Practice Note 02

Use of raised devices on the AT Network

Supplement of Engineering Design Code
Principles on selection and approval of profile for all raised devices.
Guidance on construction setting-out and checking.
Changes to profiles for some target speeds.

Edition 2, June 2024

Contents

1. Purpose

This Practice Note (PN) applies to all raised devices: raised safety platforms (RSPs), speed humps and speed cushions. It identifies acceptable profiles and uses for all raised devices in all road contexts within the Auckland Transport Network. It has been produced because current standards in AT TDM Engineering Design Code – Traffic calming and in AC Code of Practice for Land Development and Subdivision (AC CPLDS) do not cover all uses of Raised Devices.

Recent use of RSPs for road safety measures have shown that some existing profiles used on the transport network may appear too aggressive when used on higher-speed or higher volume roads if they are not part of an extended traffic calming scheme. Other safe and effective treatments may be more appropriate. Therefore, new detailed standards must be set and followed so that installations of raised devices on all road types are safe for all users.

This approach applies to raised device works covered by:

- the Land Development Engineering Approval (ENG) process;
- any AT approved works programme or project involving upgrading and redevelopment of road infrastructure works;
- third party developed roads and other infrastructure to be vested to AT;
- retrofit alteration of RSPs that are considered high priority due to risk to road users;
- any other Auckland Council (AC) or AT approval process which involves raised devices;

in a manner that:

- All infrastructure complies with AT's and AC's safety requirements;
- Transport infrastructure complies with AT's Transport Design Manual requirements;
- Implementation comes into effect immediately on the signed date shown at the end of this PN.

2. Scope

This Practice Note applies to:

- All AT projects initiated after implementation of this PN.
- All Consents or ENGs lodged after implementation of this PN.
- Any AT project commenced but not yet constructed or any Consent or ENG lodged with Auckland Council:
    - If the Manager – Design & Standards considers that an issue would arise if the design were not changed.
    - <u>and</u> if it is practicable to change the design prior to construction.
    - <u>and</u> the cost of changing the design can be agreed to.
- Any review of the safety of an existing RSP.

3. Revised Standards

3.1 Uses of raised devices

Vertical deflection devices are used to reduce the maximum comfortable operating speed for vehicles to acceptable Safe System collision speeds where road geometry or horizontal speed management devices cannot do so. The purpose of these devices is to reduce both the likelihood and severity of crashes by managing a safe speed at locations with conflicts between different road users or on streets where a lower speed is desired for overall community safety.

On arterial roads, ramp profiles are typically more comfortable than those used for local area wide treatment on residential streets, reflecting the buses, trucks, and emergency services that use these roads. More comfortable ramp profiles may still achieve a speed that is aligned to Safe System speeds, when other contextual factors such as signals, traffic, and the presence of other road users are considered together. These more comfortable ramp profiles are also less likely to create annoyance and community objection, particularly when used repeatedly along a corridor.

The purpose of these vertical deflection devices is to have a physical effect to signal to drivers that they are about to enter a conflict area and that slowing to Safe and Appropriate speed is required for harm minimisation but without unduly impacting comfort and speed of motorists or bus passengers.

Safe system design principles are to be adopted when considering alternative designs where vertical speed calming devices are not permitted or are deemed to be inappropriate.

Raised devices may be used at specific conflict points (intersections or crossings) as described in this Practice Note. They may also be used in area traffic calming schemes; further information is given in TDM Engineering Design Code - Traffic Calming which should be used except where this Practice Note specifies otherwise.

Raised safety platforms can affect flow of traffic, safety and comfort of some users and response times for emergency services, in various degrees depending on profile, context and location. Their use must be reviewed by AT Subject Matter Experts when they are proposed on bus routes, freight routes or FENZ critical routes. Alternative safety treatments may be necessary in some of these cases.

3.2 Context

Speed controls must be considered holistically and in line with the function of the street shown in Future Connect and mapped AT GIS.

It is a requirement that alternative speed management tools such as horizontal speed controls be considered as the preferred option first, before raised devices can be proposed.

Raised devices may be considered in any of these locations below and where raised devices are considered an important element to achieve the viability and objective of the project; Departure from Standards approval may be required as shown:

- near marae and educational facilities and major transport hubs
- within the boundary of a recognised metro, town, or local centre (Roads and Streets Framework – High place value (P3))

- Locations that have an assessed safety risk (see Appendix 1), where alternative safety improvement tools are not deemed available and where incremental benefit from phased project implementation is not deemed applicable.

When implemented, raised devices should achieve a mean speed of 40 km/h on arterials over the device with 30 km/h accepted on collectors and local roads where the traffic volume is less than an AADT of 5000 and HCV below 3%.

Arterial Roads **Frequent and Strategic Bus Network** **Level 1 Freight Network** **Strategic freight Areas** **Emergency Lifeline Routes**	Raised devices may not be used on these roads. A Departure from Standard must be requested in any of these locations if raised devices are considered an essential element to achieve the objective of the project: When implemented they should achieve a mean speed reduction of 10 km/h at the device.
Other Collector Roads	Raised devices are permitted if they are designed to achieve a mean speed of 40 km/h over the device with 30kmh accepted on collectors where the traffic volume is less than an AADT of 5000 and HCV below 3%.
Other Local Roads	Isolated devices on local roads must be designed to achieve a mean speed of 30km/h. Effect of all devices on availability of on-street parking must be considered.

3.3 Non-Compliance with the requirements of this Practice Note

Any proposal to construct a device that is not in accordance with this Practice Note will require the express approval of the Chief Engineer via a Departure from Standard form submitted to and supported by the Chair of the Design Review Panel.

3.4 Device Selection and placement

For speed control where horizontal devices or geometry are not practicable, the following devices are considered acceptable:

Arterial Roads, Frequent and Strategic Bus Network, Level 1 Freight Network, Strategic Freight Areas, Emergency Lifeline Routes	**To be used by departure from standard only:** • 75mm high speed cushions used for channelising flows on the approach legs to roundabouts that cannot achieve the correct entry speed criteria. • RSP Type 1S, 1, 2S, 2, 3S or 3
Other Collector Roads	• 75mm high speed cushions used for channelising flows on the approach legs to roundabouts that cannot achieve the correct entry speed criteria. • RSP Type 1S, 1, 2S, 2, 3S or 3 • RSP Type 4S or 4 on a Collector Road terminating at a priority control intersection where there is a pedestrian or cycle crossing (by departure from standard only) • 75mm high sinusoidal speed humps • Horizontal speed controls as defined in the Transport Design Manual: Engineering Design Code – Traffic Calming
Other Local Roads	• Horizontal speed controls must be considered first. • 100mm high sinusoidal speed humps • Isolated crossings and crossings on traffic-calmed streets: RSP Type 4S or 4

Noise & Vibration

At all times, the introduction of a raised device must not cause vibration in nearby properties above Class C of the Norwegian Standard NS 8176 E:2005 – “Vibration and shock – Measurement of vibration in buildings from land-based transport and guidance to evaluation of its effects on human beings”. See also **Section 4.1 Soil Types**

Further research is underway to link falling weight deflectometer testing to anticipated vibrations at a property. This Practice Note will be updated with this work once complete.

Other Factors

- The profiles are applicable to lifeline emergency use subject to limitations given above.
- Swedish tables (Type S) are preferred where practicable.
- Contexts are typical categories of road combined with target safe speeds at the device. The speed limit or approach design speed must not be greater than 20 km/h above the target speed at the Device (10m km/h for Arterial Roads). Design speed lower than the

speed limit may be used where features constrain approach speed. Departure from Standard approval is required where the approach speed is greater than 50 km/h.

Signalised Intersections

To be used by departure from standard only: Raised devices may be permitted at locations that have an assessed safety risk (see Appendix 1), where alternative safety improvement tools are not deemed available and where incremental benefit from phased project implementation is not deemed applicable. RSP Type 1S, 1, 2S, 2, 3S or 3 may be considered**.**

Roundabouts

Geometric design of roundabouts should ensure that the maximum Check Vehicle entry speed does not exceed survivable speed of 30 km/h (or 50 km/h for rural or highway roundabouts where pedestrians and cyclists are not present). Where this cannot be achieved, 75mm high speed cushions for channelising flows on the approach legs or RSP Type 1S, 1, 2S, 2, 3S or 3 may be used except: **for Arterial Roads, Frequent and Strategic Bus Network, Level 1 Freight Network, Strategic Freight Areas, Emergency Lifeline Routes, these are to be used by departure from standard only.**

Side road Crossings at Intersections

Raised devices are not permitted across side roads intersecting with **arterials** without an approved **departure from standard** that demonstrates the raised device does not obstruct traffic flow on the arterial road in normal conditions. Please see also the current version of **PN-04 Cycling Infrastructure - Interim Facilities** for further information for details of appropriate crossing facilities.

Pedestrian Crossings

It has been the practice to install a raised device to support a pedestrian crossing, either signalised or marked as a zebra. If the pedestrian crossing included a raised device that does not comply with this Standard, then alternative crossing provisions must be considered.

Should the raised component of an existing pedestrian crossing be no longer required then supporting treatments may be necessary where a vertical feature is not provided at or near a conflict point. A Safe System Audit must be carried out to demonstrate the safety of the pedestrian crossing.

Bus Stops

Providing safe and convenient crossing facilities near bus stops is recommended to enable safe connections for bus patronage. If raised devices are proposed for a crossing on collector or local streets, position the bus stops 20-30 metres away from the RSP. This will eliminate the potential safety issues for standing bus passengers experiencing vertical acceleration while buses move into or out of the bus stops. For arterial roads or where a raised crossing is not appropriate, consider introducing mid-block signal using Level of Service defined for pedestrians in the Auckland Network Operating Plan.

3.5 Raised Safety Platform Profile Types

Table PN02-1: RSP Profiles

Type	Approach Speed (4) (km/h)	Profile (1)				
		Nominal grade change	Approach ramp	Top (2)	Departure ramp	
					Swedish (3)	Standard
1S	70 - 80	1:25	1875 x 75	6000	4500 x 75	
1	70 - 80	1:25	1875 x 75	6000		1875 x 75
2S	60	1:20	1500 x 75	6000	3000 x 75	
2	60	1:20	1500 x 75	6000		1500 x 75
3S	50	1:15	1125 x 75	4000	3000 x 75	
3	50	1:15	1125 x 75	6000		1125 x 75
4S	<50	1:15	1500 x 100	4000	4000 x 100	
4	<50	1:15	1500 x 100	6000		1500 x 100

1. Ramp profiles are given as length and height in mm relative to the mean gradient of the road surface over a length of 2.0 m adjoining the ramp.
2. Top dimension may be extended through an intersection if the entire intersection is to be raised.
3. Swedish table profiles: Departure ramp length is the minimum; height is the maximum.
4. Approach speed may be either a posted speed limit or a measured or predicted operating speed.

3.6 Speed Humps and Speed Cushions

The design of these is to be in accord with Engineering Design Code – Traffic Calming.

They may also be used in advance of a flush pedestrian crossing where a RSP at the crossing is not permitted or practicable. They should be placed approximately 30 – 40 m from the crossing.

3.7 Road gradients at raised safety platforms

The profiles in Table PN02-1 can be used unmodified on any road with a straight gradient up to 10% or on a crest or sag curve with a K value that complies with Austroads Guide to Road Design Part 3-16-Ed3.4.

3.7.1 Crest curve

Where the vertical alignment is on a crest curve, the ramp profile must be as specified. The change of grade between the vehicle path adjoining the ramps and the tabletop must not exceed 5%. A change of grade within the length of the tabletop is acceptable, preferably near the middle of it (Figure 2). For a mid-block location, a crest curve should not exceed 4% difference in grade over the length of an RSP. This equates to a K value of 2 for the road without an RSP. A steeper crest should only be considered where the crest is part of an intersection side road.

Figure 2: Grade change over a summit

3.7.2 Crosswalk gradient

Where a table is used as a crossing point, the longitudinal grade of the tabletop also forms the crossfall of the crossing. The width of the crosswalk should have a crossfall of not more than 3%.

For a crossing close to a give-way or stop control, the grade of the tabletop either side of the crosswalk can change by up to 5% from the crosswalk grade (Figure 3). This should not be used at a mid-block crossing.

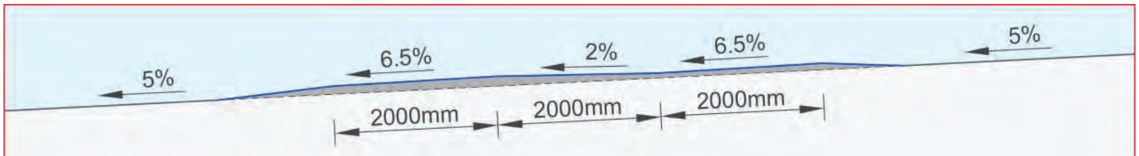

Figure 3: 2% grade crosswalk in 5% grade road

3.7.3 Cross-section gradient

The cross-sectional grade of the table at the top of a ramp must match as closely as practicable to the grade of the road surface at the toe of that ramp. Where necessary, the grade may change between each of the traffic lanes to achieve this, most commonly at the centreline of the road. Swedish table departure ramps may be extended, or their height reduced to grade smoothly into the adjoining road surface. See Table PN02-2 Note 3.

3.8 RSP Quality Control – Detailed Design and Construction

The importance of site monitoring cannot be understated, and it is a requirement that construction teams are to check the layout and monitoring the construction of the raised device by the contractor prior to forming and post construction. It is not acceptable to AT that a device be added to the fixed asset register that does not meet the tolerances within the Design of Raised Devices.

In many cases, existing road gradients and topographical constraints make the application of these profiles difficult to design and construct. The constructed shape of the RSP and of traffic lanes on approach and departure can significantly affect the vehicle ride experience crossing the RSP.

For buses, trucks, and emergency vehicles this can affect safety and stability or reduce the safe speed unacceptably. There is also a risk of vehicles grounding.

Detailed design (3.8.1) must identify the three-dimensional surface of the approaches and the footprint of the RSP sufficiently to design a compliant shape and provide sufficient setting-out information.

Construction methodology (3.8.2) must identify the critical dimensions and check them when setting out formwork and then confirming tolerances after construction.

3.8.1 Detailed design

The ramp profile must not exceed tolerance for each traffic lane tracking path, 1.5 m either side of the centre of the tracking path (that is, for each wheel path).

For installation on existing roads, the approaches and exits must be surveyed to produce an accurate ground model to develop the detailed design. If the longitudinal gradient or crossfalls change across the width of the road or along the road, sufficient sections should be surveyed to represent those changes. The best survey can be obtained using point cloud LIDAR photography, with a few key points surveyed for calibration of the model. The survey should extend from boundary to boundary and generally about 10 m either side of the extent of the RSP, sufficient to pick up kerbs, footpaths, vehicle crossings, road drainage and other constraining features.

Ramp profiles are given as length and height in mm relative to the mean gradient of the road surface over a length of 2.0 m adjoining the ramp. If the gradient of the approach road changes more than 2% within 10 m of the toe of the ramp, then clearance for Design and Check vehicles should be checked, as long vehicles could be adversely affected.

Approach ramp slope and height are relative to the gradient of the approach road. Departure slope and height gradient are relative to the tabletop gradient, except if the road on the departure rises relative to the tabletop, then the departure ramp slope is relative to the departure road gradient.

Where there is no median separation between opposing lanes, the approach lane ramp design should determine the overall ramp design. Departure lane ramp design may, if necessary, be less than the slope or height specified in Table PN02-1.

If it is not possible to make the ramp grade the same across the width of any one traffic lane, then the ramp should be lengthened so that the maximum grade change in Table PN02-2 is not exceeded within that lane.

Setting-out information should be indicated on the drawings that is sufficient to ensure that the designed profiles can be constructed as designed. This should include where gradients change and what gradients are required, both along and across traffic lanes and crosswalks. Key points are those that will be used to set formwork and check dimensions during construction. Detailed design should show the longitudinal and cross sections as in Figure 4.

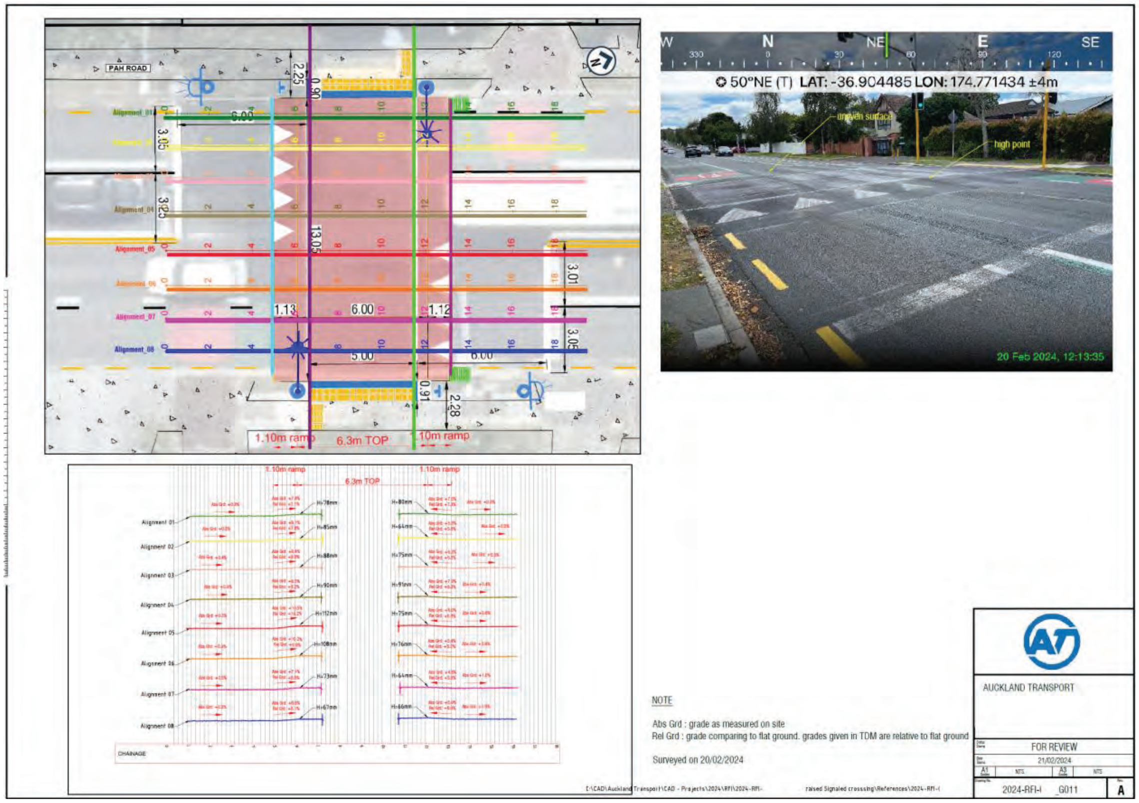

Figure 4 – Example design and post-construction survey drawing

3.8.2 Construction

Critical dimensions must be identified and checked when setting formwork and checking levels before and after construction. Most significant are the wheel track approach to give the height and length of approach ramps. Secondary significance is the height and length of departure ramps, which may be less severe than approach ramps, but not more severe. Dimensional tolerances should be ± 5 mm for height and ± 25 mm for length of approach ramps and standard table departure ramps. For Swedish departure ramps, tolerances are + 5 mm for height and - 50 mm for length. Lesser height and greater length than designed may be accepted, provided other design dimensions and gradients are achieved.

Formwork should be used to ensure design profiles are achieved. For in-situ concrete or asphalt, side form profiles should be used for screeding and compaction to maintain the correct profile.

3.8.3 As-built information

As-built information that contains the ramp gradients, height and gradient of the road must be provided to Transport Design & Standard as soon as practicable for verification that the device has been constructed in accordance with this Standard and the approved drawings.

3.8.4 Remediation

If it is proven that the device was not constructed in accordance with the approved design, then it is the responsibility of the Construction Delivery teams to rectify as soon as possible with the contractor and ensure that the constructed device is rectified to the satisfaction of the Chief Engineer.

4. Pavement design

4.1 Soil types

Dynamic loads caused by heavy vehicles encountering RSPs may propagate through soft soils, especially with high groundwater tables, to cause vibration within buildings. RSPs may not be used in areas with soft soils, unless pavement strength has been proven and only with the approval of AT Pavement Specialist through a Departure from Standard. Areas in the former Papakura district are mapped in Appendix 2.

4.2 Pavement design requirements

RSPs on arterial and collector roads and local roads with bus routes are to be designed to suit to the traffic load classification and loading and existing pavement performance with deflection including remaining life. We have developed a preliminary draft design based on the deflection test following a validation with Circly to the FWD back analysis to the pavement modelling using ELMOD5 software.

For other local roads including school bus routes:

- The carriageway condition where the RSP is proposed should be in a condition with no major defect such as rutting and cracking but can be aged and due for surfacing.
- Mill out 50mm of the existing pavement surface to at least 2m on both sides of proposed RSP extent and provide membrane seal or heavy tack and grits for water proofing.
- Overlay with multi-layer of AC10 – from 35mm (minimum) to 60mm (maximum thickness). DG10 dense mix is unsuitable due to its higher percent of fine contents and bitumen. However, we can remove AC20 basecourse requirements.
  Asphalt concrete to be made of PG64V performing grade binder to resist the rutting and deformation due to braking / acceleration and slow traffic movements.
- The pavement / surfacing life may be short life – say 10-12 years but economically can be a benefit.

If high-friction surfacing is proposed as a supporting measure, the existing surface must be in good condition, free of surface cracking and rutting to avoid delamination of the pavement surface from occurring.

Further advice should be sought from AT Design & Standards for recommended pavement design and draft construction Standard Engineering Drawings.

4.3 Materials and details

Each RSP Type is to be detailed as shown in the corresponding Standard Engineering Drawings. RSPs should be constructed in pre-cast or in-situ concrete. Pre-cast concrete should be used for retro-fitting existing roads where temporary traffic management for allowing in-situ concrete to gain strength would cause significant congestion or unacceptable diversions.

Structural asphalt may be used where pre-cast concrete is not practicable. Pavement design advice should be sought from AT Transport Design & Standards.

Acceptable materials are:

- Asphalt concrete as per the requirements contained in this practice note except Type 4S and 4 which are not suitable for forming in asphalt.
- Concrete 30MPa or higher with reinforcement or in combination with non-steel fibres
- Coloured concrete with 40MPa
- Products made from Rubber or plastic – by approval of the Transport Design & Standards Manager only.

Any other products not listed above will require the submission of a Departure from Standard to the Transport Design & Standards Manager for evaluation against the standards.

5. Signs and Markings

Raised devices used in isolation must be accompanied by advance warning signs and red band with SLOW marking. These should be placed together with pedestrian crossing advance warning signs and diamond markings for pedestrian priority crossings, or just before them where raised devices precede a flush crossing. This is in addition to the signs and markings normally required at raised devices.

Advisory speed plates should display a value 15 km/h less than the posted speed limit and need not be used for a 30 km/h speed limit.

6. Stormwater management

RSPs can affect surface water flow in existing and new roads. The effects of proposed RSPs should be investigated to ensure that design standards in AT-TDM – Road Drainage and in particular Tables 1, 2 & 3 can be met.

Auckland Transport’s Climate Change Adaptation Policy 2022 is required to be complied with; this is mandatory.

Road drainage and road surface flooding in coastal marine area should be designed for climate change and effects from sea level rise and storm surge.

Topographical survey of existing road including channel grades and crossfalls is required to determine a suitable drainage solution.

The basis of design should adhere to the Auckland Council Stormwater Code of Practice version 3.0 or most recent revision and AT-TDM – Road Drainage. The stormwater runoff flows should be calculated using Auckland Council TP108 method. Rainfall depths are obtained from NIWA HIRDs V4, using climate adjustment of 2.1°C for the Auckland region in line with AC SW COP V3.0. A sensitivity analysis for CC adjustment of 3.8°C is also required to ensure future proofing of the road improvement project.

Capture and conveyance of Service Level surface water (generally 10%AEP run-off) must be provided by an approved method. Flow through the site should be designed using 10%AEP with climate adjustment of 2.1°C. This must include upstream catchment flow, less flow captured by upstream inlet devices. Inlet capture should be by raingarden, combined kerb drainage blocks or catchpit, except that bypass flow may be permitted where connection to the drainage network or other discharge is not feasible. Bypass flow should be selected in this order:

i) combined kerb drainage blocks where feasible;
ii) grated channel drain;
iii) open channel with non-slip plated footpath cover.

Plated covers may not be used adjacent to traffic lanes or where wheel loading may occur.

Effects on Overland Flow Paths for Major Events (generally 1%AEP run-off) must be checked to ensure increased discharge to private properties is avoided and the road remains safe and serviceable to the standards in AT TDM – Road Drainage. Major Event flow should be designed using 1%AEP with climate adjustment of 3.8°C. A full hydraulic/hydrological flood assessment of the road corridor and adjacent properties for 10% and 1%AEP with CC should be carried out for the vertical features affecting surface flow. Where existing OLFP and flood plain exists within road corridor, the design should demonstrate that pre- and post-development effects are contained within the road reserve or do not increase flood risk to property outside the road reserve.

At any proposed site where these road drainage standards cannot be met, alternative safety measures should be considered instead of an RSP.

7. Definitions

Term	Definition
Raised device	A speed hump, speed cushion or raised safety platform constructed to manage vehicle speeds either as an isolated device, at an intersection or as part of a sequence of traffic calming devices
Raised Safety Platform (RSP)	Either a speed table or a Swedish table as defined below. A raised safety platform is a class of road hump as controlled by the Land Transport Rule Traffic Control Devices 2004.
Swedish table	A speed table with a departure ramp that allows a smooth transition from a tabletop to the adjoining road.

8. Supporting Information

Supporting documents	• Auckland Transport – Transport Design Manual • Auckland Council Code of Practice for Land Development and Subdivision Chapter 3: Transport
Related documents	• New Zealand's first raised safety platforms | Waka Kotahi NZ Transport Agency (nzta.govt.nz) • Case study - raised safety platforms (nzta.govt.nz) • Effectiveness and Implementation of Raised Safety Platforms (queenslandwalks.org.au) Austroads AP-R642-20 • Road Design Note 03-07 - Raised Safety Platforms - VicRoads • Austroads Guide to Road Design Part 3-16-Ed3.4

9. Approval

Practice Note Contact	Andy Irwin Principal Specialist Transport Design	DocuSigned by: [signature] E0C59C1A0AD541D...	24 June 2024
Endorsed by:	Chris Beasley Transport Design and Standards Manager	DocuSigned by: [signature] 646D1613508748A...	24 June 2024
Endorsed by:	Teresa Burnett GM Transport Safety	DocuSigned by: Teresa Burnett C92D7D83E17D4CD...	26 June 2024
Endorsed by:	Andrew Allen GM Road Network Operations	DocuSigned by: [signature] 7918D0411C0A4F2...	01 July 2024
Authorised by	Murray Burt Acting Chief Engineer	DocuSigned by: Murray Burt E8F8F833D8914E2...	01 July 2024
Effective date	01 July 2024		

AT reserves the right to review, amend or add to this Practice Note at any time upon reasonable notice to users of the Transport Design Manual and related documents.

Appendix 1

Network risk assessment

Investing heavily in a blackspot programme is unlikely to achieve a step change in road network safety, simply because these sites treated represent a very small proportion of the fatal and serious injuries at a network level.

The relative rarity of fatal and to lesser extent serious crashes occurring at the same location is evident in an analysis of crash data in Auckland. Analysis of crashes at intersections showed that 79% of fatal and serious crashes occurred at locations with no previous fatal and serious crashes in the previous five years and 64% occurred at locations with two or fewer injury cashes in the same period.

Furthermore, the treatment of crash cluster sites and routes have commonly been identified and delivered through Crash Reduction Studies (CRS), Minor Improvement Programme (MIP) or Regional Safety Programme (RSP).

Whilst this approach has served New Zealand well in the past, the ability to achieve safety benefits has become increasingly difficult and because it is reactive and is inconsistent with the safe system philosophy on which the New Zealand Road Safety strategies are based.

1 Urban KiwiRap: Risk Assessment Process

Three risk assessment processes form the basis of Urban KiwiRAP; for intersections, for corridors and for active road users.

1.1 Intersection Risk Assessment Process

The Urban KiwiRAP intersection risk assessment process directly adopts the process described in the New Zealand Transport Agency's High-Risk Intersections Guide (July 2013). The 'High-Risk Intersections Guide' provides practitioners with best practice guidance to identify, target and address key road safety issues at high-risk intersections. The approach aligns with the Safer Journeys focus on reducing deaths and serious injuries.

The new technique calculates an estimated number of Death and Serious injury (DSi) casualties based on relationships between the speed environment, intersection form and control type and crash movement type factors.

The DSi casualty equivalents method acknowledges that actual fatal and serious crash data alone is not a good indicator of the underlying risk of a high-severity crash at many intersections.

This guide also introduces a new technique for identifying priority high-risk intersections that have a disproportionally higher than average risk of future deaths or serious injuries if recent crash trends continue.

Level of Safety Service (LOSS) is also calculated for comparing the safety performance of the intersection with similar intersections having the same intersection control, form, speed limits and configurations.

The current intersection assessment is ranked based on Collective Risk (Collective DSi casualty equivalents) and followed by Personal Risks. This is to ensure the prioritisation is forward-looking even though it is using historic information.

While this risk assessment process is being adopted to form the majority of the investigation programme, crash data are also analysed to ensure that all intersections which have actual DSi and/or significant increase in high-risk crashes (ie crashes that are likely to result in death or serious injury) have been examined. These might be identified through the routine network risk screening process, requests from the communities as well as fatal and serious crashes investigations.

1.2 Corridor Risk Assessment Process

A key innovation has been the development of a risk assessment process for urban corridors as these are likely to provide greater casualty reduction when compared to targeting cluster sites.

Corridors which are performing poorly and have a high number of DSi's need to be addressed. Also, some corridors are performing above average, but with the crash types occurring along the corridor it is anticipated that the number of DSi's may increase over time. Therefore, the corridor risk assessment has been ranked using actual DSi and DSi casualty equivalents as this method will target corridors with existing safety issues and those where safety is likely decline.

Due to the lengths of corridors, the risk has been calculated in two parts: an intersection component and a mid-block component. This is to identify if intersections within the corridor are causing the risk rather than mid-block. If the majority of crashes on a corridor occur at intersections, then the intersections only may be investigated.

As with the intersection assessment, the Level of Safety Service (LOSS) has also been calculated for comparing the safety performance of the corridor with corridors of a similar nature.

1.3 Active Road Use Risk Assessment Process

With a growing desire to understand the risk that is posed to Active Road Users (ARU) within transport networks, separate intersection and corridor risk analyses have been completed for crashes involving ARU. This includes crashes that involve bicycles, skateboards, inline skaters, pedestrians, wheelchairs, power chairs or mobility scooters. There is a different set of risk assessment and banding for ARU risks. This reflects the physical limits that human bodies have physical for tolerating crash forces before death or serious injury occurs.

The volume of ARU across many parts of the transport network is unknown, therefore, only Collective Risk values are calculated.

Appendix 2

Papakura soil types and CBR estimates