An Roinn Iompair,
Turasóireachta agus Spóirt
Department of Transport,
Tourism and Sport

Temporary Traffic Management Operations Guidance

Part 3

Level 3 Roads

Dual Carriageways and Motorways

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3.1 Introduction

Operations on dual carriageways and motorways (Level 3 roads) are covered in this part of the guidance documents. The relevant sub-levels, carriageway type and speed limit / speed are outlined in the following table.

Level		Carriageway Type	Speed Limit / Speed (km/h)
Main	**Sub**		
Level 3	i	Dual and Motorway	80
	ii	Dual and Motorway	≥ 100

Table 3.1.1: Level 3 Roads Sub-levels, Carriageway Type and Speed

The approach is to give a simple step by step guide complemented with visuals where required. This gives a quick and easy reference on how to install, operate, amend, maintain and remove TTM operations in these areas.

The following items are covered in this part of the guidance documents:

- General Information;
- Vehicles and Equipment;
- Static Operations; and
- Mobile Operations.

3.1.1 Roles, Responsibilities and Competence

Roles, responsibilities and competence for TTM on Level 3 roads are outlined in Section 0.2.2.3 of Part 0 of this document.

3.1.2 Crew Structure

The table below outlines the minimum crew structure required for typical TTM teams on Level 3 roads.

Crew Size	TTOS	Operatives	Maximum Trainees
2 Man Crew	1		1
3 Man Crew	1	1	1
4 Man Crew	1	2	1
5 Man Crew	1	3	1
6 Man Crew	1	3 - 4	1 - 2

Table 3.1.2.1: Crew Structure

3.1.3 Use of Job Information Pack and Site Briefing

Job Information Pack

A Job Information Pack should be provided to the TTOS and operatives before they prepare to go to site. This pack contains the information and instructions required by the TTOS and TTM operatives to plan for and execute the works safely.

Job Information Pack **must** include:

- TTM Drawings;
- Risk Assessments of site and works, including risks associated with overhead power lines, site deliveries, working at heights etc
- SSWP;
- Location and times of Operation;
- Contact numbers.

Job Information Pack **may** also include:

- Road space booking;
- SOPs; and
- Other job specific information.

The TTM plan (TTMP) should be implemented in accordance with the job information pack. The job information pack should always be maintained on site.

Site Briefing

- A site briefing is a talk carried out prior to a TTMP being installed;
- Duration of a site briefing may vary depending on the level of risk;
- There can be two separate site briefings; the first given before the works start and then a second while on site. The second usually involves instructions given to operatives;
- The aim of a site briefing is to:
    - Communicate the SSWP and TTMP to the work crew;
    - Highlight specific hazards;
    - Raise the awareness of attendees; and
    - Inform attendees of the control measures put in place to mitigate risks and prevent accidents.
- It should be easily understood by those with reading or language difficulties;
- TTOS should keep it simple and encourage interaction with the attendees;
- TTOS should check the level of understanding by having a quick questions and answers session at the end; and
- There should be a sign off procedure of these checks with a record kept of the relevant paperwork.

3.1.4 Establish and Communicate Location

The guidance given here for establishing and communicating your location can be applied during static and mobile operations on Level 3 roads. Advance directional signs (ADS), chainage markings and plates can be used to quickly establish your location.

Where present, chainage markings, plates and posts should be used by crew members to establish their location. Chainage markers are set at 100m intervals and are located on the inside of the hard shoulder. Chainage plates are located every 500m on a post. The first number is the route number followed by N, S, E or W indicating the direction North, South, East or West bound carriageway. The arrow indicates the direction of the nearest Emergency Response Telephone (ERT). The numbers indicate the chainage from the start of the route (267.5km, 11km and 27.3km in the examples below).

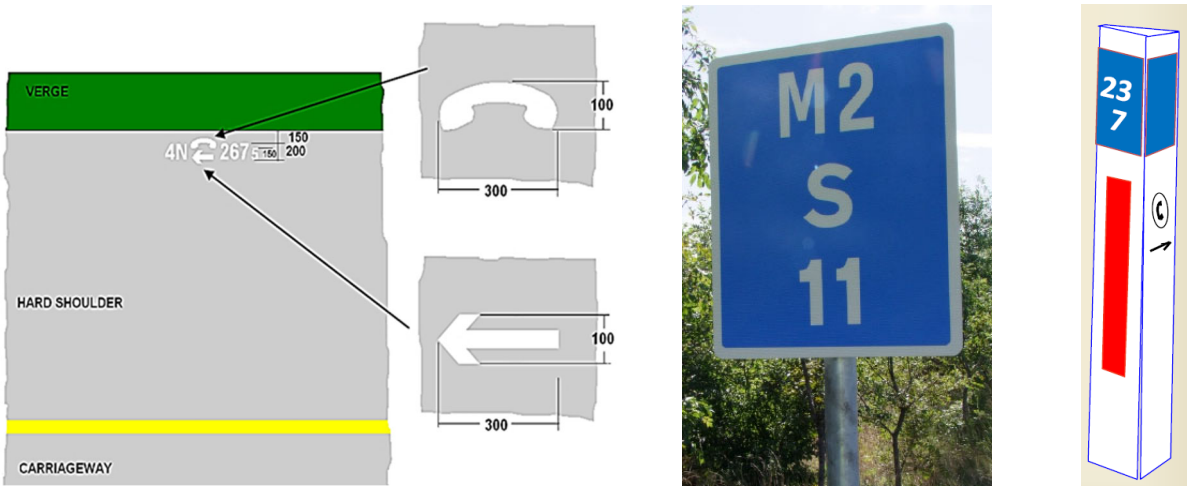


Figure 3.1.4.1: Chainage and Emergency Telephone Marking, Chainage Marker Plates and Marker Posts

Road studs at 12m centres and median barrier reflectors at 24m centres can also be used by crew members to set out TTM at the required intervals.

3.1.5 Night-time Works

Lane availability requirements and safe traffic volumes may require TTM operations to be undertaken at night. This introduces additional risks and may require additional resources and different operating procedures than day time works.

Lower traffic volumes generally mean that traffic related risks for the workforce are reduced during night-time works, however the risk of other work-related accidents are increased due to the following:

- Fatigue;
- Ability to judge distances; and
- Reduced visibility.

Additionally, the TTM crew may be under pressure to complete TTM operations before peak morning traffic and lane availability times. This means that safe operating procedures must be in place and followed by site personnel.

The personnel for such works must be fit for the tasks they are to carry out, including adequate vision and hearing. Their training and skill development should include instruction on works during hours of darkness. The crew should have adequate rest periods both prior to and after each work shift and as a minimum should comply with the Working Time Act.

Pre-planning during daylight hours is essential, including:

- Determine and identifying stopping points for vehicles, particularly where there are narrow (or no) hard shoulders;
- Identify the location points for advance warning signage, start of tapers, and length of cone run. This should include an assessment of the width necessary to place signage and equipment, for narrow medians, hard shoulder running or a narrow lanes operation. Pre-placing of signage may be carried out during daylight hours for deployment during hours of darkness;
- Areas where sight lines or visibility is restricted should be identified and made known to the TTM crew so that crossing the carriageway is avoided at those points; and
- Overhead obstructions and electric wires should be identified and a clear method statement for works at those locations marked and made available to the TTM crew.

If it is practicable to use an existing electricity supply to power lighting for night-time works, then this should be used. If generators or batteries are to be used, then the fuel or charge should be checked to ensure it is sufficient to last the night.

Work areas must be adequately lit, both in terms of lighting levels achieved and lighting consistency within the works areas, while avoiding dazzle for traffic.

Erecting or moving lighting towers should be done during daylight hours. Lighting towers should be erected on a flat well compacted area to reduce the risk of them becoming unstable. If lighting towers need to be moved they must be lowered first.

Contra-flows and crossovers must be lit for traffic to the required levels and consistency, including the approaches to these points. Lighting towers and generators located outside the works areas and near carriageway edges may need to be guarded with vehicle restraint barriers.

Crews must have torches, with fully charged batteries, available to them on-site. Batteries for road lamps must also be checked and fully charged before works begin.

Night-time works also require that sign faces and other equipment is kept clean, as this adversely effects the visibility of the signage especially at night. Adequate stocks of replacement equipment should also be on hand so that damaged equipment can immediately be replaced.

Finally, crews must have an adequate communication system available to them, and clear communication channels established between the traffic management crew, works crew, and supervisory staff.

3.2 Vehicles and Equipment

Vehicles and equipment are covered in this section under the headings of IPV, static operations and mobile operations.

3.2.1 Vehicles

All Vehicles

- Vehicle colour should be conspicuous yellow or white. Hazard beacons mounted on top visible 360°.
- Rear wording to be displayed "ROAD MAINTENANCE" retro-reflective Class RA1. Text height minimum of 300mm but wording not taking up more than 2m^2.
- Front wording to be displayed "ROAD MAINTENANCE" retro-reflective Class RA1. Text height minimum of 300mm but wording not taking up more than 2m^2.
- No front or side chevron markings; and
- Must have driver restraint system; (3-point inertia seat belts and head restraints).

Vehicles in excess of 3.5 tonne

- Must have side reflective strip (solid yellow colour) 50 to 60mm width up to 80% of length. Height of strip to be between 250mm and 1.5m.
- Rear markings of entire flat rear surface to be alternate strips of orange / red chevron 45° Class RA2 retro-reflective material and fluorescent yellow non retro-reflective material. Each strip should not be less than 150mm width.
- Reversing bleeper;
- Should have 360° cameras; and
- CCTV for rearward vision.

3.2.2 IPV

The IPV must display a light arrow and sign RUS 001 Keep Left / RUS 002 Keep Right at the rear, warning and instructing drivers of which side to pass the IPV, as shown in Figure 3.2.1.1. When deployed, the IPV should display the light arrow when used in live lanes and in the hard shoulder. When the crash cushion is up, 'Road Maintenance' text may be included at the rear of the IPV. It should not be used as a TTM vehicle when deployed as an IPV. There should be no operations on the back of the machine when it is operated as an IPV.

Along with 3.2.1, the additional requirements for an IPV are:

- 10 tonne minimum 'on the road' weight;
- Lorry mounted crash cushion;
- Automatic brake activation system;

- Light arrow sign;
- Adjustable blue arrow sign;
- Should have a Road Traffic Specialised Permit for Particular Vehicles Regulations 2007, (SI 283 of 2007) from the Road Authority;
- Must be tested at 110km/h; and
- Must maintain a 50m to 100m buffer zone ahead of it when providing impact protection.

Figure 3.2.1.1: IPV showing Keep Right Arrow at the rear

3.2.3 Static Traffic Management

3.2.3.1 Prepare Loading Schedule

- Items required;
- Quantity of each item;
- Order in which items should be loaded and to which vehicle; and
- Must take into account Plan(s), Method Statement(s) and Risk Assessment(s).

3.2.3.2 Calculation of TTM Equipment Requirements and Weights

The calculation of the TTM equipment required for an operation should be done when the works type and its specific location on the road have been determined. The specific design parameters can then be referred to and the specific amount of equipment can be calculated for each area of a TTM operation. A calculation sheet such as the example given below should be used.

EQUIPMENT CALCULATION SHEET							
Area of the TM	Cones	Lamps	Frames	Sand Bag Bars	Sand Bags	Sign Plates	Supplementary Plates
Advance Signs							
Lead in Taper							
Transition Length							
H/S Taper							
Chicane							
Longitudinal Run							
Safety Zone							
End Signs							
TOTALS							

When the totals for each type of equipment have been identified, the overall weight of the TTM equipment should be calculated.

The typical equipment weights are:

- 1m cone 10kg;
- Sign frame (including bars) 15kg;
- Sand bag (wet) 15kg;
- 1200mm sign plate 12kg;
- Supplementary plate 5kg; and
- Lamp 1kg.

3.2.3.3 Checks at Depot

- Drivers of vehicles should carry out daily walk around checks to ensure vehicles are in good working order – defects should be recorded;
- Check to make sure the equipment is clean and in good working order;
- Replace damaged equipment;
- Ensure the correct TTM equipment is loaded onto the TTM vehicle and in the correct order of installation as per the loading schedule;
- Calculate the total weight of the equipment to make sure the TTM vehicle used can carry the overall weight;
- Sufficient batteries for lamps; and
- Driver should ensure the load is secure for transit.

3.2.3.4 Positioning Signage and Equipment

When positioning signs next to live traffic, the nearest edge of the sign should be 1.2m from the traffic lane where possible. Where narrow medians / verges are present, a minimum of 600mm should apply using 900mm signs. Further reduction of sign size below 900mm is not permitted.

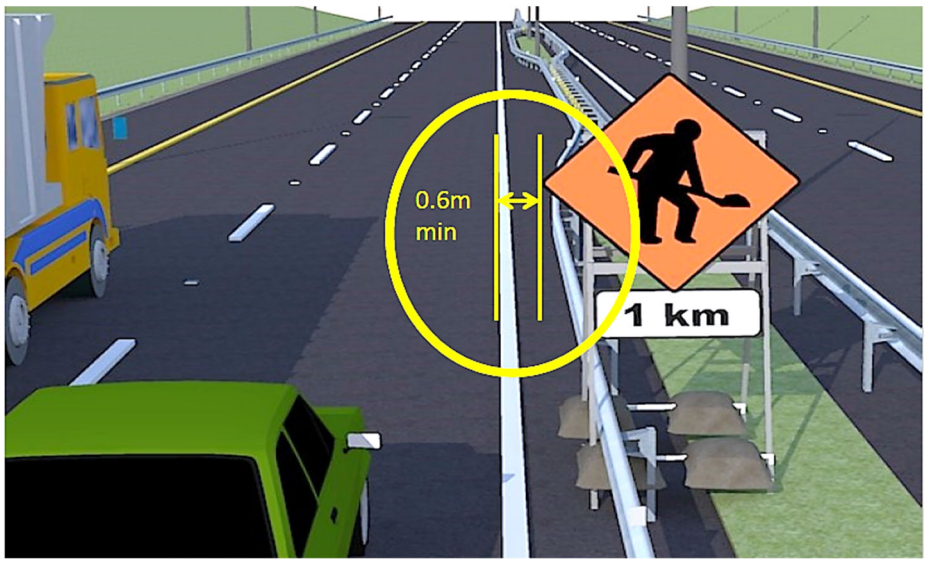


Figure 3.2.3.4.1: Positioning of Signs

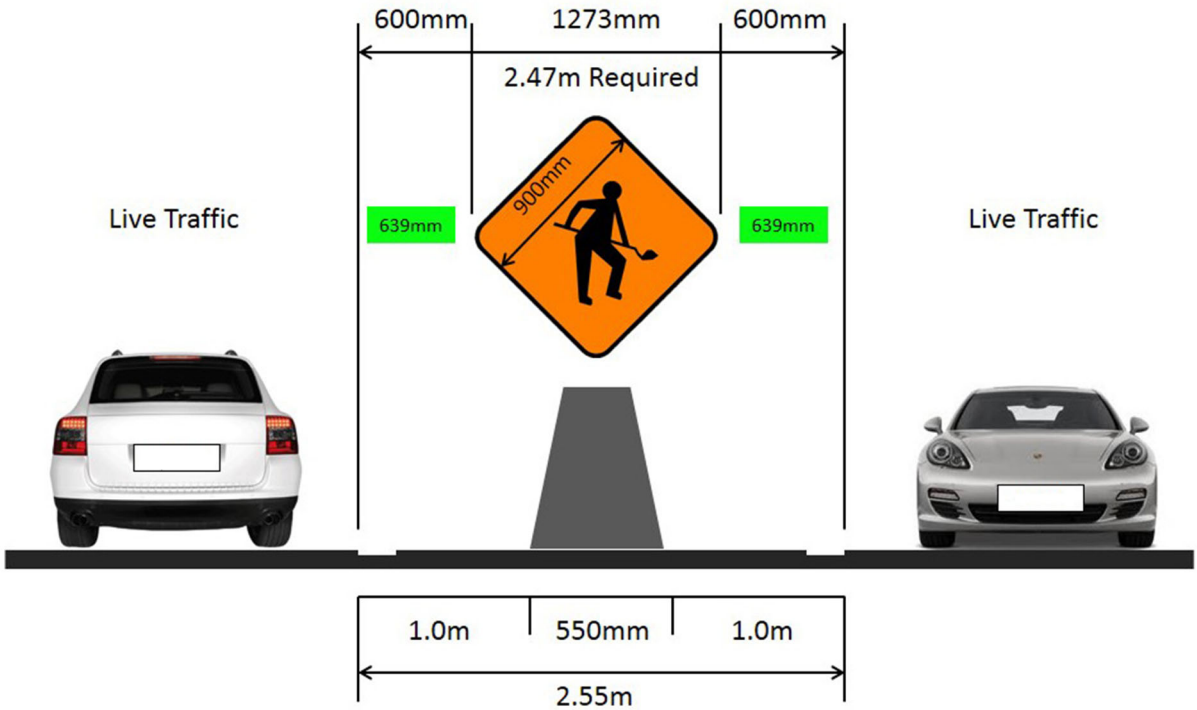


Figure 3.2.3.4.2: Positioning of Signs on a Narrow Central Median

TTM operatives should ensure that signs are visible with a clear minimum visibility of 90m for Level 3(i) roads and 160m for Level 3(ii) roads.

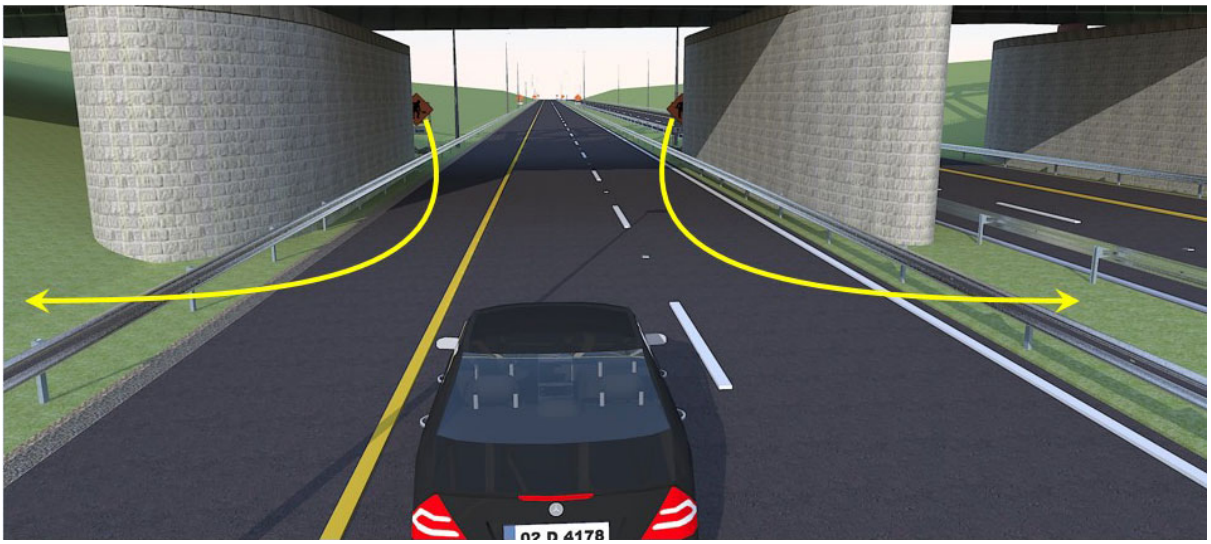


Figure 3.2.3.4.3: Clear Visibility – signs obstructed by bridge abutments and piers. In this instance, signs should be relocated to drivers' approaching side of the abutment or pier

3.2.3.5 Securing Signage and Equipment

Signs should be located and secured so that they do not pose a hazard to road users or road workers. The sign frame should be placed on a firm level footing. Where required, sand bags should be placed on the lower two sandbars of A frames (and not on upper frames). For frames where sandbars cannot be used, sandbags should be placed at the base of each frame leg. Where required for example lamped cones, double-based cones should be used rather than using sand bags.

3.2.3.6 Equipment Checks on Road

- Should be carried out daily by the TTOS or a competent person nominated by the TTOS;
- Equipment should be checked to ensure it has not moved during transit prior to removing. Results should be recorded and reported; and
- Faults / defects should be rectified prior to use of equipment in the TTM operation.

3.2.4 Mobile Lane Closures

3.2.4.1 Mobile Lane Closure Vehicles

The vehicles used on a mobile lane closure are the following:

- Advance warning sign vehicles / trailers;
- IPV;
- Slip road vehicles;
- Lead pilot vehicles; and
- Works vehicles.

A mobile lane closure consists of three or more advance warning vehicles, an IPV fitted with a crash cushion, and the works vehicles. A lead pilot vehicle or slip road vehicle may also be required.

Figure 3.2.4.1.1: Mobile Lane Closure Vehicles

General Mobile Lane Closure Vehicles Requirements

- Should be yellow or white (a conspicuous colour);
- Rotating amber flashing beacon visible from 360°;
- Equipped with a reliable communication system;
- 3-point inertia seat belts and head restraints correctly positioned; and
- Minimum kerb weight of 1.5 tonne.

Where rear facing high visibility markings may be obscured, additional markings may be applied to any face of the device which is displayed to the rear and other road users.

Advance Warning Vehicles

Advance warning vehicles are positioned in the verge or travelling along the hard shoulder. They carry signs at the rear warning and informing motorists of the roadworks and lane restrictions ahead. The requirements of advance warning vehicles are as follows:

- Advance warning signs can be vehicle mounted or towed on a trailer;
- Vehicle should be yellow or white (a conspicuous colour);
- Signs must be on a 'yellow' non-reflective backing board and should not be directly illuminated;
- Four-fold high intensity flashing lamps are required in the four corners of the backing board;
- The backing board should be 3m high and minimum 2.1m wide;
- The vehicle must have rotating amber flashing beacon or LED beacon visible from 360°; and
- Minimum kerb weight of 1.5 tonne.

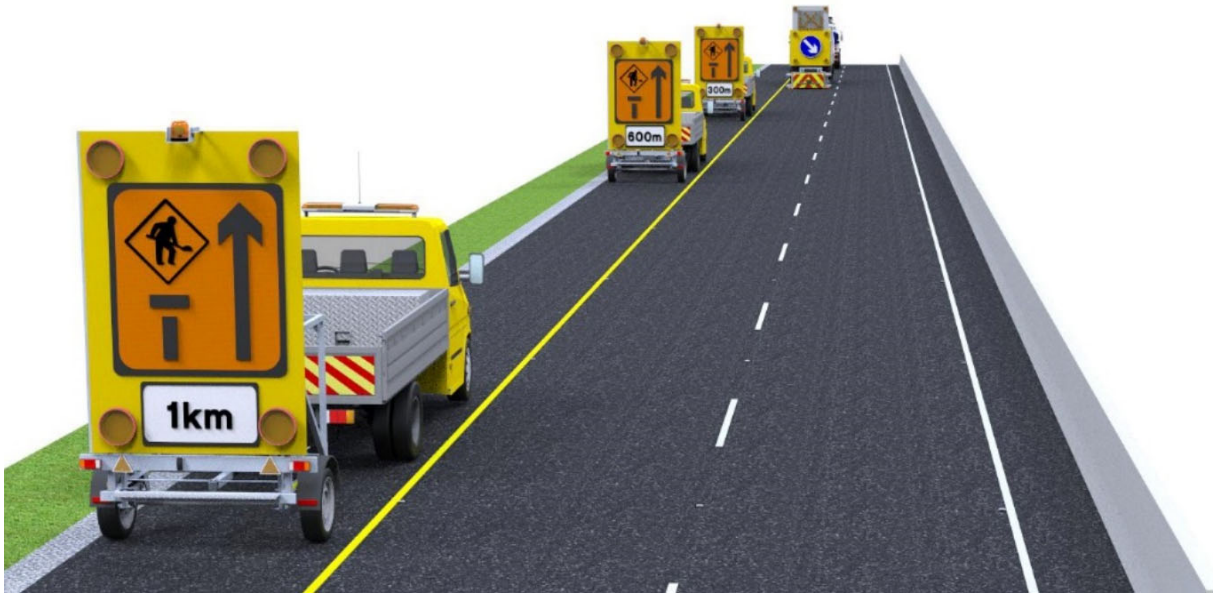


Figure 3.2.4.1.2: Advance Warning Vehicle

Lead Pilot Vehicle

A lead pilot vehicle is used during mobile lane closures. It must be used where there are workers on foot in a live lane. It is also used where a works vehicle does not have the required 1200mm RUS 001 Keep Left / RUS 002 Keep Right arrow.

Figure 3.2.4.1.3: Lead Pilot Vehicle

Slip Road Vehicle

A slip road vehicle follows the same specification as an advance warning vehicle as specified above.

Figure 3.2.4.1.4: Slip Road Vehicle

IPV Signs

The IPV should display sign RUS 001 Keep Left / RUS 002 Keep Right at the rear, warning and instructing road users which side to pass.

Mobile Lane Closures

Rolling Road Blocks

Figure 3.2.4.1.5: IPV Vehicle Signage

Works Vehicle and Lead Pilot Vehicle Signs

The works vehicle should display sign RUS 001 Keep Left / RUS 002 Keep Right at the rear, warning and instructing road users which side to pass. Light arrows, backing boards and 4 folds or a combination there of, may also be used as an alternative to these signs.

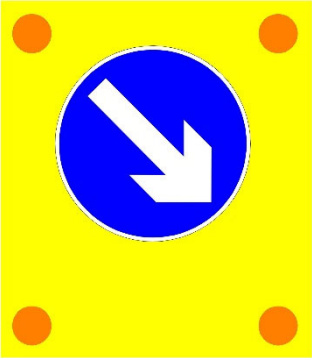


Figure 3.2.4.1.6: Works Vehicle and Lead Pilot Vehicle Signs

3.2.4.2 Rolling Road Block Vehicles

- Monitor Vehicle - They need to be conspicuous in colour, have a roof mounted amber light bar and appropriate reflective markings.
- Hard Shoulder Vehicle - They need to be three tonnes minimum on road weight, conspicuous colour, appropriate lamps and beacons and reflective markings, and carry sign RUS 002 Keep Right to the rear.

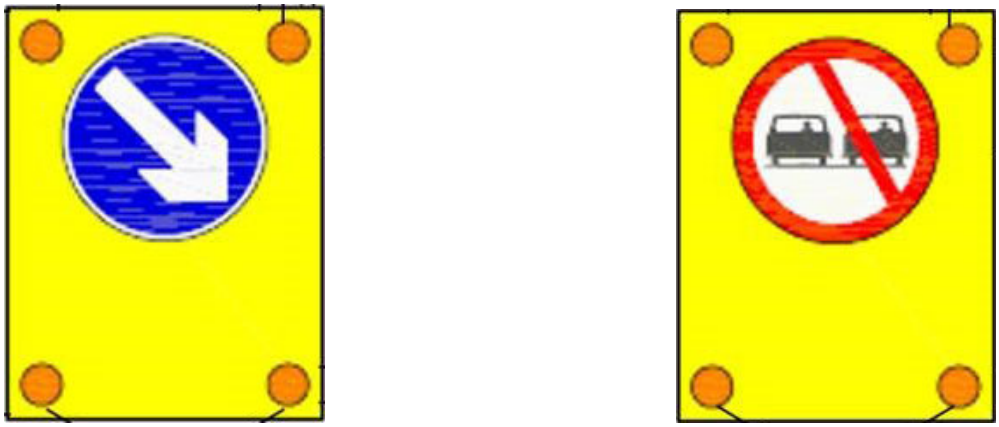


Figure 3.2.4.2.1: Hard Shoulder Vehicle Mounted Sign and Live Lane Vehicle Mounted Sign

- Slip Road Vehicle – these can be either an IPV or the same specification as a monitor vehicle.
- Advance Warning Vehicle - these should be as per the specification for a MLC advance warning vehicle and carry sign WK 062 Queues Likely to the rear.

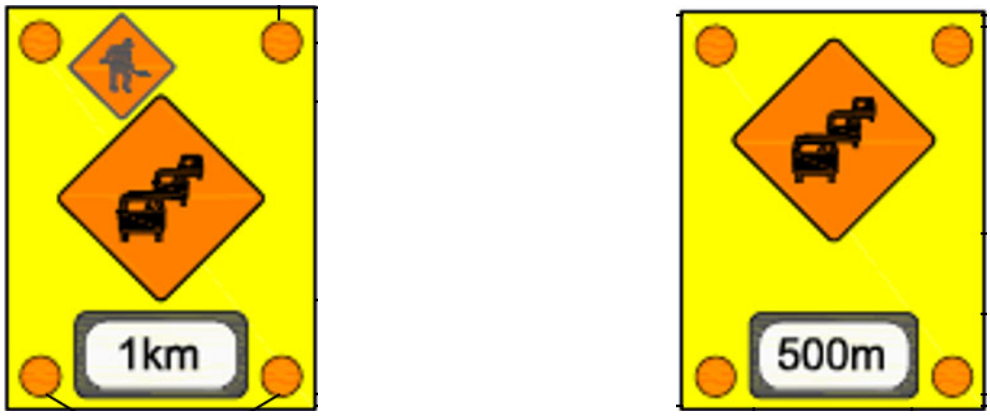


Figure 3.2.4.2.2: Advance Warning Signs for a Rolling Road Block

- Impact Protection Vehicle – these should be standard IPV specification and carry sign RUS 014 No Overtaking to the rear.

3.3 Static Traffic Management

3.3.1 Ancillary Operations

Cones, Vehicle Barriers, Vehicle Restraint Barriers

Vehicle barriers may be used as a delineation device as an alternative to cones. These may include euro barriers and mass guard barriers. Where temporary vehicular restraint barriers, such as vario guard, are used, they should be installed as per the manufacturers' specifications.

Temporary Road Markings

Where temporary road markings are used, the permanent road markings should be removed or masked where they conflict with the new layout.

Temporary Road Studs

Temporary road studs may be used to define temporary traffic lanes. They should be installed a maximum of 12m apart (maximum of 6m apart where there are radii of < 720m). They should be fixed to the road surface in a way that permits removal without damaging the surface. They may be installed either side of a traffic cylinder at a lateral distance of 0.7m or 1.2m. Where temporary road studs are used, permanent road studs may be removed where they conflict with the new layout.

Traffic Cylinders

Traffic cylinders should be red in colour, be either 750mm or 1m high and have a white reflective sleeve. They should be installed a maximum of 12m apart longitudinally. They can fit into existing road stud bases or can be fitted using heavy duty moulded base plates and double sided sticky pads.

Lighting the Works

Lamps used on Level 3 roads should be uni-directional (light in one direction only) and cone mounted ensuring that the reflective sleeve of the cone is not covered. Anti-vandalism cages over lamps are not permitted on Level 3 roads. Lamps should be a maximum of 24m apart longitudinally. Lamps on a longitudinal cone run may be replaced with reflectors. Lamps are required in unlit areas only.

Where used, sequential lamps shall be placed at a maximum of 12m centres and shall comply with manufactures requirements. Steady state lamps are omitted where sequential lamps are used. Where multiple tapers are required, the lighting arrangement used on the first taper shall be used on all subsequent tapers. Sequential lamps shall be used for live lane closures only.

Trailer Mounted VMS

Trailer mounted VMS used on Level 3 roads must be located so as not to present a hazard.

3.3.2 Traffic Flow for Static Traffic Management Operations

This table is applicable when using a fast into slow lead-in taper and transition length arrangement ahead of the works. The table indicates the maximum traffic flows permitted while undertaking TTM operations, including installation, modification and removal.

Lane Closure	Maximum Allowable Traffic Flow per Carriageway	
	Veh / hr	Veh / 3 min
Dual Two-Lane Carriageway		
Lane 1 [3]	1200	60
Lane 2	1200	60
Dual Three Lane Carriageway [3]		
Lane 3	2700	135
Lane 2 + 3	1200	60
Dual Four Lane Carriageway [3]		
Lane 4	3900	195
Lane 3 + 4	2700	135

Table 3.3.2.1: Traffic Flow for Static Traffic Management

Notes:

1. Where the HGV content is high, the above figures may need to be reduced. Typically, HGV content is 15 to 20%. If the HGV content is 30%, then the figures in this table should be reduced by 10%.
2. When working past slip roads, the maximum flow on the slip road should not exceed 500 vehicles per hour (25 veh / 3 mins) during the TTM operation whether it is a single or multi-lane slip.
3. The traffic flow figures are not applicable to Direct Lane 1 Closures. Refer to Section 56
4. 3.3.4.6.
5. A maximum traffic count of 65 veh / 3 mins per lane applies to hard shoulder works.

3.3.3 Setting Out Methodology

3.3.3.1 Context

This section identifies and describes the aspects of static TTM layouts that are commonly used and referred to during operations on Level 3 roads. These aspects are shown together in Figure 3.3.3.1.1. Refer to Part 0 of these guidance documents for general TTM elements such as safety zones, works access and works areas.

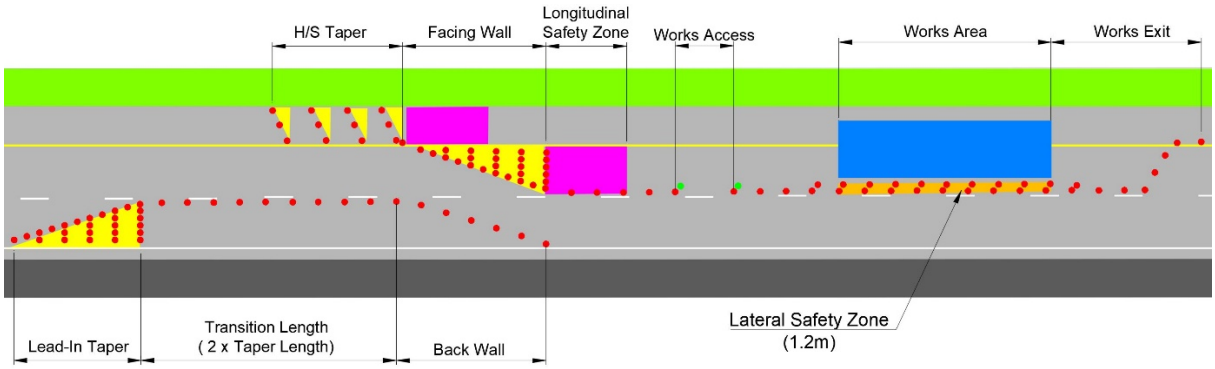


Figure 3.3.3.1.1: TTM Elements

Installing static TTM on Level 3 roads, typically requires combining a number of distinct TTM tasks into a carefully planned operation. The sequence in which these tasks are completed may vary depending on the works or site requirements but will generally follow the steps outlined in Figure 3.3.3.1.2. The method described assumes a 10 tonne IPV and a 7.5 tonne TTM vehicle. Other combinations are equally possible.

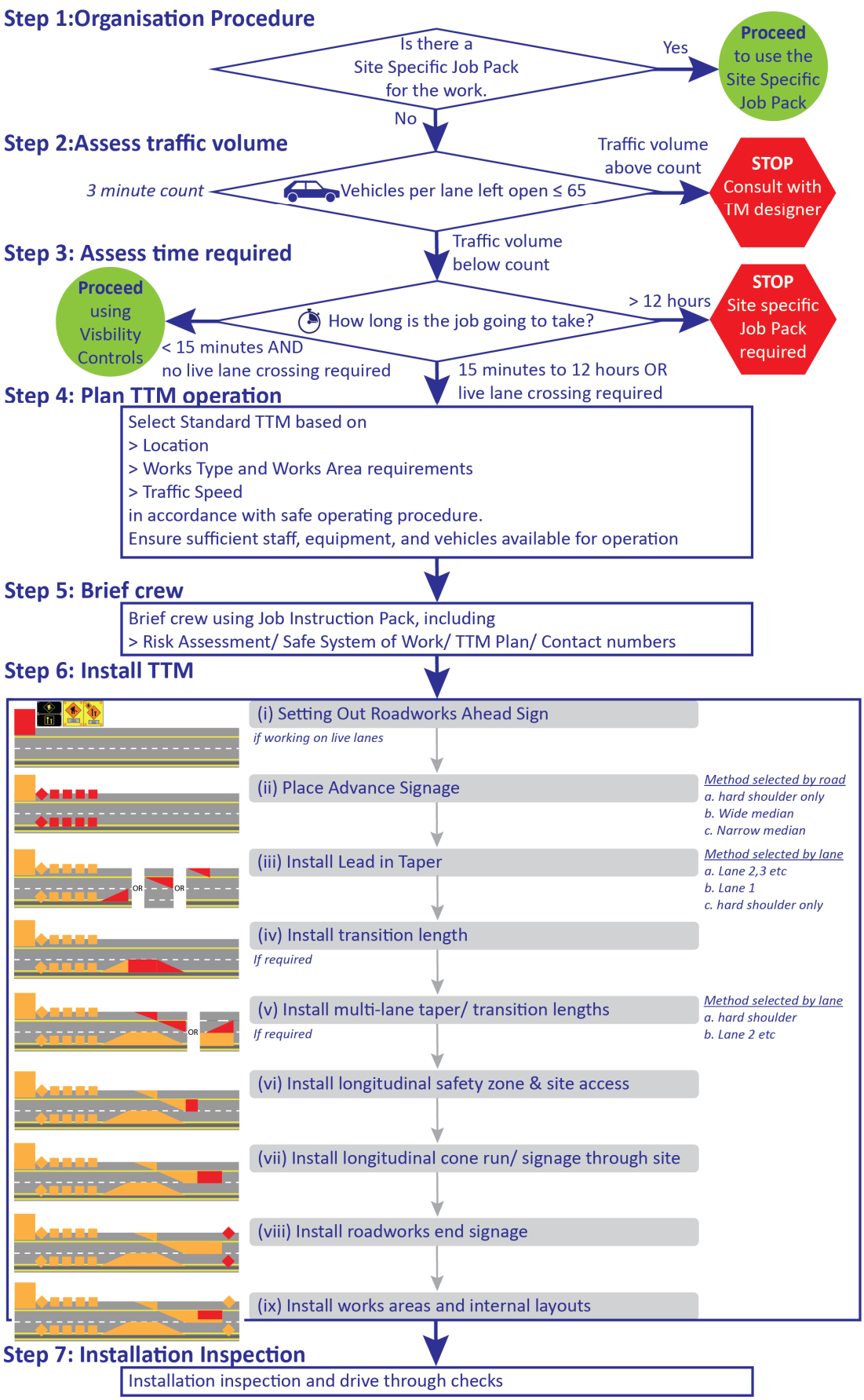


Figure 3.3.3.1.2: Typical Sequence of Static TTM Operations on Level 3 Roads

3.3.3.2 Setting-out Roadworks Ahead Signage (Lane 1 / 2 / etc.)

Where a live lane closure is being carried out, an additional warning sign should be provided before installation of the advance warning signage commences. The purpose of the sign is to warn road users that operatives may be in or crossing the carriageway installing the advance warning signs and that an IPV is in the live lane protecting the operatives during installation.

The additional warning should be provided using a VMS sign. The VMS shall be placed in a suitable location on the verge not less than 300m and not more than 2km in advance of the first advance warning sign, typically the distance is 500m.

A two-frame message should be displayed on the VMS as follows:

- Frame 1: WK 001 Roadworks Ahead preferably in pictogram format; and
- Frame 2: WK 040 – WK 049 Lane closed as appropriate. This should indicate the lane in which the IPV is operating during installation. (This may be presented as 'Left Lane Closed' / 'Right Lane Closed' as appropriate if the VMS is text only based).

When installation of the advance warning signage is complete, the VMS may be left in place to act as additional high visibility warning of the TTM in place. Where this is the case, the VMS should display a single frame only as WK 001 Roadworks Ahead.

If an incident occurs at the roadworks during operations, a second frame can be added to the VMS during the incident displaying "Incident Ahead". The VMS should revert to single frame WK 001 once the incident is cleared.

During TTM removal of the advance warning signs, a two-frame message should be displayed as follows:

- Frame 1: WK 001 Roadworks Ahead preferably in pictogram format; and
- Frame 2: WK 040 – WK 049 Lane closed as appropriate. This should indicate the lane in which the IPV is operating during installation. (This may be presented as 'Left Lane Closed' / 'Right Lane Closed' as appropriate if the VMS is text only based).

A static sign accompanied by a high intensity flashing warning light or a mobile trailer unit complete with standard flashing lamps may be used in place of the VMS if necessary. The format of the sign is to be as per Figure 3.3.3.2.1. Where a static sign or mobile trailer unit is used they should be removed once installation of the TTM is complete and replaced only when TTM is being removed.

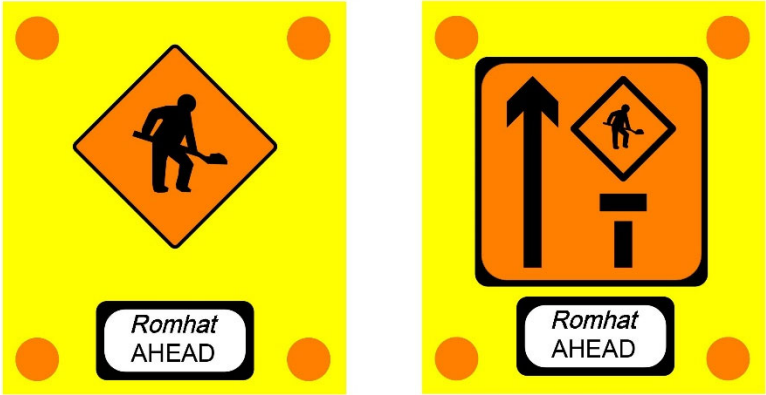


Figure 3.3.3.2.1: Setting-out Roadworks Ahead Sign

3.3.3.3 Placing Advance Warning Signage

Advance warning signage should be placed on both sides of a Level 3 road as shown below.

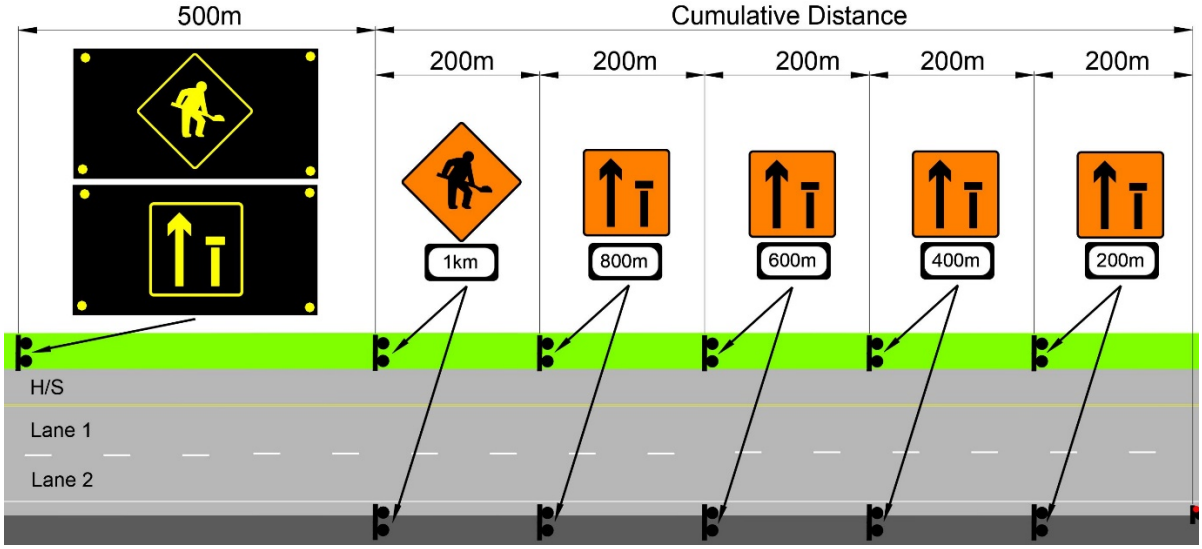


Figure 3.3.3.3.1: Typical Advance Warning Signs (Example shows a Lane 2 Closure with Setting Out Roadworks Ahead sign during installation)

TTM layouts must start in safe locations by avoiding hazardous positions such as close to a curve, slip road, junction or the crest of a hill. They should also ensure there is a minimum clearance of 1.2m between the edge marking of the live lane and where workers are expected to position signs, etc. Signs are placed, beginning with the 1km sign, in sequence towards the works site. Where the TTM will impact a live lane during the installation operation, a TTM vehicle should be protected with a separate IPV, although this may be relaxed if the TTM will be on the hard shoulder only.

Where the central median does not provide a sufficient lateral safety zone (≤ 1.2m), signs should be installed with the use of an IPV in lane 2 with TTM operatives crossing back to the hard shoulder (with a sufficient lateral safety zone). Alternatively, where crossing the carriageway on foot is not permitted, the TTM vehicle and IPV may be required to install the advance warning signage on the hard shoulder first, before circling back around and installing the signage on the central median. Where this is done, equipment relating to the hard shoulder closure / lane 1 closure is also pre-laid, before circling back around. Where an IPV is used for setting out signs for live lane closures, the Setting-out Roadworks Ahead sign in Figure 3.3.3.2.1 or a VMS must be installed.

3.3.3.4 Lead-in Tapers

The location of a taper is an important component of TTM, as it guides the road user onto the temporary road layout. A lead-in taper should be a minimum of 180m in length. However, subject to a site-specific risk assessment, a TTM Designer may specify a longer taper.

- Minimum clear visibility to the end of the taper from the lane being should be:
  - 300m for 80km/h;
  - 400m for 100km/h; and
  - 500m for 120km/h.

Tapers should not be placed opposite merges, diverges or junctions or at the start of chicane tapers off the point of a diverge / merge nosing. Generally, the start point of tapers should be kept 200m away from these locations.

A number of installation methods can be adopted, but all will generally involve the use of a TTM operative acting as a traffic hazard spotter working in conjunction with the TTM operative placing the equipment. An IPV should take up position 50 to 100m ahead of the live lane taper start point with the TTM vehicle taking up position at the start of the taper.

Refer to Section 3.4.2.5 (iv) for two methods for deploying an IPV.

A typical Lead-in Taper installation method is as follows:

1. Beginning 50 to 100m ahead of the IPV, installs a block line of three cones behind the TTM vehicle. Sign RUS 001 Keep Left / RUS 002 Keep Right is installed on the outside edge of this block line.

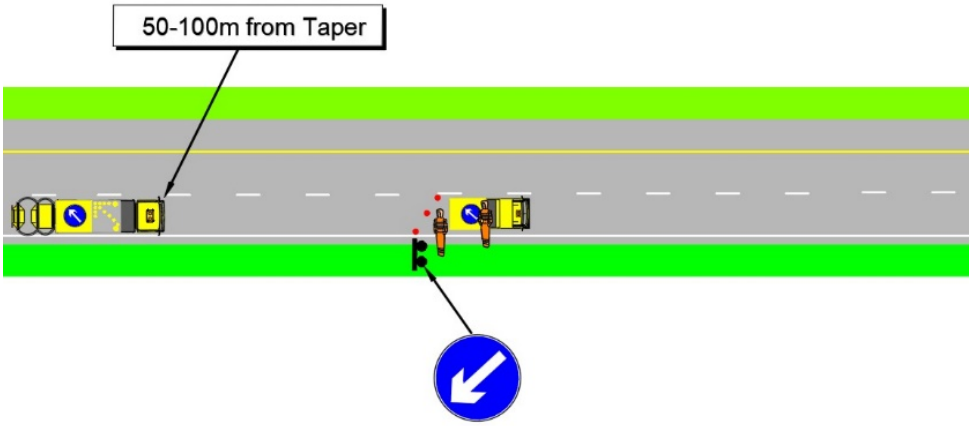


Figure 3.3.3.4.1: Typical Lead-in Taper Installation Method – Step 1

2. The TTM vehicle then continues dropping out cones at 3m centres along the inside edge of the closed lane and every 12m along the live lane edge. Additional cones for the block lines need to be dropped out every 36m.

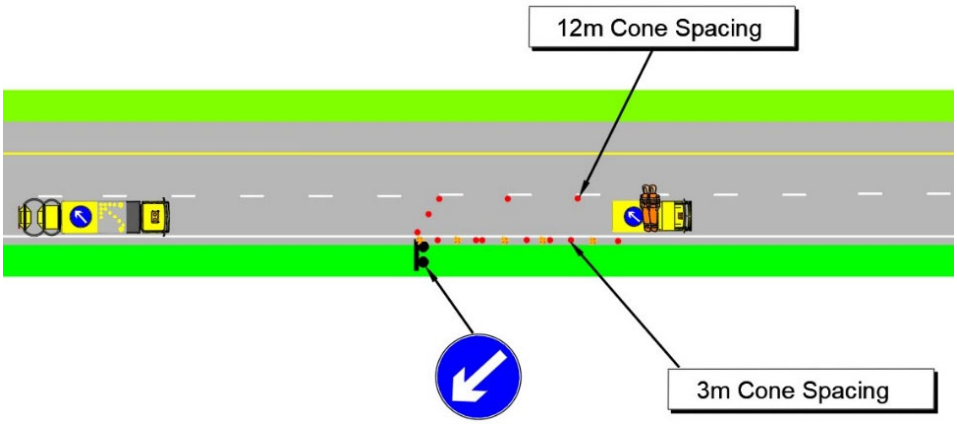


Figure 3.3.3.4.2: Typical Lead-in Taper Installation Method – Step 2

3. Working from the end of the taper, the operatives install the taper by pulling the cones from the inside edge and the live lane as they work towards the front of the taper. They also install the block lines of cones as they proceed ensuring a good taper line is achieved.

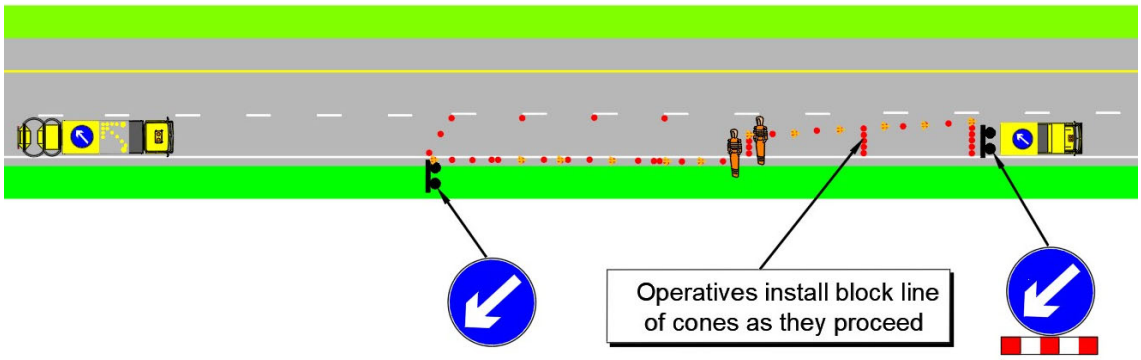


Figure 3.3.3.4.3: Typical Lead-in Taper Installation Method – Step 3

4. If lamps are required, they are now installed on the completed taper. should be placed every 6m along the taper. The outside cone of each block line may be re-placed with a heavier traffic delineator panel if required.

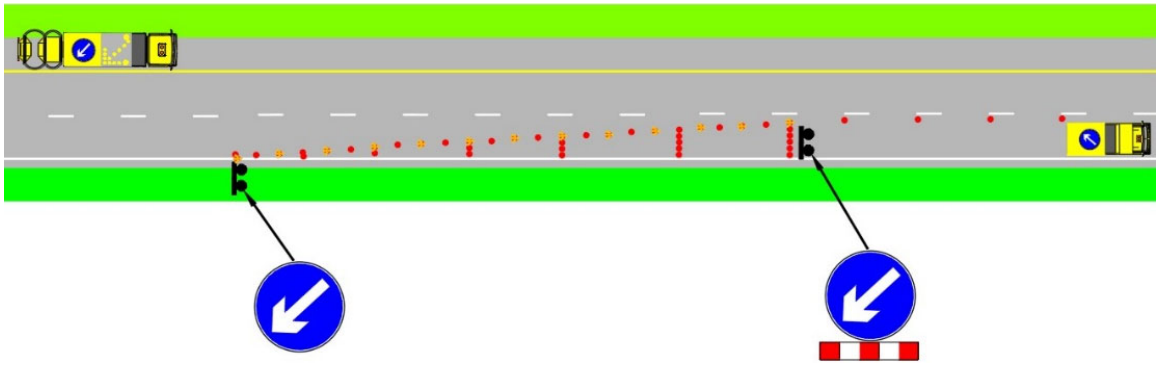


Figure 3.3.3.4.4: Typical Lead-in Taper Installation Method – Step 4

Once the taper is installed, the IPV moves onto the hard shoulder. It should move into the transition length / longitudinal cone run once a sufficient longitudinal safety zone has been achieved.

Hard Shoulder Closure

A hard shoulder taper is required to close off the hard shoulder on a dual carriageway. Typical lengths of dual carriageway hard shoulder taper lengths are given in Table 3.3.3.4.1 below. Block lines are not required on a dual carriageway hard shoulder taper. The layout required for a motorway hard shoulder closure is shown in Figure 3.3.3.4.2. A taper is not required on a motorway.

Speed (km/h)	H/S Width (m)	Length (m)
80	2.5	50
	3.0	60
≥100	2.5	75
	3.0	90

Table 3.3.3.4.1: Dual Carriageway Hard Shoulder Taper Length

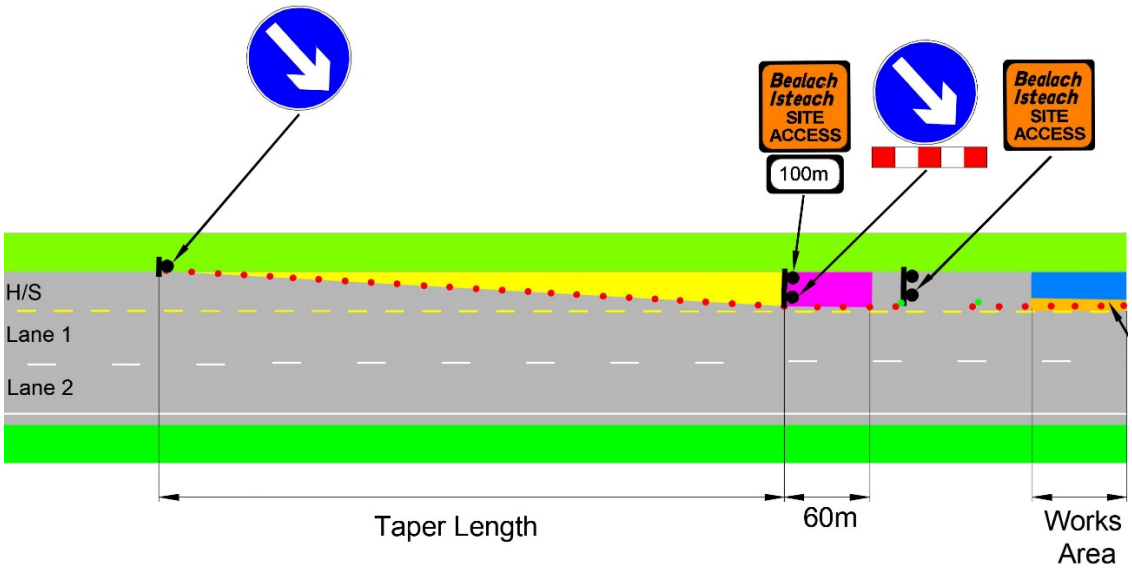


Figure 3.3.3.4.5: Dual Carriageway Hard Shoulder Taper

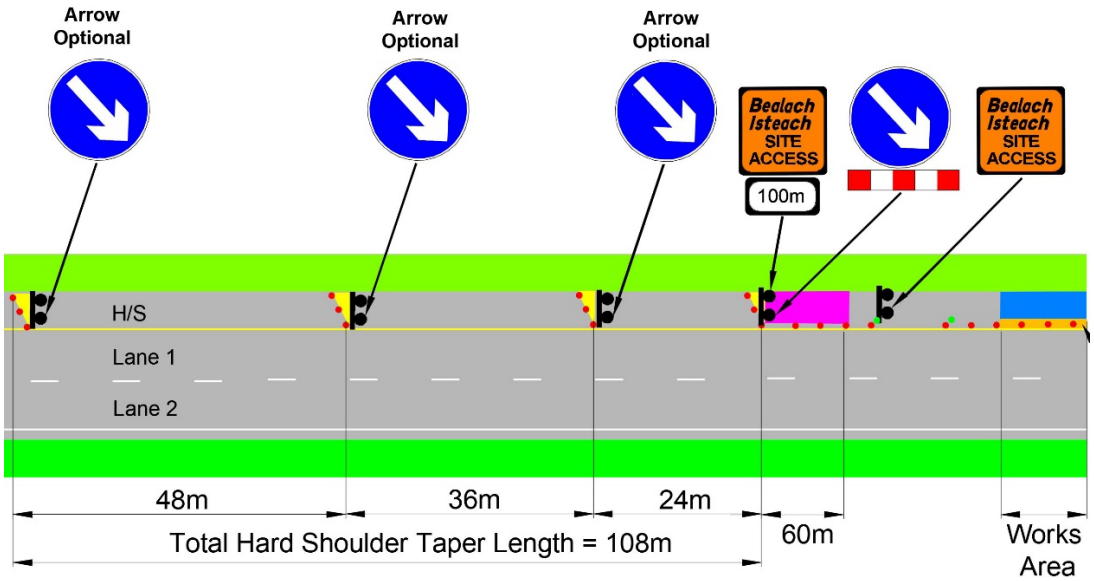


Figure 3.3.3.4.6: Motorway Hard Shoulder Closure

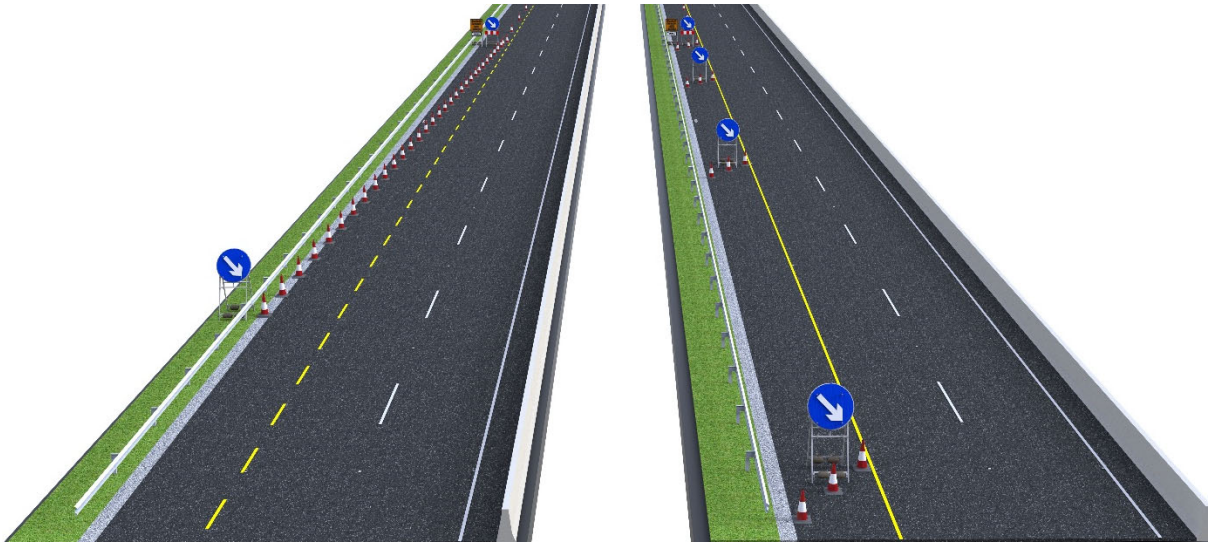


Figure 3.3.3.4.7: (a) Dual Carriageway Taper and (b) Motorway Hard Shoulder Closure

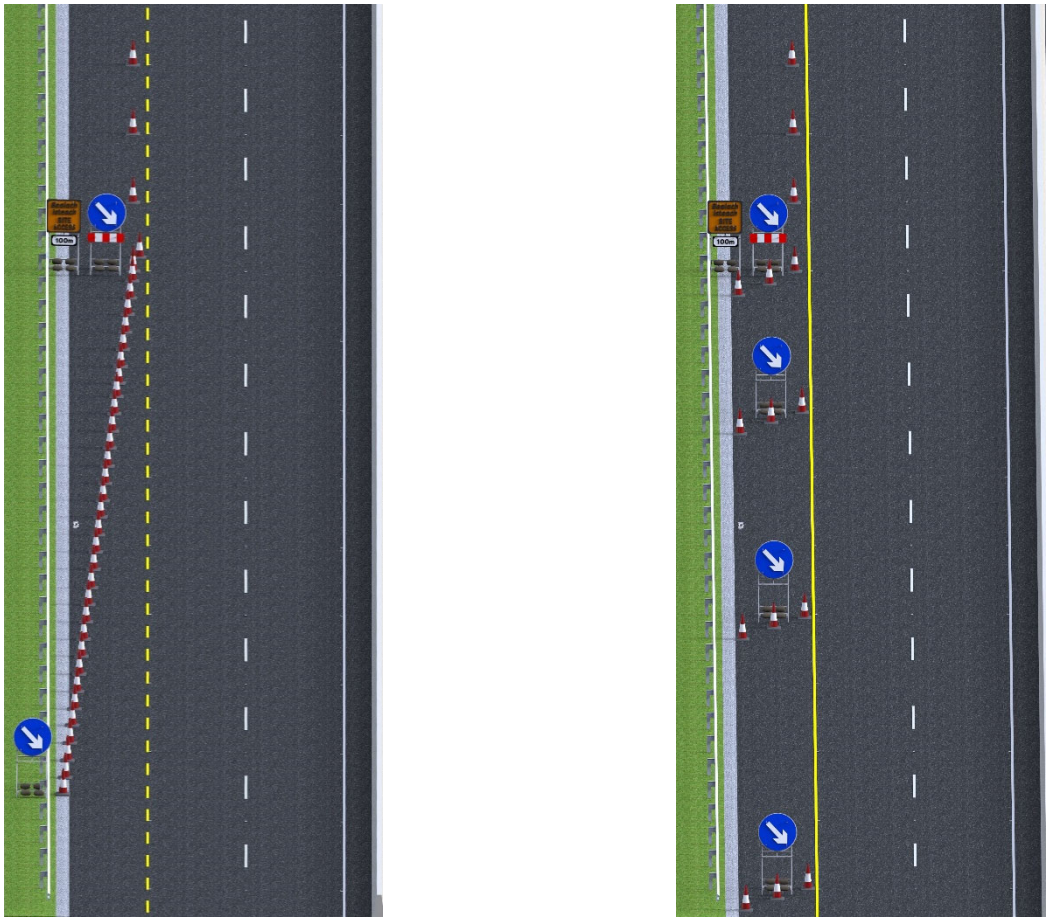


Figure 3.3.3.4.8: (a) Dual Carriageway Taper and (b) Motorway Hard Shoulder Closure

3.3.3.5 Transition Length

The transition length is the distance required between the first lead-in taper and the start of the next taper (chicane) for the reduction of a number of lanes on multi-lane carriageways. A transition length is needed following each lane closed before a further taper is installed. The transition length should be a minimum of 360m (twice the taper length).

Where a working window is required to install a facing wall, splitter, open or close a 'gate', then a transition length (or single lane length in advance of the operation), should be installed in accordance with the Table 3.3.3.5.1. This allows a rolling block to be used to provide a working window in which to perform the tasks.

Working Window (minutes)	Transition Length (km)	
	Rolling Block Speed	
	30km/h	50km/h
1	0.75	2
2	1.5	4
3	2.25	N/A
4	3	N/A

Table 3.3.3.5.1: Transition (or single lane) Lengths to establish a Working Window

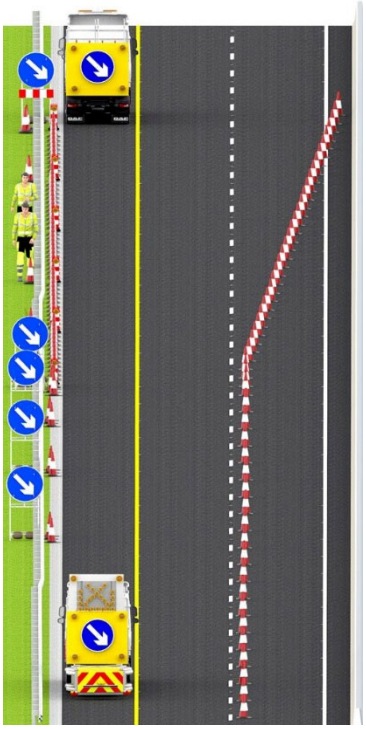
Where a 7.5 tonne TTM vehicle is used (and to conserve the equipment payload for installing any remaining hard shoulder / lane 1 / etc. tapers), the TTM vehicle continues to place cones at 12m centres for a further 60m. This is done by either walking them from the inside edge of the closed lane to the live edge or, if there is a coning well on the vehicle, can be dropped directly out along the live edge.

The IPV can now pull in front of the TTM vehicle to lay the remaining equipment. Continue placing cones safely along the live edge at 12m centres for the length of the transition and at 6m centres along the live edge for the length of the back wall. Install the back wall by pulling cones from the edge of the live lane into their required positions beginning at the end of the back wall and working towards the start while working within the coned area.

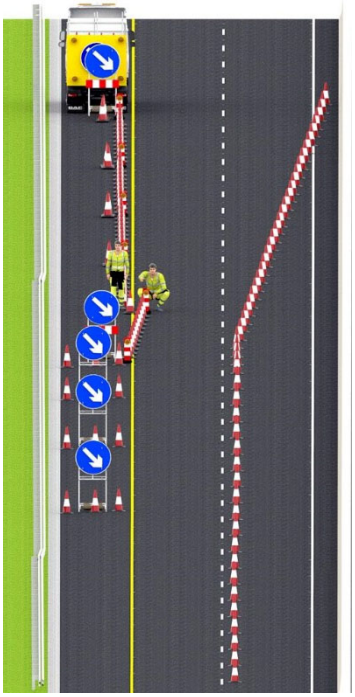
3.3.3.6 Multi-Lane Tapers/ Further Transition Lengths

Hard Shoulder and Facing Wall Tapers

The IPV moves across to take up position 50-100m in advance of the start of the hard shoulder taper, followed by the TTM vehicle taking up position at the start of the taper. The TTM vehicle places cones and signs for the full length of the hard shoulder and facing wall taper along the verge. At this point the TTM vehicle will be stopped on the hard shoulder at the end of the facing wall taper, and if required can proceed to park in a safe location. Install the hard shoulder taper under the protection of the IPV. The IPV should now leave the hard shoulder and may proceed to circle around to provide a rolling block for installing the facing wall taper.



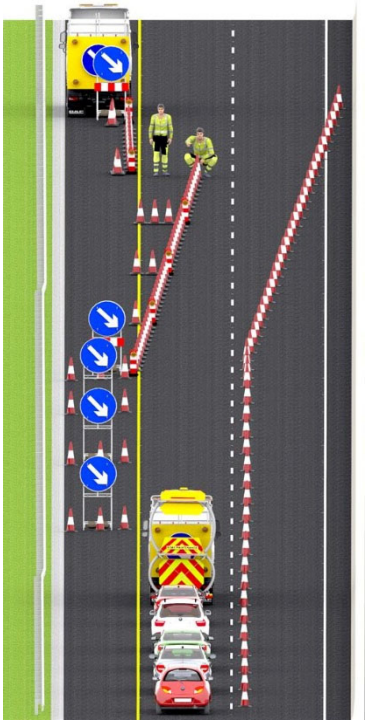
As it is not possible to use an IPV to protect the full installation time of the facing wall, a TTM operative must act as a traffic hazard spotter working in conjunction with the TTM operative placing the equipment. This task must be completed safely, and efficiently. Before proceeding, all cones must be brought to the live edge of the hard shoulder. The TTM operative and their spotter begin pulling the cones out to their required positions beginning at the start of the taper and working towards the end. The final positions of the cones are sighted in before the cones are moved. After 36m of the facing wall has been installed, which includes 1 block line, the IPV may be used to provide a rolling block affording the operatives around 30 seconds to continue to install the taper. This is generally referred to as the kick over.



Time should not be wasted installing block lines during this period. The length of time achieved is dependent on the transition length. The remainder of the facing wall including block lines can then be installed.

Multi-Lane Tapers and Transition Lengths

On roads with three or more lanes, where tapers are used in conjunction with transition lengths, the methodology described in placing the lead-in taper may be used.



Where a TTM layout requires multiple tapers, the lighting arrangement used on the first taper shall be used on all subsequent tapers.

A transition length should be used for Type A works. A direct multi-lane taper should be used for Type B works, therefore a transition length is not required in this scenario. In summary, this means a transition length is not required where the following criteria is met:

- Works are less than 12 hours duration;
- The traffic flow will remain less than carriageway capacity (1,200 to 1,300 vehicles / hour per lane left open);
- A direct multi-lane taper to the hard shoulder is not permitted; and
- A direct multi-lane taper of 3 or more lanes is not permitted.

Note:

The restriction on one or two items of plant is not applicable on Level 3 roads.

3.3.3.7 Longitudinal Safety Zone and Works Access

The Longitudinal Safety Zone provides a passive safety area for errant vehicles ahead of the works area. It is measured from the end of the taper to the start of the works or the works access, whichever comes first. This must be 45m on a Level 3(i) or 60m on a Level 3(ii) road. Generally, 100m is provided if the longitudinal safety zone is to be used immediately ahead of a works access. This area must be kept clear of operatives, plant and materials. Additional cones, coloured green, should be used to demarcate works access / egress points".

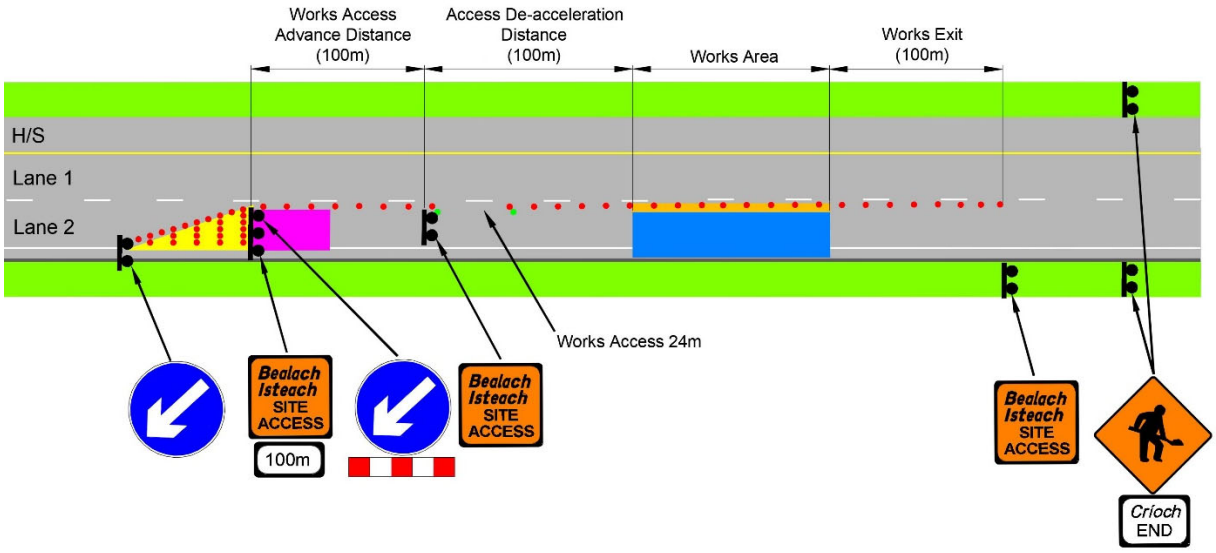
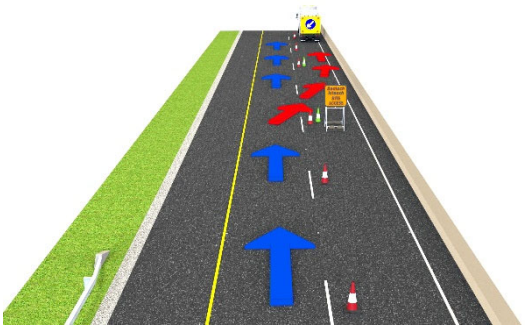


Figure 3.3.3.7.1: Site Access Installation on a Lane 2 Closure of a 2 Lane Carriageway

Advance warning of a site access should be provided on roads with a speed limit of 80km/h or more. Sign WK 052 Site Access with supplementary plate P 001 should be installed approximately 100m prior to the actual site access and again at the site access. The access point is usually indicated by two to three cones placed close together at an angle. A flashing lamp may also be used to indicate to road users that this presents a hazard.

The gap for the site access is governed by the speed of traffic and size of vehicles required to use it. The gap should be a minimum of 24m but can be extended to 48m. It is not advisable to exceed 48m as this may indicate to other road users that the lane is open. Sufficient room, generally 100m, should be allowed immediately after the site access within the coned area for vehicles entering the works to slow down/stop prior to the works area.



Legend:

3.3.3.8 Longitudinal Cone Run, Lateral Safety Zone and Signage through the Site

A longitudinal cone run serves as the main dividing line between the live traffic and the work zone. A longitudinal cone run should be installed from a TTM vehicle, preferably with a coning well, or low working platform, so that cones can be placed directly from the vehicle onto their required location, operating within the closed lane up to the end sign locations (initially 20-50m beyond the works exit, to be brought back once the end signage is erected). Required signage through the site is generally placed on the closed lane edge only (where only 1 lane is left open), to reduce the number of crossings required. If it is required to place signage through the site on a narrow median, then the use of a rolling block vehicle should be considered to provide the necessary time to complete the task, or alternative safe method of work used.

The second line of cones delineating the works area may be omitted if the works are continually moving or making frequent short duration stops, e.g. sweeping, road stud replacement, weed spraying, slot drain cleaning etc.

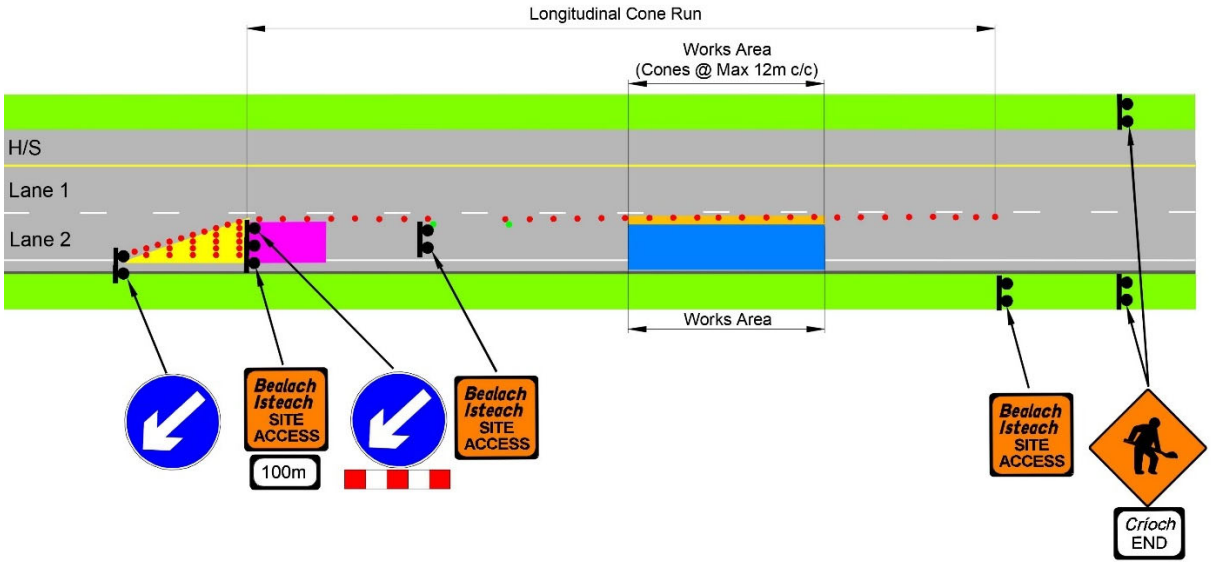
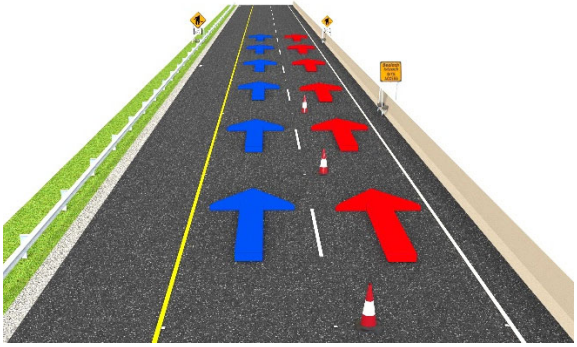


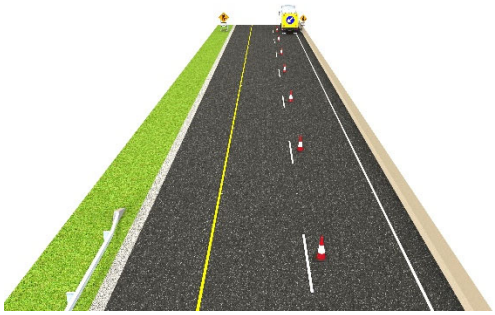
Figure 3.3.3.8.1: Longitudinal Cone Run and Lateral Safety Zone

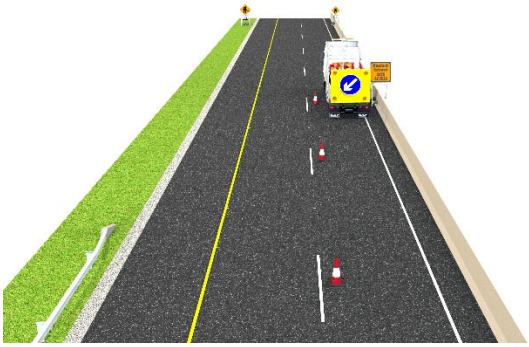
3.3.3.9 Install Works Exit and Roadworks Ends Signage

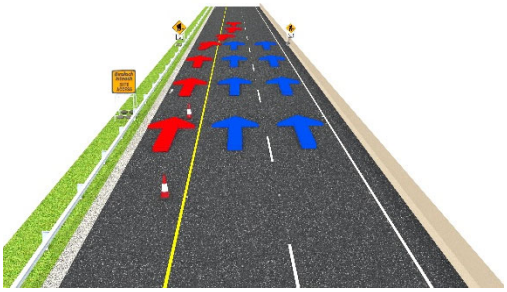
The Roadworks End Signage should be erected from a point of safety by the extension of the longitudinal cone run described in the previous step. Where the signage needs to be erected on the other side of the carriageway, there needs to be a minimum clearance of 1.2m between the edge marking of the live lane and where workers are expected to position the signs. As such, where there is a no crossings policy, or a narrow central median (on a lane 1 closure), a rolling block will be required to install the Roadworks End sign on the other side of the carriageway.

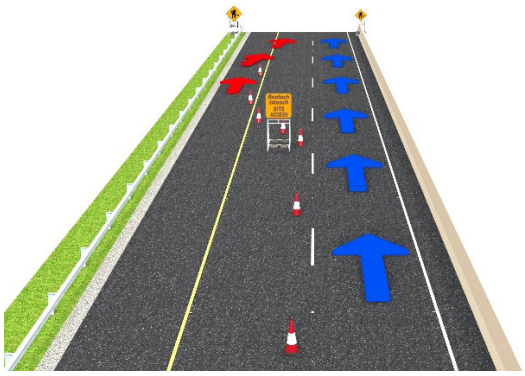
After the end signage is complete, the (additional) length of longitudinal cones are removed by reversing the TTM vehicle back towards the site while picking up the cones. The works exit can then be installed at the required location. The layout of the works exit is dependent on the lane being closed. An example is shown for hard shoulder, lane 1 and lane 2.

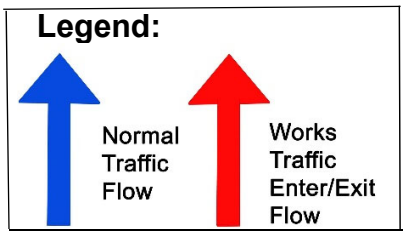












3.3.3.10 Install Works Area and Internal Layouts

To install a lateral safety zone, a second line of cones is dropped out along the length of the works area at a maximum distance of 12m apart. Figure 3.3.3.8.1 shows an example of where a lateral safety zone is used. To create a physical divide, a safety line may be installed. The maximum length of continuous safety line is 50m. Double cones are used at these 50m intervals to begin new lengths of safety line.

3.3.3.11 Installing a Diverge Nosing Splitter

Installing a diverge nosing splitter involves an additional hazard of having to place equipment between two live lanes of traffic. The installations need to be timed to comply with the traffic flow requirements in Table 3.3.2.1, with crew members being fully briefed on their tasks and clear about what is expected from them, task timings, and the control measures that are going to be used. It is critical that all steps are completed without undue delay and that the crew is protected from live traffic during the installation.

Method 1

Method 1 is implemented by extending the line of longitudinal coning past the final location for the splitter, while still allowing a minimum of 100m in advance of the signage vehicle (between the front of the vehicle and the start of the ghost hatching) for traffic to continue to use the diverge.

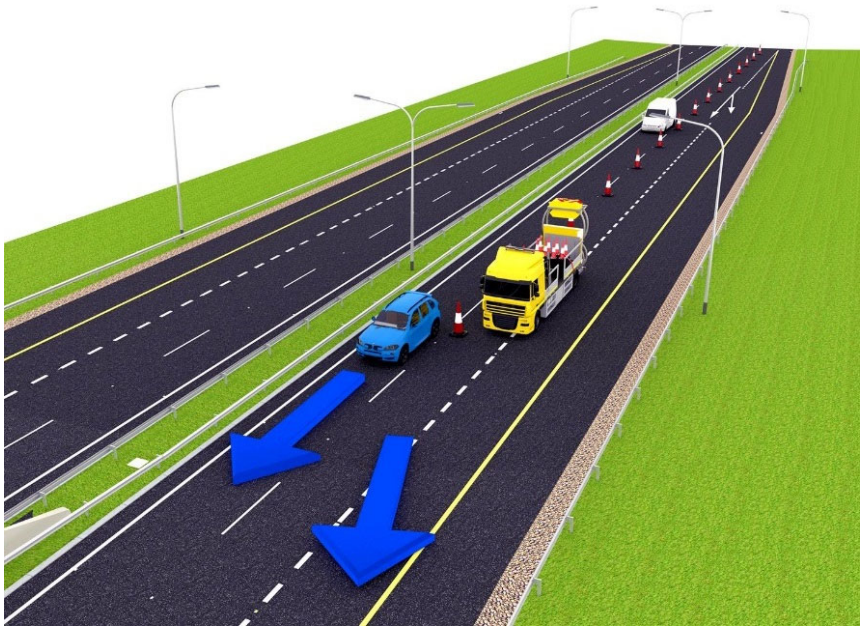


Figure 3.3.3.11.1: Installing a Diverge Nosing Splitter – Method 1

The crew should erect the diverge splitter behind the vehicle under the protection of the longitudinal cone run.

Coning to the front of the traffic management vehicle on both sides to provide a safe area for the next step. Do not erect sign RUS 003 Pass Either Side until it is safe for road users to do so during the next step.

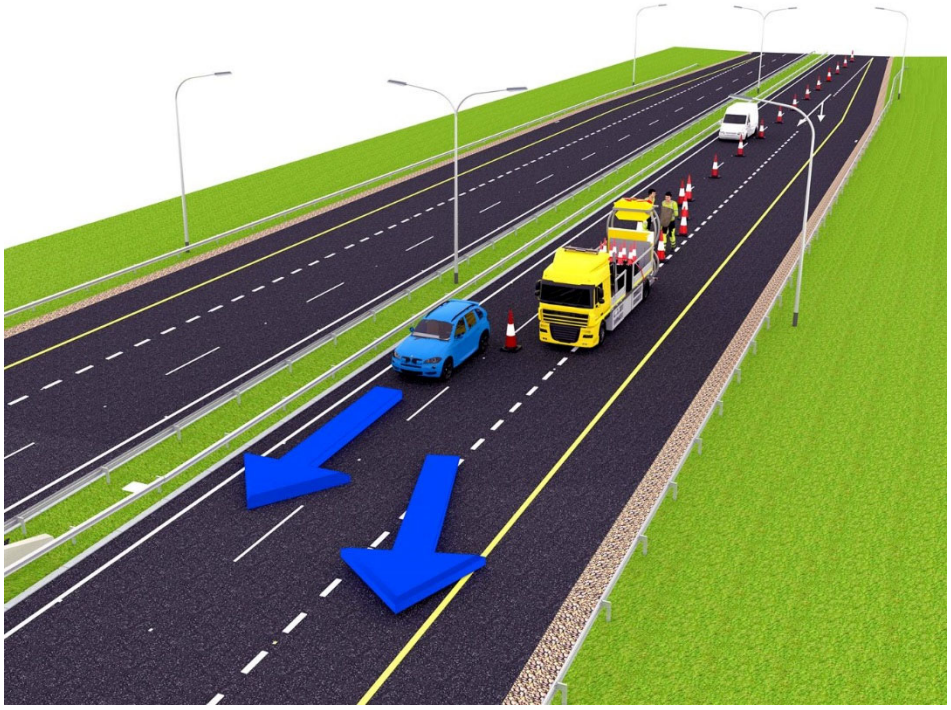


Figure 3.3.3.11.2: Installing a Diverge Nosing Splitter – Method 1

Once the splitter is built, the crew can then begin to build the diverge taper. They pull the longitudinal cones into the taper from the start of the splitter working backwards, and safely under the protection of the preceding cones, towards the beginning of the final diverge taper.

Figure 3.3.3.11.3: Installing a Diverge Nosing Splitter – Method 1

When it is safe to do so, the crew can now cross over to the safe area of the splitter and continue to install the traffic management beyond the exit point. The 100m gap in front of the truck should be closed quickly when there is a gap in traffic. The crew need to be aware that traffic is now passing them on both sides, and not to cross over the diverge without checking it is safe to do so first, when continuing to place cones on diverge hard shoulder.

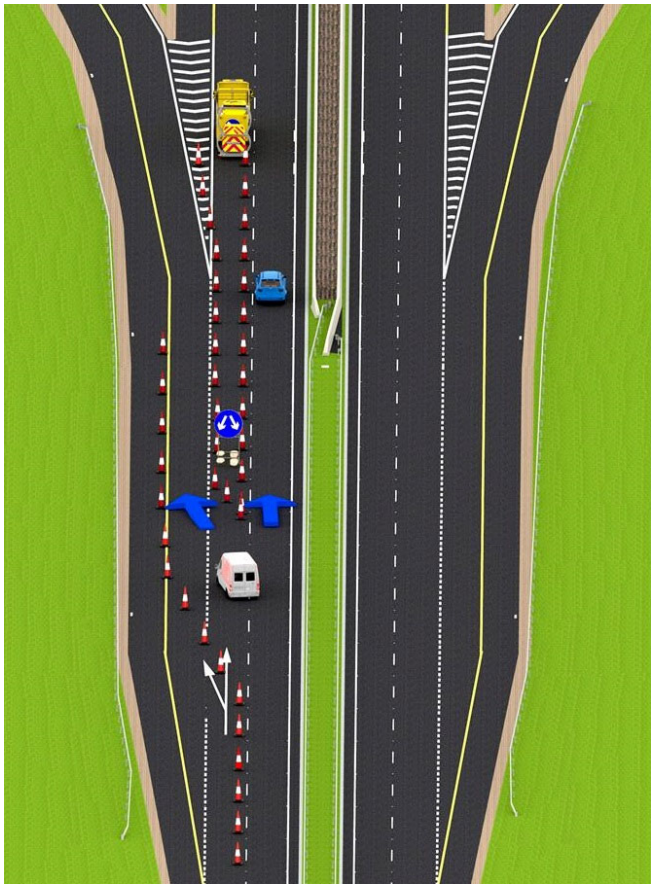


Figure 3.3.3.11.4: Installing a Diverge Nosing Splitter – Method 1 Final Layout

Alternative Method

In some locations where there is insufficient length to allow the required distances in front of and behind the traffic management vehicle, or where there are visibility issues for the crew to see oncoming traffic, an alternative method may be required. This method will involve the use of a rolling block vehicle to introduce a working window to allow the crew to place equipment into the off-ramp splitter. With proper planning and sufficient crew, the amount of time required to place the necessary equipment (nosing cones and splitter sign with sandbags) can be kept as low as one minute, but two additional minutes need to be factored in as a safety measure in calculating the total working window required. The length of the approach section required, where traffic will be under the control of the rolling block vehicle can be estimated from the following table. The rolling block vehicle should preferably travel at 50km/h and not less than 30km/h.

Working Window (minutes)	Transition Length (km)	
	Closure Speed	
	30km/h	50km/h
1	0.75	2
2	1.5	4
3	2.25	N/A
4	3	N/A

Table 3.3.3.11.1: Installing a Diverge Nosing Splitter – Alternative Method – Control Distance

The exit taper is established on the hard shoulder side of the diverge, and equipment pre-placed at the required crossing point in preparation for establishing the splitter.

Figure 3.3.3.11.5: Installing a Diverge Nosing Splitter – Alternative Method

The rolling block is started, communicated and confirmed with the crew with a spotter keeping look out for the point where crew must be off the road. The spotter should be in direct communication with the rolling block vehicle. The crew place the necessary equipment.

After the rolling road block vehicle has passed, the crew can continue to work behind the newly established diverge splitter. The crew need to be aware that traffic is now passing them on both sides, and in particular not to cross over the diverge without checking it is safe to do so first, when continuing to place cones on off-ramp hard shoulder.

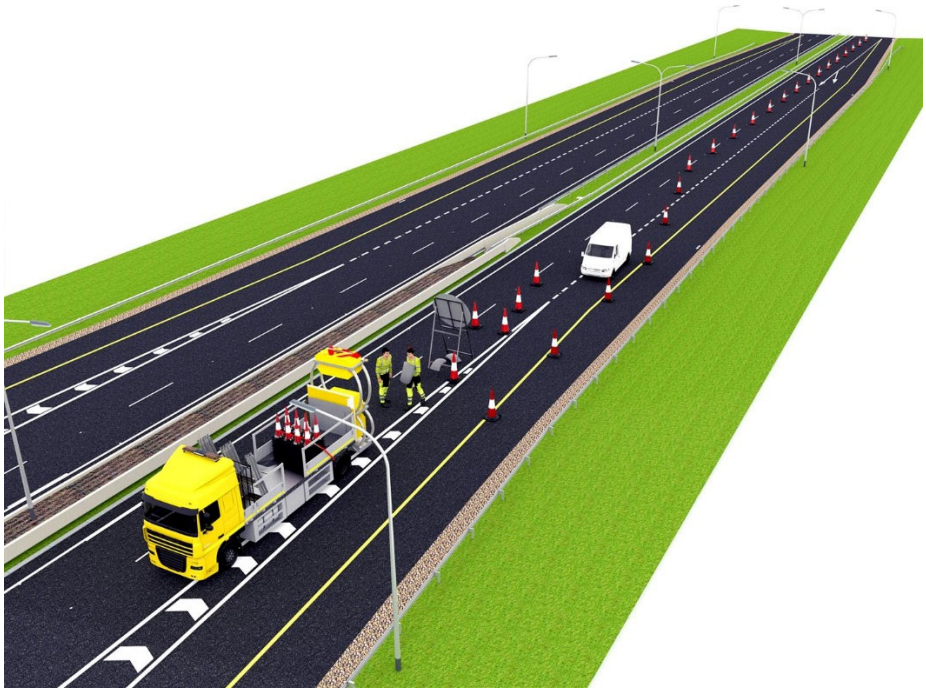


Figure 3.3.3.11.6: Installing a Diverge Nosing Splitter – Alternative Method

3.3.4 Traffic Management Installations

3.3.4.1 Context

Using the setting out methodologies outlined in Section 3.3.3, the following traffic management installations are described:

- Hard Shoulder Closures;
- Lane 1 Closures;
- Lane 2 / Lane 3 / Lane 4 Closures;
- Multi-Lane Closures;
- Direct Lane 1 Closures;
- Merges and Diverges;
- Up and Overs;
- Hard Shoulder Running;
- Lane Switches during Works;
- Narrow Lane System;
- Lane Gain and Lane Drop;
- Contra-Flows;
- 2+1 Carriageways;
- Transition from Single Carriageway to Dual Carriageway;
- Roundabouts; and
- Working on the Verge.

3.3.4.2 Hard Shoulder Closures

Type A

Advance warning signs must be placed on both sides of the carriageway.

For dual carriageways, the IPV and TTM vehicle then move along the hard shoulder to the start of the taper where the first Directional Arrow is erected, and cones are dropped out along the inside of the hard shoulder. Operatives then walk back to the start of the taper and walk each cone out to install the taper and close the hard shoulder. A second Directional Arrow and Lane Closed Board are erected.

For motorways, three block lines of cones are provided. The block cones are at intervals of 24m, 36m and 48m in advance of the closure over a total length of 108m. The IPV and TTM vehicle move along the hard shoulder to the location of each of the block cones and cones are dropped out along the inside of the hard shoulder. Operatives then install the block cones at these locations.

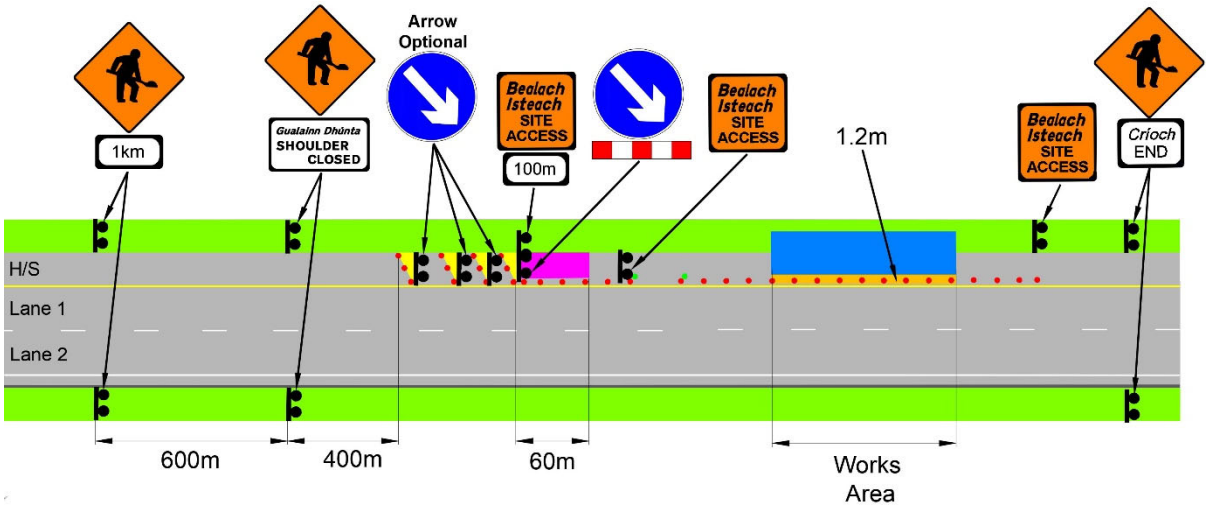


Figure 3.3.4.2.1: Hard Shoulder Closure on a Motorway

Type B

Figure 3.3.4.2.2 shows the permitted layout for short duration works. This is a scaled down static hard shoulder closure with no median signs required.

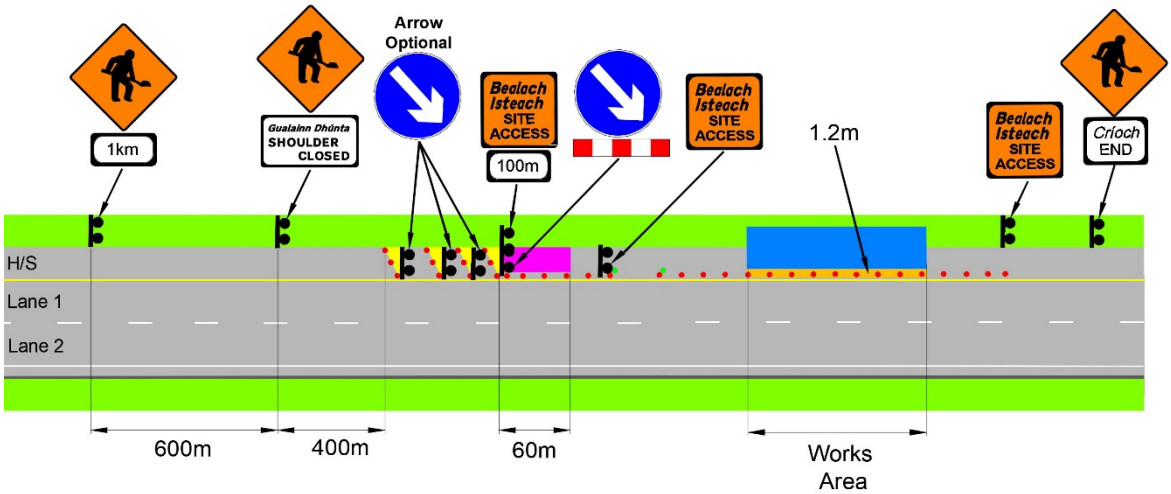


Figure 3.3.4.2.2: Hard Shoulder Closure on a Motorway with no Median Signage

Type C

Type C hard shoulder works may be carried out under the protection of an IPV.

3.3.4.3 Lane 1 Closures

Firstly, using an IPV and a TTM vehicle, a lead-in taper, transition length and back wall taper are installed on lane 2. A longitudinal cone run and exit taper are installed to guide the traffic back into the open lane 2. A hard shoulder taper, facing wall, longitudinal safety zone, longitudinal cone run works access and works exit are then installed to complete the lane 1 closure. Refer to Figure 3.3.4.3.1. In some cases, it may be necessary to provide cones along the verge to prevent vehicles from driving into any hazards.

To close lane 1 on a 3 lane Level 3 road, a merge to the right manoeuvre should be used. Refer to Figure 3.3.4.3.2. This is only allowed where there are three or more lanes. A similar procedure to that used for a lane 2 closure is used, excluding the installations on lane 2.

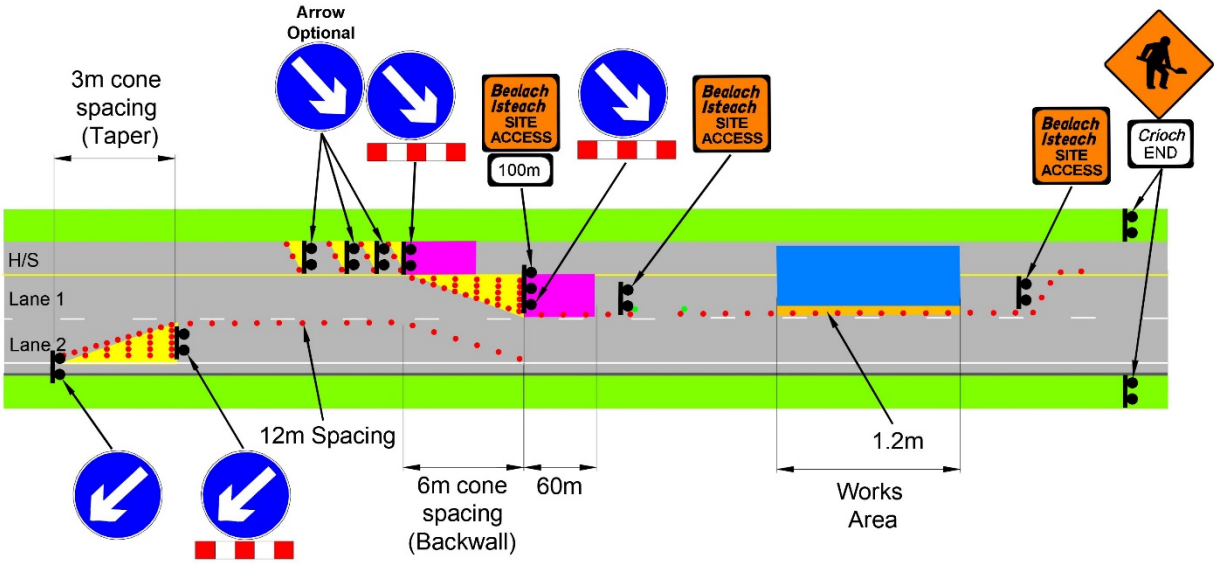


Figure 3.3.4.3.1: Lane 1 Closure on a 2 Lane Motorway

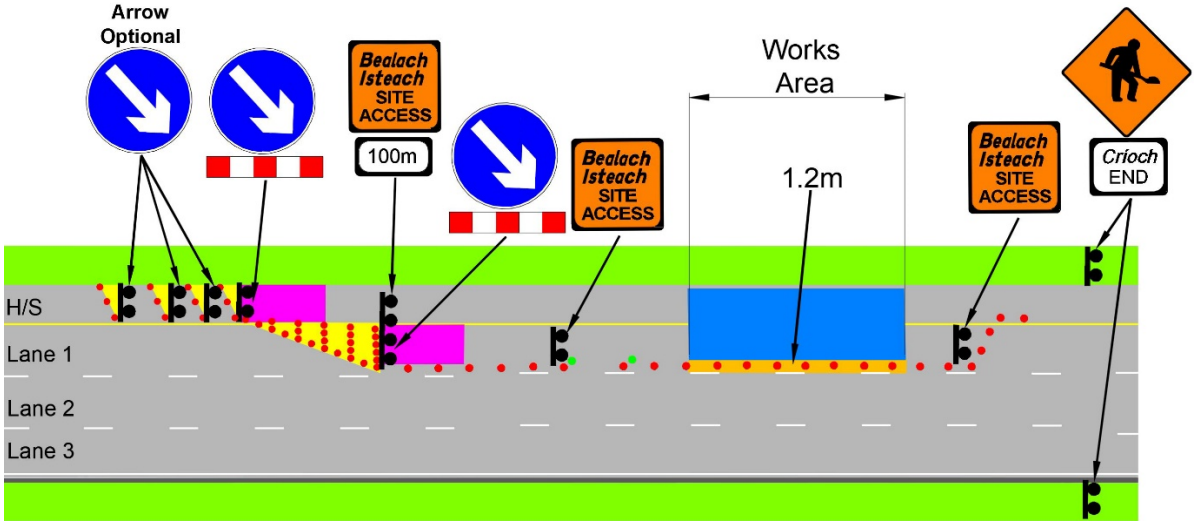


Figure 3.3.4.3.2: Lane 1 Closure on a 3 Lane Motorway

3.3.4.4 Lane 2 / Lane 3 / Lane 4 Closures

Lane 2 Closure

Using an IPV and TTM, a lead-in taper, longitudinal safety zone, works access, longitudinal cone run and exit taper are installed on lane 2. Where possible the hard shoulder should be used to accommodate traffic, but only if sufficient lane width is provided.

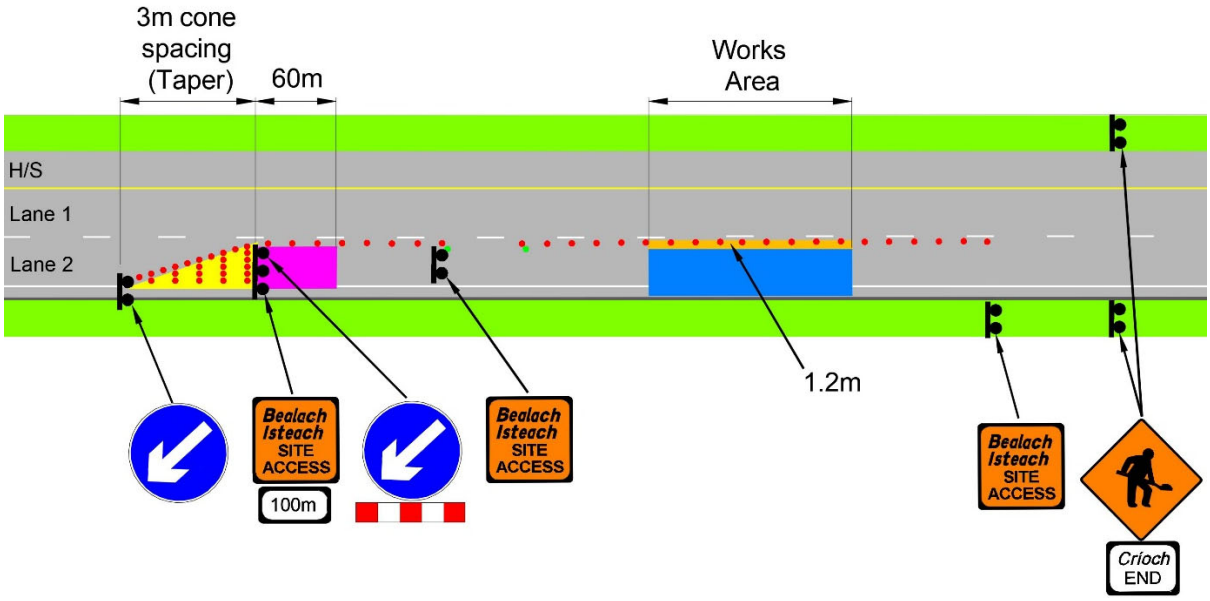


Figure 3.3.4.4.1: Lane 2 Closure on a 2 Lane Carriageway

Lane 3 Closure

A lane 3 closure on a 3-lane carriageway should follow the principles of a lane 2 closure.

Lane 4 Closure

A lane 4 closure on a 4-lane carriageway should follow the principles of a lane 2 closure.

3.3.4.5 Multi-lane Closures

Multi-lane closures are grouped in Type A works and Type B works. Refer to Section 3.3.3 for installation method.

Type A Works

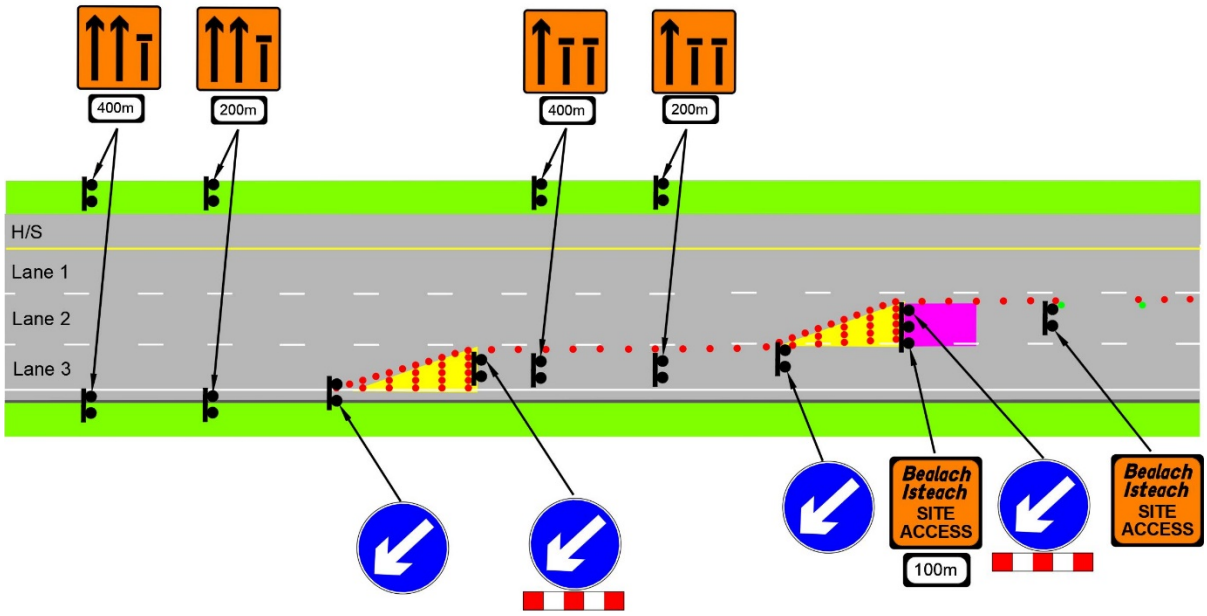


Figure 3.3.4.5.1: Lane 2 and 3 Closure on a 3 Lane Carriageway for Type A Works

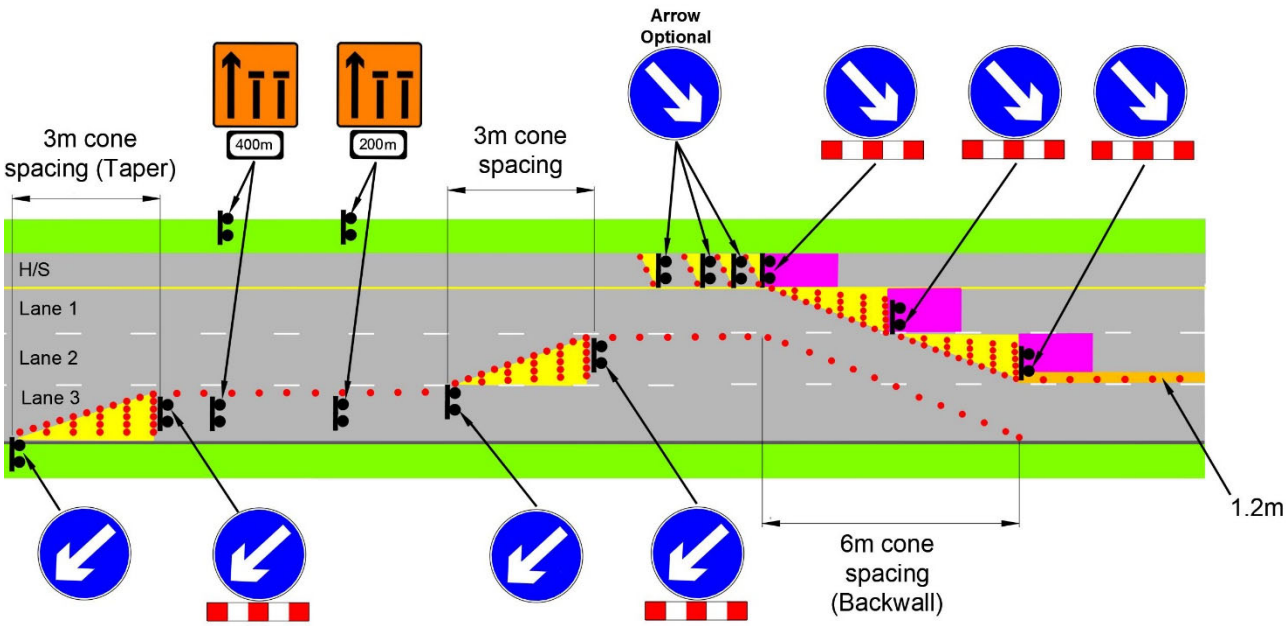


Figure 3.3.4.5.2: Lane 1 and 2 Closure on a 3 Lane Carriageway for Type A Works

Type B Works

A direct multi-lane taper should be used for Type B works, therefore a transition length is not required. This allows the closure of an auxiliary / lane 1 and lane 2 by a direct taper from the hard shoulder without the requirement for transitions.

3.3.4.6 Direct Lane 1 Closures

Direct Lane 1 closures mean that a fast into slow lead-in taper and transition length arrangement is not used ahead of the works. Direct Lane 1 closures can only be used subject to a site-specific risk assessment, site specific plan and are subject to the criteria described in Table 3.3.4.6.1 Traffic counts shall be carried out before the operation commences and every 15 minutes during the closure. The TTM shall be decommissioned if traffic flow exceeds the permitted volumes – refer to Note 3 of Table 3.3.4.6.1.

The table below outlines the restrictions on the use of direct lane 1 closures on two lane, three lane and four lane carriageways.

Lane Closure	Permitted Traffic Flow	Maximum Duration (hours)	Sequential Lamps (both day-time & night-time)	Verge Advance Warning Signage	Median Advance Warning Signage
Dual Two-Lane Carriageway					
Lane 1	≤ 800 veh / hr (≤ 40 veh / 3 min)	8	Required (H/S & Lane)	Required	Required [6]
Dual Three Lane Carriageway					
Lane 1	≤ 2000 veh / hr (≤ 100 veh / 3 min)	≤12	Required	Required	Not required [7]
Lane 1	≤ 2000 veh / hr (≤ 100 veh / 3 min)	>12	Required	Required	Required
Lane 1 + 2	≤ 800 veh / hr (≤ 40 veh / 3 min)	8	Required	Required	Required
Dual Four Lane Carriageway					
Lane 1	≤ 3200 veh / hr (≤ 160 veh / 3 min)	≤12	Required	Required	Not required [7]
Lane 1	≤ 3200 veh / hr (≤ 160 veh / 3 min)	>12	Required	Required	Required
Lane 1 + 2	≤ 2000 veh / hr (≤ 100 veh / 3 min)	12	Required	Required	Not required [7]
Lane 1 + 2 + 3	Not permitted				

Table 3.3.4.6.1: Direct Lane 1 Closures Criteria

Notes:

1. Where the HGV content is high, the above figures may need to be reduced. Typically, HGV content is 15 to 20%. If the HGV content is 30% then the figures in this table should be reduced by 10%.
2. When working past slip roads the maximum flow on the slip road should not exceed 500 vehicles per hour (25 vehicles / 3 minutes) during the TTM operation whether it is a single or multi-lane slip.
3. A TTM Crew is required on site throughout the period of the lane closure so that it can be removed if:
   - 2 successive 3 minute counts are above the required level; or
   - Traffic flow counts show a rising trend with the last one above the required level.
4. On dual two-lane carriageways, a VMS shall be erected approximately 2km in advance of the closure. The VMS shall remain in place for the full duration of the works.
   - First frame - Roadworks Ahead preferably in pictogram format; and
   - Second frame – Left Lane Closed or pictogram.
5. A 90m hard shoulder taper shall be used in lieu of 3 cone blocks.
6. Where a narrow central median is present and subject to a site-specific risk assessment, 5 number advanced warning signs (at a cumulative 1km distance) in combination with high visibility flashing warning beacons / lamps may be used in lieu of central median advance signage.
7. Median advance warning signage must be installed if it is identified as a required control during the site-specific risk assessment.

Direct Lane 1 Closures on a 2 Lane Carriageway

The following requirements shall also apply to Direct Lane 1 Closures on a 2 Lane carriageway:

- The longitudinal safety zone shall be increased to 120m;
- Minimum visibility to the end of the taper shall be the following:
  - 300m for 80km/h;
  - 400m for 100km/h; and
  - 500m for 120km/h.
- An IPV shall be placed in the centre of lane 1 immediately after the longitudinal safety zone with sign RUS 002 Keep Right. This shall be in place during both day-time & night-time conditions.

A direct lane 1 closure on a 2 Lane carriageway is shown in Figure 3.3.4.6.1.

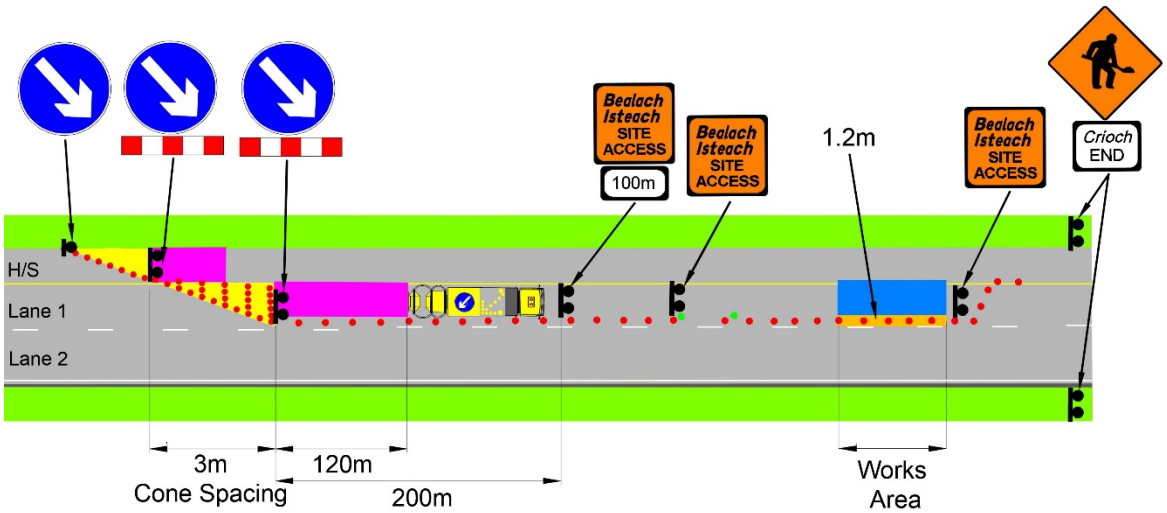


Figure 3.3.4.6.1: Direct Lane 1 Closure on a 2 Lane Carriageway

3.3.4.7 Merges and Diverges

200m should be provided as a settling in distance between tapers and merge or diverge points.

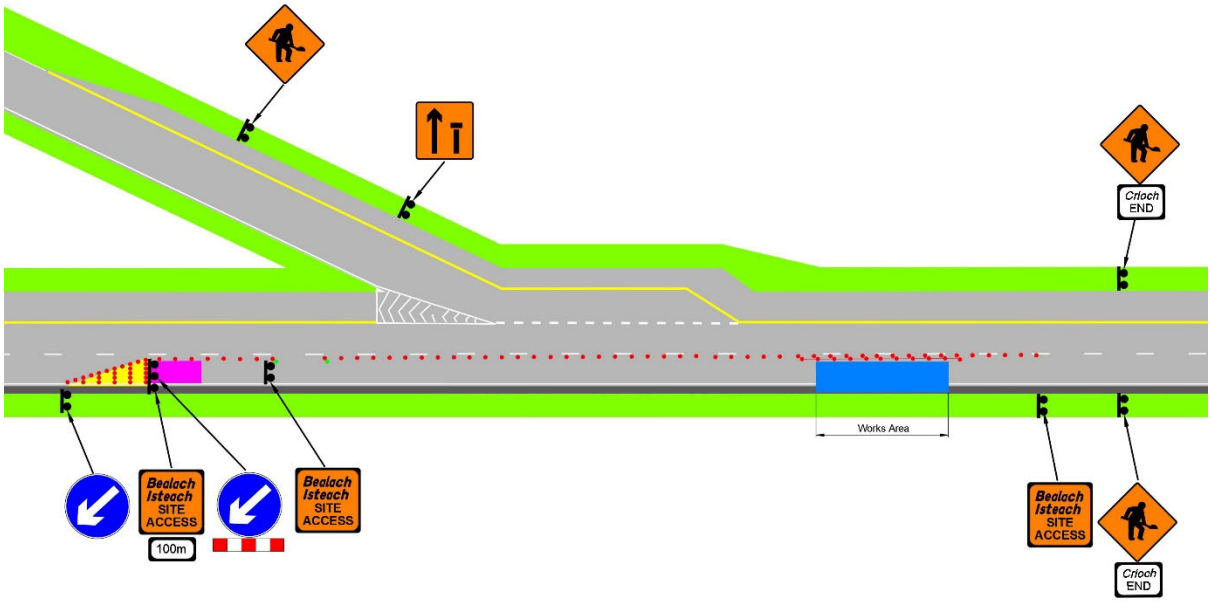


Figure 3.3.4.7.1: Merge with Works in Lane 2

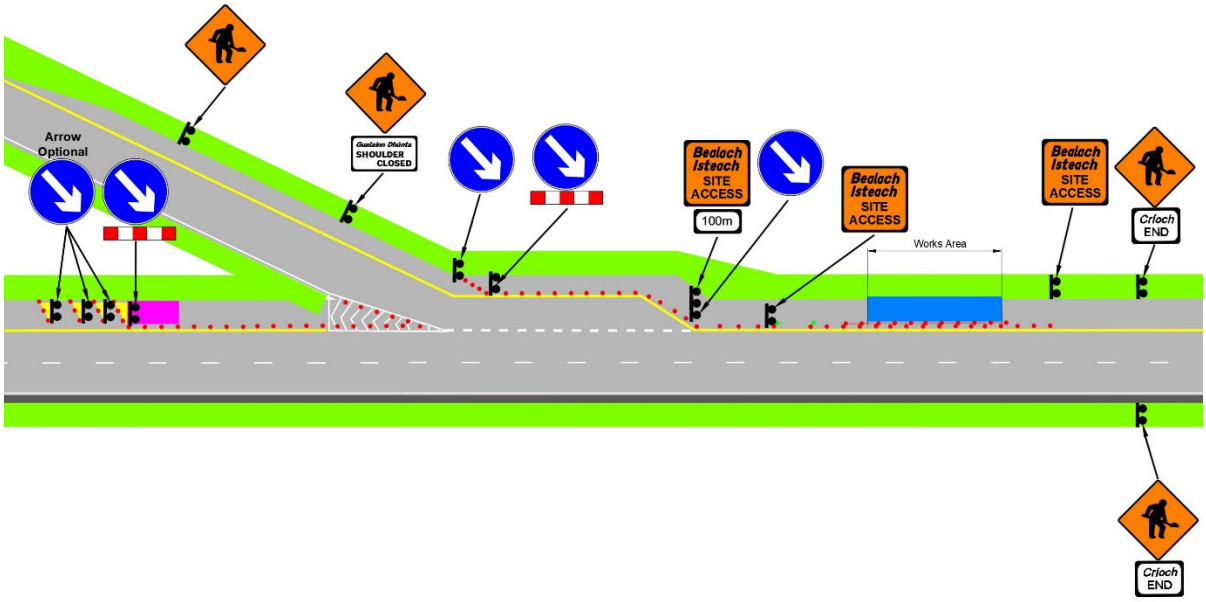


Figure 3.3.4.7.2: Merge with Works in Hard Shoulder

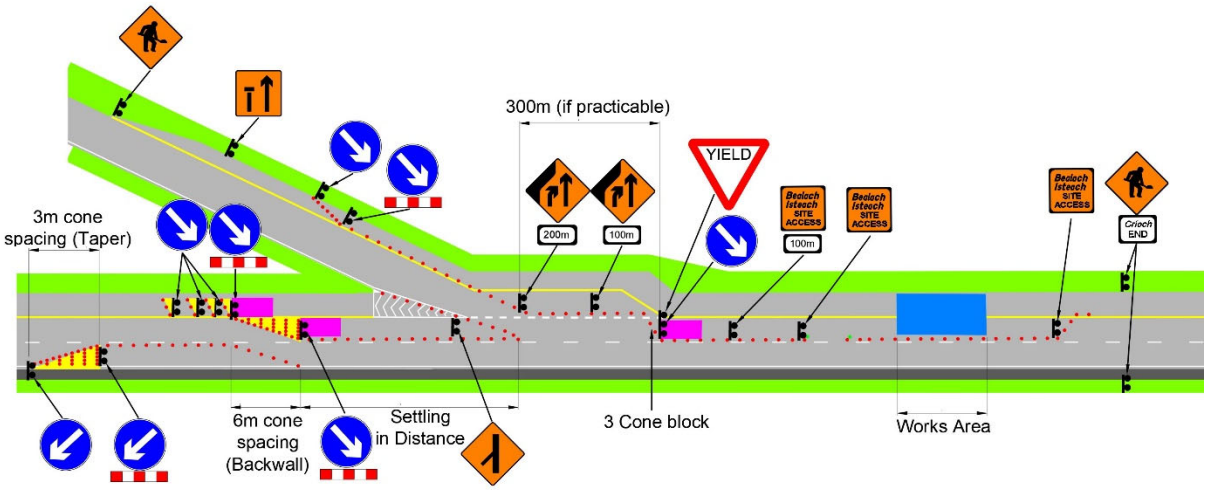


Figure 3.3.4.7.3: Merge with Works in Hard Shoulder and Lane 1

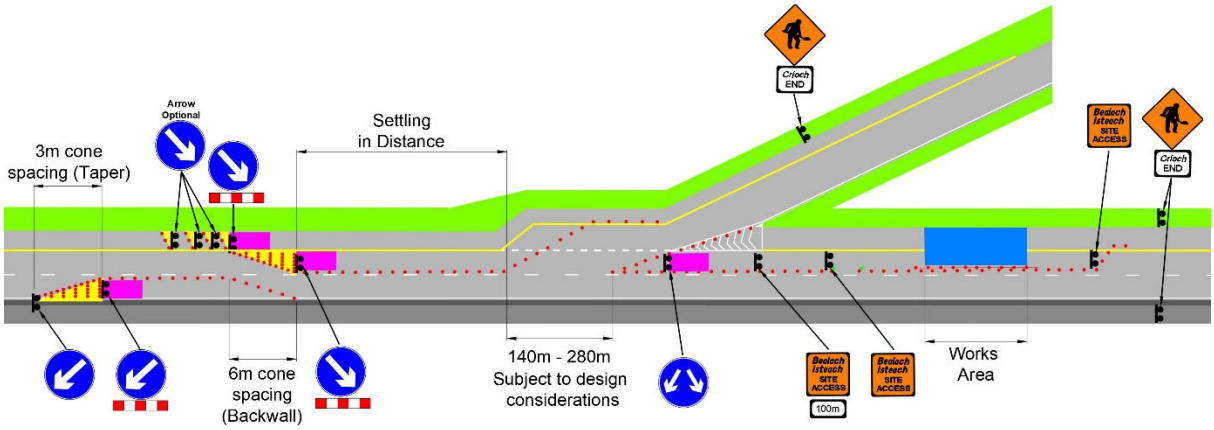


Figure 3.3.4.7.4: Diverge with Works in Lane 1 and Hard Shoulder

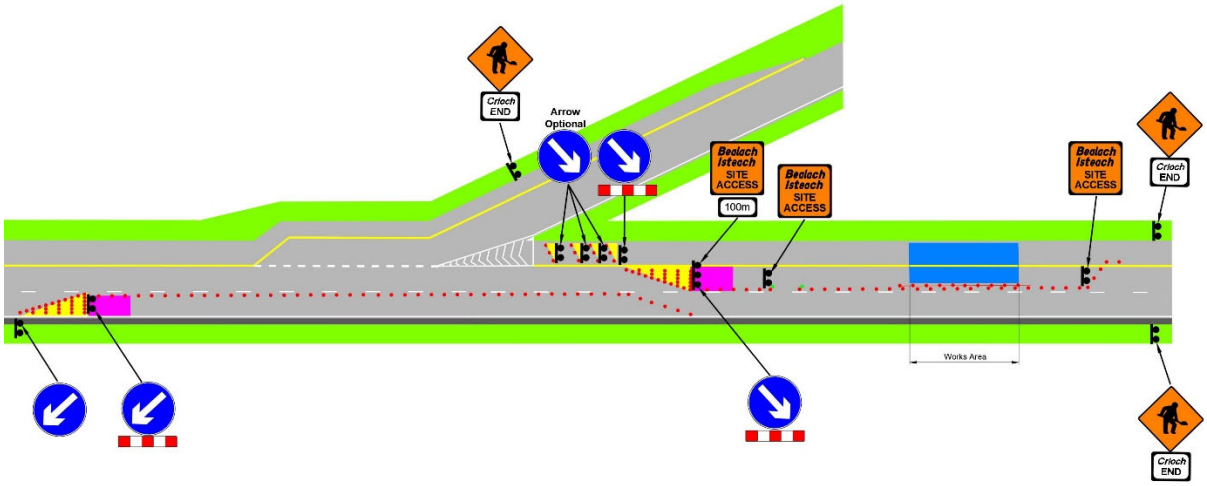


Figure 3.3.4.7.5: Works in Hard Shoulder and Lane 1 and Longitudinal Safety Zone beyond Diverge

3.3.4.8 Up and Overs

Up and Overs is when works are required at a junction overbridge and traffic is diverted from the mainline up onto the diverge and then merged back onto the mainline. Control may be required at the junction to prevent traffic from queuing down the slip road and onto the mainline.

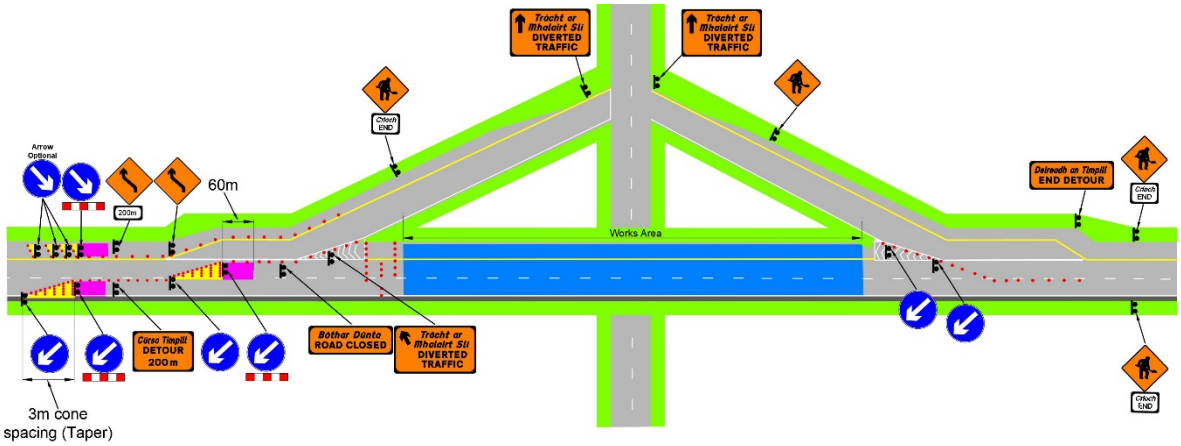


Figure 3.3.4.8.1: Up and Over Layout

3.3.4.9 Hard Shoulder Running

Hard shoulder running is when TTM arrangements are installed to force traffic to run on the hard shoulder for a set length. Without proper planning and site controls there is a high risk of TTM operatives getting struck due to disorientation and habit of working on the hard shoulder. Before installing, the hard shoulder should be checked for suitability as a running lane.

The installation process is different from the standard installation process as the coning layout is completed entirely on the hard shoulder before the lead-in taper / transition length / lane 1 taper is installed. This installation includes the hard shoulder taper, hard shoulder back wall, and hard shoulder re-join taper. Note that block lines of cones are not used on the hard shoulder lead-in taper or re-join taper. The criteria are shown in the table below.

Speed (km/h)	H/S Width (m)	H/S Lead-in Taper Length (m)	H/S Re-Join Taper Length (m)
80	2.5	50	100
	3.0	60	120
≥ 100	2.5	75	150
	3.0	90	180

Table 3.3.4.9.1: Hard Shoulder Running – Criteria

The lead-in taper, transition length and lane 1 taper should then be installed as already described in Section 3.3.3. Note that the cones separating the hard shoulder used as a running lane and the closed lane 1 must achieve the required lane widths and are set back from the yellow line marking.

Cones are used along the verge for the length of the hard shoulder running to protect the drainage channel. These should be spaced at 24m centres. When used, they must be installed immediately adjacent to the asphalt surface during the hard shoulder installation process. It is not permitted to work behind this line of cones. Cones are not required along the verge where a hard shoulder is kerbed.

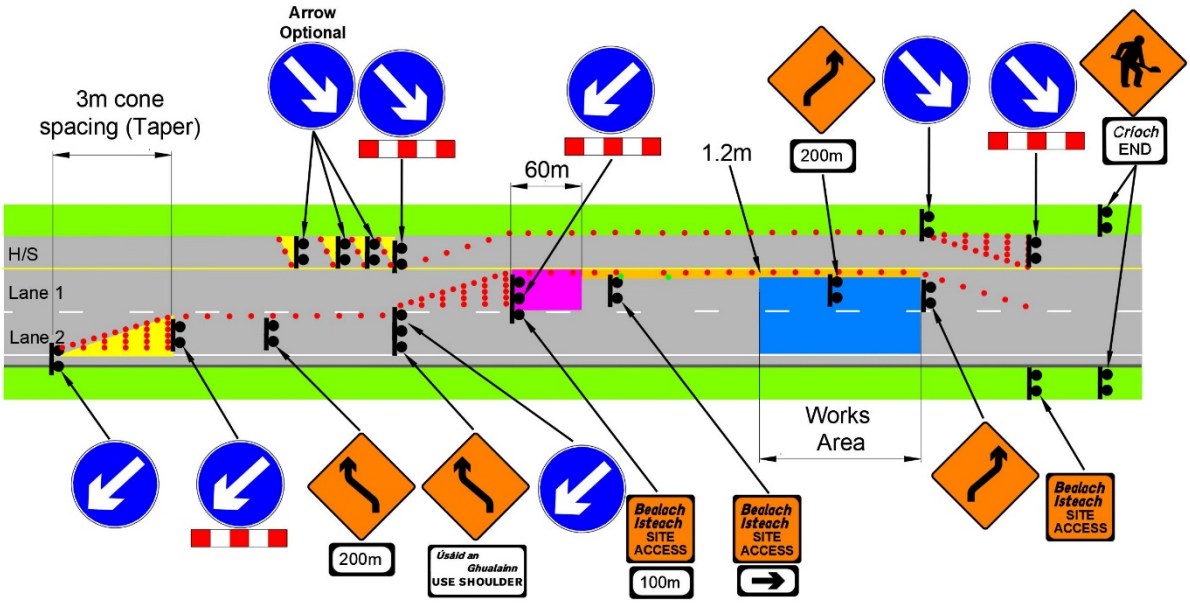


Figure 3.3.4.9.1: Hard Shoulder Running

3.3.4.10 Lane Switches during Works

Lane switches change the lanes that live traffic use during TTM operations. This operation needs to be well planned and co-ordinated between the TTM crew and the works crew. Consideration should be given to extending transition lengths at the initial setup to provide for a sufficient window to allow crews to execute the switch. Both crews need to be fully aware of which side of the cones they can work on during each stage of the switch. Layouts must begin with a merge to the left so that advance warning signage is consistent between switches. Work by the works crew should be suspended during this operation. The following is an example of a switch from a lane 1 closure to a hard shoulder running.

- Step 1: TTM operatives should construct most of the next phase within the existing closure to minimise the work required when the actual switch occurs. The required sign frames should be erected, but sign faces that could confuse the road user should not be erected

until the switch is complete. Likewise, existing sign faces on display that may confuse the road user should be taken down prior to the switch.

a. Build the back wall (180m @ 6m centres).
b. Build the end of the new facing wall (approximately 70m at 3m centres). This should be "eyed-in" from the end of the taper to hit the start point of the switched taper. Any lamps on this new section of taper are not to be switched on at this point.

- Step 2: Prepare for the 'gate' operation by:
  a. Removing block lines of cones. Unaffected block line cones on 4th and last block line may be left in place.
  b. Thin out taper cone spacing between 2nd and 3rd block lines to 6m centres, leaving any lamps in place. The taper cone spacing between the start and 2nd block lines should be left at 3m. The cones at the end of the taper, which will not affect the switch, may be left in place. (Approximately between the 3rd block lines and the end of the 70m taper).
- Step 3: For the gate operation, a TTM vehicle provides cover under a rolling block for operatives to switch the 'gate' between lane 1 and 2.
  a. During the rolling block, the first 72m of cones are installed @ 3m centres (the start of the taper to the new 2nd block line). Any installed lamps should be switched on.
  b. The next 40m of cones are installed at 6m centres (until you reach the already installed portion of the taper). Any installed lamps should be switched on.
  c. Any installed lamps on the pre-prepared end of taper should now be switched on (Step 1b).
  d. Immediately following the switch and prior to the rolling block vehicle passing, the sign faces should be replaced. Any lamps on the old facing wall and back wall should be switched off.
- Step 4: The new taper is now filled out:
  a. The middle 40m section of the taper is now filled out with cones at 3m centres
  b. The block lines are completed @ 36m, 72m, 108m, 144m and end points.
  c. The old back wall (lane 1 to lane 2) can now be removed.
  d. The end of the old facing wall can now be removed.

When carrying out a lane switch should consider increasing the transition length to give additional time for a rolling block to swap tapers.

Once the new layout is established, the old TTM layout can be safely removed. The new layout and arrangement should be confirmed between the TTM crew and the works crew, including which side of the cones it is safe to work on.

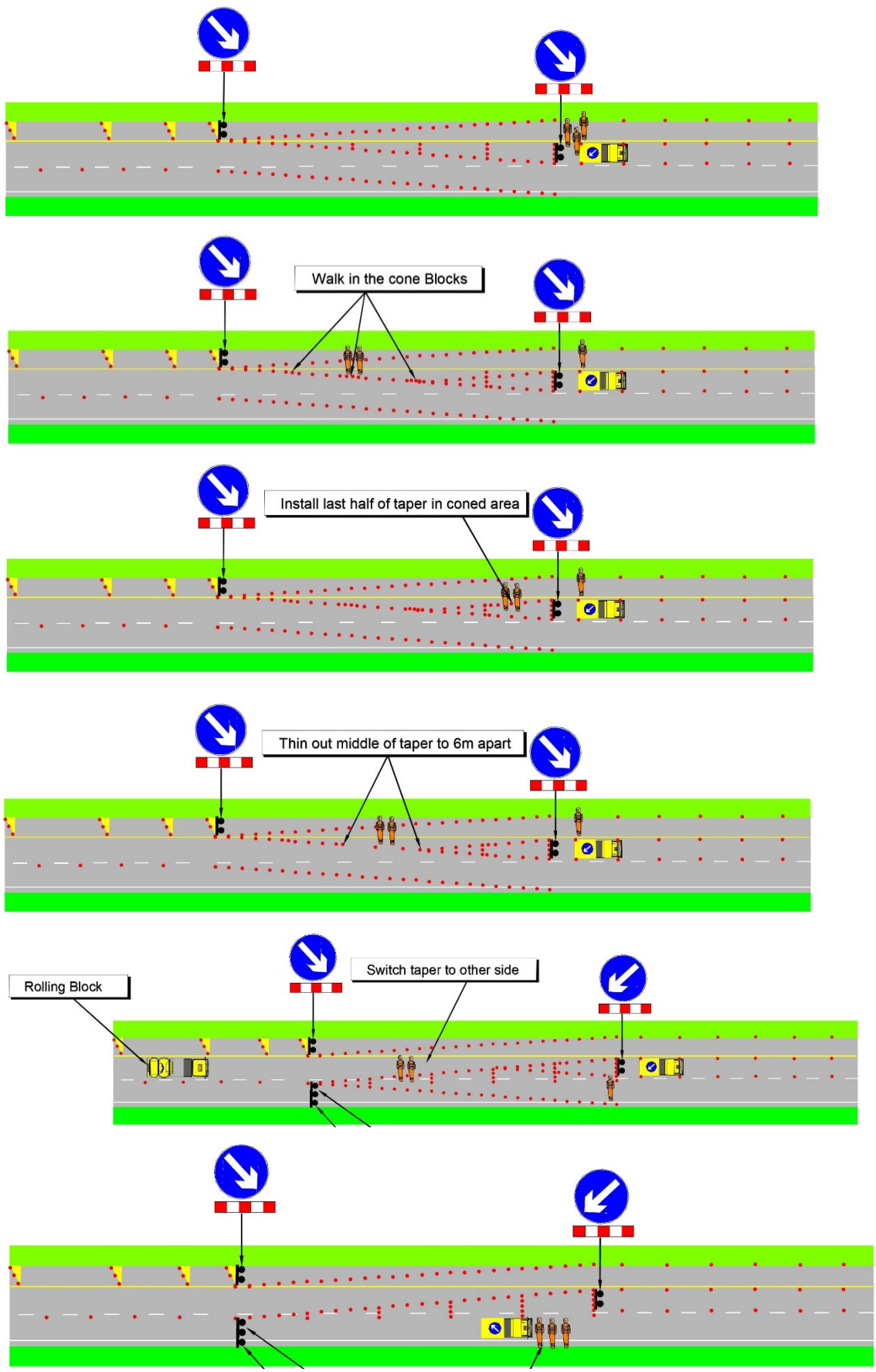


Figure 3.3.4.10.1: Lane Switches during Works

3.3.4.11 Narrow Lane System

Works which encroach onto an adjacent lane require a narrow lane system. This system can be from the verge, from a hard shoulder or from a central median.

Advance Warning Signs

A narrow lane system requires advance warning signs which indicate the width of the narrow lane. These are shown below.

Figure 3.3.4.11.1: Typical Narrow Lane System Advance Warning Signs

In the above signage, lane 1 should be at the minimum width for all types of vehicles including HGVs but lane 2 at 2.85m would only be suitable for cars and light vehicles. Variations to the above allow for multiple lanes and for lanes that are diverted to the left.

Narrow Lane System Signs through the Works

Road users should be informed and reminded of the narrow lane widths throughout the works. The intervals at which signs are repeated should not exceed 500m. Examples of the signs are given below.

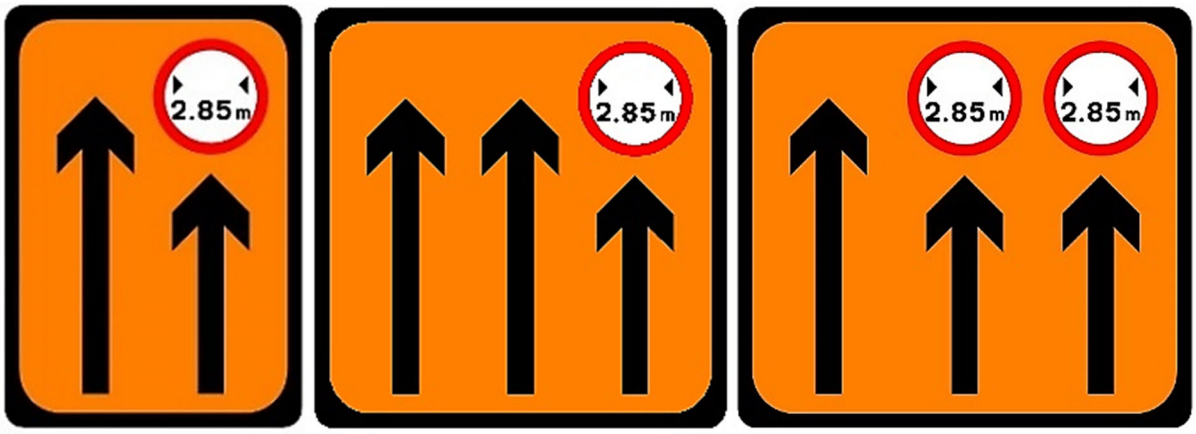


Figure 3.3.4.11.2: Typical Signs for a Narrow Lane System

The carriageway width displayed should be at least 150mm less than the actual lane width on the narrowest part of the road. Where the road is not straight, this clearance may need to be greater to allow for longer vehicles.

Installing a Narrow Lane System on a 2 Lane Carriageway from a Hard Shoulder

A hard shoulder running TTM arrangement is temporarily put in place first, closing both lanes 1 and 2. This allows the dashed white line and studs to be removed and temporary road markings and studs to be installed at the new lane widths. The location of the lead-in hard shoulder taper for this stage should be selected to correspond with the required position during the narrow lane system. Once the temporary road markings and studs are installed, traffic is switched from the hard shoulder into lane 2. This allows the temporary edge line, temporary vehicle barrier etc. to be installed.

Cones should then be pulled back to their required position working from the end of the works through the narrow lane section towards the beginning of the lane 1 narrowing taper. If required, a temporary vehicle barrier should be installed and set back from the temporary road marking line and in accordance with manufacturer's specifications.

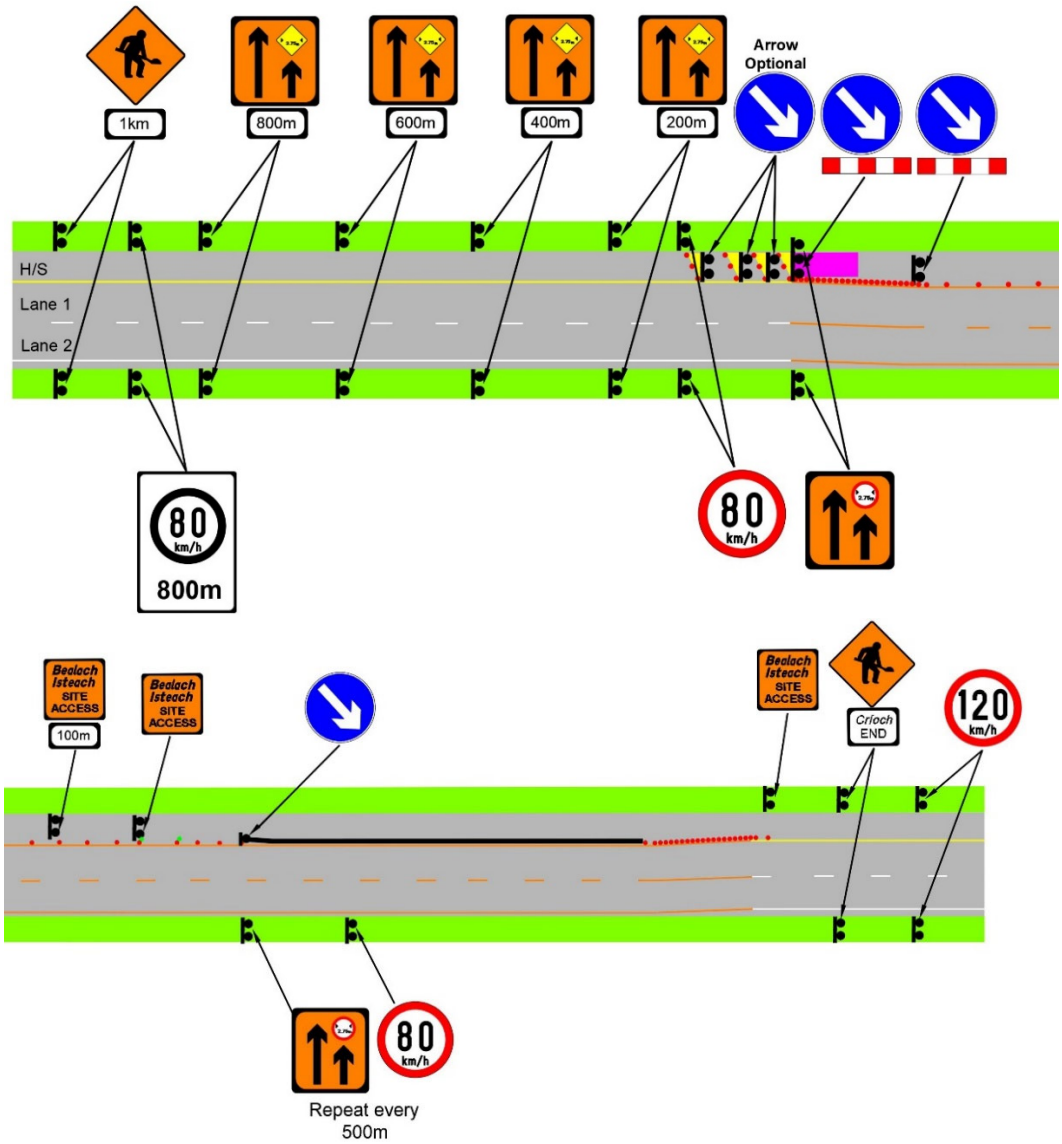


Figure 3.3.4.11.3: Narrow Lane System from Hard Shoulder

Narrow Lane System on a 2 Lane Carriageway from Central Median

Both lane 1 and the hard shoulder are closed first, to allow the temporary lining etc. work to be completed on these lanes. A lane switch is then completed between the lane 1 / hard shoulder closure and hard shoulder running. The locations of the hard shoulder back wall and re-join taper should correspond with the required locations during the final narrow lane running. This allows the temporary markings, barriers, cones etc. to be installed in lane 2. This is completed internally within the lane 1 and 2 closure while the hard shoulder running is in place. The lane 1 and 2 closure can then be removed, while leaving the arrangements for the hard shoulder in place, exposing the newly installed narrow lane system.

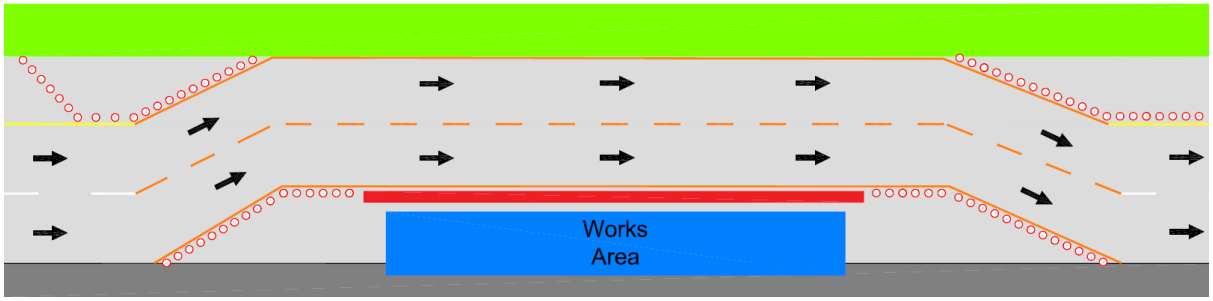


Figure 3.3.4.11.4: Narrow Lanes System from Central Median

3.3.4.12 Lane Gain and Lane Drop

A lane gain is when the merge runs straight into an additional parallel lane. A lane drop is when the left-most lane diverges off, leaving one less lane on the straight ahead.

Where work is being carried out in the lane gain, the hard shoulder should be closed on the slip road. Road users on the mainline should have a minimum settling in period of 200m prior to the merge with the slip road.

3.3.4.13 Road Closures

A road closure is where the full carriageway is closed for works and road users are diverted from the carriageway, typically via a grade separated junction.

3.3.4.14 Crossovers and Contra-Flows

A contra-flow system creates a sterile area free from traffic in which works may be carried out. It involves creating crossover points and switching traffic onto the opposite carriageway to allow works to be carried out safely. It is essential that appropriate preparation time is allowed for installing a contra-flow system which for major schemes may take up to two weeks. The same preparation time applies to switches and removal.

Advance Warning Signs

Advance warning signs on approach to the lead-in taper should be installed. TTM operatives should install signage to inform road users of the crossover at a distance approximately 200m from the crossover. The signage will depend on the set-up being installed. For example, on a 2 Lane carriageway where 1 lane is crossed over, sign WK 010 One-lane Crossover (Out) with supplementary plate 200m should be placed in the transition lane and in the hard shoulder. TTM operatives should repeat this signage at a point close to the crossover.

WK 010		**One-lane Crossover (Out):** this sign should be used on divided carriageways to depict traffic crossing the central reserve in a single lane from one carriageway to that of the opposing traffic, forming a contra flow.
WK 011		**One-lane Crossover (Back):** this sign should be used on divided carriageways to depict traffic crossing the central reserve in a single lane from the carriageway of the opposing traffic back to the original side at the end of a contra flow.

Figure 3.3.4.14.1: Standard 2 Lane Carriageway Crossover Signage

Repeater signs should be erected at 500m intervals to reinforce the roadworks speed limit if applicable. TTM operatives should install sign WK 011 One-lane Crossover (Back) with supplementary plate 200m approximately 200m from the crossover. TTM operatives should install another WK 011 sign at a point close to the crossover. These should be erected behind the barrier on the central median only.

The signs in Figure 3.3.4.14.2 may also be used where the contra-flow configuration is different to the layout described above.

WK 020		**Lanes Diverge at Crossover:** this sign should be used on a dual carriageway to depict traffic in lane 1 carrying straight on by deviating to the left and traffic in lane 2 crossing the central reserve to the opposite carriageway at the start of a contra-flow.
WK 021		**Lanes Rejoin at Crossover:** this sign should be used on a dual carriageway to depict traffic in lane 1 carrying straight on by deviating back to the right and traffic in lane 2 crossing back over the central reserve at the end of a contra-flow.
WK 022		**Two-lane Crossover (Out):** this sign should be used on a dual carriageway to depict two lanes of traffic crossing the central reserve to the opposing carriageway side by side at the start of a contra-flow.
WK 023		**Two-lane Crossover (Back):** this sign should be used on a dual carriageway to depict two lanes of traffic crossing back over the central to the left-hand carriageway side by side at the end of a contra-flow.

Figure 3.3.4.14.2: Crossover Signage

Buffer Zone

A buffer zone is an area provided between two opposing lanes of traffic travelling on the same carriageway at the start and end of a contra-flow operation. This buffer zone should preferably be a lane width but can be reduced to 1.2 or 0.7m.

When installing the buffer zone for a contra-flow system on a 2 lane carriageway, traffic needs to be pushed into the hard shoulder to give workers the required 1.2m lateral safety zone. The buffer zone may be constructed using traffic cylinders and temporary road studs. A buffer zone may also be constructed using traffic cones and lamps/reflectors. A third type of buffer zone may be constructed using temporary vehicular restraint barriers, but the disadvantage of this method is that it may restrict access for the recovery of broken down vehicles.

Figure 3.3.4.14.3: Buffer Zone and Emergency Zone

Installing a Contra-Flow System on a 2 Lane Carriageway

Initially a lane 2 closure is required on both carriageways. Work should then begin on removing any delineation devices / barriers at the crossover points, such as sections of barrier, wire rope or bollards. The crossover points may require regulating and surfacing to ensure they are suitable for live traffic. TTM operatives should build the tapers for the crossover within the lane closures as shown in in the figure below.

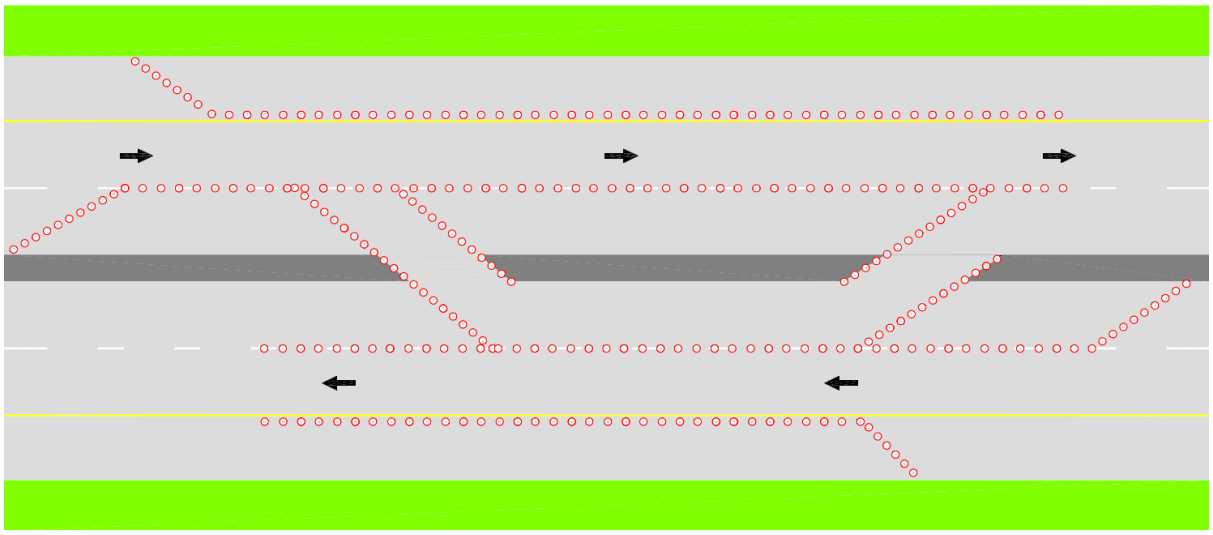


Figure 3.3.4.14.4: Step 1 - Create Crossover Points

Step 2 - Switching Traffic

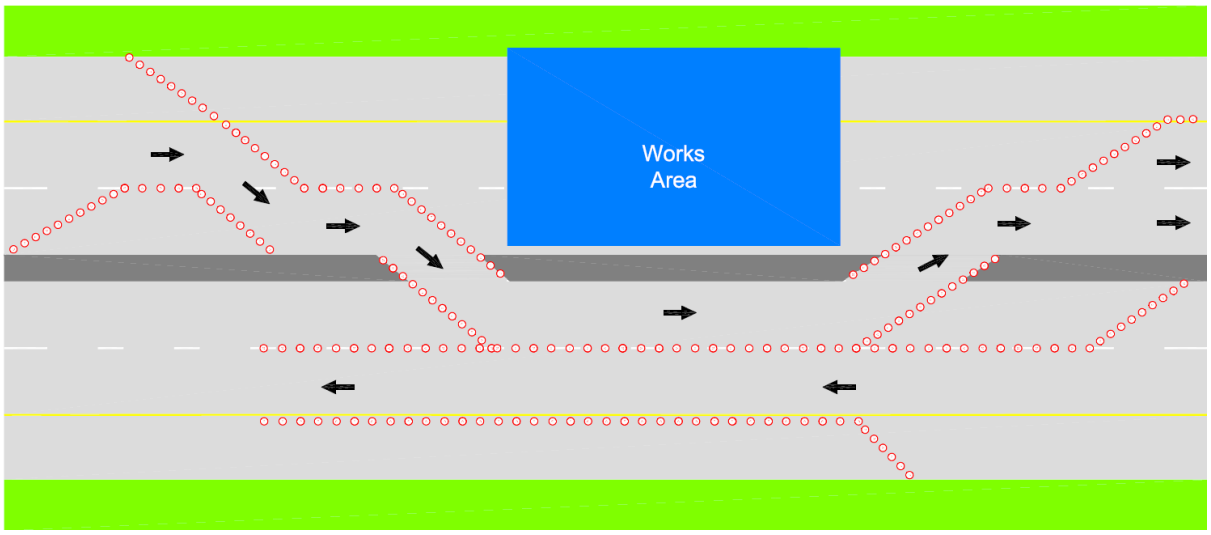


Figure 3.3.4.14.5: Switch Traffic and install Works Area

Completed Contra-flow

The completed contra-flow should be as shown in the figure below.

Figure 3.3.4.14.6: Completed Crossover

Wide Loads

Provision for wide loads negotiating a contra-flow system should be made. This may include installing advance warning signage to notify road users of wide loads to stop in a designated area until an escort vehicle may be provided to accompany the load through the works.

3.3.4.15 2+1 Carriageways (Type 3 Dual Carriageways)

Advance warning signage should be placed on a single side of the carriageway as shown in Figure 3.3.4.15.1. The advance warning signage and the lane 2 closure should be installed as outlined in Section 3.3.3. Signage should not to be placed over the wire rope barrier separating the two carriageways.

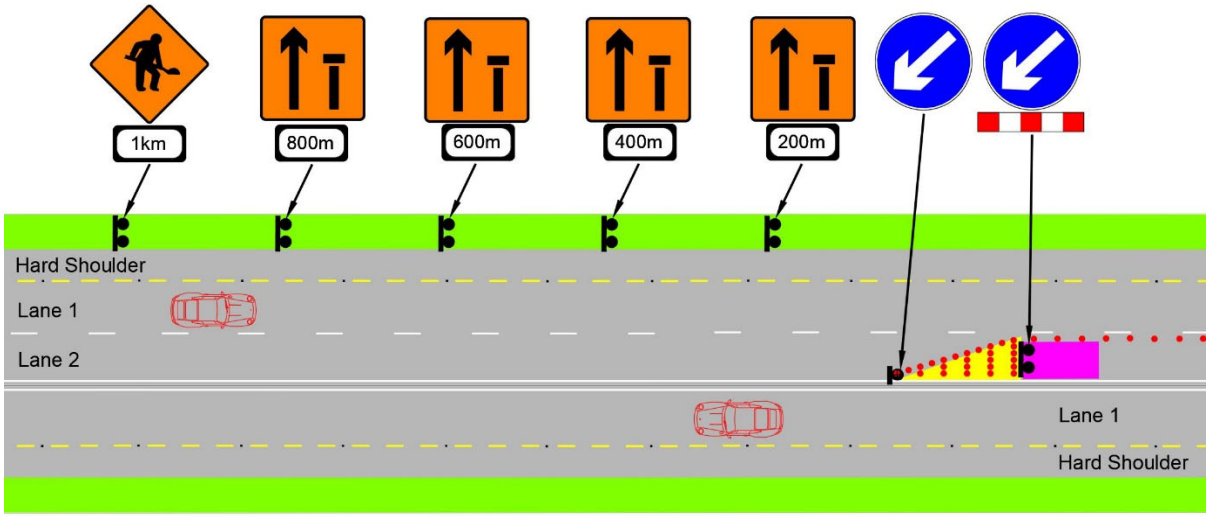


Figure 3.3.4.15.1: Advance Warning Signage on 2+1 Carriageway with Hard Shoulder

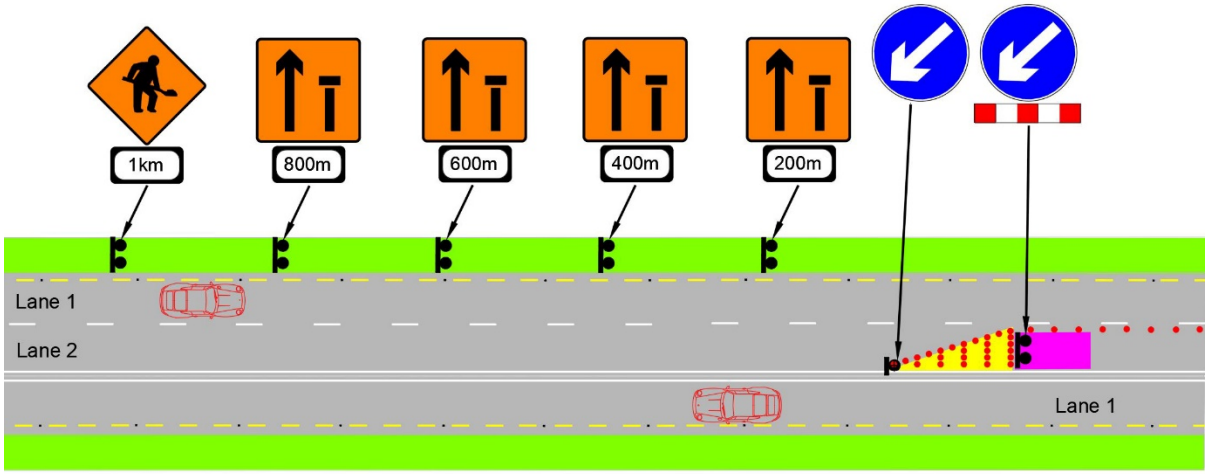


Figure 3.3.4.15.2: Advance Warning Signage on 2+1 Carriageway without Hard Shoulder

3.3.4.16 Transition from Single Carriageway to Dual Carriageway

Where road users transition onto a dual carriageway or motorway, they should be kept in a single file until they have passed the works area. Road users can then take advantage of the second lane.

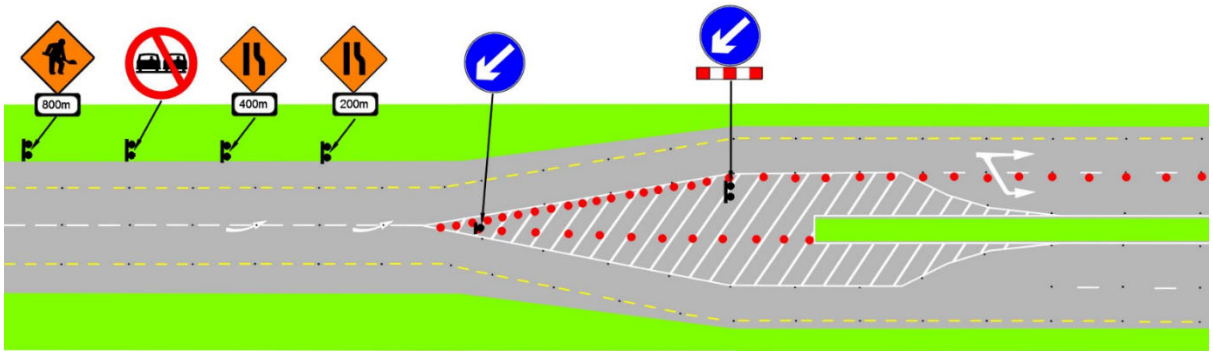


Figure 3.3.4.16.1: Scenario 1 – works taking place within hatched area in advance of median barrier on approach to dual carriageway section. Cones are located within hatched area.

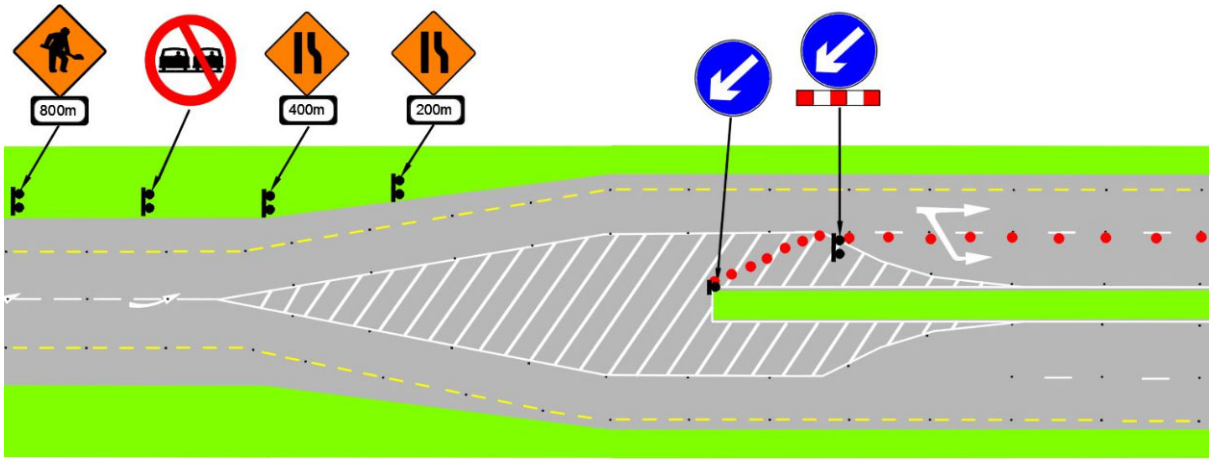


Figure 3.3.4.16.2: Scenario 2 – works taking place on median barrier only on approach to dual carriageway section.

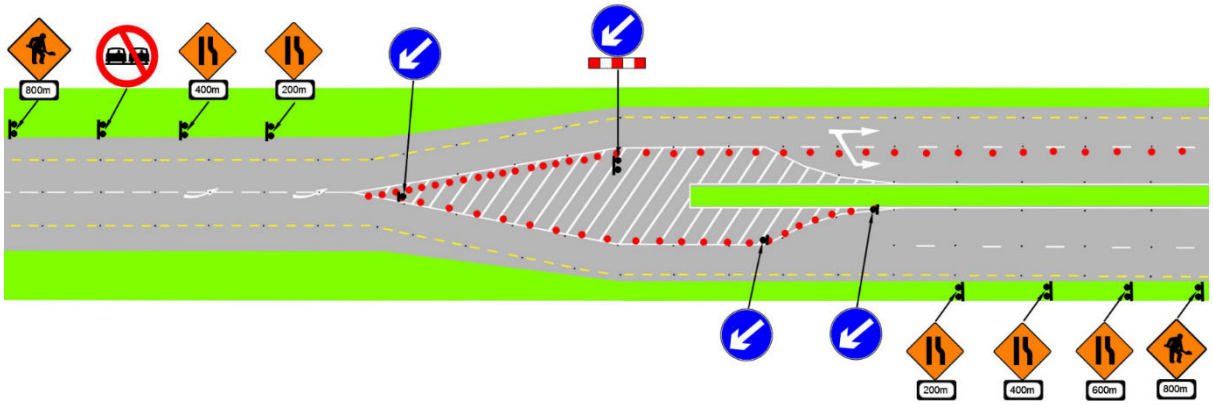


Figure 3.3.4.16.3: Scenario 3 – works taking place within entire hatched area in advance of median barrier on approach to dual carriageway section. Cones are also located within hatched area.

3.3.4.17 Roundabouts

Roundabout Installations

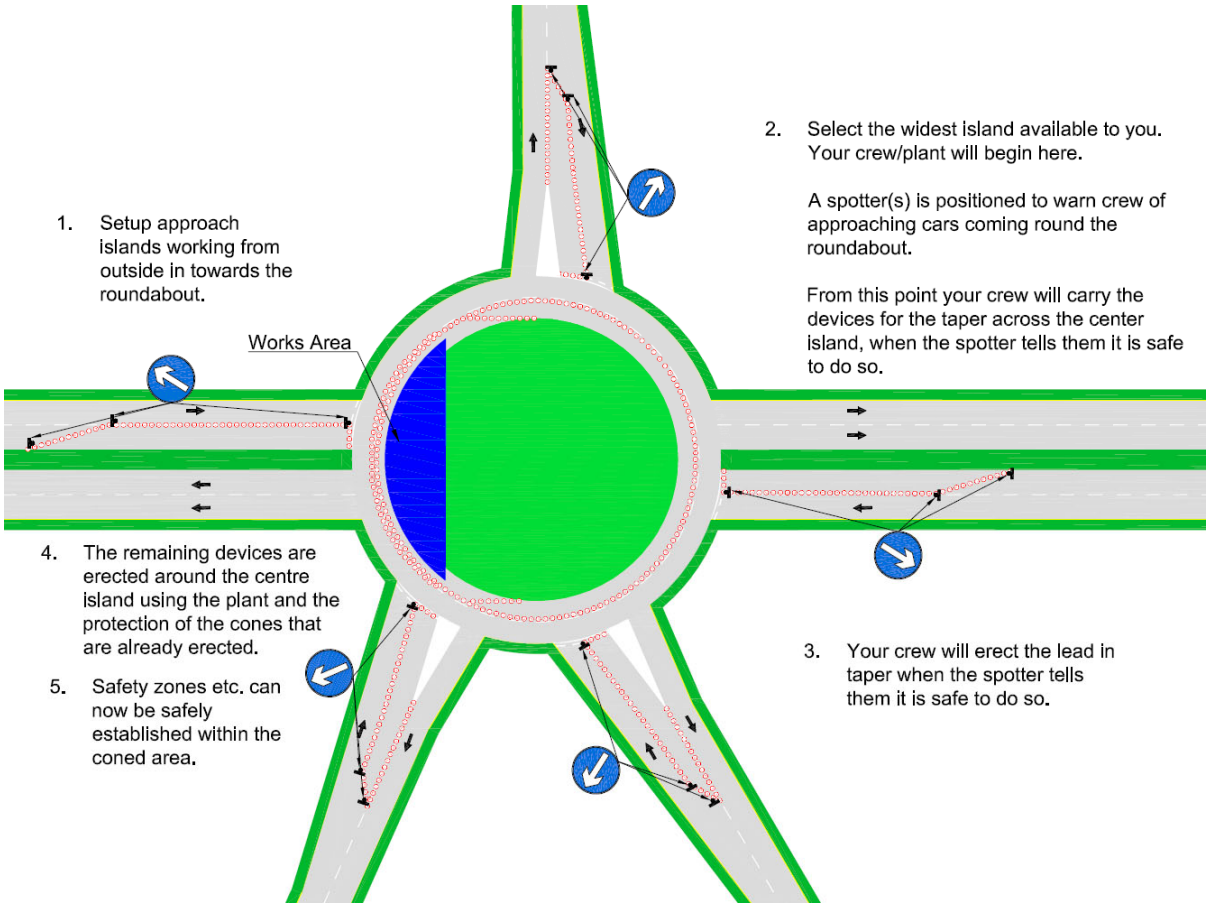


Figure 3.3.4.17.1: Roundabout Installations

Roundabout Layouts

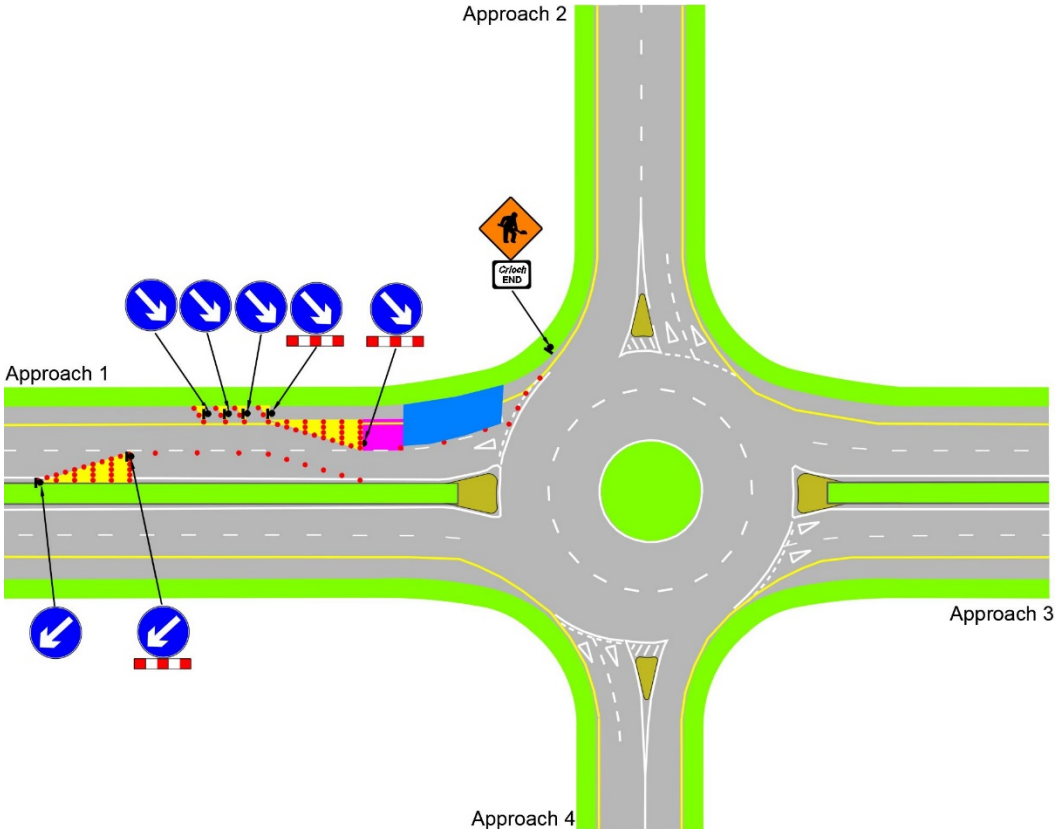


Figure 3.3.4.17.2: Works on Approach 1, Hard Shoulder and Lane 1

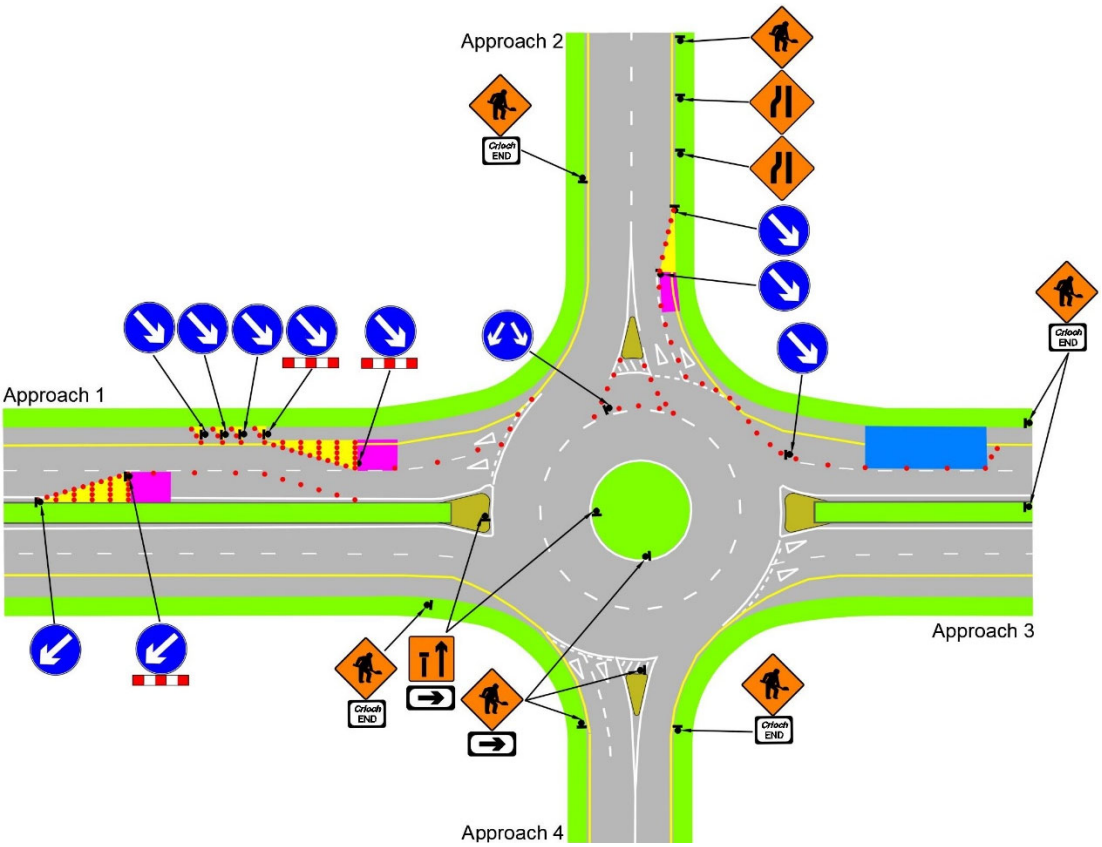


Figure 3.3.4.17.3: Works on Approach 3, Hard Shoulder and Lane 1

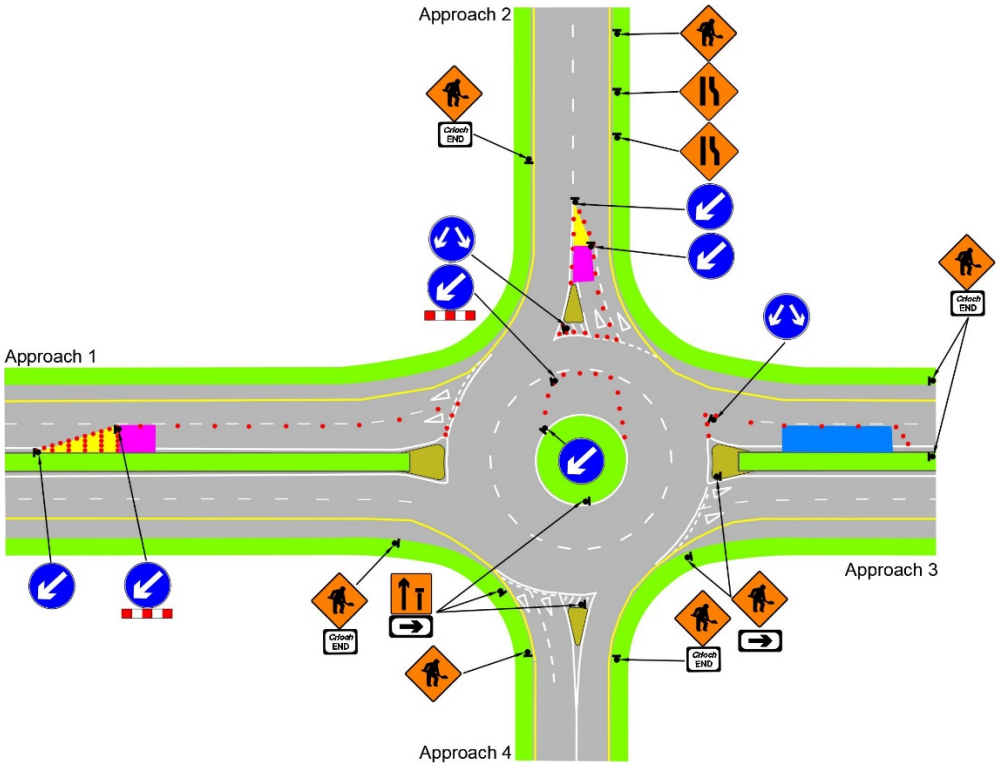


Figure 3.3.4.17.4: Works on Approach 3, Lane 2

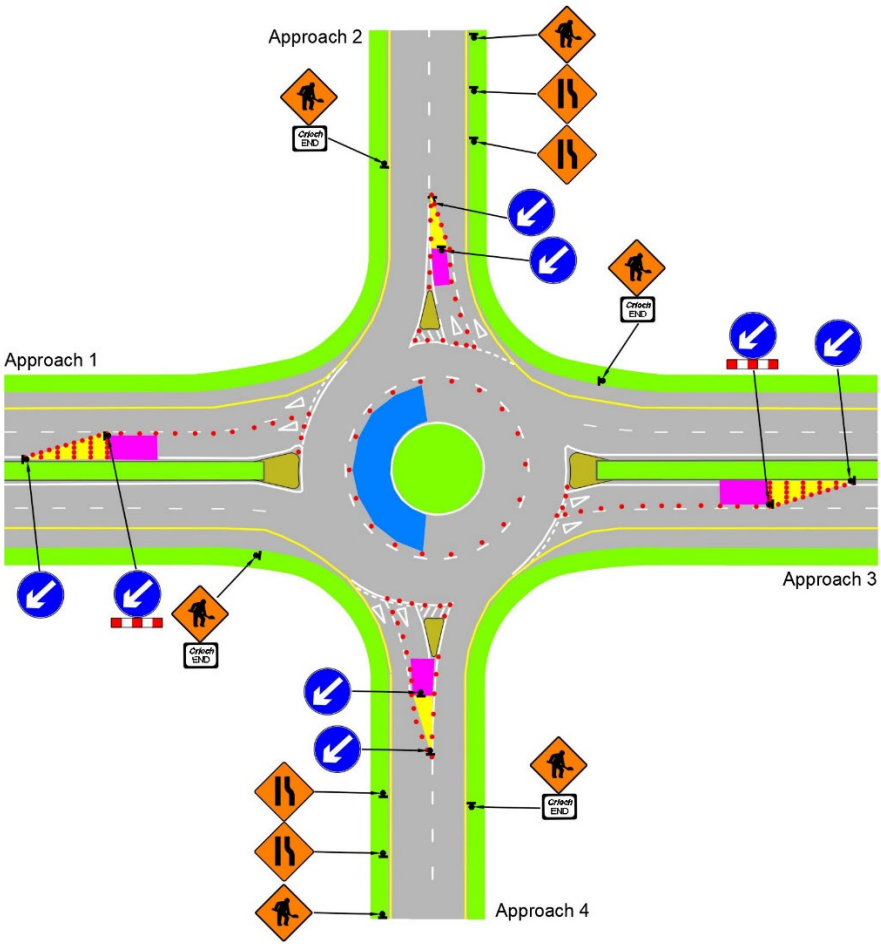


Figure 3.3.4.17.5: Works on Circulatory Carriageway

3.3.4.18 Working on the Verge

Verge works are classified as works which are taking place greater than 3m from the edge of the live lane. If working on the verge, vehicles should be parked off the carriageway completely where this is possible, ensuring there is a route for the vehicle to access the location safely without causing damage to the road assets (including drainage) or environment (e.g. vegetation). Access by operatives to and from the vehicle also needs to be considered. The parked vehicle should not adversely affect the performance of safety barriers, including the required working width.

Verge Works less than 15 minutes

Vehicles shall be parked a minimum of 1.5m from the edge of the live lane and must be visible for a minimum of 300m to approaching traffic with warning beacons in operation. Where vehicles cannot be parked off the carriageway, they may be parked on the hard shoulder or at the side of the road in such a way to maximise the lateral clearance between the vehicle and the trafficked carriageway. If required, the verge should be used to maximise this clearance, provided this can be achieved without damaging road assets or the environment. The works area itself (including operatives) must be greater than 3m from the live lane.

If a series of stops (< 15 minutes) are made on the verge / hard shoulder, in support of activity such as a walk-through survey or litter picking, a minimum separation distance of 3m must be maintained between the operatives and the nearest live lane. This activity requires a risk assessment and appropriate controls need to be selected, including any of the following / or combination of the following:

- Lane closures,
- Use of IPV; and
- Coning along the verge.

If the works area is less than 3m from the live lane, then a hard shoulder closure is required to provide a safe area of work.

Verge Works greater than 15 minutes

If the task will take greater than 15 minutes a WK 001 Roadworks Ahead sign of 1200mm size shall be erected 200m in advance of the works area. Minimum 120m visibility must be achieved to the WK 001. This sign should be located on the verge and not on the hard shoulder. WK 001 with supplementary plate P 010 Roadworks End shall be placed 20-50m after the works area again placed on the verge. The works vehicle is not allowed to park on the hard shoulder during this task. The vehicle should be greater than 3m from the edge of the live lane and must have conspicuous markings and a flashing beacon to provide greater prominence to the road user of its presence.

Note: If the works area is less than 3m from the live lane and the duration will be greater than 15mins then a hard shoulder closure is required.

3.3.5 Maintenance

Regular maintenance should be carried out to ensure the TTM layout continues to function correctly. Refer to Part 0 of these guidance documents for further guidance on TTM maintenance, inspections and audits.

Cleaning Signs

Sign faces should be cleaned by an operative with another person acting as a spotter. While cleaning signs, operatives should stand in a safe location clear of the live lane. Operatives should not stand on roadside furniture or safety barriers, the use of a long-handled brush is recommended to reach large signs. A mobile elevating work platform (MEWP), also referred to as a cherry picker, is commonly used for cleaning signs.

Removal and Replacement of Damaged Equipment

Where the TTM layout has been damaged, such as a taper being displaced by an errant vehicle, repairs may need to be carried out under the protection of an IPV. In this case the crew should notify the TTOS immediately to ensure the necessary works are carried out.

Maintain Safety Zones

The TTOS should ensure the safety zone is:

- Kept clear of plant;
- Not used to store materials;
- Site staff do not cross / lean against barriers; and
- Vehicles are not parked in the safety zone.

Keeping Site Tidy

Due to the nature of construction work, dust and mud may be generated therefore regular cleaning of cones, signs, reflectors and road surfaces is required, as their reflectivity is greatly reduced by just a thin covering of dust or mud. Particular attention should be given to cleaning reflectors on temporary safety barriers. Also signs and cones can be knocked over or displaced and should be checked regularly and rectified.

Emergency Procedures (Recovery)

Where a recovery of broken down vehicles service has been provided, the TTM crew should call the contact number in the event of a breakdown.

Sign WK 096 Free Recovery should be repeated every 500m through the site. Sign WK 097 Free Recovery End should be erected where the end of the free recovery service takes effect beyond the works.

3.3.6 Removal

Equipment is removed in reverse order to the installation procedure. This requires a safe operating procedure, with operatives fully briefed and aware of the process. As during the installation process, appropriate resources are required including operative numbers, vehicles etc. On completion, everything is removed from the site, including old sand bags, lamps, batteries, rope / tape, used temporary road studs, damaged equipment etc.

Before removing equipment, the relevant Setting-out Roadworks Ahead sign should be installed 500m before sign WK 001 Roadworks Ahead.

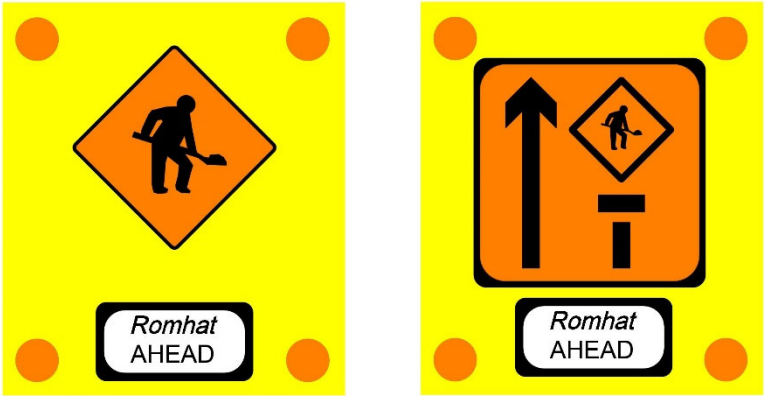


Figure 3.3.6.1: Setting-out Roadworks Ahead Signs to be removed

3.3.6.1 Pre-Removal Checks

Before beginning the removal of TTM, a drive through should be completed to check that:

- Workforce and their vehicles have left the site;
- Works equipment and materials have been removed from site;
- The condition of the road surface is appropriate for traffic to run on;
- If conditions are below freezing, that the new running surface has been gritted; and
- Any other risks that might become apparent during the drive through.

3.3.6.2 Removing the Longitudinal Cone Run

The following steps should be covered when removing the longitudinal cone run;

- Check that works area is clear of debris and it is safe to open the lane up to traffic;
- Remove the safety zone cones and tape;
- Remove the cones up to the End signs;
- Remove the End signs;
- Reverse back removing 20-50m of cones;
- Remove the Works exit sign;
- Reverse back picking up the longitudinal run of cones directly onto the vehicle;
- Use a low level working platform for this, do not walk on the traffic side of your vehicle; and
- Remove works access equipment.

3.3.6.3 Removing the Lead-in Taper

The following steps should be covered when removing the lead-in taper:

- IPV pulls into position 50-100m in front of the taper;
- Remove the arrow and lane closed board from the rear of the taper;
- Walk the cones out to allow room for the vehicle to reverse;
- Reverse down the taper removing cones directly to the vehicle;
- Use the low level working platform for this;
- Do not walk along the live traffic side of your vehicle;
- Remove the final 3 cone block and arrow from the front of the taper; and
- Proceed to the advance warning signs.

3.3.6.4 Removing the Advance Warning Signs

The following steps should be covered when removing the advance warning signs:

- Vehicles move away after removing the lead-in taper;
- TTM vehicle approaches advance warning signs with the flow of traffic, on the hard shoulder;
- Signs are then removed from the site in the following order; 1km, 800m,600m, 400m, 200m;
- The Setting-out Roadworks Ahead sign is removed last; and
- The final turnaround should be used as an opportunity to check that all equipment has been removed from site.

3.3.7 Inspections

3.3.7.1 Inspections

Inspections should be carried out regularly or as per contract. The TTOS should record results in their TTM diary.

3.3.7.2 Record Keeping and Incident Reporting

In order to keep an up to date record of incidents and TTM activities a site diary must be used. This can be hard copy or an electronic device. The information recorded in a site diary shall be as follows:

- What time the installation began;
- What time the installation was completed;
- All maintenance activities carried out;
- Time of any planned switches or modifications to the traffic management;
- All additional requests from the client;
- Any incidents or near misses that occurred;
- What time the removal process began;
- What time the removal process was completed; and
- Any issues that arose during the work day.

To aid the record keeping of a TTOS, a system of internal reporting of all accidents and incidents of non-compliance with the safety and health management system should be set up within a TTM Crew so that the experience gained may be used to improve the management system.

3.3.7.3 Responsibility and Handover between Works Crew and TTM Crew

- **TTM Crew:**

  The TTM crew on site has direct responsibility for implementation, maintenance, modification and removal of TTM arrangements.

- **Works Crew**

  The works crew has responsibility for any other health, safety and other site issues which are not connected to the implementation, maintenance, modification and removal of TTM arrangements.

3.3.7.4 Site Handover / Induction

- TTOS to contact Client / Contractor;
- Agree procedures for maintenance and interim requirements;
- Agree procedure for removal notification; and
- Record time of handover in the TTM diary.

3.3.7.5 Audits

Audits on Level 3 roads generally only require a drive through to review TTM. A review of dash cam footage may also be used as a means of reviewing the TTM. If an auditor is required to stop within the confines of the TTM, then they should inform the TTOS, obtain relevant site induction(s) and adhere to site rules. They should park their vehicle in a safe secure location where it is not an obstruction or impact on visibility of road users or road workers. They should exit the site as directed by the TTOS and as instructed at the site induction.

3.4 Mobile Lane Closures

3.4.1 Introduction

Mobile operations are covered in this section. The purpose is to take the reader from being aware of the requirements of the design standards and layouts within Chapter 8 of the TSM to being able to implement safe operation methods for those layouts.

The approach is to give a simple step by step guide complimented with visuals. This gives a quick and easy reference on how to install and remove different mobile operation scenarios. This section includes the following items:

- Operating Methodologies;
- Applications of Mobile Operations;
- Hazard Negotiation; and
- Verge and Median Works.

3.4.2 Operating Methodology

3.4.2.1 Context

The operating methodology is summarised as follows:

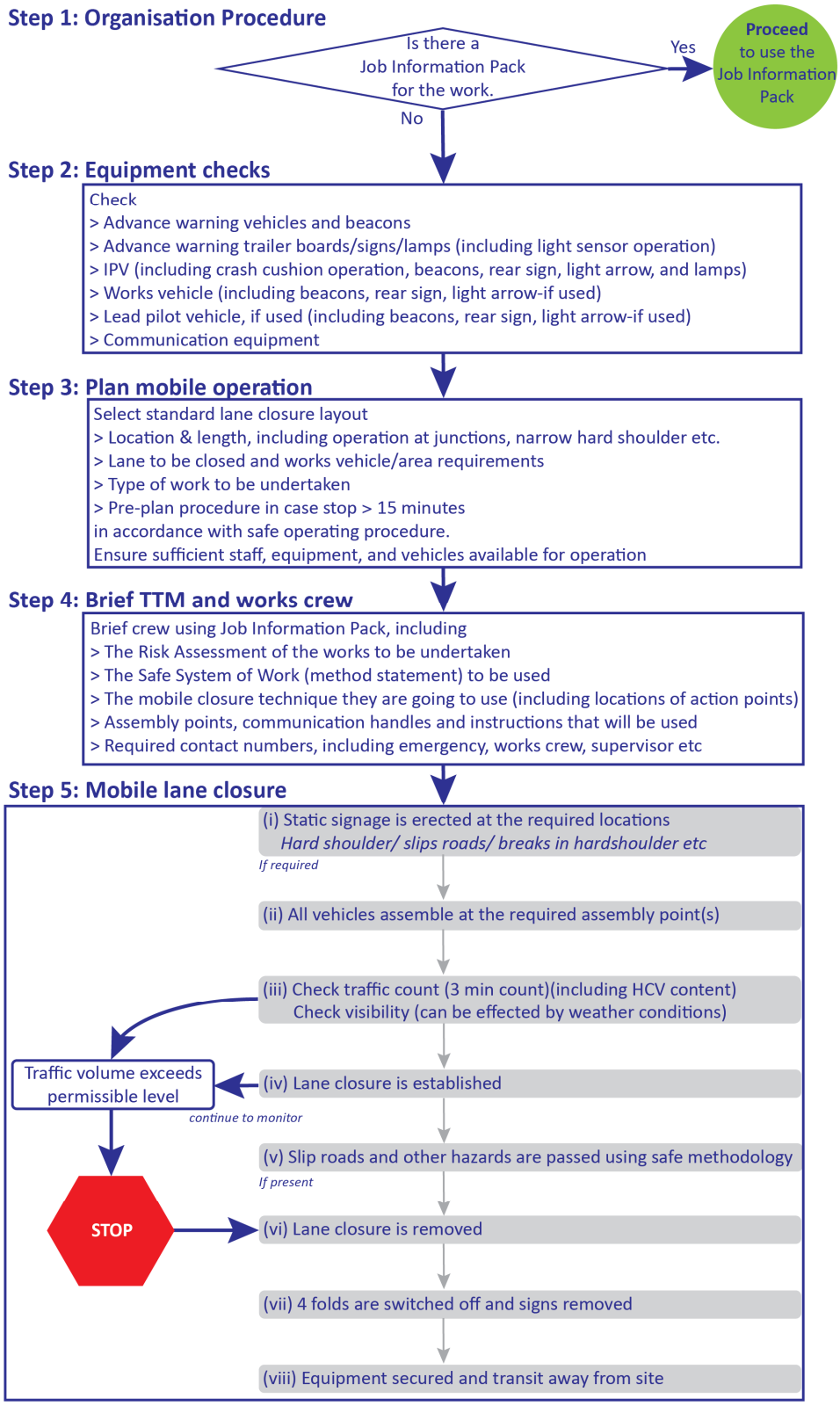


Figure 3.4.2.1: Mobile Lane Closures Operating Methodology

3.4.2.2 Step 2: Equipment Checks (assuming Step 1 directs you here)

Communication Equipment

All members of the Mobile Lane Closure and the works vehicle driver must be issued with a communication device. This should be through an open channel 2-way radio system. The radio handles that are to be used to identify vehicles should be agreed in advance along with the terminology that will be used to issue instructions.

Vehicles and Equipment

A walk around check should be completed on each vehicle and trailer to be used during the closure. The trailers need to have the correct signs and the condition of trailer boards and signs need to be checked. The use of abrasive weights to secure signs on trailers should be avoided as these tend to damage their surface condition. The operation of the light sensor (to change the light intensity between daylight and darkness) should be checked regularly. The rate of flashing of the 4 folds should also be checked regularly to ensure it is between 60 and 90 flashes per light per minute.

IPV

The IPV needs to have a minimum 10 tonne on the road weight. In some instances, this may require some equipment to be loaded onto and kept on the IPV during the lane closure. Along with the walk around checks, additional checks should be completed, typically with the aid of an operative in addition to the driver. These include:

- Lowering and raising the cushion from inside the cab (ensuring it is safe to do so);
- Checking the rear working lamp, sign, and light arrow;
- Checking the operation of the beacons;
- Testing the automatic brake system is functioning correctly;
- The operation of the light sensor (to change the light intensity between daylight and darkness) should be checked regularly;
- The rate of flashing of the light arrow should be checked regularly to ensure it is between 30 and 50 flashes per minute with each “on” period twice as long as the “off” period;
- The xenon flashing lamps must only flash on during the light arrows “off” period; and
- The in-cab voltage meter for the cushion and lights is checked.

The automatic brake should be switched off when travelling above 25km/h or when crossing lanes on a carriageway. The automatic impact brake should be deactivated when the IPV is no longer being used for impact protection purposes, including when operatives are working off the vehicle.

3.4.2.3 Step 3: Plan the Mobile Operation

There should be a clear safe operating procedure for the mobile lane closure. This should cover events that may arise during the mobile lane closure, including where the works vehicle needs to be stationary for ≥ 15 minutes, or other approved time.

Where a hard shoulder is not available for over 400m, site specific arrangements need to be made. These arrangements may include:

- A site specific methodology for the mobile closure at that point;
- Suspension of the mobile lane closure at that point; and
- Coordination with a static traffic management arrangement at that point.

3.4.2.4 Step 4: Brief TTM and Works Crew

The crew need to be aware of the assembly points, start and stop points of the closure and other hazards and controls that are to be used during the closure. The works vehicle must be able to communicate with the mobile closure operation and must operate between 50m and 100m ahead of the IPV. Where operatives will be on foot ahead of the IPV, they must also work within this distance and shall use a Lead Pilot Vehicle. Where a Lead Pilot Vehicle is used, it must be within 100m of the IPV.

3.4.2.5 Step 5: Mobile Lane Closure

Communication

Proper communication is essential for the safe operation of a mobile lane closure. Communication should be clear and concise. During the mobile lane closure, radio channels should be kept clear of all communication that is not for the Mobile Lane Closure. Communication is generally passed up and down the line in sequence from the works vehicle/IPV through to trailer 3. As slip roads and hazards are encountered they are communicated backwards beginning with the works vehicle/IPV to trailer 3. Traffic information, such as counts or gaps in traffic are passed forwards beginning with trailer 3 to the works vehicle/IPV. Drivers should confirm that they have heard each communication in sequence.

Identifying Location and Maintaining Station

When operating a mobile lane closure, the advance warning trailers should maintain the correct distance between them.

- The 1km trailer will typically operate between 900m and 1.1km in advance of the IPV;
- The 600m trailer will typically operate between 540m and 660m in advance of the IPV;
- The 300m trailer will typically operate between 270m and 330m in advance of the IPV; and
- The IPV should operate between 50m and 100m in advance of the works.

These distances may be temporarily changed at locations where there are no hard shoulders, or obstructions such as crash barriers preventing a safe stopping location (subject to a maximum distance of 400m). Inter-visibility between 2 adjacent vehicles is still required in these circumstances.

Mobile lane closure vehicle drivers should communicate their position by identifying roadside features such as signage or road markings to the rest of the mobile lane closure team. On roads where chainage markings and plates are present, the chainage markings are the best way of ensuring the vehicles maintain station.

When travelling to or from site, signs should not be displayed, and vehicle warning beacons should be switched off when driving in normal traffic conditions. The 4-fold lamps should be switched off. On the IPV, the cushion is up, light arrow board lowered, and automatic brake is switched off.

(i) Static Signage Erected

If required, static signage should be erected in advance of the lane closure and on slip roads. In some cases, slip road vehicles, with mobile sign trailers, may be used. This is done under a Type C static operation on the verge / hard shoulder.

(ii) Vehicles assemble at designated meeting point

Before the lane closure operation begins, vehicles generally meet in advance of the lane closure starting point. This allows final assessment of traffic and conditions to be completed before beginning the closure. This assembly point may be on over / under bridges or roads adjoining the dual carriageway / motorway where there is a safe area for vehicles to park and for crews to exit and enter their vehicles on the safe side.

(iii) Traffic Counts

Traffic counts should be carried out before the operation commences and every 15 minutes during the closure. The closure should be removed if:

- 2 successive counts are above the permissible level; or
- The traffic flows counts show a rising trend with the last one above the permissible level.

Lane Closure	HGV Level	If HGV Count ≤ HGV Level then Max Traffic Count (Veh / 3 Min)	If HGV Count ≥ HGV Level then Max Traffic Count (Veh / 3 Min)	Max HGV Count Permitted (Veh / 3 Min)
Dual Two-Lane Carriageway				
Lane 1	10	40	35	15
Lane 2	15	60	55	20
Dual Three Lane Carriageway				
Lane 1	20	100	90	30
Lane 3	25	135	120	40
Lane 1 + 2	15	60	55	20
Lane 2 + 3	15	60	55	20
Dual Four Lane Carriageway				
Lane 1	30	160	145	50
Lane 4	40	195	175	60
Lane 1 + 2	25	120	110	35
Lane 3 + 4	25	135	120	40

Table 3.4.2.5.1: Mobile Lane Closures - Permissible 3 Minute Counts

Notes:

1. As HGV content increases, the permitted traffic count decreases. If the HGV count exceeds the permitted level, the closure should be removed.
2. When performing mobile lane closures past slip roads, the maximum flow on the slip road should not exceed 25 veh / 3 mins whether it is a single or multi-lane slip.
3. A maximum traffic count of 65 veh / 3 mins per lane applies for hard shoulder works.

Visibility

The minimum visibility requirement for a mobile lane closure is 500m. There must always be inter-visibility between 2 successive vehicles. A mobile lane closure is not a suitable procedure for a curvilinear alignment with tight curves. Visibility may be impacted by road spray, heavy rain and by a low sun dazzling approaching drivers.

(iv) Establishing a Closure

There are a number of methods that may be used to establish a closure dependant on site conditions and traffic flows. Broadly they all follow two outline methods. Signs are not displayed when travelling to or from the starting point. On the IPV, the cushion should be up, light arrow lowered, and automatic brake switched off to begin with.

Vehicle warning beacons should only be switched on approximately 400m in advance of pulling into the hard shoulder. Vehicles should indicate that they are pulling into the hard shoulder approximately 200m in advance. They should also use their 360° warning beacons when traveling on the hard shoulder and should not use their hazard lights, as this will impair the signalling by their indicators. Lane 1 and the hard shoulder must not be straddled while parked or travelling along the hard shoulder. Drivers should be aware of roadside features, such as filter drains, barriers and soft verges to avoid this occurring.

<u>Method 1</u>

All mobile lane closure vehicles park in the hard shoulder in advance of the start of a lane closure, typically 2km ahead of this point. The signs are displayed and the 4-fold lamps on the trailers are turned on and the vehicle warning beacons are switched off. The IPV lowers the crash cushion using a safe method, displays the Keep Right arrow, raises and turns on the keep right light arrow. The IPV and works vehicle move into the required lane when it is safe to do so, with the advance trailer vehicles taking up their required position and maintain station. The IPV and works vehicle need to ensure that the correct arrow signs and light arrow are displayed at the correct times during this operation. The IPV switches on its automatic braking system and the lane closure commences.

<u>Method 2</u>

All vehicles may meet up at a designated assembly point prior to the lane closure. This may be on the hard shoulder, or where a hard shoulder is not available at another suitable point. The advance trailer vehicles take up their required positions at the start of the lane closure. The IPV lowers the crash cushion using a safe method before joining the live lane of traffic along with the works vehicle. The advance vehicle signs are displayed (without turning the 4 folds on, but keeping the vehicle warning beacons on) in advance of the IPV and works vehicle approaching the lane closure.

The IPV and works vehicle approach the lane closure in the live lane. On approach, and coordinating via the communication equipment, the advance trailer 4-fold lamps are turned on, and the vehicle warning beacons are switched off. The IPV also raises and turns on the correct light arrow. The IPV and works vehicle move into the lane closure with the flow of traffic and reduce speed to the required amount. The IPV switches on its automatic braking system and the lane closure commences.

In all methods, the IPV cannot deploy the cushion in a live lane. The IPV must dominate the lane it is in and not straddle into adjoining lanes, with the exception of a middle IPV within a 3 IPV multi-lane mobile closure.

(v) Passing Slip Roads and Hazards

If, at any point during a mobile lane closure, a vehicle comes to a stop and the period of that stop exceeds 20 seconds, the TTOS must be informed immediately and all mobile lane closure vehicles must stop accordingly to maintain the correct distances.

Vehicles may stop on the hatched areas present at junctions, provided it is safe to do so. Vehicles communicate that they are approaching and have reached a junction, beginning with the IPV / works vehicle and subsequently each trailer vehicle, while maintaining their station. Vehicles cross over the slip road when it is safe to do so. Each vehicle communicates that they are going to commence and have completed this action. For diverges this is commonly known as ‘jumping off’ and for merges as ‘jumping on’. Compact junctions do not have a hard shoulder for over 400m. This will require a pre-planned method to allow the mobile lane closure to pass it, with all operatives briefed on the method.

Diverge slip roads may be signed as shown below. A Roadworks End sign may be placed on the verge for road users exiting the main carriageway.

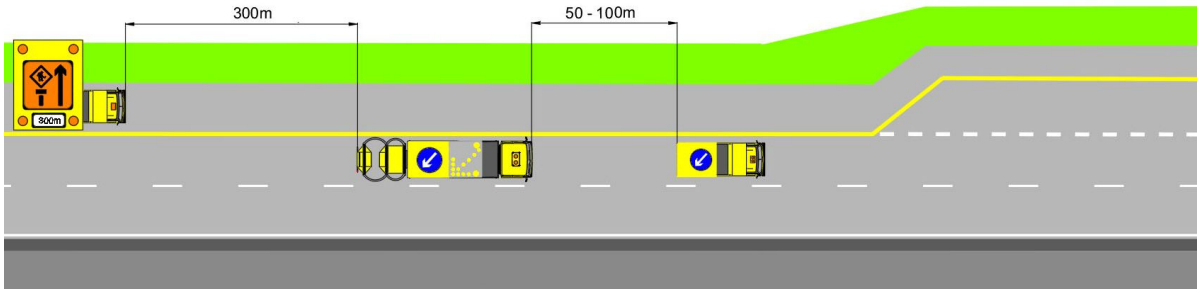


Figure 3.4.2.5.1: Diverge Slip Road Negotiation Mobile Signage

Merge slip roads should be signed as shown in the figures below. Sign WK 001 Roadworks Ahead with supplementary plate P 001 or P 082 shall be installed on the verge side for road users entering the carriageway via the merge slip road.

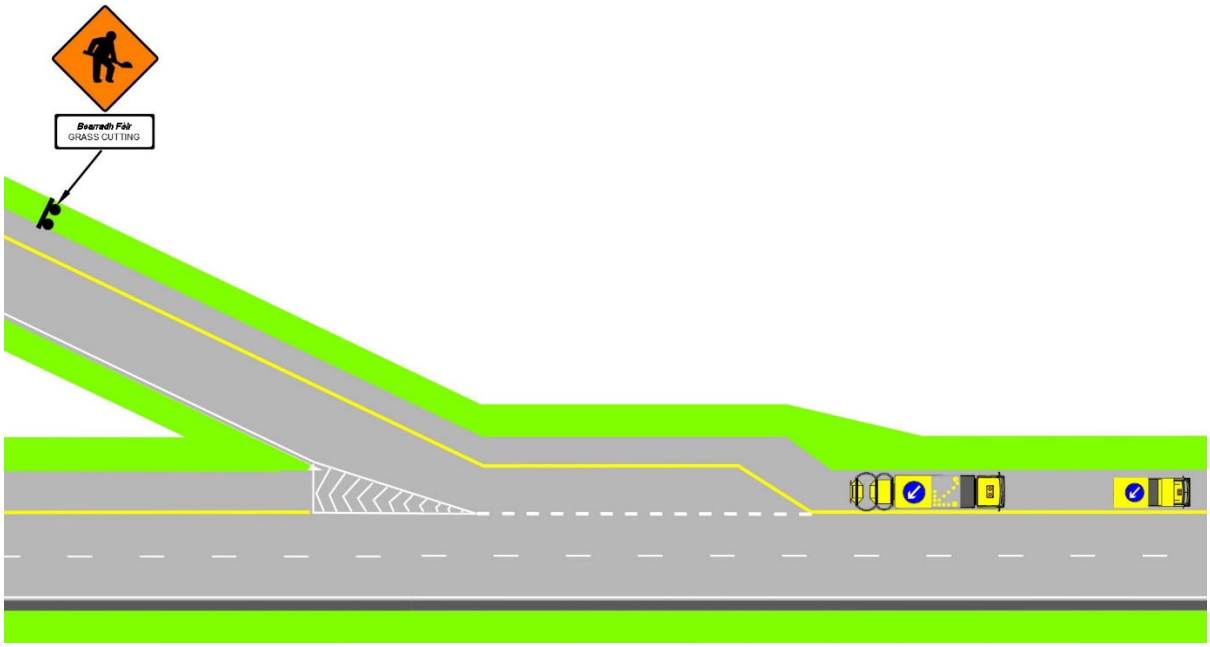


Figure 3.4.2.5.2: Merge Slip Roads Negotiation Static Signage

The use of a slip road vehicle is also an option. When using a slip road vehicle there is no end sign placed on the diverge slip road. The slip road vehicle is in place just prior to the MLC train reaching the slip road and is removed just after the MLC train has passed. The operation remains entirely mobile with no static signs.

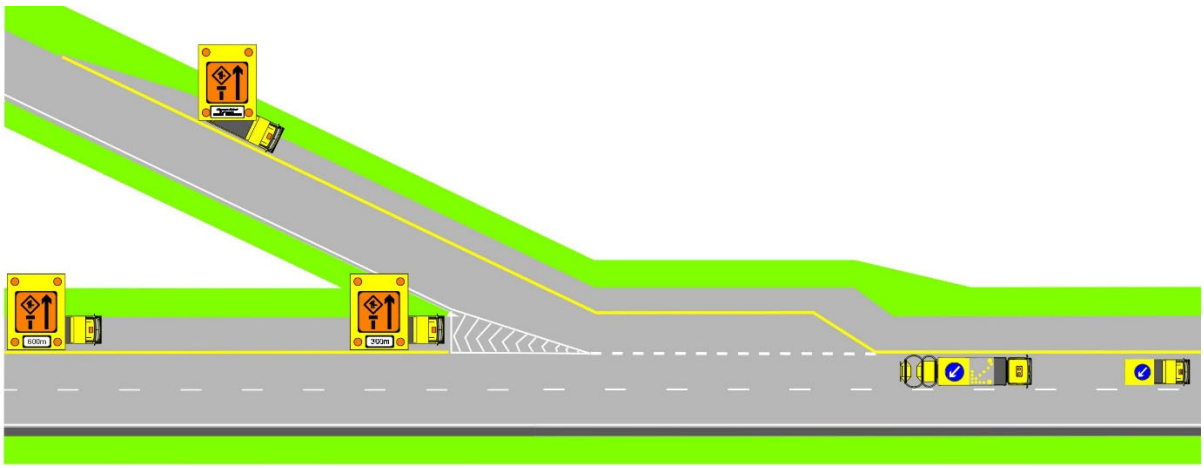


Figure 3.4.2.5.3: Merge Slip Road Negotiation Mobile Signage

Where the hard shoulder is blocked, vehicles should move out and around the hazard provided it is safe to do so, and there is a sufficient break in the traffic.

(vi) Removing the Lane Closure

The IPV switches off the automatic braking system. The IPV and works vehicle move onto the hard shoulder when it is safe to do so. The correct arrow sign and light arrow should be displayed at the correct points during this operation. When the lane closure was in the right lane(s), this may require the IPV and works vehicle to accelerate in the lane and cross when a sufficient gap in traffic appears. The trailer vehicles continue to maintain station during this operation.

(vii) Turning Off 4 Folds and Removing Signage

When the lane closure is removed, all vehicles should stop on the hard shoulder or alternative safe location. They turn off their 4 folds, remove signage, and turn on their vehicle warning beacons. The IPV can lower its light arrow and raise its crash cushion, if it has not already done so, once it is ready to leave site.

(viii) Equipment Secured and Transit Away from Site

Trailers etc. should be checked and equipment securely stored for transit back to the depot. Using their indicators, vehicles should re-join the traffic, once it is safe to do so, and there is a sufficient break in the traffic. Vehicles should turn off their warning beacons once they have re-joined normal traffic. Vehicle beacons should be kept off when travelling back to the depot in normal traffic.

Moving Between Sites

When working on separate sites that are less than 3km apart, the mobile lane closure should be kept in place with vehicles travelling at 20 to 25km/h to the next work site. When the next work site is greater than 3km away, the mobile lane closure should be stopped, and all signs covered. In this instance vehicles move to the next arranged assembly point, prior to re-establishing a mobile lane closure.

3.4.3 Applications of Mobile Operations

3.4.3.1 Hard Shoulder Closures

For works carried out in a hard shoulder, WK 001 Roadworks Ahead sign of minimum dimension 600mm shall be provided on the rear facing panel of the IPV or initial advance warning vehicle. Alternatively, WK 001 signs with supplementary plate P 002 shall be provided at 2km intervals. Static signing can be pre-placed over a maximum distance of 10km.

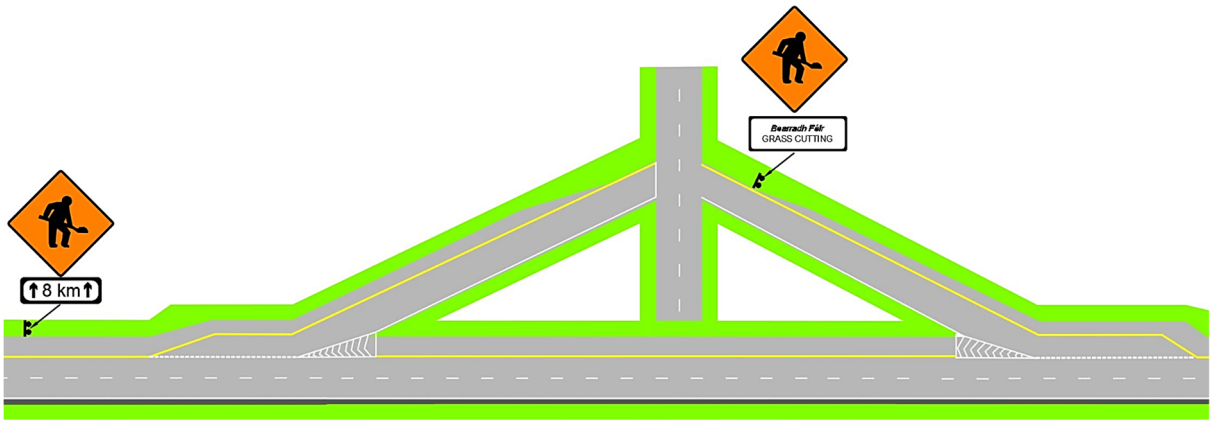


Figure 3.4.3.1.1: Static Signs for Hard Shoulder Works

Hard Shoulder Safety Zone

On hard shoulder works where an operative is on foot, the lead pilot vehicle or works vehicle is used to reduce the risk of a vehicle pulling in.

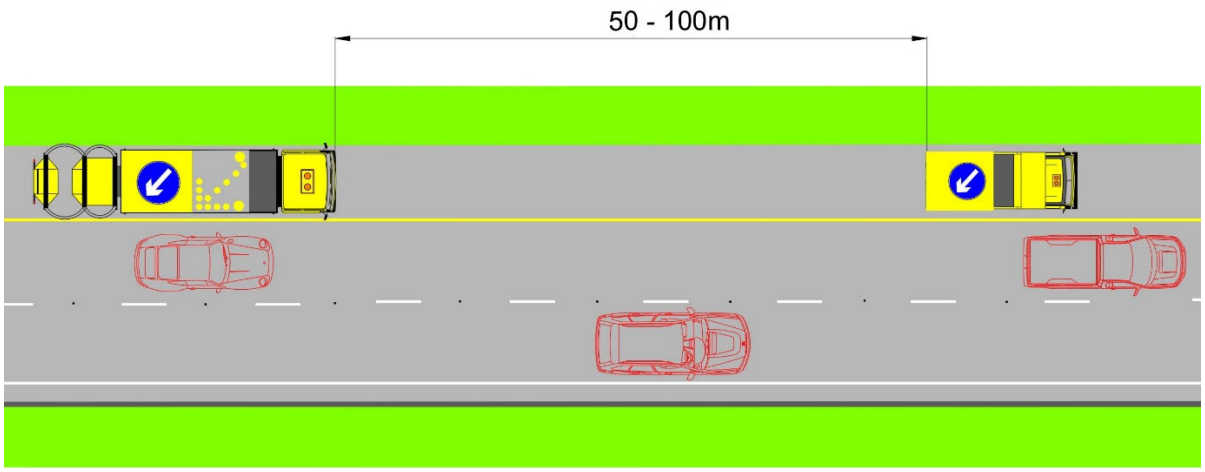


Figure 3.4.3.1.2: Hard Shoulder Safety Zone

3.4.3.2 Mobile Lane 1 Closures

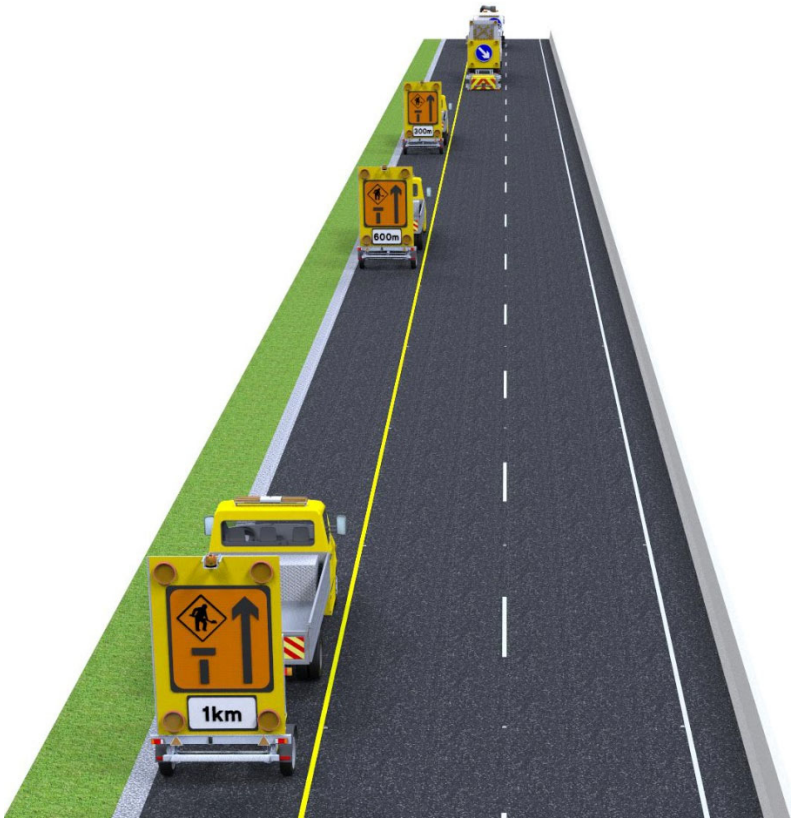


Figure 3.4.3.2.1: Mobile Lane 1 Closure on a 2 Lane Carriageway (Sign WK 111)

Figure 3.4.3.2.2: Mobile Lane 1 Closure on a 3 Lane Carriageway (Sign WK 113)

3.4.3.3 Mobile Lane 2 / Lane 3 Closures

Figure 3.4.3.3.1: Mobile Lane 2 Closure on a 2 Lane Carriageway (Sign WK 110)

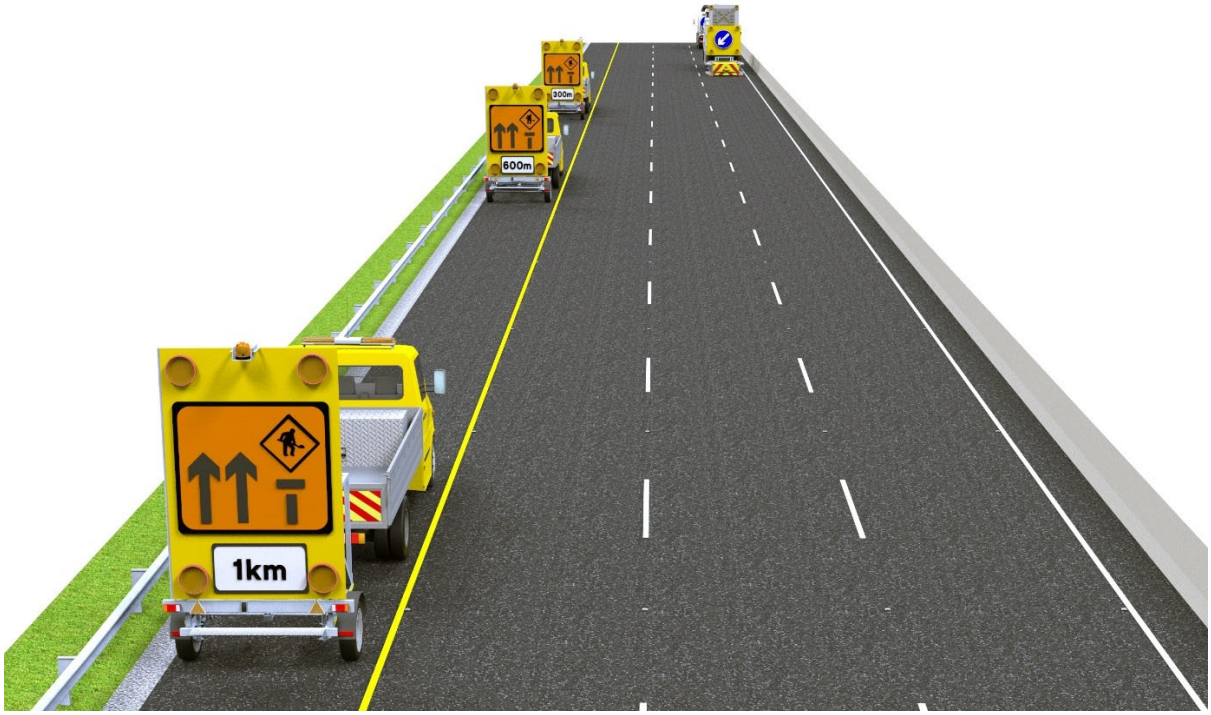


Figure 3.4.3.3.2: Mobile Lane 3 Closure on a 3 Lane Carriageway (Sign WK 112)

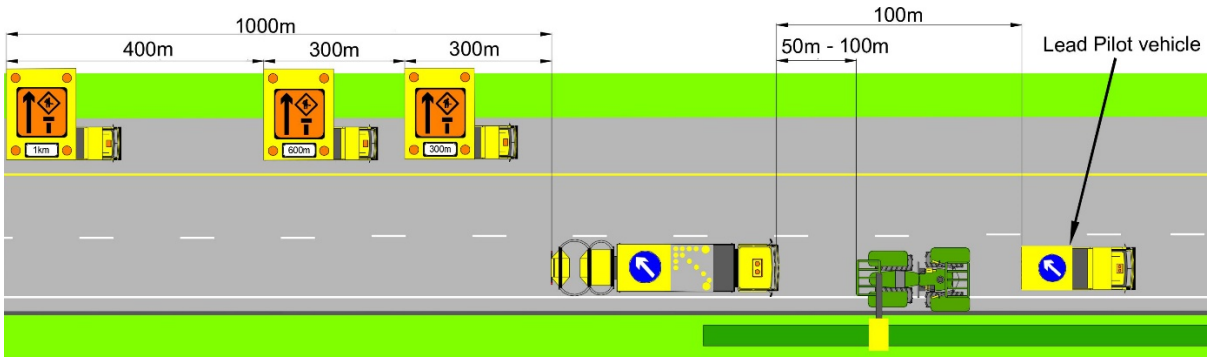


Figure 3.4.3.3.3: Mobile Lane 2 Closure on a 2 Lane Carriageway with a Lead Pilot Vehicle

3.4.3.4 Multi-Lane Closures

Figure 3.4.3.4.1: Mobile Lane 1+2 Closure on a 3 Lane Carriageway (Sign WK 114)

Figure 3.4.3.4.2: Mobile Lane 2+3 Closure on a 3 Lane Carriageway (Sign WK 115)

3.4.3.5 Slip Road Works

Single Lane

Working on a single lane slip the signs required in the 3 trailer boards are as follows:

- Trailer 1 at 300m from the nosing, change the sub-plate along with the sign to a 1500mm WK 001;
- Trailer 2 also changes the sub-plate and the sign to a 1500mm WK 001; and
- Trailer 3 also changes the sub-plate and the sign to a 1500mm WK 001.

Two or More Lanes

Where a mobile lane closure is used on a merge with 2 or more lanes, a single trailer vehicle with the relevant lane closure sign (WK 110 to WK 119) and supplementary plate P 086 On Slip Road, should be used ahead of the IPV and works vehicle. The IPV and works vehicle should ensure that the correct arrow sign and light arrow is displayed.

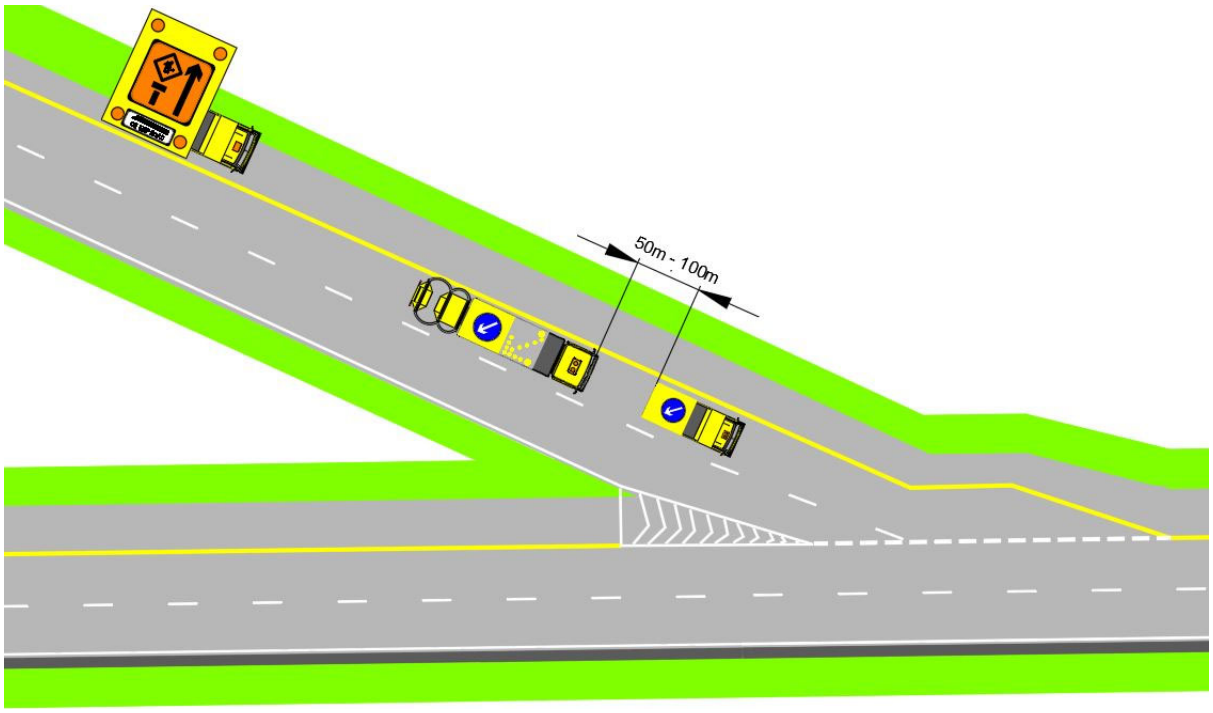


Figure 3.4.3.5.1: Works on a Merge

Where a mobile lane closure is used on a diverge with 2 or more lanes, the trailer vehicle drivers on the mainline need to replace their distance supplementary plates with a P 086 On Slip Road along with the relevant lane closure sign (WK 110 to WK 119), while maintaining station. The IPV and works vehicle should ensure that the correct arrow sign and light arrow is displayed.

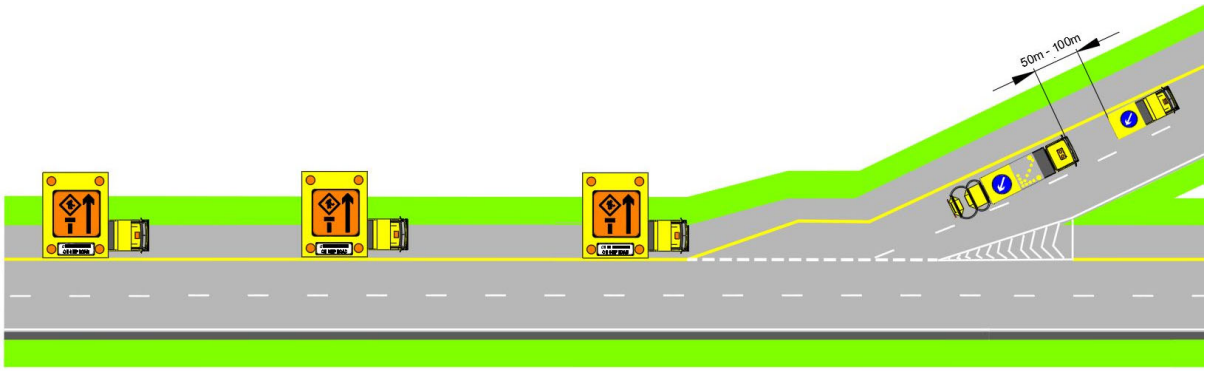


Figure 3.4.3.5.2: Works on a Diverge

3.4.3.6 Rolling Road Block

Planning

The duration of the required working window should be established. The working window should comprise of the time required to complete the task plus a safety margin of 2 minutes. In general, the working window, including the safety margin should not exceed 7 minutes. The presence of any merge / diverge, lane gain or lane drop in the length of carriageway between the works area and the closure start point should be identified.

The table below shows the distance upstream of the works area that the closure must start to provide the required working window, for closure speeds of 30km/h and 50km/h. The figures include an allowance of 2km for the closure vehicles to move into the required lanes safely and establish a rolling road block.

Time to Complete the Task (minutes)	Safety Margin Applied (minutes)	Working Window (minutes)	Closure Start Point – Upstream of the Works Area (km)	
			Closure Speed	
			30km/h	50km/h
1	2	3	4.3	8
2	2	4	5	10
3	2	5	5.8	12
4	2	6	6.5	14
5	2	7	7.3	16

Table 3.4.3.6.1: Rolling Road Block Closures

Rolling Road Block Operation Sequence

The IPV and works vehicle should be positioned on the hard shoulder as shown below.

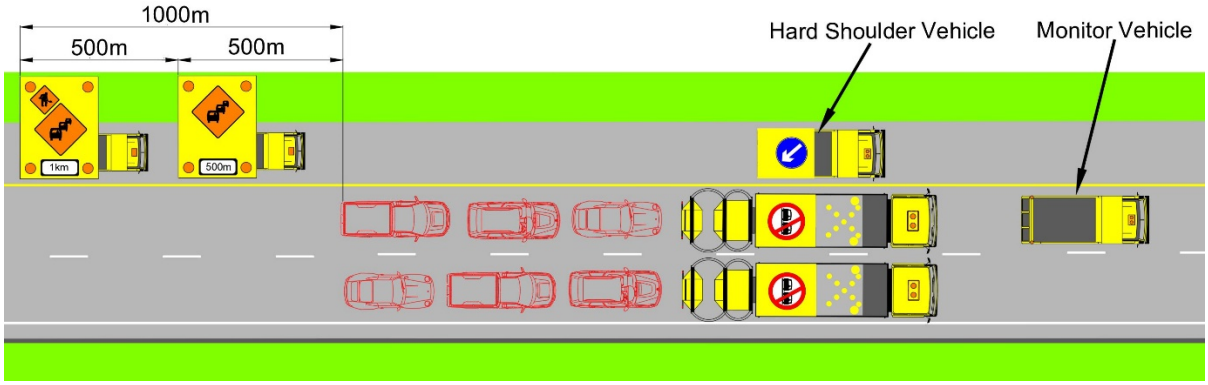


Figure 3.4.3.6.1: Rolling Road Block - IPV and Works Vehicle on Hard Shoulder

Before the RRB commences, the closure vehicles, advance warning vehicles and monitor vehicle should assemble in a safe place off the carriageway for final checks and briefing. The advance vehicles and monitor vehicles will then proceed to the agreed location. The TTOS then instructs the monitor vehicle driver to perform a traffic count (<60 vehicles / 3 minutes required to proceed) Monitor vehicle drives behind slowest moving vehicle and verifies it is travelling >80km/h. If the speed is <80km/h, the operation cannot proceed. Once the TTOS is satisfied that the operation can proceed, they should inform the closure vehicles.

The IPVs manoeuvre within normal traffic flow conditions to align laterally across the carriageway.

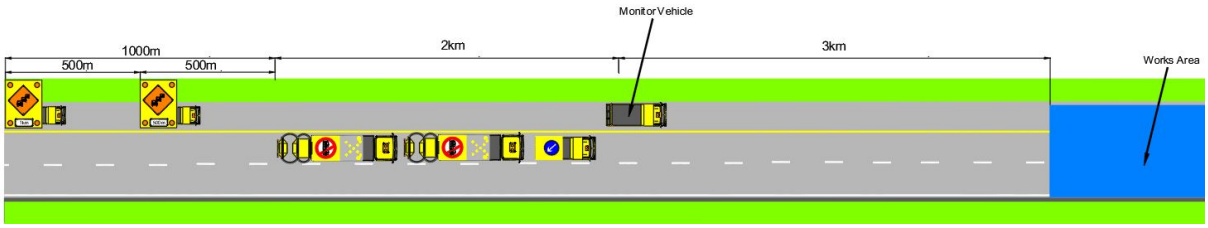


Figure 3.4.3.6.2: Start of Closure Procedure

Their speed is then gradually reduced to a pre-determined speed (30 - 50km/h), slowing the traffic behind them. This creates a traffic free zone between the IPVs and the traffic in front of them.

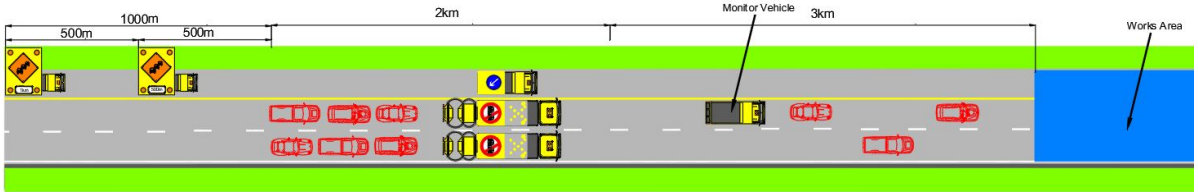


Figure 3.4.3.6.3: Start of Working Window

The IPVs and traffic gradually come to a stop before the works area.

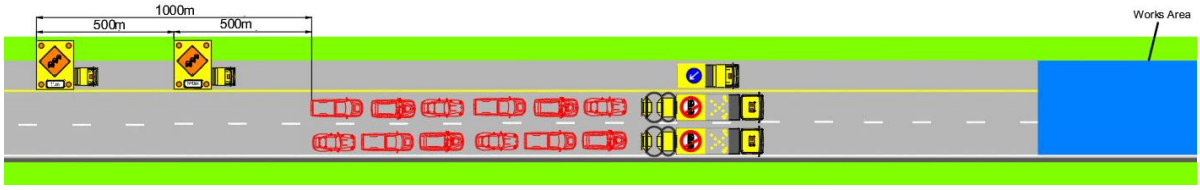


Figure 3.4.3.6.4: End of Working Window

Closing Merge Slip Roads

When implementing a RRB, merge slip roads shall be securely closed for a brief period during the operation to prevent traffic entering the 'traffic free zone' ahead of the closure vehicles. The slip road is closed just before the monitor vehicle passes and is re-opened again when the closure vehicles have passed. A Managers Order is not required for a slip road closure providing it is under 10 minutes duration. The length of the slip road, available sight lines, and the anticipated traffic flow need to be considered. This will help determine the methodology used to close the slip road.

There are two methods for closing a slip road. The first option uses a number of advance static road signs, stop and go battens and an IPV. This operation is shown below.

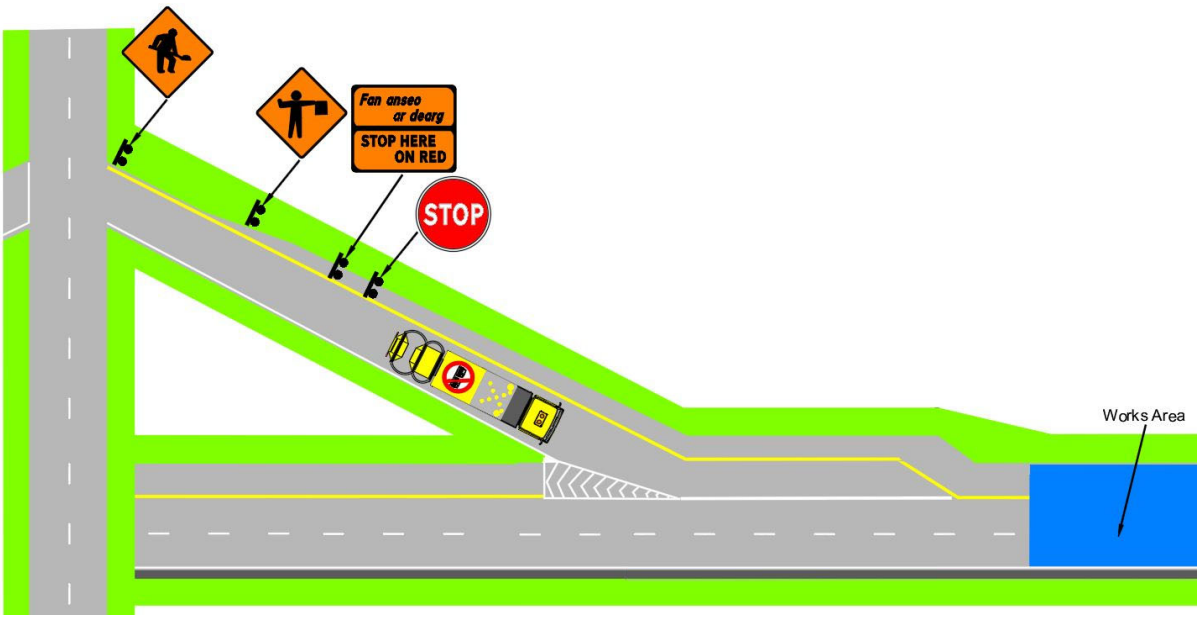


Figure 3.4.3.6.5: Merge Closure – Option 1

The second method uses static TTM equipment to close the slip road at its entry.

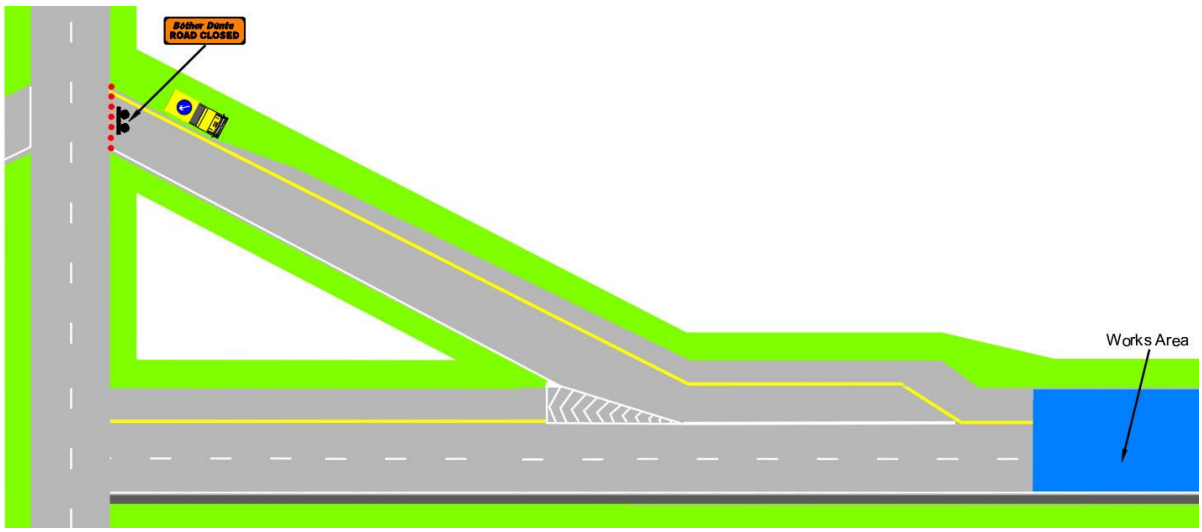


Figure 3.4.3.6.6: Merge Closure – Option 2

Multi-lane Lane Carriageways

Where a MLC is required to close two lanes of a multi-lane carriageway, three number IPVs are required. The vehicles should be positioned a minimum of 50m apart with the middle vehicle straddling the lane line to prevent road users driving between the other IPVs as shown below.

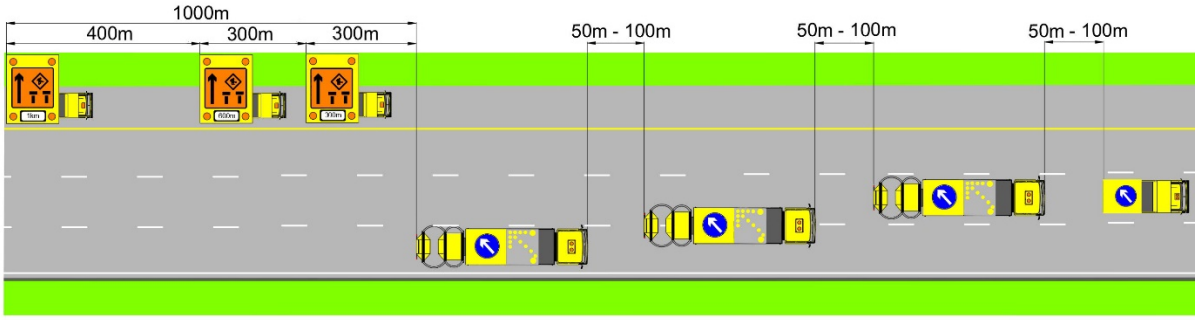


Figure 3.4.3.6.7: Positioning IPVs to prevent road users driving between the other IPVs – example shows a lane 2 and lane 3 closure

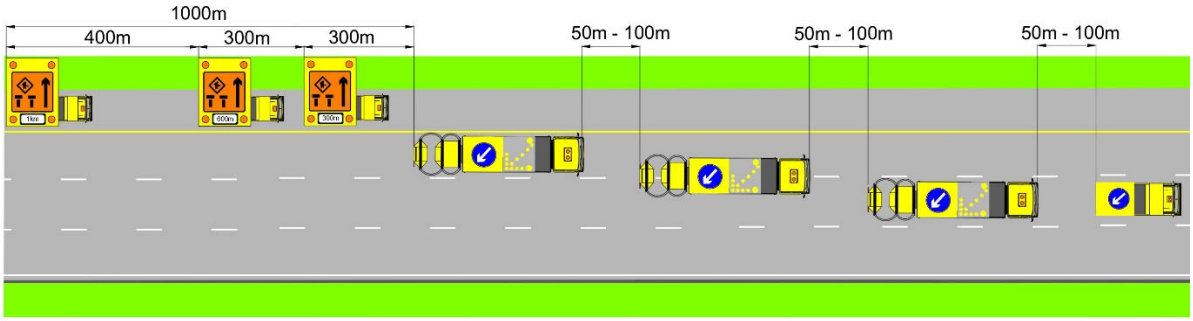


Figure 3.4.3.6.8: Positioning IPVs to prevent road users driving between the other IPVs – example shows a lane 1 and lane 2 closure

3.4.4 Hazard Negotiation

3.4.4.1 Slip Road Negotiation

The following procedure should be followed where a MLC on the mainline passes entry or exit slip roads. Static or mobile advance warning signs must be installed on all entry slip roads.

As the MLC vehicles approach the point where the slip road is to be crossed, the driver should make the necessary observations to ensure that it is safe to pass the slip road.

If a vehicle within the MLC crew comes to a stop for 20 seconds or more, the TTOS must be informed immediately and all other vehicles should be stopped accordingly to maintain the correct distances.

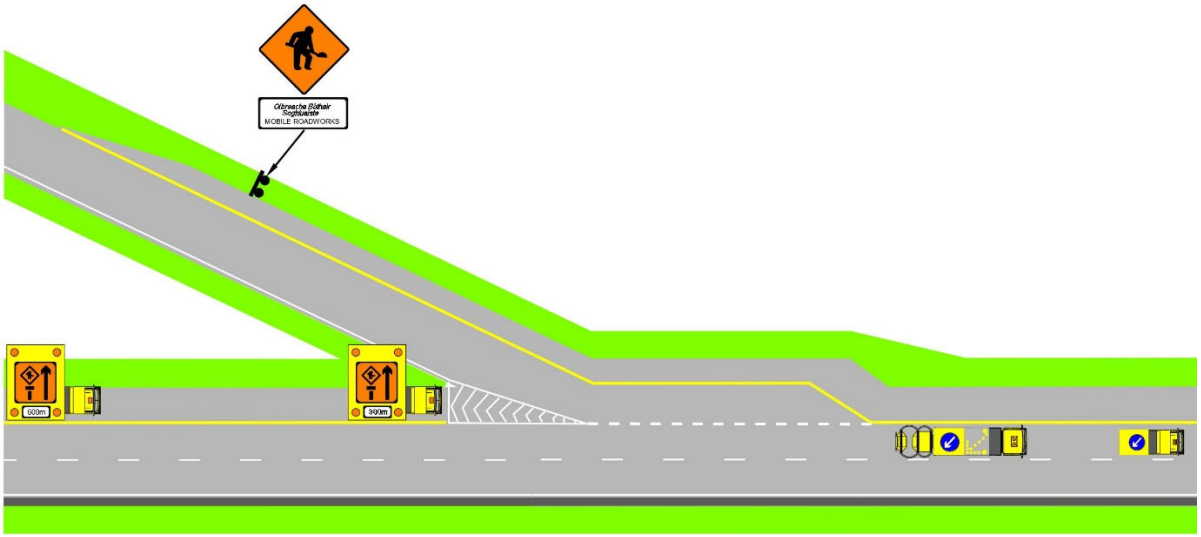


Figure 3.4.4.1.1: Slip Road Negotiation

<u>Works on a 2 Lane Slip Road</u>

When working on a 2 lane slip road, the maximum allowable traffic flow is 25 vehicles / 3 minutes. When works are taking place coming up to a slip road, the signage on the rear of the trailers is showing the work in lane 1 of the main carriageway. The operatives in that trailer should remove the distance supplementary plate and replace it with supplementary plate P 086 On Slip Road. An example of this operation is shown below.

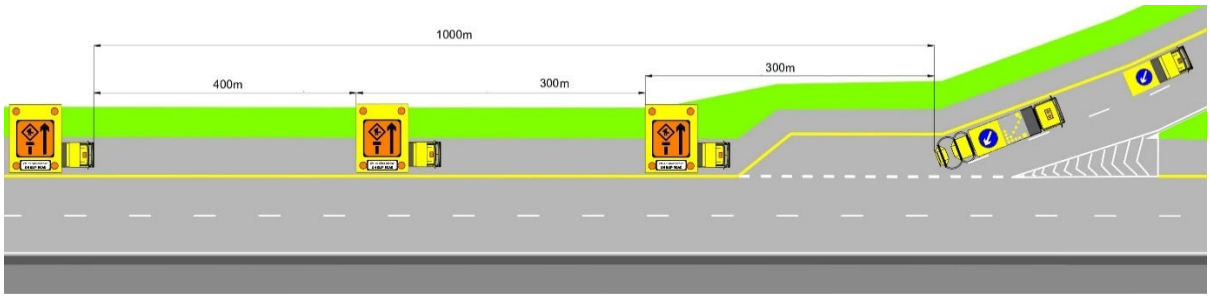


Figure 3.4.4.1.2: 2 Lane Slip Road Negotiation

3.4.4.2 Passing Obstacles

Where there is an obstacle in a hard shoulder, the IPV driver should communicate the details of the hazard to the other drivers. Trailer 1 then comes to a stop and informs the drivers of the other advance warning sign vehicles to maintain their positions. The procedure for passing the hazard is the same as for negotiating slip roads. When the hazard has been successfully passed, Trailer 1 should inform the other advance warning sign vehicles drivers and trailer 2 and 3 can now move up to their correct station. This procedure is repeated for the other trailer drivers.

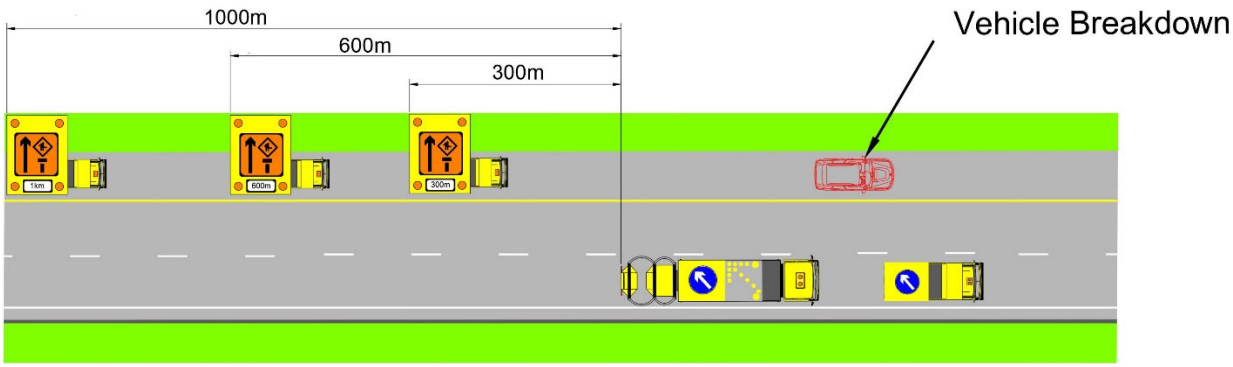


Figure 3.4.4.2.1: Passing Obstacles

3.4.4.3 Compact Junction Negotiation

Compact junctions like the one illustrated below generally have no hard shoulder between the merges and diverges. Negotiating these junctions can be difficult due to the distance the advance warning signage trailer vehicles need to travel in the live traffic lane.

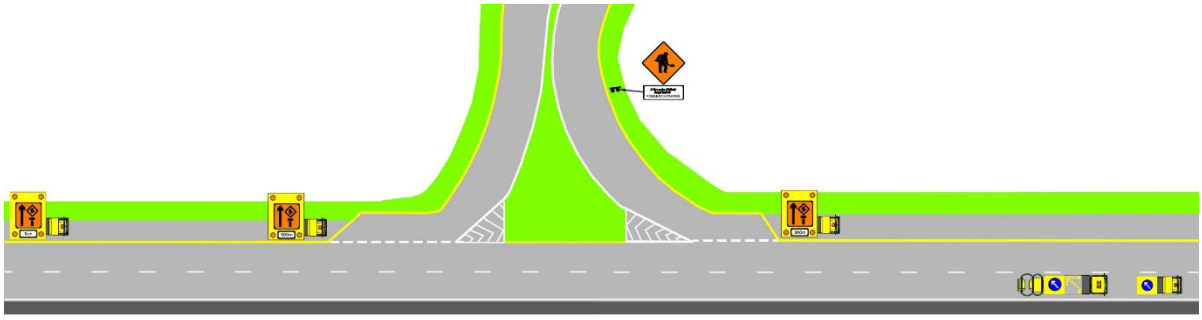


Figure 3.4.4.3.1: Compact Junction Negotiation

3.4.4.4 Operations where Hard Shoulder is not present

Figure 3.4.4.4.1: Operations where a Hard Shoulder is not present

3.4.5 Verge and Median Works

Where a series of short or medium duration stops are made which comprise mobile works on the verge, in support of activity such as walk through surveys or litter picking, a minimum separation distance of 1.2m must be maintained between personnel and the live lane. The risks involved in such work must be assessed, and a risk assessment must demonstrate that consideration has been given to providing appropriate protective measures such as lane closures, protection of a blocking vehicle in the hard shoulder coning along the edge of the verge or a combination of measures appropriate to the risks involved.

3.5 Summary

Operations on dual carriageways and motorways (Level 3 roads) have been covered in this Part 3 of the guidance documents. The approach has been to give a simple step by step guide complemented with visuals where required, on how to install, operate, amend and remove TTM operations in these areas.

Appendix A – Design Parameter Tables

Table 3.1
Minimum Design Parameters for Level 3(i) Roads
(Dual Carriageways and Motorways of 80km/h)

Design Parameter	Type A > 12 hours	Type B < 12 hours	Type C < 15 mins
Advance Warning Signage			
Sign Size (mm)	750	750	-
Sign Visibility (m)	90	90	90
Number of Signs	4 (both sides)	3 (both sides [D]) 4 (left side only [C])	-
Cumulative Distance (m)	480	360 [D] 480 [C]	-
Distance between advance warning signs (m)	120	120	-
Taper			
Lane Taper Length (m)	180	180	-
Hard Shoulder Taper Rate	1 in 20	1 in 20	-
Transition Length (m)	360	360	-
Cones			
Cone Height (mm)	750	750	-
Taper Spacing (m) [A]	3	3	-
Longitudinal Spacing (m) [A]	12	12	-
Lamps (unlit areas only)			
Taper Spacing (m)	6	6	-
Longitudinal Spacing (m)	24	24	-
Safety Zones			
Longitudinal (m)	45	45	-
Lateral (m)	1.2	1.2	-
Set Back (m) [E]	0.4	0.4	-
Lanes			
Lane Width (m) [B]	3.3	3.3	-

Notes:

A. Cone spacing shown is the maximum permitted. Where geometry or any other site specific reason dictates, the spacing shall be reduced accordingly.

B. Where two lanes are being maintained, the minimum width for lane 1 should be 3.3m and 3m for lane 2 (or subsequent lane on multi-lane carriageways). Where one lane is to be maintained the minimum lane width for all classes of vehicles is 3.3m.

C. Where TTM is being placed, or works are taking place on lane 1 of a ≥ 3 lane carriageway only. Refer also to Section 3.3.4.6 regarding direct lane 1 closures and associated restrictions.

D. Where TTM is being placed, or works are taking place, on lane 2 or subsequent lane.

E. See definition of Set Back in Section 0.1.5 Glossary of Terms.

Table 3.2
Minimum Design Parameters for Level 3(ii) Roads
(Dual Carriageways and Motorways ≥ 100km/h)

Design Parameter	Type A > 12 hours	Type B < 12 hours	Type C < 15 mins
Advance Warning Signage			
Sign Size (mm) [C]	1,200	1,200	-
Sign Visibility (m)	160	160	160
Number of Signs	5 (both sides)	4 (both sides [E]) 5 (left side only [D])	-
Cumulative Distance (m)	1,000	800 [E] 1,000 [D]	-
Distance between advance warning signs (m)	200	200	-
Taper			
Lane Taper Length (m)	180	180	-
Hard Shoulder Taper Rate	1 in 30	1 in 30	-
Transition Length (m)	360	360	-
Cones			
Cone Height (mm)	1,000	1,000	-
Max Taper Spacing (m) [A]	3	3	-
Max Longitudinal Spacing (m) [A]	12	12	-
Lamps (lit and unlit areas)			
Taper Spacing (m)	6	6	-
Longitudinal Spacing (m)	24	24	-
Safety Zones			
Longitudinal (m)	60	60	-
Lateral (m)	1.2	1.2	-
Set Back (m) [F]	0.6	0.6	-
Lanes			
Lane Width (m) [B]	3.3	3.3	-

Notes:

A. Where geometry or any other site specific reason dictates, the spacing shall be reduced accordingly. Where the roadworks length is greater than 200m excluding tapers, the longitudinal cone spacing may be increased to 24m on straights and radii greater than 1000m.

B. Where two lanes are being maintained, the minimum width for lane 1 should be 3.3m and 3m for lane 2 (or subsequent lane on multi-lane carriageways). Where one lane is to be maintained, the minimum lane width for all classes of vehicles is 3.3m.

C. Where there is a narrow central median, 900mm signs may be used in the central median.

D. Where TTM is being placed, or works are taking place on lane 1 of a ≥ 3 lane carriageway only. Refer also to Section 3.3.4.6 regarding direct lane 1 closures and associated restrictions.

E. Where TTM is being placed, or works are taking place, on lane 2 or subsequent lane.

F. See definition of Set Back in Section 0.1.5 Glossary of Terms.