NZ Guide to Temporary Traffic Management

Managing Risk

Note:

This document is a preliminary draft of the advice being developed by Waka Kotahi relating to the control of risk to road workers carrying out tasks on the New Zealand road network. The document illustrates the way in which the concepts and principles apply to temporary traffic management. However, it must be noted that this is a very early version of this document and has been adapted from Part 10 of the Austroads Guide to Temporary Traffic Management (2019). The contents will be subject to change as the review continues.

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1. INTRODUCTION

1.1 Purpose

Managing the risks associated with providing an optimal level of safety for persons working in or near traffic and the impact of road work on road users, road congestion and the general community, is a significant issue for Road Controlling Authorities (RCA's) and industry. RCA's and industry have a legislative requirement as an employer of construction, operational and maintenance services to provide a safe work environment and to manage the risks of working in or near traffic through Health, Safety and Wellbeing (HSW) requirements, regulation, training and roadwork planning.

The New Zealand Guide to Temporary Traffic Management (NZGTTM) details the contemporary temporary traffic management practice for use in New Zealand. In doing so, it provides guidance to Temporary Traffic Management Planners in the production of safe, economical, and efficient temporary traffic management system designs. This Guide recognises the level of variability of the road environments for which guidance is provided. The guidance provided in *NZGTTM* is intended to encourage the consistent planning, design, and implementation of temporary traffic management systems across New Zealand while also supporting the streamlined safe progress of work. It applies to all works on roads and near roads, in addition to off road development and other activities that interact with and impact on the road environment.

The purpose of the *NZGTTM* is to provide guidance and supporting material that:

- supports the ability of Road Controlling Authorities and industry to meet their HSW requirements and leads to improved safety outcomes at road worksites
- improves the standard of temporary traffic management in New Zealand through consistency of application which assists road users to recognise and understand temporary traffic management systems, thereby improving their behaviour and safety
- aims to reduce the rate of incidents occurring at worksites
- improves the ability of Road Controlling Authorities and industry to manage the increasing frequency and variety of activities that are being undertaken on and near the road
- allows continuous industry review to maintain best practice.

This purpose is achieved through:

- providing direction for all matters relating to the planning, design, and implementation of temporary traffic management systems
- facilitating improved adaptation to changes in technology and practices through being reactive to changes and being able to readily include new innovations
- providing guidance focused on the users of this Guide
- providing Road Controlling Authorities and industry with uniform practices whilst carrying out works on or near roads.

The benefits associated with uniform guidance broadly accepted by Road Controlling Authorities and industry include:

- guidance and training that appropriately develop Temporary Traffic Management Planners with the skills necessary to develop and deliver safe traffic management systems at road worksites
- providing improved consistency for road users, including vulnerable road users such as pedestrians and cyclists. This is targeted at improving road user behaviour, safety of road worksites and reducing impact on road congestion and the general community.

1.2 Structure of *NZGTTM*

The structure and content of the New Zealand Guide to Temporary Traffic Management is discussed in *NZGTTM Part 1*: Introduction. Within the NZGTTM, the terminology that applies is detailed in Table 1.1.

Table 1.1: Guidance terminology

Guide	The description for the complete New Zealand Guide to Temporary Traffic Management including all Parts
Part	The description for the individual documents within the Guide. This document is Part 10 of the New Zealand Guide to Temporary Traffic Management
Section	The description for a numbered section within each Part of the Guide. This is Table 1.1 placed within Section 1.2 of Part 10 of the Austroads Guide to Temporary Traffic Management.

In the context of the other guides within the Austroads/Waka Kotahi NZ Transport Agency range of publications, this Guide is restricted to matters relating to TTM practice and refers only briefly to issues more appropriately addressed in other Austroads/Waka Kotahi NZ Transport Agency Guides. It is recognised it is difficult, if not impossible, to discuss many aspects of TTM practice without reference to traffic management, road design and/or safety issues. The view is taken that within the *NZGTTM*, any such advice should be brief and be supported by references to other Guides for the appropriate guidance as required.

The scope of the *NZGTTM* is broad, addressing requirements and recommendations for protecting road workers and all road users, including vulnerable road users, from hazards, road traffic and other impacts of road works across a range of situations that may include:

- urban and rural environments
- motorways, major arterial roads, local roads, roads in built-up areas, roads in open road areas and unsealed roads
- all variations of road use by cars, heavy vehicles, public transport, motorcycles, cyclists and pedestrians
- day and night works
- changing road and weather conditions.

1.3 Scope of the Risk Management Section

The Risk Management Section provides guidance to road controlling authorities, traffic management coordinators, any party conducting works on or near a road, and all persons involved in planning, designing, implementing, managing, and completing TTM works.

Guidance is provided to support the other parts of the *NZGTTM* on a range of topics relating to TTM. This Part includes the following topics:

- risk management
  - process for undertaking risk management
  - application to TTM at road work sites
  - best practice process.

2. RISK MANAGEMENT FOR TTM

2.1 General

Risk management is a widely adopted and well accepted process in New Zealand. It is a primary process for a wide range of safety related functions, particularly in the area of Health, Safety and Wellbeing

Within the context of risk management, the distinction between a hazard and a risk must be understood.

Hazard is any aspect that can cause harm or damage to humans, property, or the environment. In the context of TTM, a hazard is focussed on any item or event that affects the safety of road workers or road users.

Risk is the probability that exposure to a hazard will lead to a negative consequence. Importantly a hazard poses no risk if there is no exposure to that hazard. Risks can include a range of other items that are risks to a project but may not be a safety risk.

Within *NZGTTM*, risk management is focussed on the operational safety risk associated with traffic and the risks associated with traffic flow and impact to local business and residents. It is expected that those responsible for the overall works will consider other risks including:

- legal
- environmental
- financial (cost)
- political
- reputational
- quality.

These other risks are not discussed further in *NZGTTM*. However, risks associated with TTM may need consideration within these other risk topics. For example, TTM can create environmental risks, may impact on the financial risks to a project and so forth. In this case, the person preparing the risk management plans for the other risks may seek the necessary input from the TTM team.

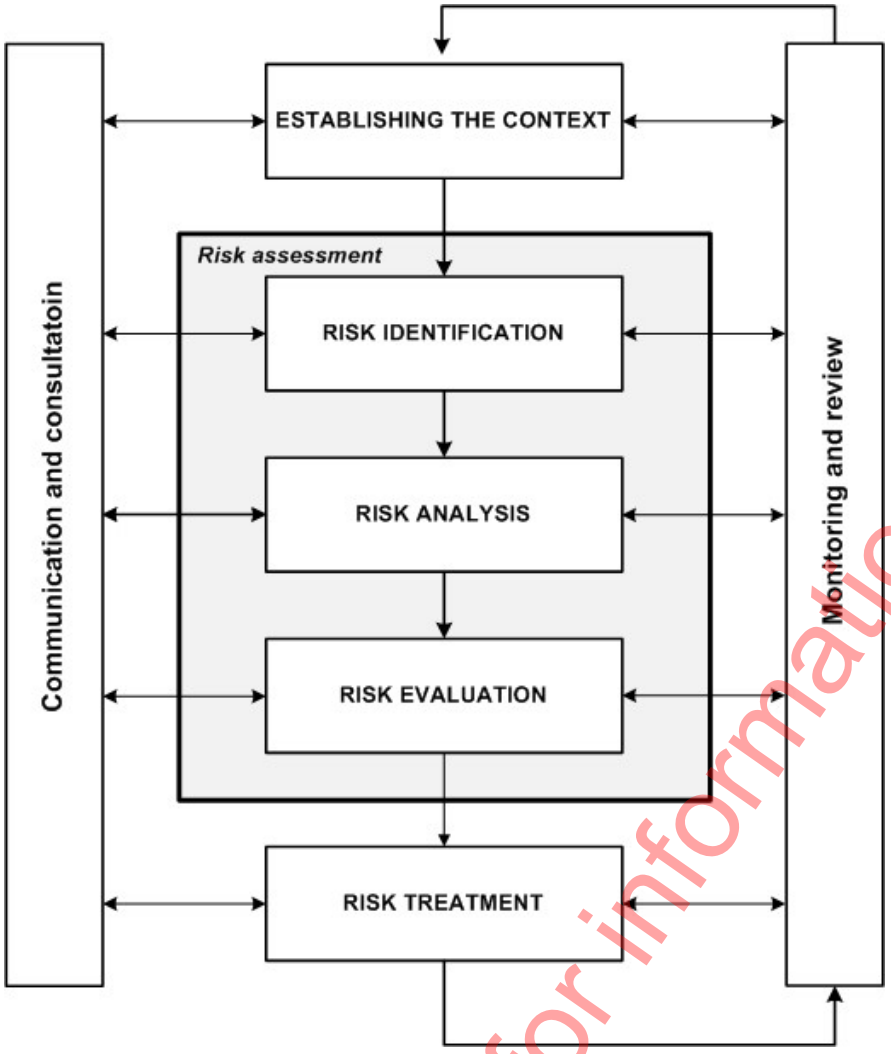
Information and advice for risk management is covered to provide a uniform approach to the management of risks for TTM worksites and the application of traffic management plans (TMP's). The guidance in this section represents the minimum requirements for undertaking risk management for TTM.

2.2 Overview

The risk management process discussed in AS/NZS ISO 31000:2018 is represented by the process flowchart in Figure 2.1.

AS/NZS ISO 31000:2018 defines risk as an 'effect of uncertainty on objectives' and goes on to describe risk as often being 'characterised by references to potential events and consequences, or a combination of these' and further it 'is often expressed in terms of a combination of the consequences of an event and the associated likelihood of occurrence'.

Figure 2.1: Risk management process – overview



Source: ISO 31000:2018

AS/NZS ISO 31000:2018 defines risk management as 'the culture, processes and structures that are directed towards realising potential opportunities whilst managing adverse effects. This then requires that a person accountable for managing the risk 'coordinates activities to direct and control an organisation with regards to risk'.

There are three core components to the risk management process as defined by the Standard. These are:

- establishing the context
- risk assessment, which is comprised of identifying, analysing and evaluating risk
- treating the risk.

Operating across these three components, and interacting with them at multiple levels, is the additional risk management components of communication/consultation and monitoring/review.

Each of these components of the risk management process has an important relevance to TTM at road work sites.

2.3 Application to TTM at Work Sites on Roads

The application of risk management for TTM at road works is appropriate at all levels of planning and operation, from the minor and routine TMP's through to large scale and complex road work sites.

Figure 2.1 identifies "establishing the context" as an important first step of the risk management process. The context of risk management for TTM at road work sites may be summed up as managing safety and work productivity. The context for TTM at road work sites includes the road and traffic environment; it involves members of the public as road users who are travelling through and past the road work site; it includes site personnel, labour hire, contractors and the traffic controllers themselves; and it must consider the nature of the work to be undertaken, the scheduling of key tasks and the need to manage the disruption that is caused to the traffic flow.

This context permits the identification of a broad range of risks that road controlling authorities, designers, project planners and work site managers must consider when preparing traffic management plans.

Road works requiring TTM may be divided into a number of types. The extent of TTM measures that need to be planned and implemented is often determined by such factors as:

- period of operation
- type and extent of works being undertaken
- road (operating) environment where the works are to occur including factors such as:
  - the prevailing traffic volume and type of vehicles using the road
  - road width and sight distance
  - sign posted speed limit approaching the road work site
  - prevalence of vulnerable road users (pedestrians and cyclists) including children and the elderly.

2.4 Elements of Best Practice

2.4.1 A model risk management process

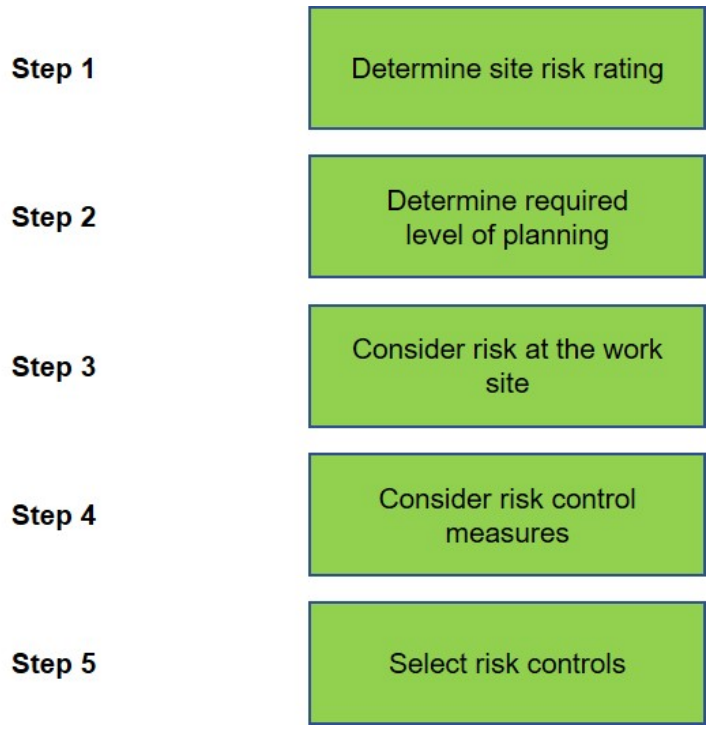
The elements of a best practice risk process steps are illustrated in Figure 2.2 with further information for each step detailed in the following sub-sections.

At road work sites, a risk exists for both workers and road users from an uncontrolled interaction between passing vehicles and the road work site/activity, or between passing traffic due to the road work site/activity. These risks exist for all road users including motorists, motorcyclists, pedestrians, cyclists and of course workers associated with the road work activity, and consideration of risks should be given from the perspective of all.

Managing risk requires the consideration of two components of risk, the likelihood of an event occurring and the consequence of that event occurring.

Typically, the consideration of these risk factors (likelihood and consequence) occurs via a risk matrix, the outcome of which will assist to identify a measure of the level of risk associated with the defined event.

Figure 2.2: Traffic management at work sites process steps - risk management



Source: Austroads (2012), modified from Victorian Government (2004).

Road environment factors that contribute to risk at road work sites include the:

- proximity to passing traffic (particularly the clearance between the traffic stream and the road work site, workers and any plant or machinery)
- speed of the traffic stream, including cyclists, passing adjacent to or through the work site
- traffic volume and composition
- presence, movement paths, the number and types of vulnerable road users
- type of work activity
- operating hours of the road work site and the associated TTM
- changes to the traffic arrangements
- site access and egress
- upstream and downstream traffic conditions
- geometry of the road approaching and past the work site (e.g. sight distance, curve radii etc.).
- weather conditions.

The application of the model process and the key tasks it defines are discussed in more detail in the following steps.

Step 1 – Determine the site risk rating for planning of TTM

The site risk rating considers the road environment where the work site is to be established and seeks to determine if a low or high risk exists for workers without any protective measures or special management of the traffic stream. That is, this initial assessment considers the in-situ conditions of the proposed work site to determine if it represents a low or high risk to road users and workers.

The level of site risk can then be used to determine the degree of planning required to reduce the risks present in the context of the work, i.e. the period of operation, the type and extent of works being undertaken and the road (operating) environment.

The site risk rating for planning of TTM may be determined using the site risk matrix in Figure 2.3. The input parameters for the site risk from the matrix are:

- speed zone (existing, signposted)
- road category
- lateral clearance between workers and the traffic stream.

Figure 2.3: Determining the site risk rating for planning – See Appendix 1 for Categories of Road

New Zealand Note:

These Road Categories are for illustrative purposes only. This table should be used to help understand the principle of risk in relation to road categories, but not applied to a New Zealand risk assessment. Until a New Zealand specific table has been published, the Road Levels as defined in the current NZ CoPTTM (2018) should be used.

Site risk rating						
		Clearance between traffic lane and workers				
		< 1.0 m	1.0 – 3.0 m	3.0 – 6.0 m	6.0 – 9.0 m	> 9.0 m
Posted speed limit and road type	40 km/h					
	Category 1 road	Medium	Low	Low	Low	Low
	Category 2 road	Medium	Low	Low	Low	Low
	50 km/h					
	Category 1 road	Medium	Low	Low	Low	Low
	Category 2 road (urban)	High	Medium	Low	Low	Low
	60 km/h or 70 km/h					
	Category 1 road	High	Medium	Low	Low	Low
	Category 2 road	High	High	Medium	Low	Low
	80 km/h or 90 km/h					
	Category 1 road	High	High	Medium	Low	Low
	Category 2 road	High	High	High	Medium	Low
	Category 3 road	High	High	High	Medium	Low
	100 km/h or higher					
	Category 1 road	High	High	High	Medium	Low
	Category 2 road	High	High	High	Medium	Low
	Category 3 road	High	High	High	Medium	Low

A low risk site will generally require less planning and preparation to manage the identified risks. A high-risk site will require decidedly more planning and preparation to reduce the risks to acceptable levels.

It should be noted that selection of this site risk for planning of TTM simply represents a starting point for the protection of workers from traffic. The overall risk rating will also include a range of other parameters which consider the risk created for pedestrian, cyclists, and other road users. These other factors should also be considered to determine if an alternative higher or lower risk rating is applicable.

Step 2 – Determine the required level of planning

The level of planning and the amount of documentation produced to prepare and implement a traffic management plan and associated traffic management diagram(s) will initially be determined by the site risk rating. This risk rating will also determine the potential for the use of generic TMD for repetitive activities as detailed Table 2.1.

Table 2.1: Level of TMP required and use of Generic Traffic Management Drawing (TMD)

Step 1 Site Risk Rating	Level of traffic management planning	Generic TMD suitability	Site specific TMP
Low	Required but minimal	Generally, directly suited for most maintenance and construction activities with minimal amendments	Will be required to be developed to ensure the safe and efficient treatment for • more complex sites • sites impacting other road user groups such as pedestrians and cyclists
Medium	Required to assess the risks associated with working in proximity to traffic and identify restrictions regarding use of generic plans.	Generally, remain suitable for most maintenance activities	
High	A comprehensive traffic management plan shall be prepared prior to the use or development of TMD for the works and should seek to eliminate or reduce risk to acceptable levels.	May remain suitable for routine maintenance activities in accordance with a TMP specifying all necessary restrictions for their use	Will be required for all other activities not specifically identified as being suitable for use of generic TMP

Many organisations may develop Generic TMD's with a selection and risk process to be applied. Once selected, the generic TMDs may often be applied with adjustment within the approved authorisation for a STMS to then establish them to be deemed 'site suitable" for implementation at road work sites.

Step 3 – Consider risk at the work site

A review of all risks associated with a site and the work activities should be undertaken, factoring in the type of work activity, time of day of the operations, presence of vulnerable road users, changes to the traffic arrangements, site access and egress, upstream and downstream traffic conditions etc. This process may result in a review of the site risk rating and a change in the level of planning that is required.

Key consequences to consider include:

- injury to workers
- injury to motorists and motorcyclists
- injury to pedestrians and cyclists
- vulnerable road users where alternative routes may create personal safety and security issues, particularly at night.

When planning TTM for road work sites, other consequences that are not directly safety based should also be considered. These include:

- impact on local businesses and residents
- effect on traffic flow and congestion, particularly during peak traffic periods
- effect on services such as public transport and emergency services
- the effect of traffic detours on adjoining properties, traffic flow and movement of vulnerable road users, particularly when local streets may be utilised as a detour route
- Network wide risks arising from diversion by traffic avoiding the locality of the worksite.

Table 2.2 lists common work site events, their causes and the consequences and can be used to identify the range of risks that may be present at a site. This list is not exhaustive, and the risk management process should ensure that the risk assessment considers any additional risks not listed.

Table 2.2: Common risks at road work sites

Risk Event	Cause	Consequence
Penetration of the work site / closure by a vehicle	• Failure to comprehend or observe TTM signs • Failure to navigate the Temporary Traffic Management • Inadequate controls – direction, speed reductions, lane drop merge etc. • Failure to comply with controls – direction, speed reduction etc.	Injury to workers, drivers and passengers Property damage and other financial losses
Worker strays onto live roadway or into a safety zone	• Inadequate delineation • Inadequate clearance • Inadequate procedures • Inadequate controls	Injury to workers, drivers and passengers
Establishment/changing/ dismantling Temporary Traffic Management expose workers to traffic	• Poor planning and preparation for works • Inadequate instructions for workers • Inadequate controls	Injury to workers, drivers and passengers
Construction and delivery vehicles entering, traversing, and exiting the road work site / closure, particularly over-dimensioned vehicles	• Poor planning and preparation for site access/egress • Inadequate instructions for vehicle operators • Inadequate control of site traffic	Injury to workers, drivers and passengers
Obstacles on work site	• Untidy work site • Work site left unattended • Improper attention given to traffic • Improper attention given to pedestrians and cyclist traffic	Injury to motorists or motorcyclists Injury to pedestrians or cyclists
Failure to navigate through the work site	• Poor signing • Inappropriate signing • Inadequate delineation • Inadequate control of traffic	Injury to motorists, motorcyclists or cyclists Property damage and other financial losses
Works vehicle impacting on motorists, motorcyclists or cyclists	• Inadequate signing • Inadequate delineation • Inadequate instructions for workers • Inadequate controls	Injury to motorists, motorcyclists or cyclists
Failure by pedestrians / cyclists to navigate through the work site, or poor route definition through / past the work site	• Poor signing • Poor lighting • Inappropriate signing • Inappropriate route through/past the work site • Inadequate path surface, width or obstructions on the path • Inadequate ramps at changes from path to road • Inadequate delineation or separation from other traffic • Inadequate delineation or separation from the work site	Injury to pedestrians or cyclists
Increased exposure for vulnerable road users to traffic	• Poor planning of crossing points for vulnerable road users • Inappropriately long diversions result in vulnerable road users entering road unsafely	Injury to pedestrians or cyclists

Risk Event	Cause	Consequence
Significant traffic delays/congestion	• Poor planning of traffic management arrangements • Failure to cater for works and TTM • Worksite event	Excessive lost time to motorists, commuters and public transport services
		Property damage and other financial losses

Source: Modified from Victorian Government (2004).

The risks should be assessed by determining how much harm or damage they can cause, or how much impact they can have on road users, adjacent residents or businesses (consequence) and how likely they are to result in harm or negative consequences (likelihood). This analysis is based on all the identified controls being in place, with their established degree of effectiveness.

Likelihood is the chance of something happening and can be established using the example likelihood measures as detailed in Table 2.3.

Table 2.3: Risk matrix – likelihood descriptions

Likelihood	Description
Almost certain	• Expected to occur in most circumstances or • Expected to occur at least 8 in 10 times the event or action occurs, i.e. more than an 80% chance of occurrence or • Will probably occur with a frequency in excess of 10 times per year.
Likely	• Expected to occur multiple times during any given year or • Expected to occur between 8 in 10 and 1 in 10 times the event or action occurs, i.e. between a 10% to 80% chance of occurrence or • This risk is known to occur often but less than 10 times per year
Possible	• Expected to occur once during any given year or • Expected to occur between 1 in 10 and 1 in 100 times the event or action occurs, i.e. 1% to 10% chance of occurrence or • This risk is known to have occurred on occasions
Unlikely	• Expected to occur once every 1 to10 years or • Expected to occur between 1 in 100 and 1 in 1000 times the event or action occurs, i.e. 0.1% to 1.0% chance of occurrence or • This risk could occur but not often
Rare	• Not expected to occur in the next 10 years ie less than once every 10 years or • Expected to occur less than 1 in 1000 times the event or action occurs, i.e. less than 0.1% chance of occurrence or • It is unusual that this risk occurs, but it has happened

Source: Modified from Roads and Maritime Services (2018).

Consequence is the outcome resulting from a risk being realised. The appropriate consequence rating may be selected using the consequence measures contained in Table 2.4.

Table 2.4: Risk matrix – consequence descriptions

Rating	Safety and Health Impacts
Insignificant	No treatment required
Minor	First aid treatment required
Moderate	Medical treatment required or Lost Time Injury
Major	Single fatality or major injuries or severe permanent disablement
Catastrophic	Multiple fatalities

The consequence/likelihood risk matrix in Table 2.5 can be used to identify the level of risk for each event identified at the proposed work site.

Table 2.5: Consequence / likelihood risk matrix

		Likelihood				
		Rare	Unlikely	Possible	Likely	Almost certain
Consequence	Catastrophic	Medium	High	High	Very high	Very high
	Major	Low	Medium	High	Very high	Very high
	Moderate	Low	Low	Medium	High	High
	Minor	Low	Low	Low	Medium	High
	Insignificant	Negligible	Low	Low	Low	Medium

Based on the consideration of the risks in Table 2.5, if any risks are determined to fall within the Very High, High or Medium categories then the site risk rating should be revised to High and the level of planning reviewed accordingly. This then requires the Temporary Traffic Management Planner to revisit and assess the traffic management options from the planning stage rather than attempting to address and mitigate each risk individually. The suggested treatment approach is described in Table 2.6.

Table 2.6: Suggested treatment approach for risk levels

Risk	Suggested treatment approach	
Very high	Unacceptable. Must be corrected.	Significant and urgent action is required to eliminate the safety risk or reduce the consequence or likelihood of the risk and overall risk exposure.
High	Should be corrected or the risk significantly reduced, even if the treatment costs are high.	Immediate action is required, and effort must be made to ensure that the safety risk is eliminated so far as is practicable or minimised so far as is practicable if elimination is not reasonably practicable.
Medium	Should be corrected or the risk significantly reduced, if the treatment cost is moderate, but not high.	Action is required and effort must be made to ensure that the safety risk is eliminated so far as is practicable or minimised so far as is practicable if elimination is not reasonably practicable.
Low	Should be corrected or the risk reduced, if the treatment cost is low.	A level of safety risk that requires monitoring and review to ensure that the safety risk remains at this level.
Negligible	No action required	Safety risk has been determined to be so low that no further action is required. In this case the consequence is considered to not result in any injury to any person.

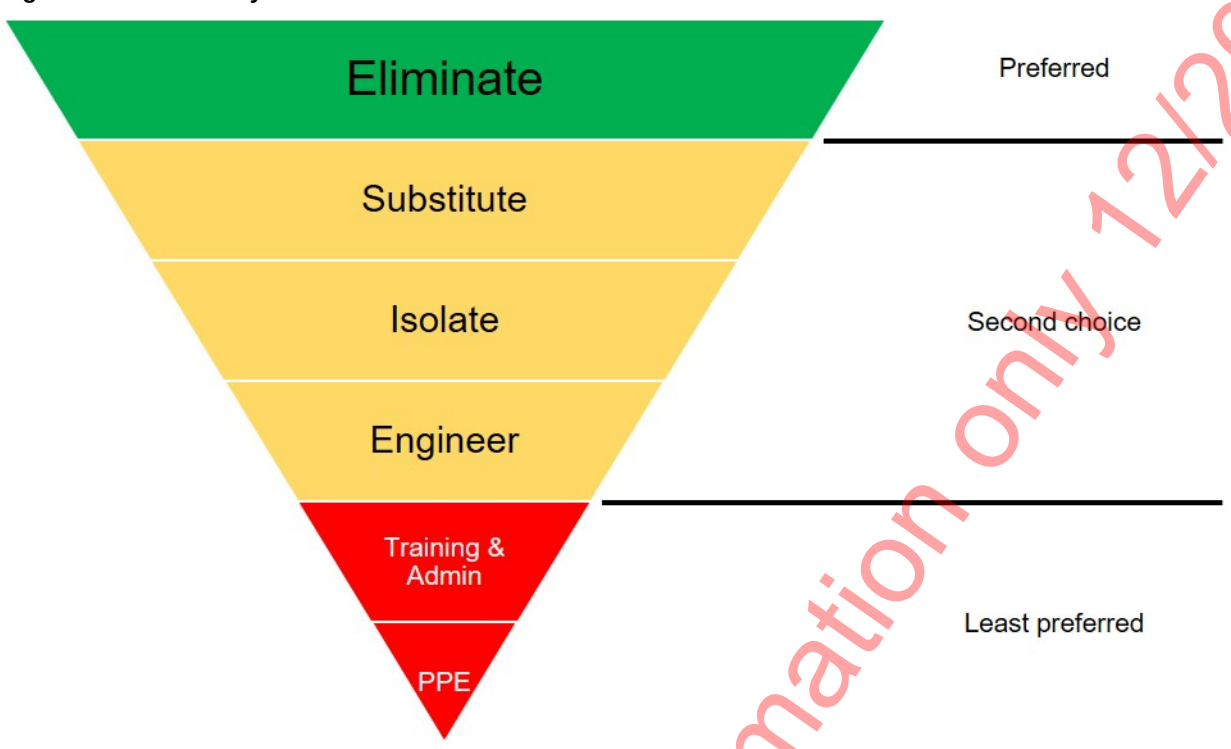
Step 4 – Consider risk control measures

Once the range of risks associated with a road work site are identified, consideration can be made as to how they can be reduced. The starting point in the consideration of the appropriate control measures should be to not expose workers or the public to an uncontrolled environment. Hence the first consideration should be to eliminate the risk before any subsequent consideration of alternative measures. In any project there are competing objectives, and this is no less the situation when considering hazard control measures to manage risk. For TMP's associated with road works, the key objectives include maximising safety for road users and workers at the site.

The required approach for treating risk is the hierarchy of controls. This method considers risk control measures in a hierarchical manner, and thus provides a mechanism that allows project managers to make judgements based on the competing objectives mentioned above.

The hierarchy of controls approach groups control measures under one of six categories that describe the ability to control the hazard and thus reduce risk are shown in Figure 2.4.

Figure 2.4: Hierarchy of controls



Source: Modified from Roads and Maritime Services (2018).

For some risks, certain levels of control may not be available, practicable or feasible, while for other risks combinations of controls may achieve the best outcome to reduce risk. In addition, different solutions may be selected for different parts of a job or at different times. In all cases there are a range of considerations that need to be made when determining the optimum outcome, including the severity outcome of the risk, the nature of the works and the cost of implementing the countermeasure.

Equally, the lower order countermeasures such as training, administrative and PPE should be readily available and cost-effective in the vast majority of situations; however, these are generally considered the least effective countermeasures to reduce risk.

Table 2.7 provides further description on the hierarchy of controls and example TTM mitigations:

Common road work site risks have been developed and are presented in Table 2.8 along with broad control measures, grouped under the applicable tier of the control hierarchy. Where a particular risk is not described in Table 2.8 then the application of the hierarchy of controls method can be readily applied to assist completing the risk management process for the site.

Table 2.7: Example TTM mitigations

Control	Description	TTM Control Example
Eliminate	The most effective control measure involves eliminating the hazard and associated risk. The best way to do this is by, firstly, not introducing the hazard into the workplace. Eliminating hazards is often cheaper and more practical to achieve at the design or planning stage of a product, process or place used for work. In these early phases, there is greater scope to design out hazards or incorporate risk control measures that are compatible with the original design and functional requirements. It may not be reasonably practicable to eliminate a hazard if doing so means that you cannot make the end product or deliver the service. If you cannot eliminate the hazard, then you must minimise as many of the risks associated with the hazard as reasonably practicable.	Redirecting traffic "Around the work area" to eliminate the risk of traffic impact on workers or implementation of contraflow to eliminate the risk of traffic impact on traffic controllers.
Substitute	Substitute the hazard with something safer. This may not remove all the hazards associated with the process or activity and can introduce different hazards, but the overall harm or health effects will be lessened.	Portable traffic control devices to substitute the requirement of a traffic controller working in or near traffic.
Isolate	Isolate the hazard by physically separating the source of harm from people by distance or barriers. For example, restrict contact with plant and equipment, lock hazardous chemicals away and only use them under strict controls	Undertaken by the use of "Through the worksite" and "Past the worksite" arrangements and appropriately rated safety barriers.
Engineer	Look for technological solutions that reduce risk, eg use machines to do work that would be hazardous to humans, or use more modern plant with in-built safety features	Truck mounted attenuators to protect workers (and road users) in place of a typical work vehicle.
Training and Admin	Develop and document safe methods of work e.g. safe work procedures or safe work method statements and provide appropriate training, instruction and information to reduce the potential for harm	Developing safe methods of work e.g. safe work method statements, providing appropriate training and instructions etc.
Personal Protective Equipment (PPE)	Personal protective equipment (PPE) reduces workers' exposure to the hazard. PPE includes safety gloves, protective eyewear, earmuffs, hard hats, aprons, safety footwear and dust masks. PPE is the last line of defence and must be used in conjunction with one or more of the other control measures.	Hi Vis equipment and clothing, hard hat and safety boots etc.

Source: Roads and Maritime Services (2018)

Table 2.8: Common worksite risks and TTM control measures

Safety hazard/risk factors	Hierarchy of control		
	Consider the practicability of controls, from left to right. Select the most practical given the circumstances and the level of risk. Record the reason if a higher-level control is not considered practicable.		
	Elimination/substitution	Engineering/isolation	Administrative/behavioural
Clearance to traffic (between the lane carrying traffic and the work area)	Road closure Detour	Safety barriers Lane closure Vehicle crash attenuators	Speed restriction Warning signs/VMS Delineation of travel path

High speed traffic through the worksite	Road closure Detour	Safety barriers Lane closure Portable traffic signals Vehicle crash attenuators	Speed restriction Warning signs/VMS Traffic controller
Poor advance sight distance to the worksite	Road closure Traffic diversion	Safety barriers Lead and/or tail vehicles	Extra advanced warning signs/VMS Advisory of speed reduction Delineation of the travel path Traffic controller
Poor observance by motorists of directions/instructions	Road closure Traffic diversion	Lane closure Portable traffic signals	Speed reduction enhancement Extra signs/VMS Reassessment of information provided
Narrow pavement width with no escape route	Road closure Traffic diversion	Safety barriers	Speed reduction Delineation of travel path
Presence of workers at the worksite	Road closure Traffic diversion	Safety barriers Increase separation from vehicular traffic	Speed reduction Warning signs Delineation of travel path and worksite
Excavation adjacent to traffic (>300 mm deep within 1.2 m of traffic)	Road closure Traffic diversion	Different construction method Safety barriers	Speed reduction Delineation of travel path
Presence of unprotected hazards within safety zone	Road closure Traffic diversion	Safety barriers	Speed reduction Delineation of travel path
Rough or unsealed road surface due to roadworks	Road closure Traffic diversion		Speed reduction Warning signs/VMS
High volume of traffic through the worksite	Road closure Detour	Safety barriers Lane closure Portable traffic signals	Speed reduction
High volume of heavy vehicles through the worksite	Road closure Detour	Safety barriers Lane closure Portable traffic signals	Speed reduction
Works vehicles entering/leaving the worksite		Safety barriers Lane closure Portable traffic signals	Speed reduction Warning signs/VMS Delineation/control of access points
Cyclists/pedestrians through the worksite	Alternate pathway Close traffic lane for use by cyclists / pedestrians Eliminate impacts on pedestrians/cyclists	Adequate separation of shared road space	Speed reduction Warning signs/VMS Delineation from other traffic

Step 5 – Select risk controls

The final step of the formal risk management component of the TTM process is to select the risk control measures to be developed in the TMP and TMD's and applied to the road work site.

For TTM at road work sites a range of general controls are available to select from, including:

- road closure
- lane closures, traffic diversions and detours
- temporary road safety barriers
- temporary speed zones
- signs, markings, temporary traffic control signals, variable message signs etc.

The application of these general controls (or combinations of them) to any particular site will be determined by the site and traffic conditions and constraints and the level of risk posed by the risks identified earlier in the process.

Once a TMP has been prepared, it should be reviewed on-site by the personnel who have prepared it and those who will implement it and work at the site. This site review should ensure that all aspects of the site operation and management of traffic to, from, through and past the site have been considered and are appropriately addressed.

2.4.2 Documentation of risks

The risk management process should be captured and documented with all risks considered. Best practice in risk management documentation includes the following:

- Risks identified in the planning and design phase are to be documented in a risk register by the TTM Planner responsible for the design. Risks should be documented in a complete risk register within the TMP and also captured in the onsite construction / project / task risk register.
- Risk management often requires the balancing of competing risk outcomes to establish the best net risk outcome. For example, providing TTM protection for a short duration task may reduce the risks for road workers but increases the risk exposure for TTM workers. The net risk outcome should be documented to describe the reasoning behind the selected protection measures.
- Documented risks should be relevant to the task and the worksite. Only relevant risks should be captured against each TMP to minimise the chance for a risk register appearing inappropriate for the task. For example, risks relating to night works should not be documented on a TMP for tasks only occurring during daylight hours.
- Generic risk management forms that contain a large number of irrelevant risks can become a ‘tick and flick’ exercise which does not assist users in fully considering relevant risks at a site.
- Risk management may not be able reduce all risk to low and some risks assessed to be medium or high may remain following the development of the TMP. These are referred to as residual risks and should be clearly documented with appropriate monitoring and actions to be followed if the risk appears likely to occur during TTM operation.
- The appropriate owner required to monitor and respond to each risk should be identified during the documentation of the risk register.
- The STMS responsible for the site should review the risk register for the TMP prior to the implementation of the TMP. At this time any additional risks identified at the site should be added to the risk register and appropriate TTM measures identified.
- Any risks identified in the risk register that eventuate should be documented and the outcomes of the event detailed.
- Any unforeseen risks that arise should be documented and the outcomes of the event detailed.
- Risk outcomes captured during a project should be reported to the TTM Planner and captured within the company risk systems for further development of the appropriate consequence and likelihood ratings for each risk.

APPENDICES

Appendix 1: Road Categories:

Category 1 (most urban streets and lower volume rural roads).

The characteristics of category 1 roads are defined by the following parameters:

- Posted speed and AADT of: - any speed limit with less than 3,000 vehicles per day AADT
- a speed limit of less than 60 km/h and traffic volumes between 3,000 and 10,000 vehicles per day AADT

The characteristics of these roads are generally recognised as: - roads (with or without a centre line), sealed and unsealed

- two lanes two way, and sections including one-way single lane, and overtaking lanes.

Category 2 (high-volume roads).

The characteristics of category 2 roads are defined by the following parameters:

- Posted speed and AADT of: - a speed limit greater than, or equal to 60 km/h and traffic volume greater than, or equal to 3,000 vehicles per day AADT
- any speed limit with traffic volumes greater than, or equal to 10,000 vehicles per day AADT.
- Signalised intersections

The characteristics of these roads are recognised as:

- multilane or divided roads
- high speed highways.

This Category of road:

- may include major urban streets in the central business district, some arterial roads
- generally requires larger signs
- generally requires signs on both sides of the road

Stringent TTM criteria for mobile operations apply to this Category of road.

Category 3 (expressways = high-volume & high-speed roads).

The characteristics of category 3 roads are defined by the following parameters:

- These are high-volume motorways / expressways, or high volume/high-speed multi-lane expressways with a divided carriageway
- Any motorway / expressway and any associated on-ramp or off-ramps
- Grade separated road with speed limit greater than, or equal to 90 km/h. Traffic volumes are generally greater than 20,000 VPD but can be lower

For this Category, TMA's shall be used in mobile closures when setting up or removing static worksites.

These categories form a broad framework for application by road controlling authorities

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