
Testing of Updated Standard Safety Interventions Toolkit

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1. Introduction

Waka Kotahi (New Zealand Transport Agency) developed a series of Standard Safety Interventions (SSIs) which were published in the draft SSI Toolkit in February 2019. SSIs are road safety treatments which have:

- a) a proven record of reducing deaths and serious injuries when implemented, and
- b) been economically assessed to ensure value for money.

The intention of the SSI Toolkit is to provide a more streamlined funding pathway for road controlling authorities to implement safety projects where a set of criteria are met.

In late 2020, Waka Kotahi elected to formally update the SSI toolkit in response to:

- Feedback from Waka Kotahi staff and Road Controlling Authorities,
- Lessons learnt from SSI applications which have been submitted since the introduction of the Toolkit,
- The desire to investigate whether further safety interventions could become SSIs, and
- Better understanding of design and construction costs based on recent installations of various safety treatments.

To assist with updating the Toolkit, Waka Kotahi established a working group comprising Waka Kotahi staff and representatives from several Road Controlling Authorities. Following the first working group meeting, Abley Limited (Abley) were tasked with reviewing the current SSI selection criteria and costs with the intention of understanding and confirming the value for money for each SSI.

2. Methodology

Datasets

The following datasets were used to test each SSI:

- Corridor dataset as per Mega Maps Edition II,
- Intersection dataset as per ‘Development of the Road to Zero Infrastructure & Speed Management Strategic Programme’ issued in December 2020,

- Out of Context Curves 2019 dataset published on Road Safety Risk¹. The curve dataset includes information on the degree of curvature, estimated operating speed and crash statistics at an individual curve level. More information on the curve dataset is detailed in the High Risk Curves Guide (2017).
- 2014-18 injury crash data converted to DSI Equivalents as per 'Development of Revised Severity Indices' issued in June 2019, and
- One Network Framework (ONF) classification as per 'Implementing the Movement and Place Framework on the New Zealand Network' issued in September 2020.

Further Notes

The 'Upgrade of signalised intersections (right turn filter bans)' and 'skid resistance at high-risk intersections' SSIs were not tested due to a lack of recent data.

Costs provided by Road Controlling Authorities have been used to help scope the new costings tested where provided.

The corridor dataset (Mega Maps Edition II) includes injury crashes that occurred at intersections along corridors. It is important to note that the implementation of a corridor SSI may not directly address intersection risk.

Applying an intersection SSI within a corridor put forward for a corridor SSI may result in the overestimation of DSI reduction benefits and should therefore be considered carefully when SSI applications are created and processed.

Economic Assessment

Death and Serious Injury (DSi) social cost calculations

For rural corridors (current posted speed limit ≥ 80 km/h), a cost per DSI of \$1,400,000 is utilised. For urban corridors (posted speed limit ≤ 70 km/h), a cost per DSI of \$1,100,000 is utilised. These values are based on analysis which considers the ratio of fatal to serious injuries and the Ministry of Transport's latest estimates² for the social cost of road crashes and injuries. **Table 2.1** shows these calculations.

Table 2.1 Social cost savings per DSI

	Fatalities (2015-19)	Severe Injuries (2015-19)	Serious Injuries per DSI Injury	Fatal Injuries per DSI Injury	MOT cost per reported Serious/Fatal injury as at June 2019	Weighted Cost per DSI	Assumed Cost per DSI
Rural	1,300	6,566	0.83	0.17	\$850,000 / serious injury \$4,562,000 / fatality	\$1,463,000	\$1,400,000
Urban	452	6,117	0.93	0.07		\$1,105,000	\$1,100,000

Travel Time Cost Benefits calculations

The value of time has been calculated as \$22.72 per hour per vehicle in a rural environment, and \$16.27^[3] per hour per vehicle in an urban environment. These 2002 costs have been updated to the present day using an economic update factor of 1.45^[4].

¹ <https://roadsafetyrisk.co.nz/maps/out-of-context-curves>

² <https://www.transport.govt.nz/assets/Uploads/Report/SocialCostof-RoadCrashesandInjuries2019.pdf>

³ NZTA EEM Table A4.3 Composite values of travel time in \$/h (all occupants and vehicle types combined - July 2002)

⁴ <https://www.nzta.govt.nz/assets/resources/economic-evaluation-manual/economic-evaluation-manual/docs/eem-update-factors.pdf>

Vehicle Operating Cost Benefits Calculations

- The VOC benefit has been calculated based on the speed before/after SAAS or SSI.

For intersection interventions, travel time/ vehicle operating costs were adjusted using the factors shown in **Table 2.2**. These factors were extracted from the 'Road to Zero Infrastructure and Speed Management Programme - Programme Level Benefit Cost Analysis – Technical Addendum' dated February 2021.

Table 2.2 Travel Time and Vehicle Operating Cost Penalties

Scenario	Travel time change in seconds (positive = increase)		Vehicle operating cost in \$ (positive = increase)	
	Current as base speed	Safe Speed as base speed	Current as base speed	Safe Speed as base speed
Penalty on major roads for rural roundabout (>=70kph)	22	2	0.015	0.004
Penalty on major roads for urban roundabout (<=60kph)	10	1	0.005	0.001
Penalty on minor and major approaches for raised platforms (including raised midblock pedestrian crossings)	5	0	0.004	0
Penalty on major approaches for intersection zones (e.g., RIAWS)	9	-1	0.008	-0.003
Penalty on minor and major approaches for new signals	20	11	0.005	0.001

Two high-level benefit-cost ratios are estimated for each SSI:

- Base Case BCR**

This BCR estimates the costs/benefits of changing from the current state to the implementation of the SSI being considered. For example, an intersection may have a current posted speed limit of 80km/h and a Safe System speed of 50km/h. In this case, the 'do minimum' safety intervention BCR would compare the benefits/costs of changing to an upgraded intersection form (as per the SSI being considered) from an 80km/h speed limit.

- Safety BCR**

This BCR estimates the costs/benefits of changing to the implementation of the SSI being considered from a hypothetical state whereby the Safe and Appropriate Speed (if considering a corridor) or Safe System speed (if considering an intersection) had already been applied. For example, an intersection may have a current posted speed limit of 80km/h and a Safe System speed of 50km/h. In this case, the Safety BCR would compare the benefits/costs of changing to an upgraded intersection form (as per the SSI being considered) from a 50km/h speed limit.

For the 'Median and Roadside Barrier' and 'Median Barrier' SSIs, it is assumed that the corridor will be 'engineered up' to support the existing speed limit. Consequently, travel time and vehicle operating cost changes within the Safety BCR will be calculated based on changing from the SAAS to the existing speed limit. For example, a corridor may have a current posted speed limit of 100km/h, and a SAAS of 80km/h. In this case, the Safety BCR will include travel time savings and vehicle operating cost increases resulting from an increased speed limit (80km/h to 100km/h) For all other corridor SSIs, the speed limit after implementation is assumed to be the same as the SAAS, so no travel time or vehicle operating cost changes and assumed within the Safety BCR.

Allowance for Whole of Life (WOL)/ maintenance costs were made for each intervention (ranging from 20%-30% for most SSIs).

The general BCR calculation formula is shown below.

$$\text{Benefit Cost Ratio} = \frac{(DSi Savings + TTC Savings + VOC Savings)}{SSI Cost (\$) * (1 + Maintenance Cost\%) * Corridor length (km)} * PV discount factor (15.49)$$

Summary results are presented for each intervention in the following Sections. Sections 3 to 15 present revised testing results for current SSIs. Sections 16 to 18 present testing for several SSIs which are under consideration for inclusion in the Toolkit.

3. Continuous 3-Barrier (Median and Roadside Barrier)

Assumptions

- The following road stereotype will not be eligible for median barrier installation: Divided - non-traversable OR One way.
- Allowance for WOL and maintenance is 30%.

Current SSI Toolkit Criteria

Criteria	Cost per KM (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> AADT 10,000 or greater Collective Risk Medium-High or greater or predictive Collective Risk Medium-High or greater Speed limit 80km/h or higher ONRC classification - all 	\$2M, \$3M, \$4M	75%

Tested Criteria

- Increased costs

Revised Criteria & Results

After testing various criteria combinations of costs and selection criteria, it is recommended that the ONRC criteria is removed, the "High" cost value increased to \$5 million and the DSi reduction is maintained at 75%. The revised criteria and a summary of results is shown below.

Criteria	Cost per KM (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> AADT 10,000 or greater Collective Risk is Medium-High or higher or predictive Collective Risk is Medium-High or higher Speed limit 80km/h or higher 	\$2M, \$3M, \$5M	75%

	Length (km)	Predicted DSi Saved (per annum)	Monetised DSi Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	572	105	\$147 million	\$-	\$-
Safety BCR	572	84	\$117 million	\$92 million	-\$10 million

Cost Threshold	Low	Medium	High
Cost per km	\$2 million	\$3 million	\$5 million
Base Case BCR	1.5	1.0	0.6
Safety BCR	2.1	1.4	0.8

4. Median Barrier

Assumptions

- The following road stereotype will not be eligible for median barrier installation: Divided - non-traversable, One way, unsealed.
- Allowance for WOL and maintenance is 30%.

Current SSI Toolkit Criteria

Criteria	Cost per KM (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> AADT 6000 or greater Collective Risk Medium-High or greater or predictive Collective Risk Medium-High or greater Speed limit 80km/h or higher ONRC classification - all 	\$1M, \$2M, \$3M	65%

Tested Criteria

- Lower AADT threshold of 3000 or greater
- Increased cost

Revised Criteria & Results

After testing various criteria combinations of costs and selection criteria, it is recommended that the ONRC criteria is removed, the "High" cost value is increased to \$4 million and the DSi reduction is maintained at 65%. The revised criteria and a summary of results is shown below.

Criteria	Cost per KM (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> AADT 6000 or greater Collective Risk is Medium-High or greater or predictive Collective Risk Medium-High or greater Speed limit 80km/h or higher 	\$1M, \$2M, \$4M	65%

	Length (km)	Predicted DSi Saved (per annum)	Monetised DSi Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	1334	182	\$255 million	\$-	\$-
Safety BCR	1334	140	\$196 million	\$176 million	-\$22 million

Threshold	Low	Medium	High
Cost per km	\$1 million	\$2 million	\$4 million
Base Case BCR	2.3	1.1	0.6
Safety BCR	3.1	1.6	0.8

5. Wide Centreline

Assumptions

- The following road stereotype will not be eligible for median barrier installation; Divided - non-traversable or One way, Divided traversable or unsealed.
- Wide centreline will not provide TTC/VOC benefits as explained in Section 2.
- Allowance for WOL and maintenance is 25%.

Current SSI Toolkit Criteria

Criteria	Cost per KM (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> AADT 3000 or greater Collective Risk Medium-High or greater or predictive Collective Risk Medium-High or greater Speed limit 80km/h or higher All ONRC 	\$250K, \$700K, \$1.7M	35%

Tested Criteria

- 60km/h above speed limit
- Rural corridors only
- Increased cost

Revised Criteria & Results

It is recommended that the ONRC criteria is removed, and the "High" cost value decreased to \$1.5 million. The revised criteria and a summary of results is shown below.

Criteria	Cost per KM (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> AADT 3000 or greater Collective Risk Medium-High or greater or predictive Collective Risk Medium-High or greater Speed limit 80km/h or higher 	\$250K, \$700K, \$1.5M	35%

	Length (km)	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	1984	140	\$195 million	\$-	\$-
Safety BCR	1984	108	\$151 million	\$-	\$-

Threshold	Low	Medium	High
Cost per km	\$250,000	\$700,000	\$1.5 million
Base Case BCR	4.9	1.7	0.8
Safety BCR	3.8	1.3	0.6

6. Roadside Safety Barrier at High-Risk Locations

Assumptions

- Allowance for WOL and maintenance is 25%.
- The cost per km figure assumes that 250m of roadside barrier will be installed per km of corridor as exemplified in **Figure 6.1**.
- Roadside barrier reduces DSIs by 30% per km of corridor assuming 250m of roadside barrier will be installed per km of corridor.

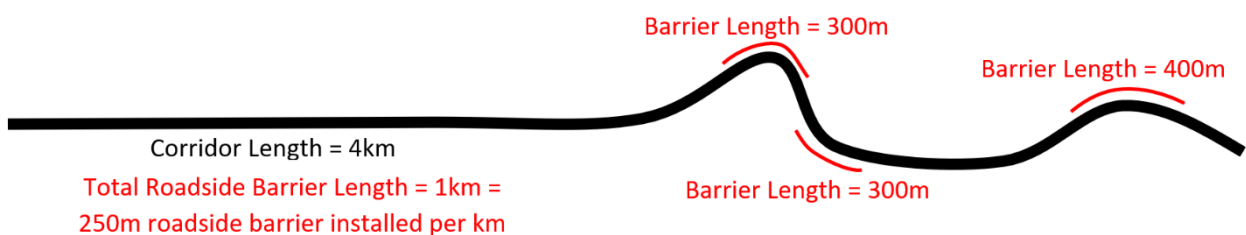


Figure 6.1 Treatment barrier length

Current SSI Toolkit Criteria

Criteria	Cost per KM (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> • AADT 1000 or greater • Collective Risk Medium-High or greater or predictive Collective Risk Medium-High or greater • Speed limit 70km/h or higher • ONRC classification - all 	\$100K, \$250K, \$400K	30%

Tested Criteria

- 60km/h and above speed limit
- Collective Risk Medium or greater or predictive Collective Risk Medium or greater
- Increased cost (up to \$1M)
- Land use filter

Revised Criteria & Results

It is recommended that the following changes are made to the selection criteria:

- Speed limit changed to include corridors with a posted speed limit as low as 60km/h,
- Collective Risk threshold changed to include corridors with a collective risk of medium or greater or predictive Collective Risk Medium or greater,
- Commercial Big Box/Industrial, Commercial Strip Shopping, Neighbourhood Centre and Urban Residential land uses (i.e. corridors with an urban land use) are excluded,
- Remove ONRC reference, and

- Medium and high cost values are increased to \$300,000 and \$600,000 respectively.

In addition, it is also recommended that clarification be made within the text to define the percentage of the corridor which would be expected to be covered by side barrier. The revised criteria is shown below.

Criteria	Cost per KM (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> • AADT 1000 or greater • Collective Risk Medium or greater or predictive Collective Risk Medium or greater • Not Commercial Big Box/Industrial, Commercial Strip Shopping and Urban Residential land uses • Speed limit 60km/h or higher 	\$100K, \$300K, \$600K	30%

A summary of results is shown below.

	Length (km)	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	7187	296	\$414 million	\$-	\$-
Safety BCR	7187	235	\$329 million	\$-	\$-

Threshold	Low	Medium	High
Cost per km	\$100,000	\$300,000	\$600,000
Base Case BCR	7.1	2.4	1.2
Safety BCR	5.7	1.9	0.9

8. Shoulder Widening at High-Risk Curves

Assumptions

- Allowance for WOL and maintenance is 25%.
- The cost figure assumes 250m of pavement widening of 1.5m on one side of the road per site.
- Shoulder widening reduces DSIs by 25% at high-risk curves.

Current SSI Toolkit Criteria

Criteria	Cost per site (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> • AADT 1000 or greater • Actual/Predicted Collective Risk is High • Speed limit 70km/h and above • All ONRC 	\$200K, \$325K, \$450K	10%

Tested Criteria

- Use curve dataset
- 60km/h or above speed limit
- Increased cost (up to \$0.5M)
- Greater DSI reduction

Revised Criteria & Results

The current SSI Toolkit allows this SSI to be considered at any eligible high risk location, however for the purposes of testing, only high-risk curves were tested utilising the high-risk curves dataset described in Section 2.

The proposed criteria and summary of results is shown below.

Criteria	Cost per KM (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> • Is a high-risk or out of context curve • AADT 1000 or greater • Corridor Collective Risk is Medium or higher or predictive Collective Risk Medium or higher. • Speed limit 60km/h or higher 	\$200K, \$325K, \$450K	25% DSI reduction at the treated curve

	Number of Curves	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	5135	43	\$60 million	\$-	\$-
Safety BCR	5135	41	\$57 million	\$-	\$-

Threshold	Low	Medium	High
Cost per site (250m section)	\$200,000	\$325,000	\$450,000
Base Case BCR	0.7	0.4	0.3

Safety BCR	0.7	0.4	0.3
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9. Audio Tactile Pavement (ATP) Marking

Assumptions

- DSI reduction of 20% (derived from 13.33% DSI reduction for Run of road crashes and 4% DSI reduction for Head on crashes rounded up).
- Allowance for WOL and maintenance is 120% due to regular replacement.

Current SSI Toolkit Criteria

Criteria	Cost per KM (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> • AADT 1000 or greater • Speed limit 80km/h and above • ONRC classification - all except access 	\$10K, \$15K, \$50K	20%

Tested Criteria

- 60km/h above speed limit
- Increased cost (up to \$100,000)
- Apply ONF filter
- 20% DSI reduction

Revised Criteria & Results

It is recommended that the ONRC filter is removed, and the current cost values are maintained. The revised criteria and a summary of results is shown below.

Criteria	Cost per KM (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> • AADT 1000 or greater • Speed limit 80km/h or higher 	\$10K, \$15K, \$50K	20%

	Length (km)	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	12246	219	\$307 million	\$-	\$-
Safety BCR	12246	172	\$241 million	\$-	\$-

Threshold	Low	Medium	High
Cost per km	\$10,000	\$15,000	\$50,000
Base Case BCR	17.7	11.8	3.5
Safety BCR	13.8	9.2	2.8

10. Mid-block Raised Pedestrian Crossing

Assumptions

- Allowance for WOL and maintenance is 25%.
- One raised pedestrian crossing every 400m or 2.5 crossings per KM (informed by AT roads and streets, “formal” provision).
- Greater DSI reduction at crossing due to the facility being attractive to vulnerable road user groups.

Current SSI Toolkit Criteria

Criteria	Cost per site (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> • Pedestrian crossing • Speed limit 60km/h and below • Land use commercial strip shopping, mixed use arterials, schools • ONRC classification - all 	\$40K, \$100K, \$300K	40%

Tested Criteria

- 60km/h above speed limit
- Increased cost (up to \$1 million)
- Apply ONF filter
- 40% DSI reduction

Revised Criteria & Results

It is recommended that the land use and ONRC filters be removed and replaced with an ONF filter which includes only Urban Connectors, Activity Streets and Main Streets. These have been identified as the most suitable corridors for a mid-block crossing SSI.

It is also recommended that the ‘Low’, ‘Medium’ and ‘High’ cost thresholds be increased to \$100,000, \$250,000, and \$750,000 respectively. The revised criteria and a summary of results is shown below.

Criteria	Cost per site (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> • Speed limit 60km/h and below • ONF - Urban Connectors, Activity Streets and Main Streets only 	\$100K, \$250K, \$750K	40%

	Length (km)	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	4174	344	\$378 million	-\$454 million	-\$55 million
Safety BCR	4174	342	\$377 million	\$-	\$-

Threshold	Low	Medium	High
Cost per km	\$100,000	\$250,000	\$750,000
Base Case BCR	-1.6	-0.6	-0.2

Threshold	Low	Medium	High
Safety BCR	4.5	1.8	0.6

11. Signage & Markings

Assumptions

- Allowance for WOL and maintenance is 30%.

Current SSI Toolkit Criteria

Criteria	Cost per KM	DSi Reduction
<ul style="list-style-type: none"> • AADT 1000 or greater • Speed limit 80km/h and above • All ONRC except access 	<\$100k	5%

Tested Criteria

- 60km/h above speed limit
- Increased cost (up to \$100,000)
- 10% DSI reduction based on recent data.

Results

It is recommended that the speed limit criterion is revised to include roads with a posted speed limit as low as 60km/h and that the ONRC filter is removed and that 'Low', 'Medium' and 'High' cost thresholds are kept less than \$100,000. The revised criteria and a summary of results is shown below.

Criteria	Cost per KM (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> • AADT 1000 or greater • Speed limit 60km/h or higher 	\$10K, \$20K, \$100K	10%

	Length (km)	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	13539	126	\$176 million	\$-	\$-
Safety BCR	13539	101	\$141 million	\$-	\$-

Threshold	Low	Medium	High
Cost per km	\$10,000	\$20,000	\$100,000
Base Case BCR	15.5	7.8	1.6
Safety BCR	12.4	6.2	1.2

12. Roundabout

This SSI combines urban and rural roundabout SSIs into one as a new SSI.

Assumptions

- Allowance for WOL and maintenance is 10%.
- The DSI reduction has been set to 75% based on Waka Kotahi Case study findings^[5].
- This SSI will have travel time penalties as indicated in **Table 2.**

Current SSI Toolkit Criteria

Criteria	Cost per site (L/M/H)	DSi Reduction
Rural <ul style="list-style-type: none"> • Intersection Collective Risk Medium-High or greater • 3 or more G,H,J,K,L,N crash types • Speed limit 80km/h and above 	\$2M, \$3M, \$5M	60%
Urban <ul style="list-style-type: none"> • Intersection Collective Risk Medium-High or greater • 3 or more H,J,K,L,N injury crash types • Speed limit 70km/h and below 	\$500K, \$1.5M, \$2M	60%

Tested Criteria

- Combined rural/ urban roundabout criteria.
- Increased cost (up to \$6M)
- Test if crash filter (>3 injury crashes) is required.
- 75% DSI reduction based on Waka Kotahi Case Study[†]

Results

It is recommended that:

- The current urban and rural roundabout SSIs are combined by removing the speed limit criteria.
- The crash filter be revised to include intersections with 3 or more injury crashes of any type in 10 years.
- Cost thresholds be set at \$500,000, \$2 million, and \$6 million respectively.

The revised criteria and a summary of results is shown below.

Criteria	Cost per site (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> • Intersection Collective Risk Medium-High or greater • 3 or more injury crashes in 10 years 	\$0.5M, \$2M, \$6M	75%

	Number of Sites	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	206	50	\$70 million	-\$105 million	-\$8 million

[5] <https://www.nzta.govt.nz/assets/Safety/docs/road-to-zero/case-study-rural-roundabouts.pdf>

	Number of Sites	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Safety BCR	206	50	\$70 million	-\$10 million	-\$2 million

Threshold	Low	Medium	High
Cost per site	\$500,000	\$2 million	\$6 million
Base Case BCR	Less than 0	Less than 0	Less than 0
Safety BCR	5.7	1.4	0.5

13. Raised Safety Platforms (at existing signals/roundabouts)

Assumptions

- Allowance for WOL and maintenance is 10%.

Current SSI Toolkit Criteria

Criteria	Cost per site (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> • Intersection Collective Risk Medium-High or greater • 3 or more injury crashes • Speed limit 60km/h and below 	\$150K, \$200K, \$300K	40%

Tested Criteria

- Increased cost (up to \$2M)
- 40% DSI reduction

Results

It is recommended that the current criteria are maintained but threshold costs be increased to \$300,000, \$750,000, and \$2 million respectively. The revised criteria and a summary of results is shown below.

Criteria	Cost per site (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> • Intersection Collective Risk Medium-High or greater • 3 or more injury crashes in 10 years • Speed limit 60km/h and below 	\$300K, \$750K, \$2M	40%

	Number of Sites	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	254	31.3	\$34 million	-\$102 million	-\$12 million
Safety BCR	254	31.3	\$34 million	\$-	\$-

Threshold	Low	Medium	High
Cost per site	\$300,000	\$750,000	\$2 million
Base Case BCR	Less than 0	Less than 0	Less than 0
Safety BCR	6.4	2.5	1.0

14. Signalised Intersection with Raised Safety Platforms (from an uncontrolled/ priority controlled intersection)

This SSI combines Raised Safety Platforms and Signalised Intersections SSIs together as a new SSI.

Assumptions

- The combined DSI reduction has been set to 55%.
- Allowance for WOL and maintenance is 10%.
- This SSI will have travel time penalties associated with both treatments as indicated in [Table 2.2](#).

Current SSI Toolkit Criteria

Criteria	Cost per site (L/M/H)	DSi Reduction
New Signalised Intersection <ul style="list-style-type: none"> • Intersection Collective Risk Medium-High or greater • Predictive intersection Collective Risk Medium-High or greater • 3 or more G,H,J,K,L,N injury crash types • Speed limit between 40km/h and 80km/h 	\$250K, \$300K, \$500K	25%
Raised Safety Platforms <ul style="list-style-type: none"> • Intersection Collective Risk Medium-High or greater • 3 or more injury crashes • Speed limit 60km/h and below 	\$150K, \$200K, \$300K	40%

Tested Criteria

- Cost up to \$2M based on LGA information.
- Increased DSi reduction expected by combining treatments (55% DSI reduction)
- Speed limit between 30km/h and 80km/h.

Criteria & Results -TTC and VOC included

It is recommended that the speed limit criterion is modified to include roads with posted speed limits as low as 30km/h. It is also recommended that the 'Low', 'Medium' and 'High'. threshold costs be increased to \$500,000, \$1 million, and \$2 million respectively. The revised criteria and a summary of results is shown below..

Criteria	Cost per site (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> • Intersection Collective Risk Medium-High or greater • 3 or more injury crashes in 10 years • Speed limit 30km/h to 80km/h 	\$0.5M, \$1M, \$2M	55%

	Number of Sites	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	113	20	\$22 million	-\$32 million	-\$151 million

Safety BCR	113	20	\$22 million	-\$1 million	-\$98 million
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Threshold	Low	Medium	High
Cost per site	\$500,000	\$1 million	\$2 million
Base Case BCR	Less than 0	Less than 0	Less than 0
Safety BCR	Less than 0	Less than 0	Less than 0

Results - TTC and VOC excluded

The negative BCR in the above scenario suggests that the reduction of speed associated with this SSI treatment results into TTC and VOC disbenefits. Therefore, in this scenario a safety only BCR is calculated. This BCR can be adopted should changes in travel time and vehicle operating costs at intersections be ignored for the purposes of assessing road safety improvements.

	Number of Sites	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	113	20	\$22 million		
Safety BCR	113	20	\$22 million		

Threshold	Low	Medium	High
Cost per site	\$500,000	\$1 million	\$2 million
Base Case BCR	5.6	2.8	1.4
Safety BCR	5.6	2.8	1.4

15. Intersection Speed Zone (RIAWS)

Assumptions

- Allowance for WOL and maintenance is 10%.
- This SSI will have travel time penalties as indicated in [Table 2.2](#).

Current SSI Toolkit Criteria

Criteria	Cost per site (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> • T or X type intersection • 3 or more H,J,K,L injury crash types • Speed limit 80km/h and above • Medium-High or greater intersection risk 	\$300K	35%

Tested Criteria

- Increased cost (up to \$500,000)
- Speed limit 60km/h or higher
- Proactive criteria (i.e., such that a RIAWS could be applied proactively where no injury crashes have yet occurred)
- Lower injury crash criteria
- 65% DSI reduction based on Waka Kotahi Case Study^[6]

Criteria & Results

It is recommended that:

- The speed limit criterion is maintained at 80km/h or higher, and
- Corridors with Collective Risk or Personal risk is Medium-High or greater is selected.

It is also recommended that 'Low', 'Medium' and 'High' threshold costs be introduced at \$250,000, \$300,000, and \$500,000 respectively. A summary of results is shown below. It is also recommended that advice be included within the updated toolkit specifying that Intersection Speed Zones should ideally be used as an interim safety treatment at very high risk intersections before a roundabout or other safe system compliant intersection treatment is applied.

Criteria	Cost per site (L/M/H)	DSi Reduction
<ul style="list-style-type: none"> • T or X type intersection • Speed limit 80km/h or higher • Collective Risk or Personal Risk is Medium-High or greater 	\$250K, \$300K and \$500K	65%

	Number of Sites	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	2695	147	\$206 million	-\$460 million	-\$45 million
Safety BCR	2695	147	\$206 million	\$51 million	\$17 million

[6] <https://www.nzta.govt.nz/assets/Safety/docs/road-to-zero/case-study-intersection-speed-zones.pdf>

Threshold	Low	Medium	High
Cost per site	\$250,000	\$300,000	\$500,000
Base Case BCR	Less than 0	Less than 0	Less than 0
Safety BCR	5.7	4.8	2.9

16. Speed Management (Speed Limit Changes)

Assumptions

- This SSI does not include infrastructure improvements.
- Allowance for WOL and maintenance is 30%.

Proposed Criteria

- All roads where the posted speed limit is greater than the Safe and Appropriate Speed
- DSI reductions are calculated using the Nilsson's Power Model.

Results

Because this intervention assumes that Speed Management will involve a change in speed limit from the current posted speed limit to the Safe and Appropriate Speed, a BCR has been determined based on the assumption that the Safe and Appropriate Speed (SAAS) is considered the 'do minimum' option so therefore no travel time or VOC changes are included in the BCR.

It is recommended that only one criterion be introduced for this SSI which requires the corridor to have a posted speed limit greater than the Safe and Appropriate Speed. It is also recommended that 'Low', 'Medium' and 'High' threshold costs be included at \$5,000, \$20,000, and \$100,000 respectively. A summary of results is shown below.

	Length (km)	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	83198	402	\$442 million	-	-

Threshold	Low	Medium	High
Cost per km	\$5,000	\$20,000	\$100,000
Base Case BCR	12.7	3.2	0.6

17. Traffic Calming (High cost)

Assumptions

- Traffic calming in high traffic volume, high pedestrianised areas is likely to cost more than treatment on Local Roads.
- Is primarily a safety benefit only treatment which will be used to reinforce SAAS.
- A 10% reduction in operating speed is expected, which is linked to a DSI reduction calculated using the Nilsson's Power Model.
- An additional 25% DSI reduction is expected due to the traffic calming treatment.
- Allowance for WOL and maintenance is 30%.

Proposed Criteria

- ONF classification –Activity Streets, Main Streets or City Hubs.
- Speed limit 60km/h or below
- 2 or more injury crashes per km in 5 years

Results – TTC and VOC included

It is recommended that three criteria be introduced for this SSI requires the corridor to be an 'Activity Street', 'Main Street' or 'City Place' under the ONF, have a speed limit of 30km/h to 70km/h and 2 or more injury crashes per KM. It is also recommended that 'Low', 'Medium' and 'High'. threshold costs be included at \$200,000, \$400,000, and \$1 million respectively. A summary of results is shown below.

Scenario 1 – Main Street, Activity Streets and City Hubs

	Length (km)	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	605	147.4	\$163 million	-\$457 million	-\$59 million
Safety BCR	605	147.1	\$162 million	-\$456 million	-\$59 million

Threshold	Low	Medium	High
Cost per km	\$200,000	\$400,000	\$1 million
Base Case BCR	Less than 0	Less than 0	Less than 0
Safety BCR	Less than 0	Less than 0	Less than 0

Scenario 2 – Main Streets only

	Length (km)	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	175	56.9	\$63 million	-\$165 million	-\$21 million
Safety BCR	175	56.6	\$63 million	-\$163 million	-\$21 million

Threshold	Low	Medium	High
Cost per km	\$200,000	\$400,000	\$1 million
Base Case BCR	Less than 0	Less than 0	Less than 0

Threshold	Low	Medium	High
Safety BCR	Less than 0	Less than 0	Less than 0

Similar to Main Streets, Activity Streets only scenario also show a base case and Safety BCR less than 0.

Results - TTC and VOC excluded

The negative BCR in the above scenario suggests that the reduction of speed associated with this SSI treatment results into TTC and VOC disbenefits. Therefore, in this scenario a safety only BCR is calculated. This BCR can be adopted should changes in travel time and vehicle operating costs be ignored for the purposes of assessing road safety improvements.

Scenario 1 – Main Street, Activity Streets and City Hubs

	Length (km)	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	605	147.4	\$163 million		
Safety BCR	605	147.1	\$162 million		

Threshold	Low	Medium	High
Cost per km	\$200,000	\$400,000	\$1 million
Base Case BCR	16.0	8.0	3.2
Safety BCR	15.9	8.0	3.2

Scenario 2 – Main Streets only

	Length (km)	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	175	56.9	\$63 million		
Safety BCR	175	56.6	\$63 million		

Threshold	Low	Medium	High
Cost per km	\$200,000	\$400,000	\$1 million
Base Case BCR	21	11	4.3
Safety BCR	21	11	4.2

Similar to Main Streets, Activity Streets only scenario also show a base case and Safety BCR greater than 1.

18. Traffic Calming (Low cost)

Assumptions

- Is primarily a safety benefit only treatment and will be used to reinforce SAAS.
- A 10% reduction in operating speed is expected, which is linked to a DSI reduction calculated using the Nilsson's Power Model.

- An additional 20% DSI reduction is expected due to the traffic calming treatment.
- Allowance for WOL and maintenance is 30%.

Criteria Applied

- ONF classification –Local Streets only
- Speed limit 30km/h to 60km/h
- 2 or more injury crashes per KM

Results

Scenario 1 – TTC and VOC included

It is recommended that three criteria be introduced for this SSI which requires the corridor to be a ‘Local Street’ under the ONF with a speed limit between 30km/h and 60km/h and have more than two injury crashes per kilometre having occurred in the last five years.

It is also recommended that ‘Low’, ‘Medium’ and ‘High’. threshold costs be included at \$20,000, \$40,000 and \$100,000 respectively. A summary of results is shown below.

	Length (km)	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	795	72.5	\$80 million	-\$69 million	-\$10 million
Safety BCR	795	73.4	\$81 million	-\$72 million	-\$10 million

Threshold	Low	Medium	High
Cost per km	\$20,000	\$40,000	\$100,000
Base Case BCR	1.3	0.7	0.3
Safety BCR	Less than 0	Less than 0	Less than 0

Scenario 2 – TTC and VOC excluded

Similar to the previous SSI, in this scenario a safety only BCR is calculated. This BCR can be adopted should changes in travel time and vehicle operating costs at intersections be ignored for the purposes of assessing road safety improvements.

	Length (km)	Predicted DSI Saved (per annum)	Monetised DSI Savings (\$/annum)	Travel Time Cost Savings (\$/annum)	VOC Cost Savings (\$/annum)
Base Case BCR	795	72.5	\$80 million		
Safety BCR	795	73.4	\$81 million		

Threshold	Low	Medium	High
Cost per km	\$20,000	\$40,000	\$100,000
Base Case BCR	60	30	12
Safety BCR	61	30	12

After the preparation of this tech note, the working group decided not to include Traffic Calming (Low cost) in the SSI toolkit.

19. Summary of Assessed Economics

Table 19.1 shows a summary of the assessed economics for each intervention.

Table 19.1 Summary of Assessed Economics

Intervention	Modified Investment Assurance Criteria for Streamlined Investment Pathway	Low Cost	Medium Cost	High Cost
Continuous 3-Barrier (Median & Roadside Barrier)	<ul style="list-style-type: none"> • AADT 10,000 or greater • Collective Risk Medium-High or greater OR Predictive Collective Risk Medium-High or greater • Speed limit 80km/h or higher 	\$2 million per km Safety BCR 2.1	\$3 million per km Safety BCR 1.4	\$5 million per km Safety BCR 0.8
Median Barrier	<ul style="list-style-type: none"> • AADT 6000 or greater • Collective Risk Medium-High or greater OR Predictive Collective Risk Medium-High or greater • Speed limit 80km/h or higher 	\$1 million per km Safety BCR 3.1	\$2 million per km Safety BCR 1.6	\$4 million per km Safety BCR 0.8
Wide Centreline	<ul style="list-style-type: none"> • AADT 3000 or greater • Collective Risk Medium-High or greater OR Predictive Collective Risk Medium-High or greater • Speed limit 80km/h or higher 	\$250,000 per km Safety BCR 3.8	\$700,000 per km Safety BCR 1.3	\$1.5 million per km Safety BCR 0.6
Roadside safety barrier at high-risk locations	<ul style="list-style-type: none"> • AADT 1000 or greater • Collective Risk Medium or greater OR Predictive Collective Risk Medium or greater • Not Commercial Big Box/Industrial, Commercial Strip Shopping and Urban Residential land uses • Speed limit 60km/h or higher 	\$100,000 per km Safety BCR 5.7	\$300,000 per km Safety BCR 1.9	\$600,000 per km Safety BCR 0.9

Intervention	Modified Investment Assurance Criteria for Streamlined Investment Pathway	Low Cost	Medium Cost	High Cost
Shoulder widening at high-risk curves	<ul style="list-style-type: none"> Is a high-risk or out of context curve AADT 1000 or greater Collective Risk Medium or higher OR Predictive Collective Risk Medium or higher Speed limit 60km/h or higher 	\$200,000 per site Safety BCR 0.7	\$325,000 per site Safety BCR 0.4	\$450,000 per site Safety BCR 0.3
Audio Tactile Pavement (ATP) Marking	<ul style="list-style-type: none"> AADT 1000 or greater Speed limit 80km/h or higher 	\$10,000 per km Safety BCR 13.8	\$15,000 per km Safety BCR 9.2	\$50,000 per km Safety BCR 2.8
Mid-block Raised Pedestrian Crossing	<ul style="list-style-type: none"> Speed limit 60km/h and below ONF - Urban Connectors, Activity Streets and Main Streets only 	\$100,000 per km Safety BCR 4.5	\$250,000 per km Safety BCR 1.8	\$750,000 per km Safety BCR 0.6
Signage & Markings	<ul style="list-style-type: none"> AADT 1000 or greater Speed limit 60km/h or higher 	\$10,000 per km Safety BCR 12.4	\$20,000 per km Safety BCR 6.2	\$100,000 per km Safety BCR 1.2
Roundabout	<ul style="list-style-type: none"> Intersection Collective Risk Medium-High or greater 3 or more injury crashes in 10 years 	\$500,000 per intersection Safety BCR 5.7	\$2 million per intersection Safety BCR 1.4	\$6 million per intersection Safety BCR 0.5
Raised Safety Platforms (at existing signals/roundabouts)	<ul style="list-style-type: none"> Intersection Collective Risk Medium-High or greater 3 or more injury crashes in 10 years Speed limit 60km/h and below 	\$300,000 per intersection Safety BCR 6.4	\$750,000 per intersection Safety BCR 2.5	\$2 million per intersection Safety BCR 1.0
Signalised Intersection with Approach Raised Safety Platforms (From Controlled/ Uncontrolled)	<ul style="list-style-type: none"> Intersection Collective Risk Medium-High or greater 3 or more injury crashes in 10 years Speed limit 80km/h and below 	\$500,000 per intersection Safety BCR (with TT and VOC included) < 0 Safety BCR (without TT and VOC included) 5.6	\$1 million per intersection Safety BCR (with TT and VOC included) < 0	\$2 million per intersection Safety BCR (with TT and VOC included) < 0

Intervention	Modified Investment Assurance Criteria for Streamlined Investment Pathway	Low Cost	Medium Cost	High Cost
			Safety BCR (without TT and VOC included) 2.8	Safety BCR (without TT and VOC included) 1.4
Intersection Speed Zone (RIAWS)	<ul style="list-style-type: none"> T or X type intersection Speed limit 80km/h or higher Collective Risk or Personal Risk is Medium-High or greater 	\$250,000 per intersection Safety BCR 5.7	\$300,000 per intersection Safety BCR 4.8	\$500,000 per intersection Safety BCR 2.9
Speed Management (Speed Limit Changes)	<ul style="list-style-type: none"> •Posted speed limit greater than the Safe and Appropriate Speed 	\$5,000 per km Safety BCR 12.7	\$20,000 per km Safety BCR 3.2	\$100,000 per km Safety BCR 0.6
Traffic Calming (High Cost)	<ul style="list-style-type: none"> ONF corridor family is Activity Streets, Main Streets, City Hubs Posted speed limit is 60km/h and below 2 or more injury crashes per km in 5 years 	\$200,000 per km Safety BCR (with TT and VOC included) < 0 Safety BCR (without TT and VOC included) 21	\$400,000 per km Safety BCR (with TT and VOC included) < 0 Safety BCR (without TT and VOC included) 11	\$1 million per km Safety BCR (with TT and VOC included) < 0 Safety BCR (without TT and VOC included) 4.2
Traffic Calming (Low Cost)	<ul style="list-style-type: none"> ONF corridor family is Local Street 2 or more injury crashes per km in 5 years 	TBC Safety BCR (with TT and VOC included) < 0 Safety BCR (without TT and VOC included) 61	TBC Safety BCR (with TT and VOC included) < 0 Safety BCR (without TT and VOC included) 30	TBC Safety BCR (with TT and VOC included) < 0 Safety BCR (without TT and VOC included) 12