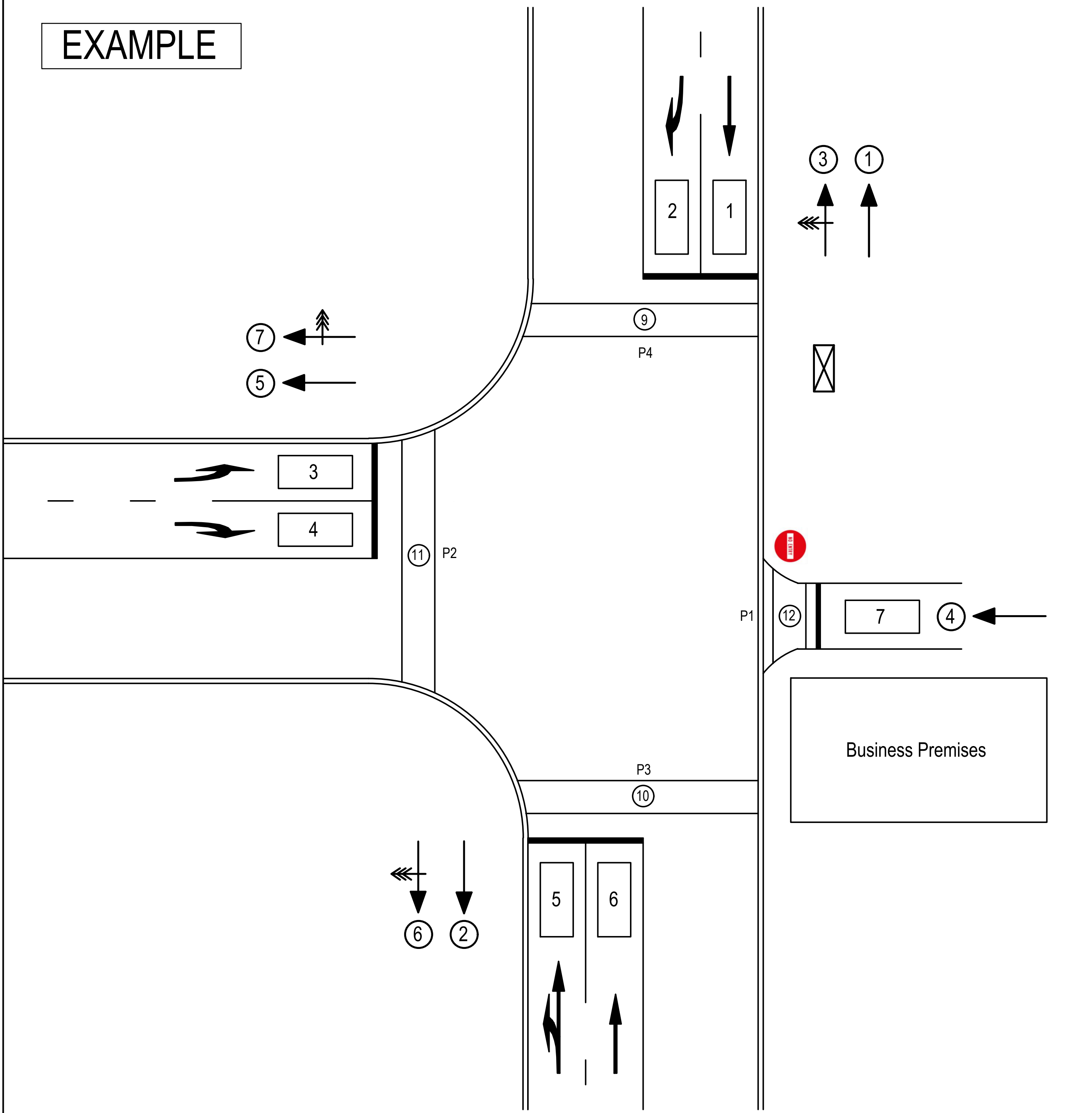
EXAMPLE

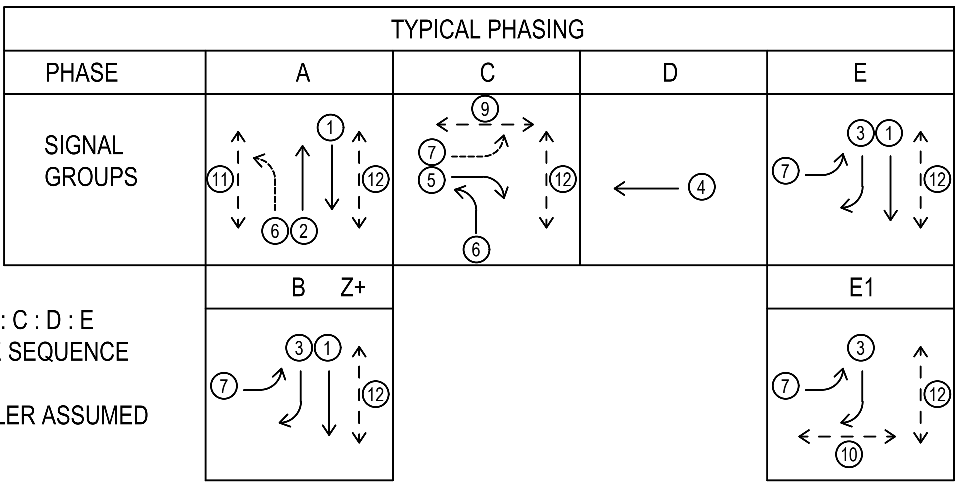


TYPICAL PHASING				
PHASE	A	B Z+	C	D
SIGNAL GROUPS	1, 12, 5, 2	3, 1, 6	11, 6, 4, 5	6, 10
				D1
				3, 1, 6

PHASE SEQUENCE A : C : D
ALTERNATIVE PHASE SEQUENCE A : B : C : D
12 GROUP CONTROLLER ASSUMED

EXAMPLE





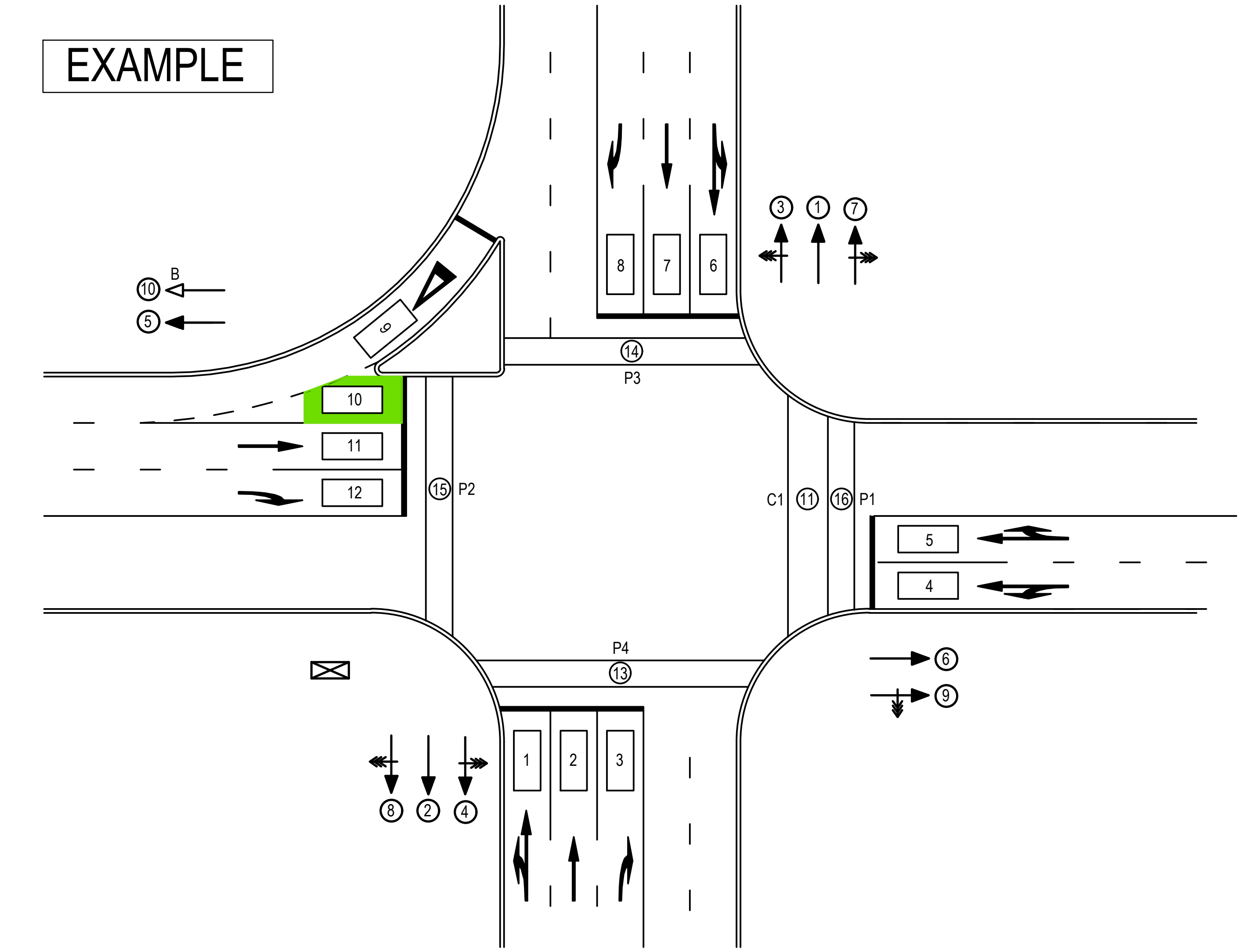
PHASE SEQUENCE A : C : D : E
ALTERNATIVE PHASE SEQUENCE
A : B : C : D : E
12 GROUP CONTROLLER ASSUMED

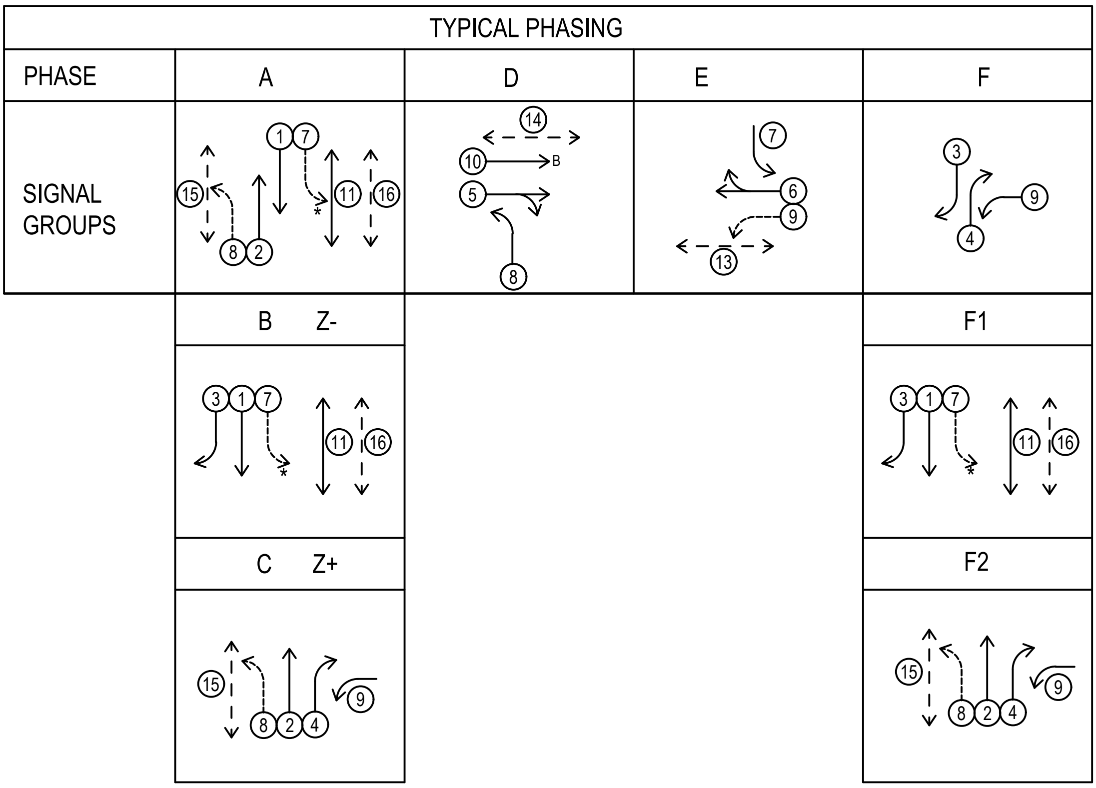
ATOC

AUCKLAND TRANSPORT OPERATION CENTRE (ATOC)
TRAFFIC SIGNAL STANDARDS

NOT TO SCALE

STANDARD SIGNAL GROUP NUMBERING
'T' INTERSECTION WITH TWO MAIN ROAD CROSSINGS
(ALTERNATIVE)
Figure 5b





PHASE SEQUENCE A : D : E : F

PEDESTRIAN PROTECTION TO BE SPECIFIED
*FULL PROTECTION C1 vs. SG7

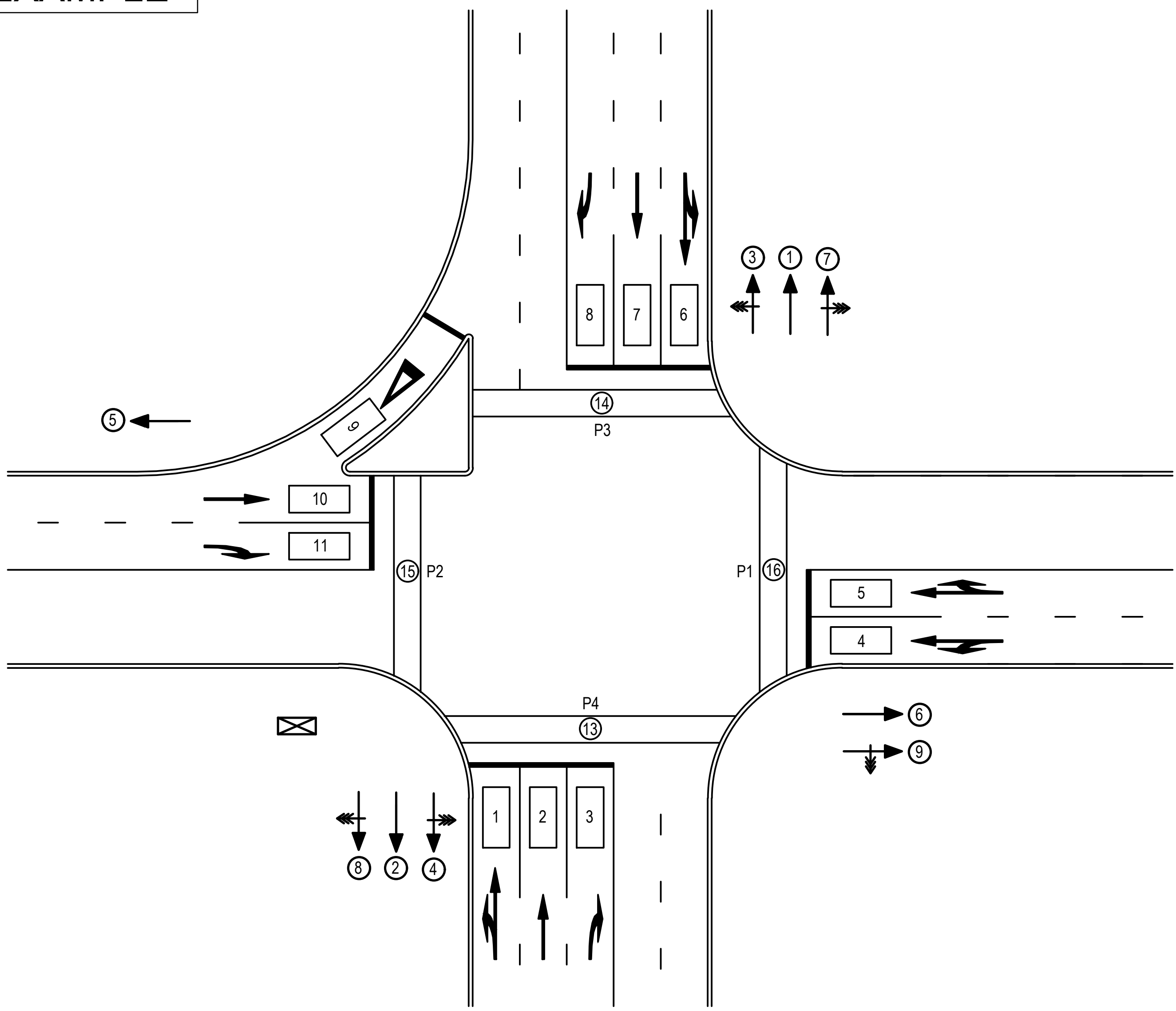
ATOC

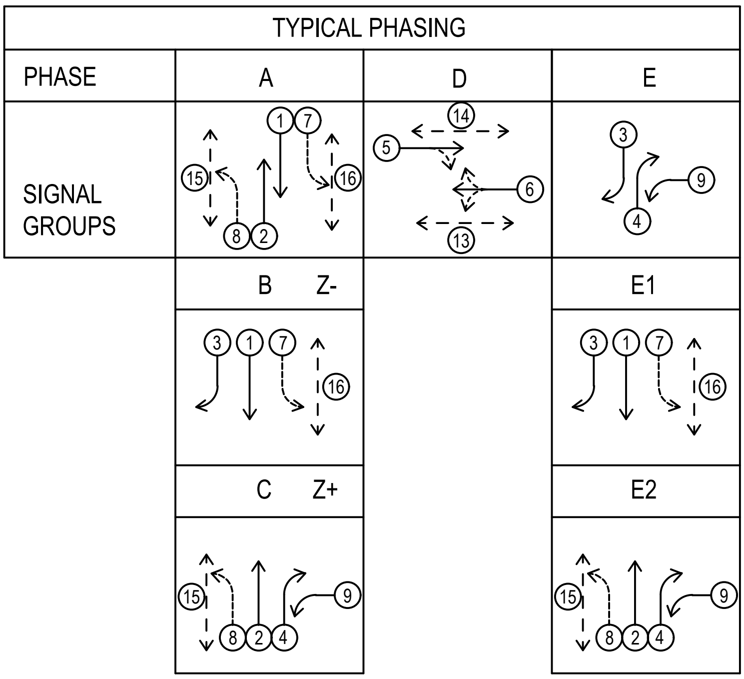
AUCKLAND TRANSPORT OPERATION CENTRE (ATOC)
TRAFFIC SIGNAL STANDARDS

NOT TO SCALE

STANDARD SIGNAL GROUP NUMBERING
SINGLE DIAMOND OVERLAP WITH SPLIT SIDE ROAD PHASES
Figure 6

EXAMPLE

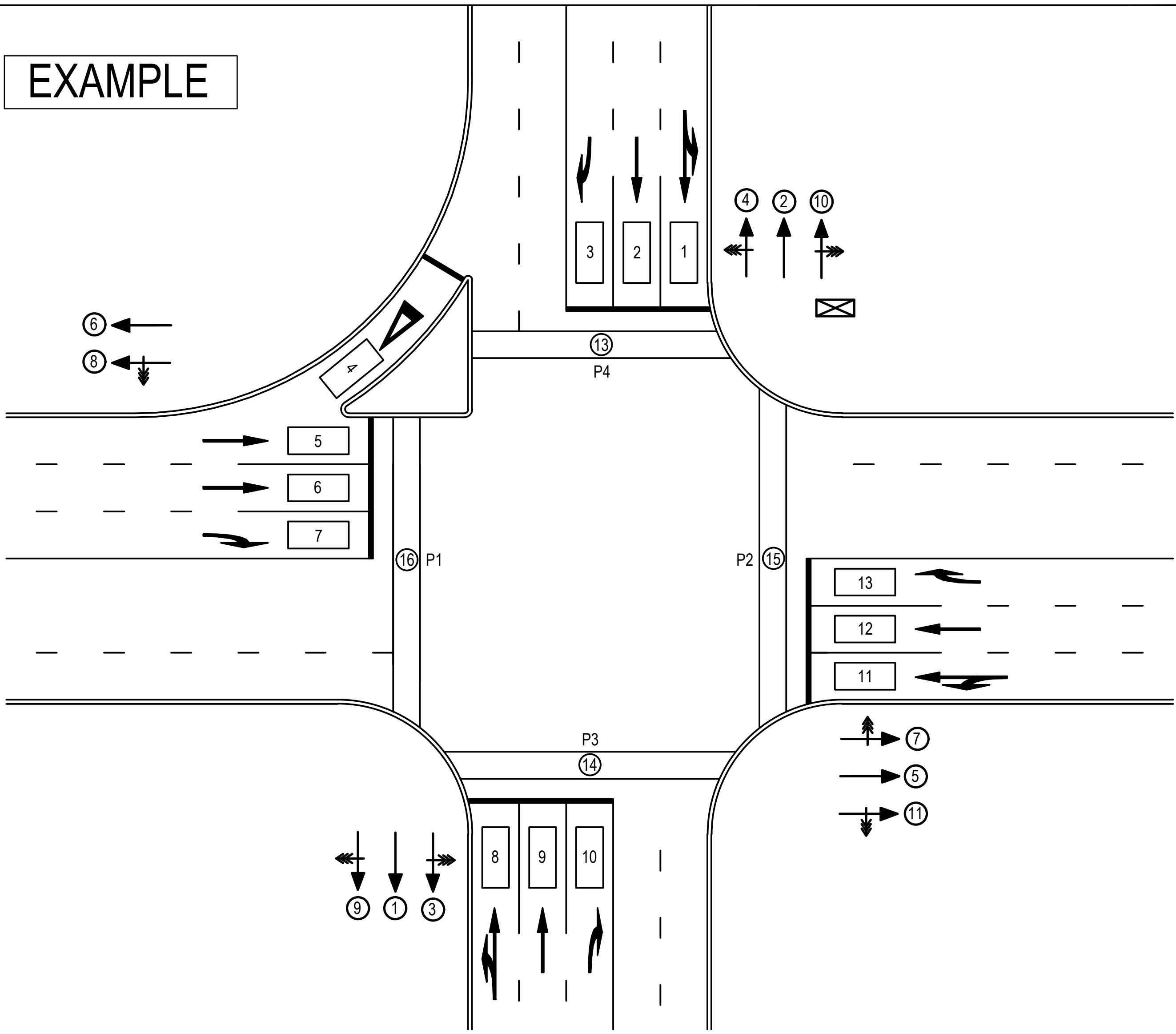


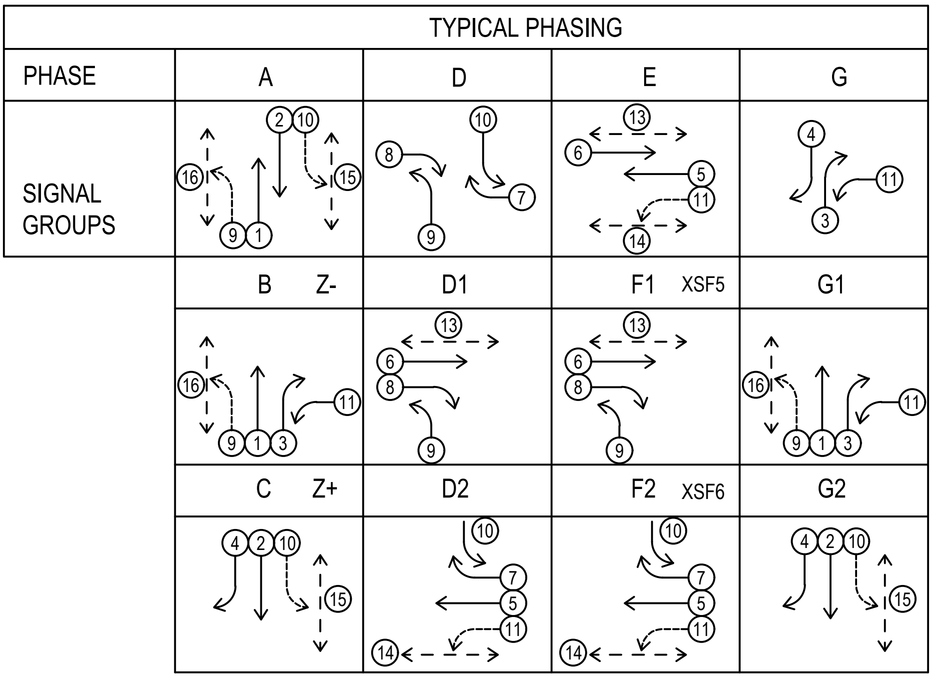


PHASE SEQUENCE A : D : E
PEDESTRIAN PROTECTION TO BE SPECIFIED

STANDARD SIGNAL GROUP NUMBERING
SINGLE DIAMOND OVERLAP WITH COMBINED SIDE ROAD PHASES
Figure 7

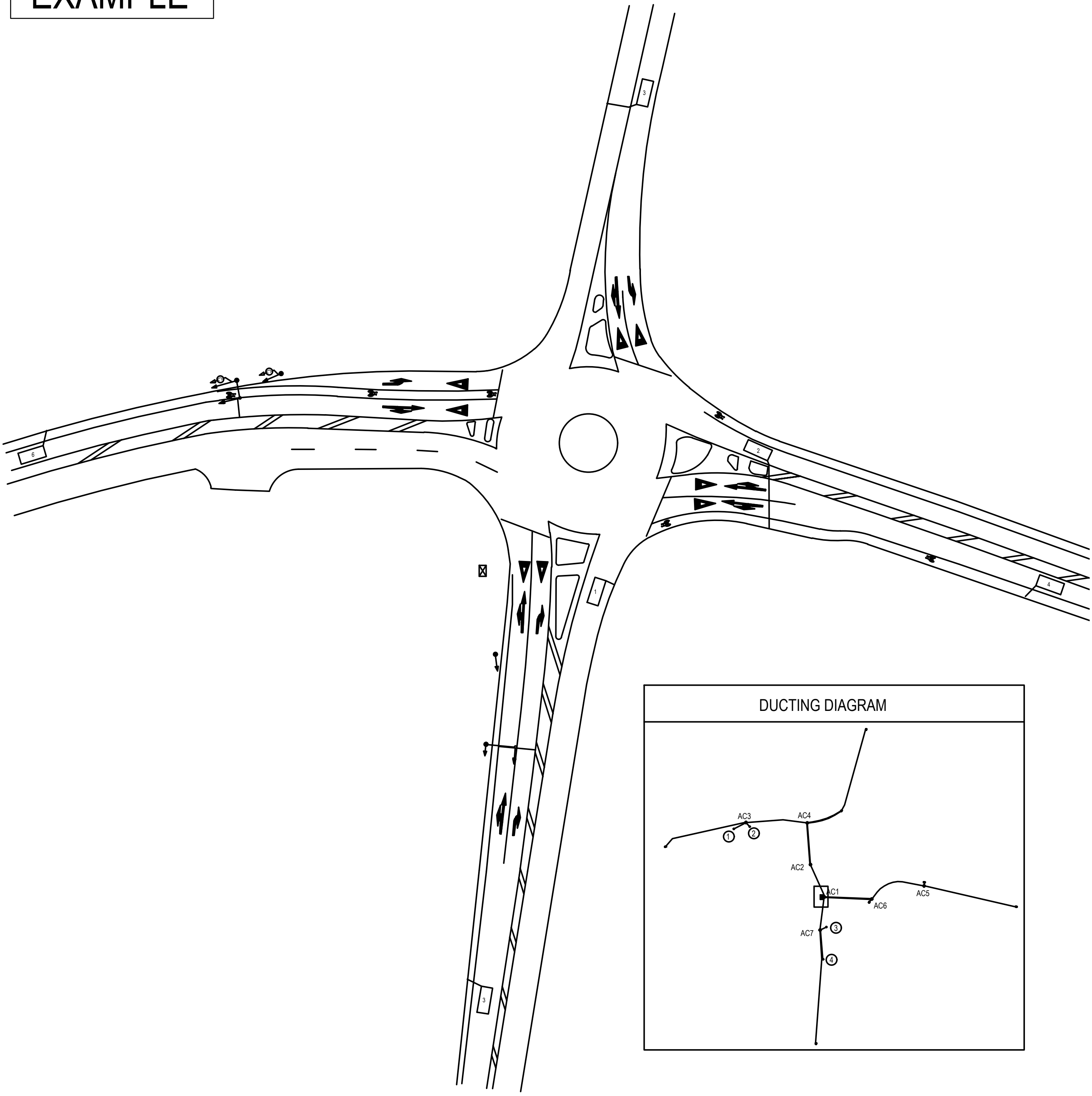
NOT TO SCALE



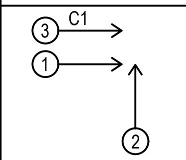
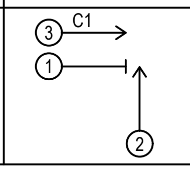
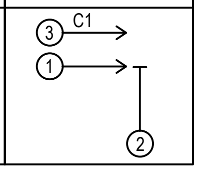


PHASE SEQUENCE A : D : E : G
PEDESTRIAN PROTECTION TO BE SPECIFIED

EXAMPLE



TYPICAL PHASING

PHASE	A	B	C
SIGNAL GROUPS			

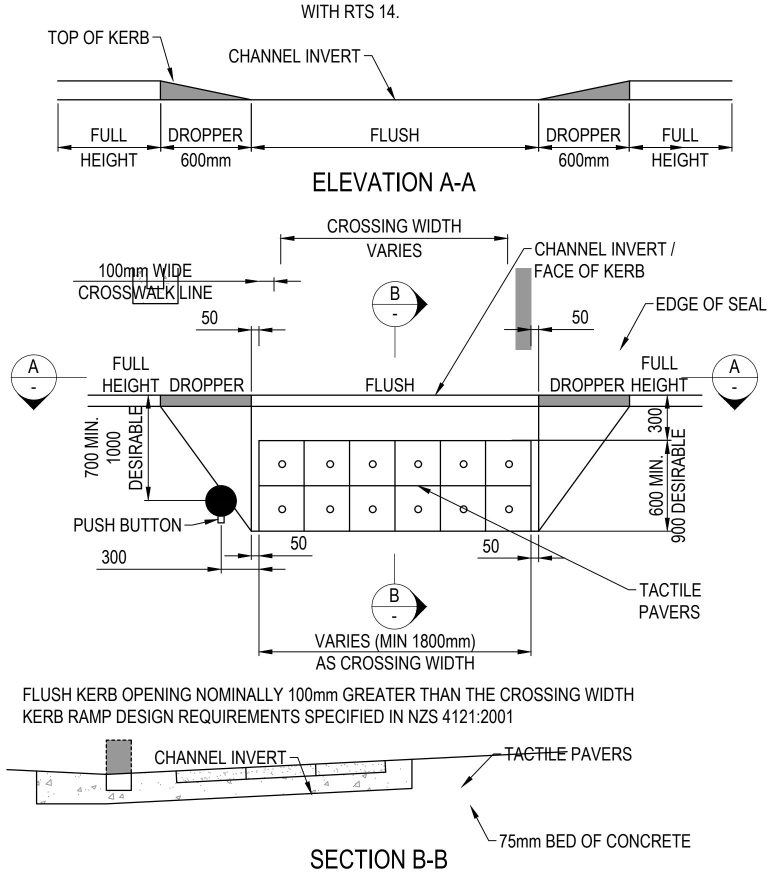
PHASE SEQUENCE A : B : C

Appendix E

Examples of Standard Signal Details

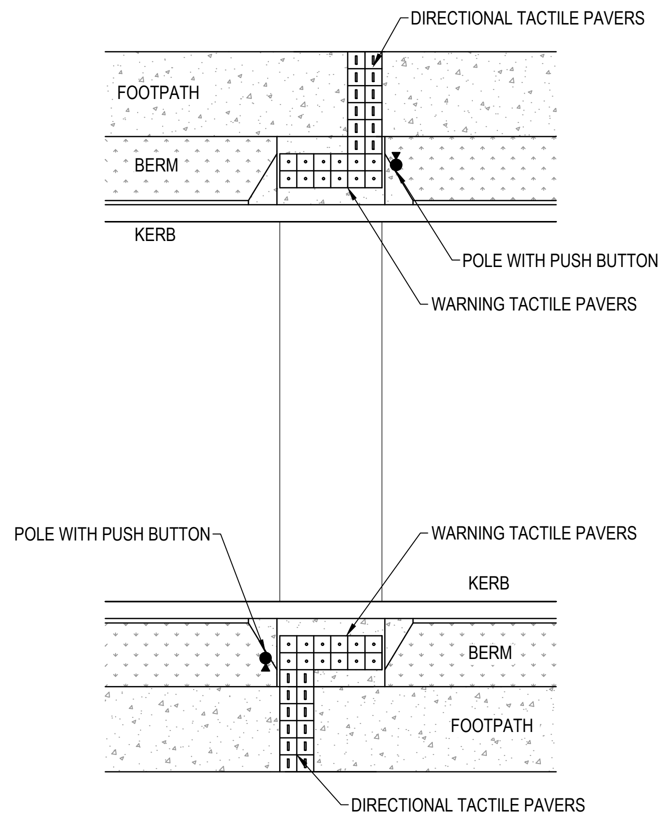
STANDARD FIGURE K6.1

ALL TACTILE PAVERS AND CROSSINGS TO COMPLY WITH RTS 14.

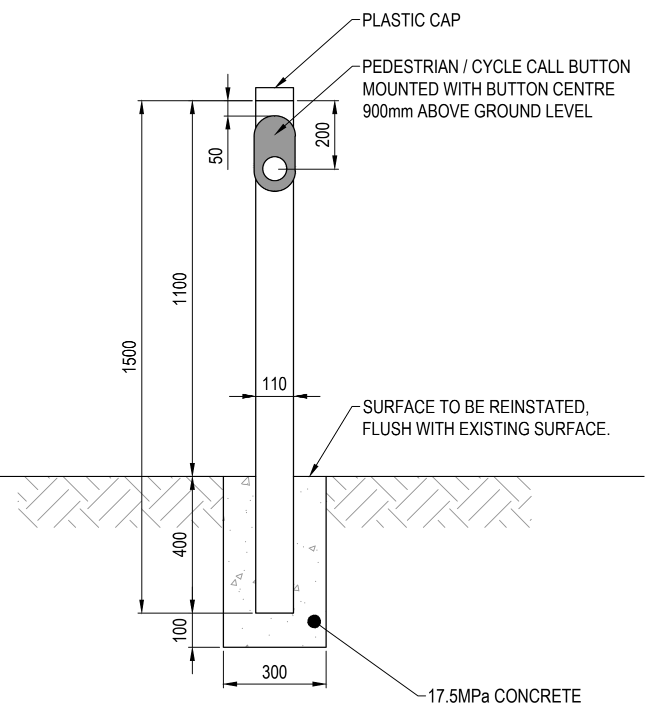


TYPICAL WARNING TACTILE PAVER LAYOUT DETAILS

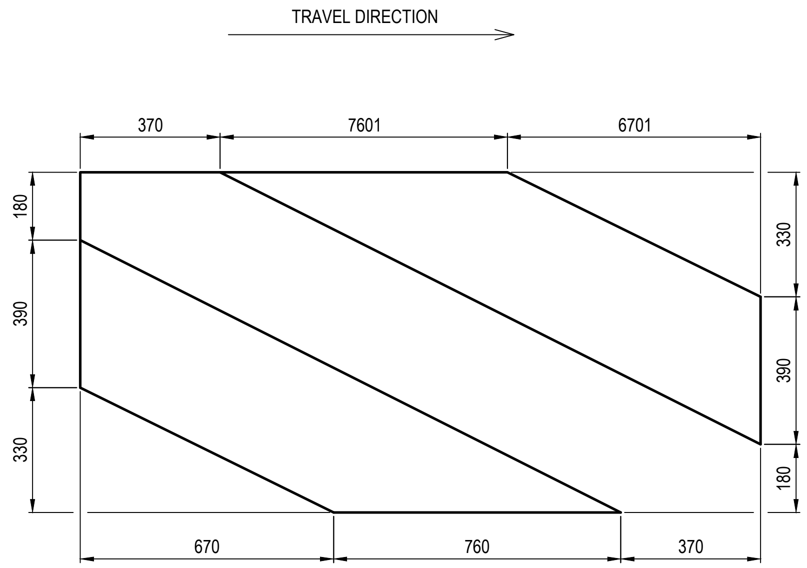
STANDARD FIGURE K6.2



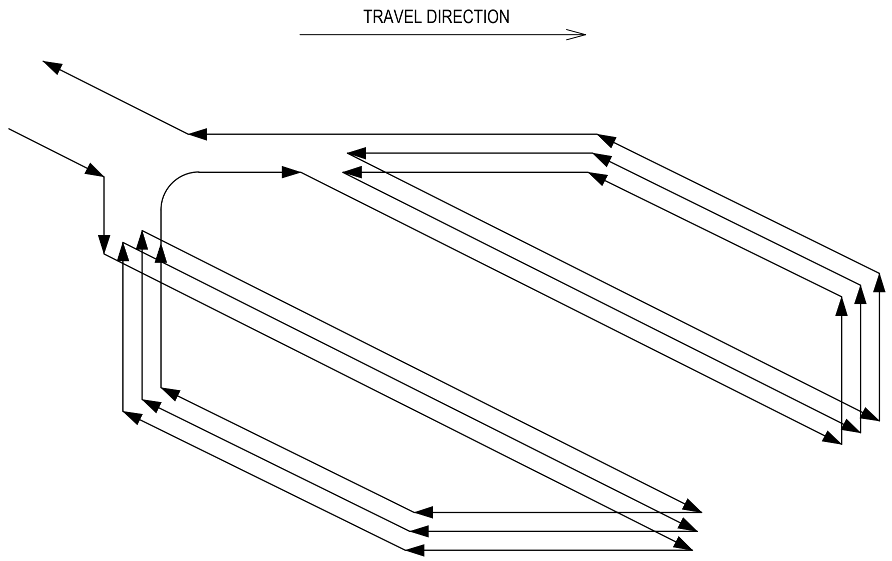
TYPICAL DIRECTIONAL TACTILE PAVER LAYOUT DETAIL



STUB POLE INSTALLATION & FOOTING DETAILS



DIMENSIONS



WINDING DETAIL (4 LOOPS)

CYCLE LOOP - DIAGONAL QUADRUPLE GEOMETRY

NOTE: Details have been developed and completed from various sources including but not limited to Auckland Transport, RTS-14 and manufactures/suppliers. Designers have responsibility for checking details are the most up to date version available

ATOC

AUCKLAND TRANSPORT OPERATION CENTRE (ATOC)
TRAFFIC SIGNAL STANDARDS

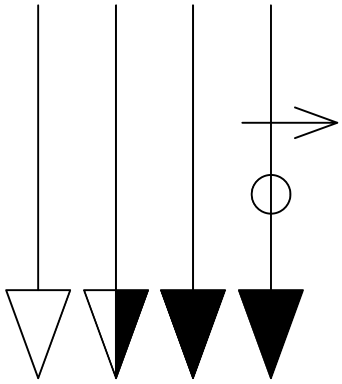
NOT TO SCALE

STANDARD DETAILS
Figure 10

Appendix F

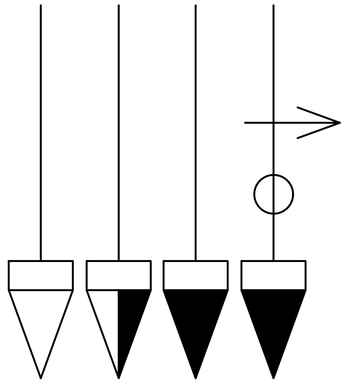
Standard Traffic Signal Lantern Display Symbols

TYPICAL SYMBOL OPTIONS



1 2 3 4

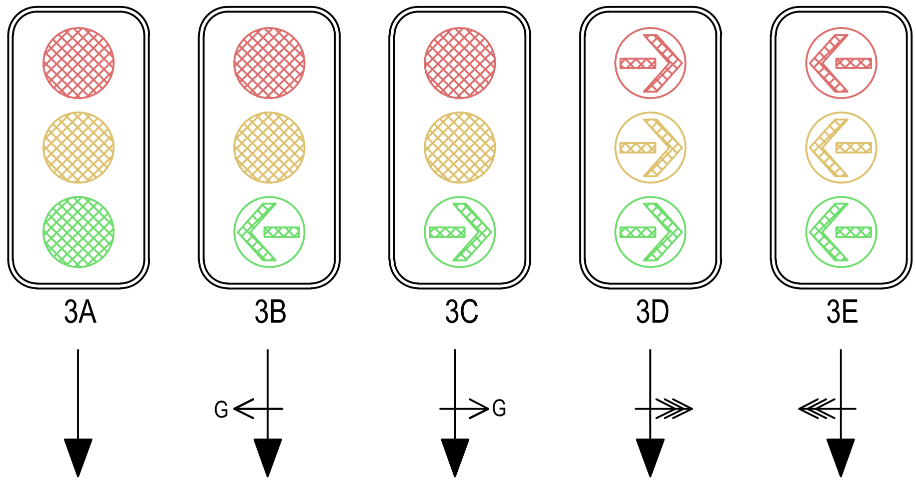
200mm ASPECTS



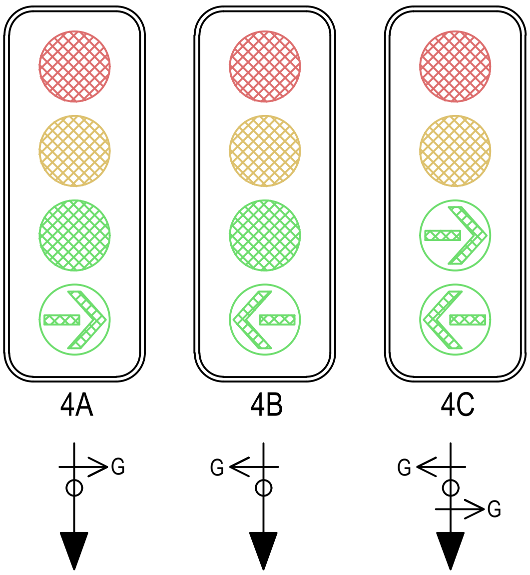
1 2 3 4

300mm ASPECTS

SINGLE COLUMN 3 ASPECT



SINGLE COLUMN 4 ASPECT



ATOC

WAKA KOTAHI

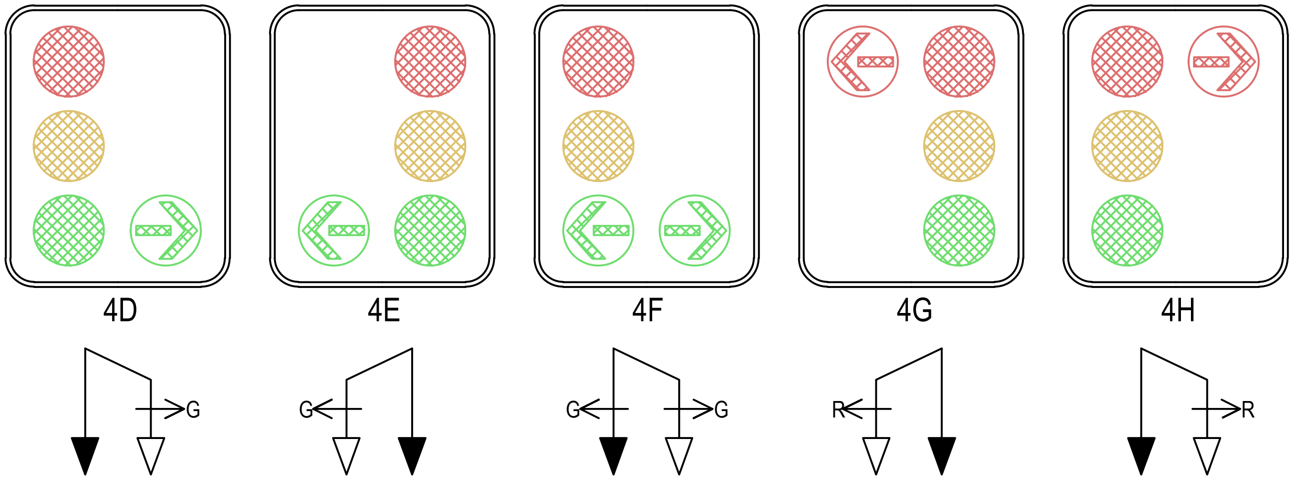
AUCKLAND TRANSPORT OPERATION CENTRE (ATOC)
TRAFFIC SIGNAL STANDARDS

NOT TO SCALE

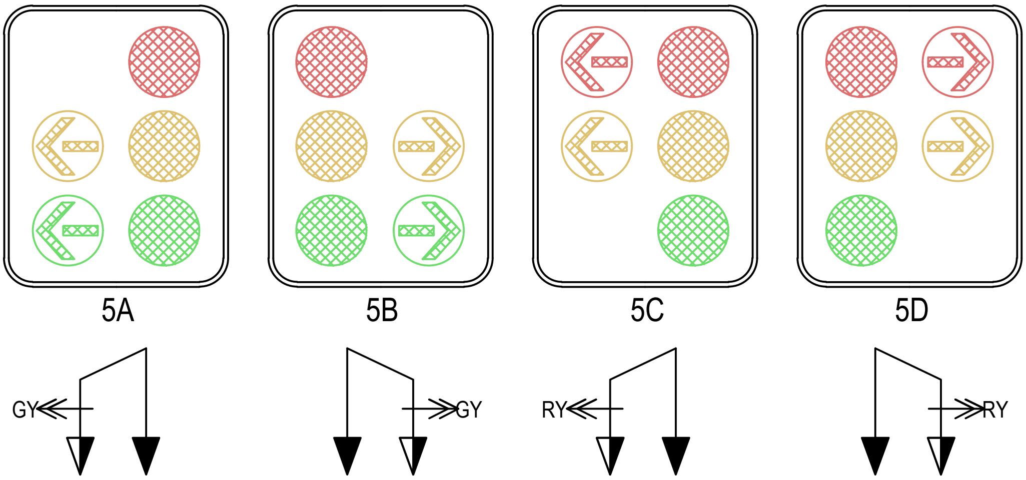
STANDARD LANTERN DISPLAYS & SYMBOLS

Figure 1

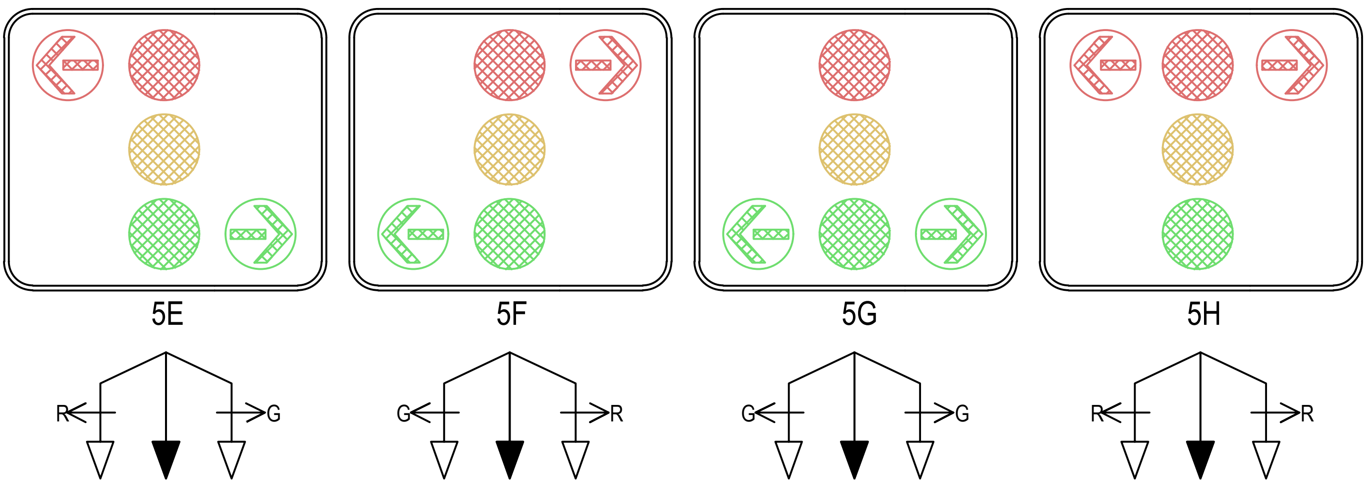
TWO COLUMN 4 ASPECT



TWO COLUMN 5 ASPECT



THREE COLUMN 5 ASPECT



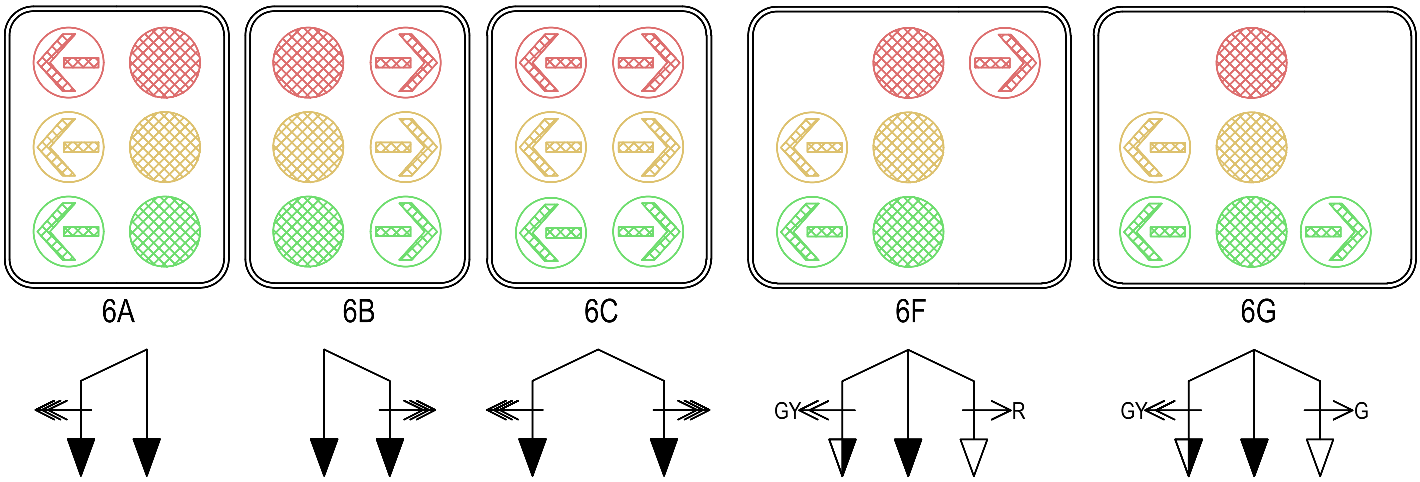
NOT TO SCALE

STANDARD LANTERN DISPLAYS & SYMBOLS

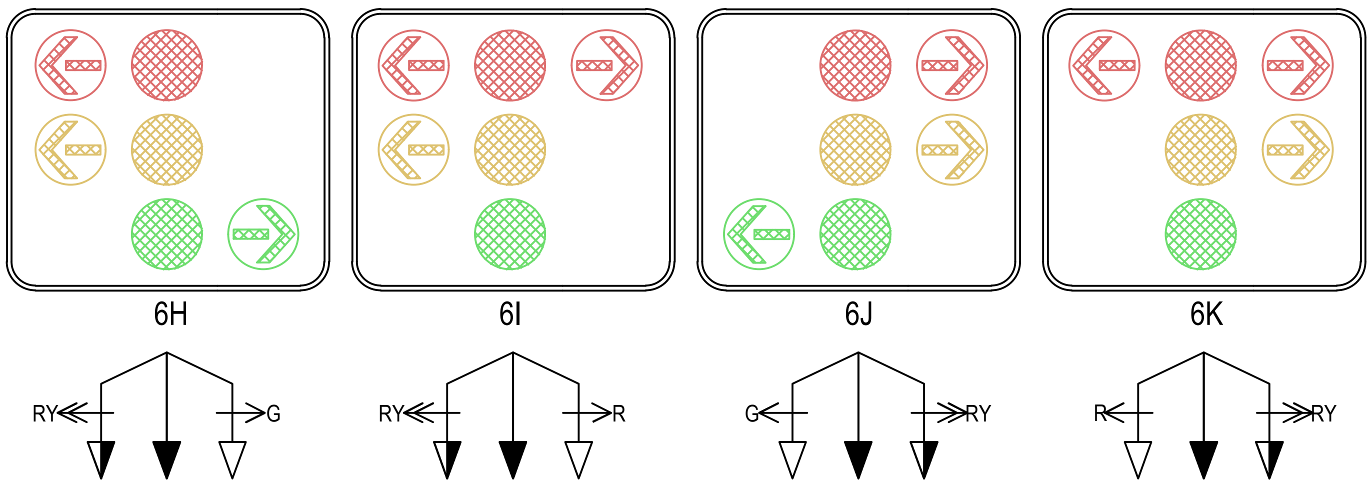
Figure 2

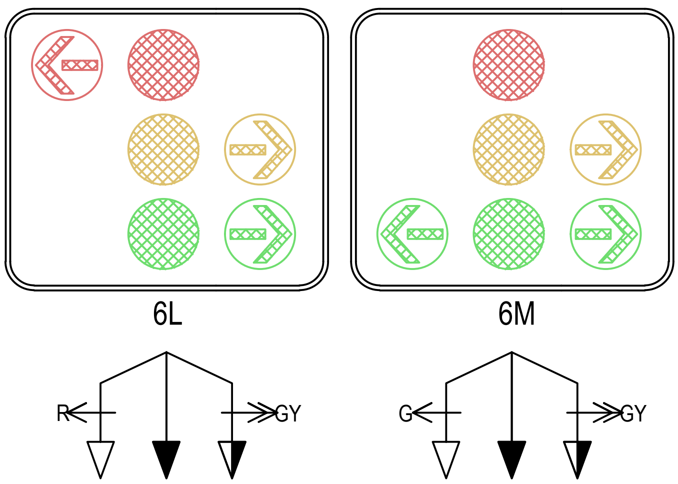
TWO COLUMN 6 ASPECT

THREE COLUMN 6 ASPECT



THREE COLUMN 6 ASPECT





ATOC

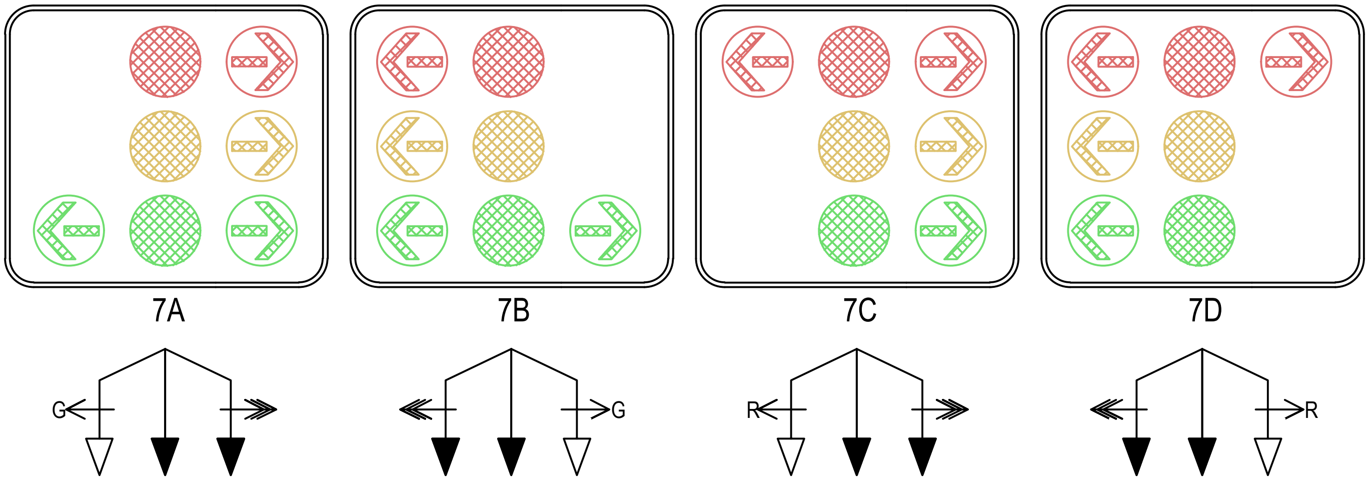
AUCKLAND TRANSPORT OPERATION CENTRE (ATOC)
TRAFFIC SIGNAL STANDARDS

NOT TO SCALE

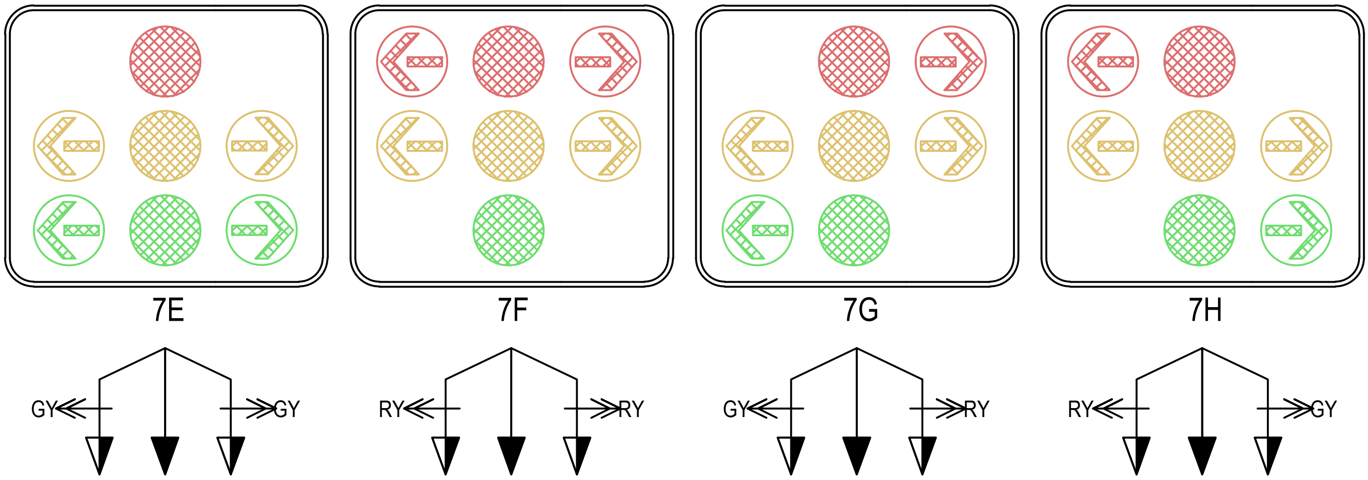
STANDARD LANTERN DISPLAYS & SYMBOLS

Figure 3

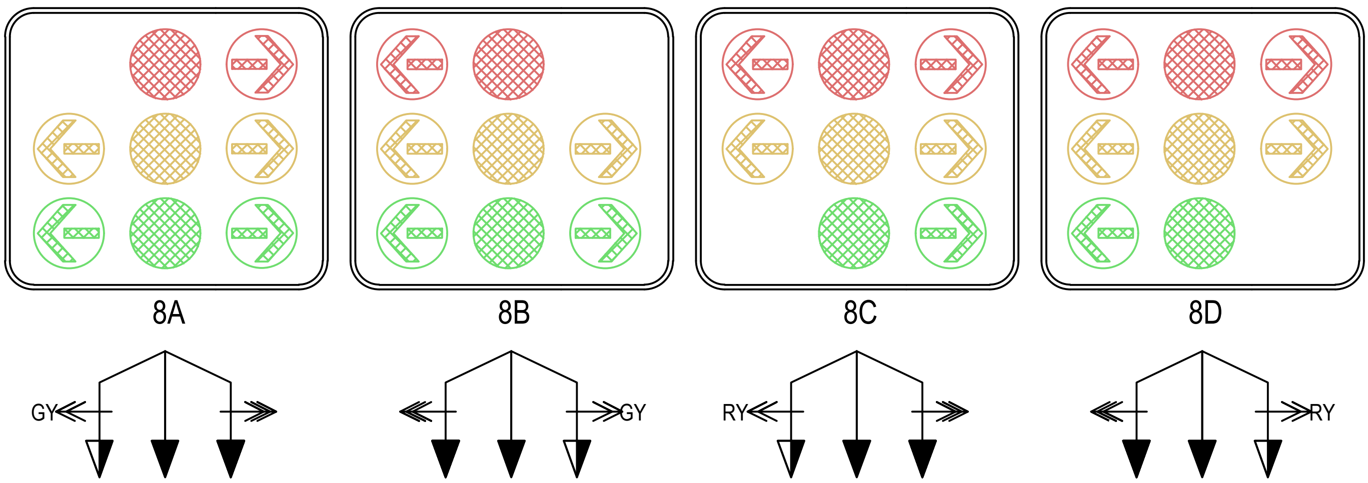
THREE COLUMN 7 ASPECT



THREE COLUMN 7 ASPECT



THREE COLUMN 8 ASPECT



ATOC

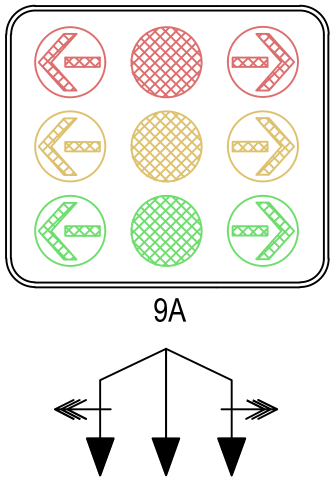
AUCKLAND TRANSPORT OPERATION CENTRE (ATOC)
TRAFFIC SIGNAL STANDARDS

NOT TO SCALE

STANDARD LANTERN DISPLAYS & SYMBOLS

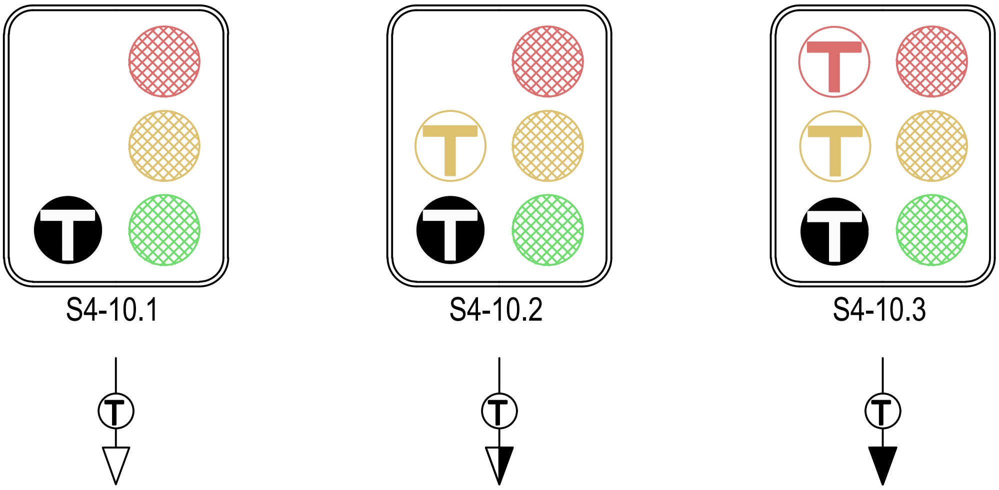
Figure 4

THREE COLUMN 9 ASPECT



9A

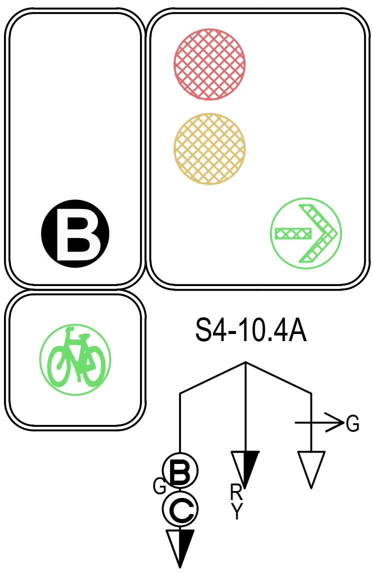
SPECIAL VEHICLE DISPLAYS

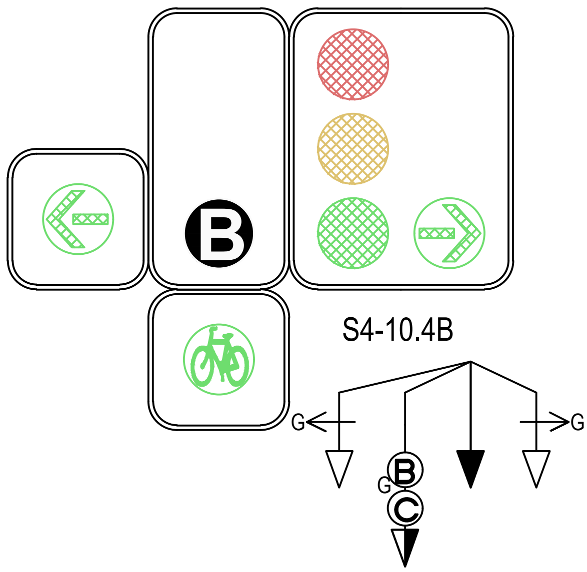


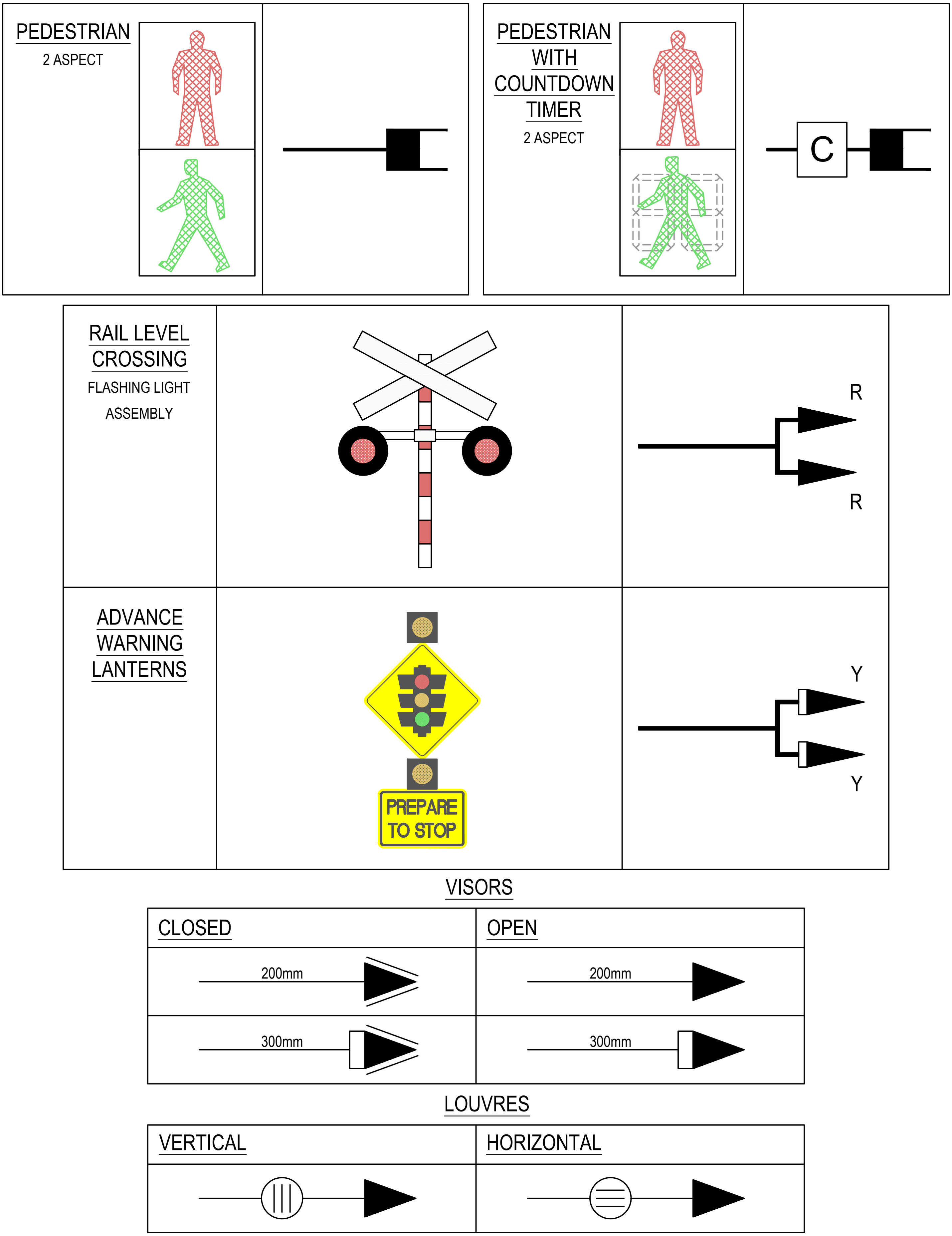
SYMBOL
(T) FOR LIGHT RAIL OR TRAM
(B) FOR BUSES
(C) FOR CYCLES

NOTE:

- SPECIAL VEHICLE DISPLAYS ARE INSTALLED ALONGSIDE OR AS AN ADDITIONAL COLUMN WITHIN THE APPROPRIATE SINGLE,TWO COLUMN OR THREE COLUMN LANTERN DISPLAYS.
- A GREEN CYCLE SYMBOL MAY BE INSTALLED BELOW A WHITE 'B' SYMBOL AS SHOWN.
- IF THE SIGNALS CONTROL ONLY THE MOVEMENT OF LIGHT RAIL VEHICLES, BUSES OR CYCLES, A SINGLE COLUMN OF THREE T, B OR CYCLE SYMBOLS MAY BE INSTALLED







ATOC

AUCKLAND TRANSPORT OPERATION CENTRE (ATOC)
TRAFFIC SIGNAL STANDARDS

STANDARD LANTERN DISPLAYS & SYMBOLS

NOT TO SCALE

Figure 6

Appendix G

Traffic Signal Design Review Process

Design Review Process

Project Phase	**STAGE 1 - Design**					**STAGE 2 - Construction**			**STAGE 3 - Operations**
Attributes	**Project Initiation (Internal AT/Waka Kotahi)/AIAL**	**Concept and/or Consent (Developer)**	**Scheme Design / Prelim Design**	**Detailed Design**	**HOLD POINT - ATOC TO CONFIRM ALL DESIGN ISSUES CLOSED OUT**	**Tender and/or Pre-construction**	**Construction**	**HOLD POINT - ATOC TO APPROVE TRAFFIC SIGNALS AND ACCEPT ONTO NETWORK**	**O&M**
Information Required (should align with Waka Kotahi/AT/AIAL delivery requirements)	• Project description • Project objective(s) • Project outcome(s) • Indicative project program	• Project concept plan(s) showing geometric layout, lane allocation, pedestrian/ cycling/ PT facilities • Project investiagtion report • Project traffic modelling (if undertaken) • Traffic data collected (if any) • Other stakeholder comments Consent Applications: • For Consent Application reviews ATOC request access to all relevant information submitted as part of the application	• Project scheme plan(s) showing concept detail plus traffic signal hardware, operational phasing, vehicle tracking plans, signage, road makring and street lighting • Project scheme assessment report • Project traffic modelling configuration and results • Traffic data collected (if any) • Conditions of Consent (if any) • Other stakeholder comments	• Project design plan(s) showing scheme detail plus ducting and cabling designs • Project detailed design report • Project traffic modelling configuration and results • Traffic data collected (if any) • Conditions of Consent (if any) • Other stakeholder comments		• Register the installation with the ATOC Assets Manager • Provide brief description of the works (new traffic signals or upgrade/modification to existing intersection) • Provide traffic signal layout plans and phasing	• Final 'Issued for Construction' Traffic signals plan(s) • Construction program for the project • Proposed commission date of the intersection		N/A
ATOC Contact	Team Leader ATOC atoc.dr@nzta.govt.nz	Team Leader ATOC atoc.dr@nzta.govt.nz	Team Leader ATOC atoc.dr@nzta.govt.nz	Team Leader ATOC atoc.dr@nzta.govt.nz		Team Leader ATOC atoc.dr@nzta.govt.nz Assets Manager ATOC	Team Leader ATOC atoc.dr@nzta.govt.nz Contracts Team Manager ATOC		Team Leader ATOC atoc.dr@nzta.govt.nz Contracts Team Manager ATOC
Timeframe	As agreed between ATOC and AT/Waka Kotahi/AIAL	• ATOC will endeavour to turn around any request for input within 10 working days from the date of the request and reciept of information • For comment on Consent Applications, ATOC will turn around requests within 5 working days	• ATOC will endeavour to turn around any request for input within 10 working days from the date of the request and reciept of information.	• ATOC will endeavour to turn around any request for input within 10 working days from the date of the request and reciept of information.		• ATOC will endeavour to turn around any request for input within 10 working days from the date of the request and reciept of information.	• Up to 6 months for COMMS connection • 6 weeks for the configuration and testing of traffic signal personality software for the controller • On-going site inspections throughout construction by ATOC appointed Contract Manager and final sign off prior to commissioning		• An operational review within 1 year of commissioning
Processes and/or tasks	ATOC team notified of a project initiation involving either new traffic signals, modification to existing traffic signals and/or works within close proximity of existing traffic signals. ATOC to review and provide input to AT/Waka Kotahi/AIAL	• ATOC will undertake a review of the supplied information outlined above to determine any or all of the following: - impact to surounding network - threats/opportunities with the proposed concept - further design and/or investigation considerations - overall suitability of the concept with regards to network operations	• ATOC will undertake a review of the supplied information outlined above to determine any or all of the following: - impact to surounding network - threats/opportunities with the scheme design - Design amendments - likely network operation impact, if felt to be negative	• ATOC will undertake a review of the supplied information outlined above to determine: - if any design changes have occured since scheme stage - all previous comments raised and input given in earlier stages have been taken onboard and addressed or closed in agreement with AT/Waka Kotahi PM		• ATOC will undertake a final review of traffic signal layout plan and phasing • Asset Manger will enable GIS location of intersection, assign SCATS intersection ID number and determine existing as built and asset details on file	• ATOC will undertake the configuration and testing of the traffic signal personality file(s) • Contracts Manger will arrange for the ordering of a COMMS line and undertake site inspections, final sign off, commissioning and formal handover of traffic signals and any asset data for RAMM		• ATOC will undertake initial monitoring of intersection soon after commissioning and undertake SCATS data collection. This will allow the set-up of split plans and more detailed SCATS functions so that the intersection is operating as efficiently as possible.
Outcomes	• ATOC have visibility in advance of what is/will be happening across the network • Key stakeholder onboard • ATOC knowledge of existing network deficiencies can inform project to deliver an improved overall network • ATOC able to detail considerations going forward	• ATOC provide overall support of the concept • ATOC require further information to be able to fully assess the proposed concept • ATOC highlight design deficiencies and/or errors to be considered and/or addressed in the subsequent phase • ATOC provide advice to AT/AC on Conditions of Consent to be applied (if applicable) • ATOC to meet with AT/Waka Kotahi/AIAL Project Manager to discuss review and close out and/or agree actions going forward	• ATOC provide continued overall support of the project • ATOC require further information to be able to fully assess the proposed scheme as it stands • ATOC highlight design deficiencies and/or errors to be considered and/or addressed in the subsequent phase • ATOC provide advice to AT/AC on Conditions of Consent to be applied (if applicable) • ATOC to meet with AT/Waka Kotahi/AIAL Project Manager to discuss review and close out and/or agree actions going forward	• ATOC provide continued overall support of the project • ATOC require further information to be able to fully assess the detailed design as it stands • ATOC highlight design deficiencies and/or errors to be considered and/or addressed prior to construction • ATOC provide advice to AT/AC on Conditions of Consent to be applied (if applicable) • ATOC to meet with AT/Waka Kotahi/AIAL Project Manager to discuss review and close out and/or agree actions going forward • AT/Waka Kotahi to ensure that the relationship between the project team and ATOC is defined in the Principals Requirements of the tender documents and contract documents		• ATOC provide final design feedback • ATOC to provide SCATS ID number to AT/Waka Kotahi/AIAL PM • For existing intersections Assets Manager to supply as built info (pdf and/or CAD file) as required	• ATOC to set up new intersection onto SCATS system ready for commissioning or be prepared to modifiy an existing intersection on SCATS immediately following commissioning • AT/Waka Kotahi advised of the Contract Manager from ATOC who will undertake site inspections and commissioning • Intersection is accepted onto the network subject to the above processes being completed • Supply of traffic signal asset data (as builts) to ATOC for input into RAMM • Provide udated/ new traffic signal as built drawings to ATOC requirements, and including the CAD dwg file. This is required prior to the defects liability period/hand over to the traffic signal maintenace contact		• ATOC will review the operation of the intersection(s) post opening (+6 months) to ensure operation and outcome are planned.and report back to AT/Waka Kotahi PM.