Safe System Assessments

Michael Gillies, Manager (Safer Roads)

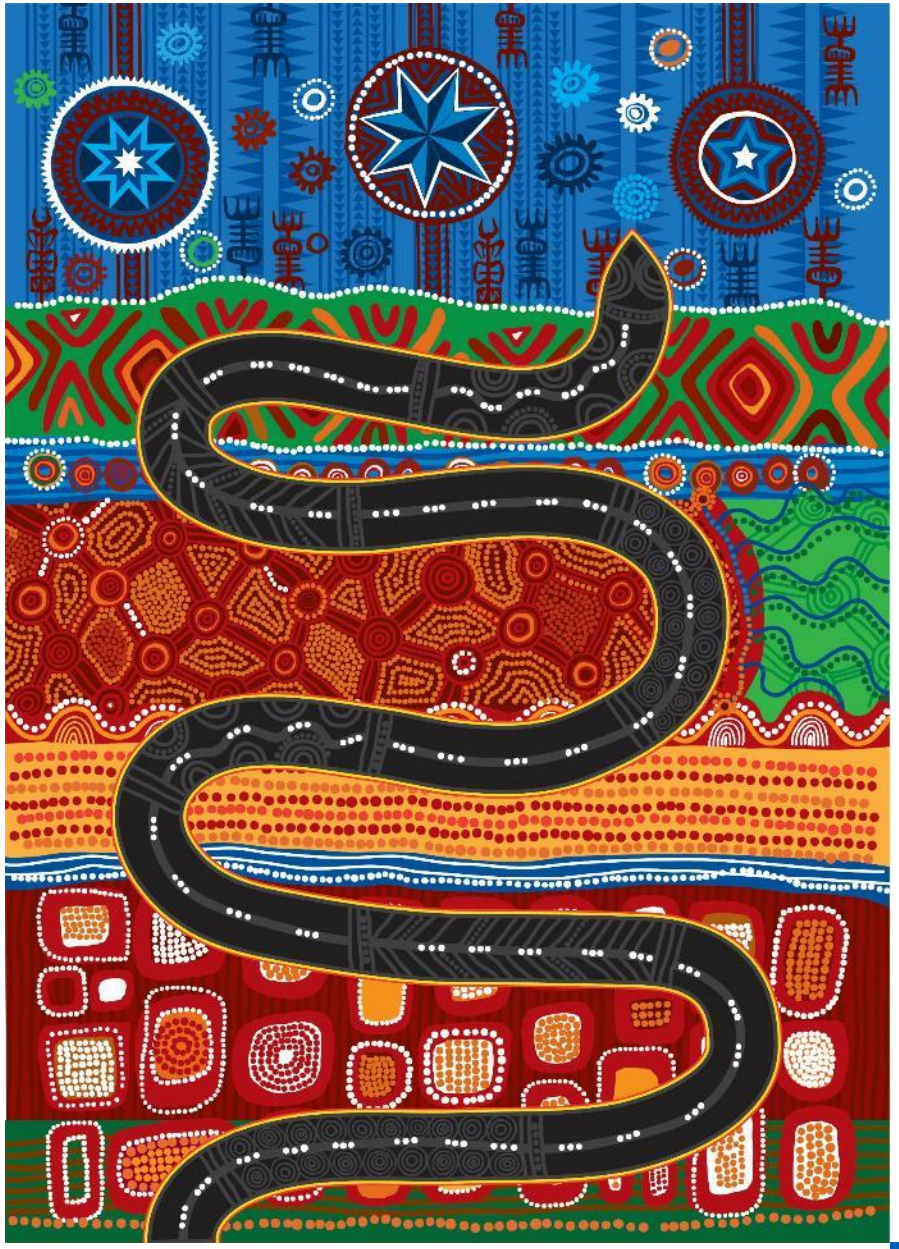
Department of Transport and Main Roads (TMR)

8 July 2025

Acknowledgement of Traditional Owners and Elders

I’d like to begin by acknowledging the Traditional Owners of the land where we meet today. I would also like to pay my respects to the Elders both past and present.

I also extend that respect to the Aboriginal and Torres Strait Islander people here today.



'Travelling' by Gilimbaa

Agenda

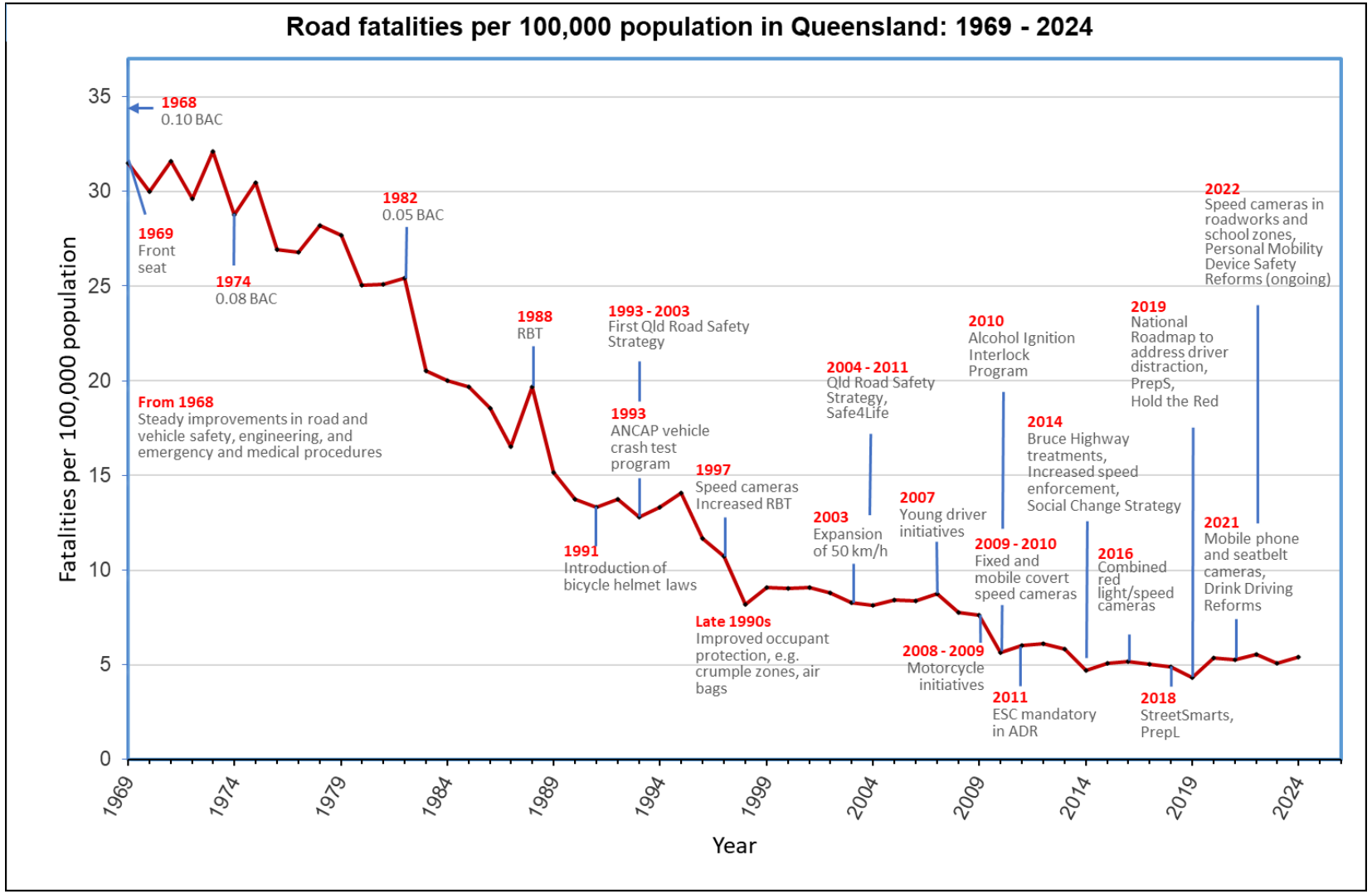
- Background and overview of Safe System Assessment (SSA)
- Safe System Assessment v Road Safety Audit (RSA)?
- Safe System Assessment process
- Supporting material
- Questions

Road safety in Queensland – trends

After significant reductions over time, Queensland has seen fatalities rising again since 2019

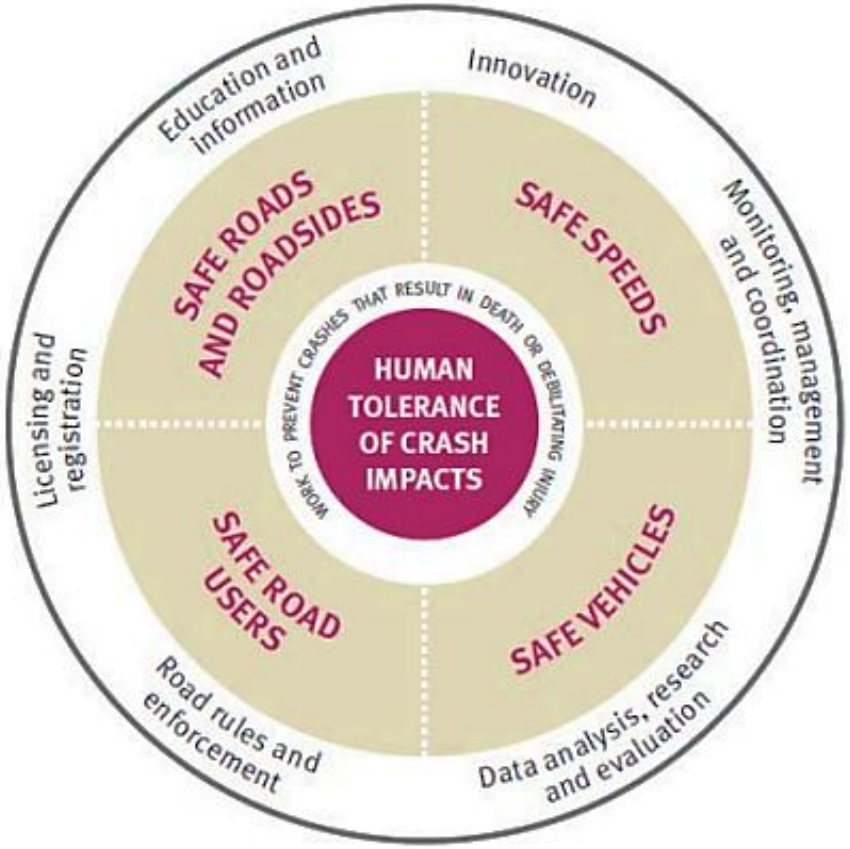
This is driven by complex issues, including:

- Our large and geographically challenging network.
- Our growing and ageing population – 5.5 million in 2023, estimated 11% growth to 6.1 million by 2031.
- New technology disruption.
- Behavioural differences between urban and regional areas.
- Post-covid behaviour challenges.

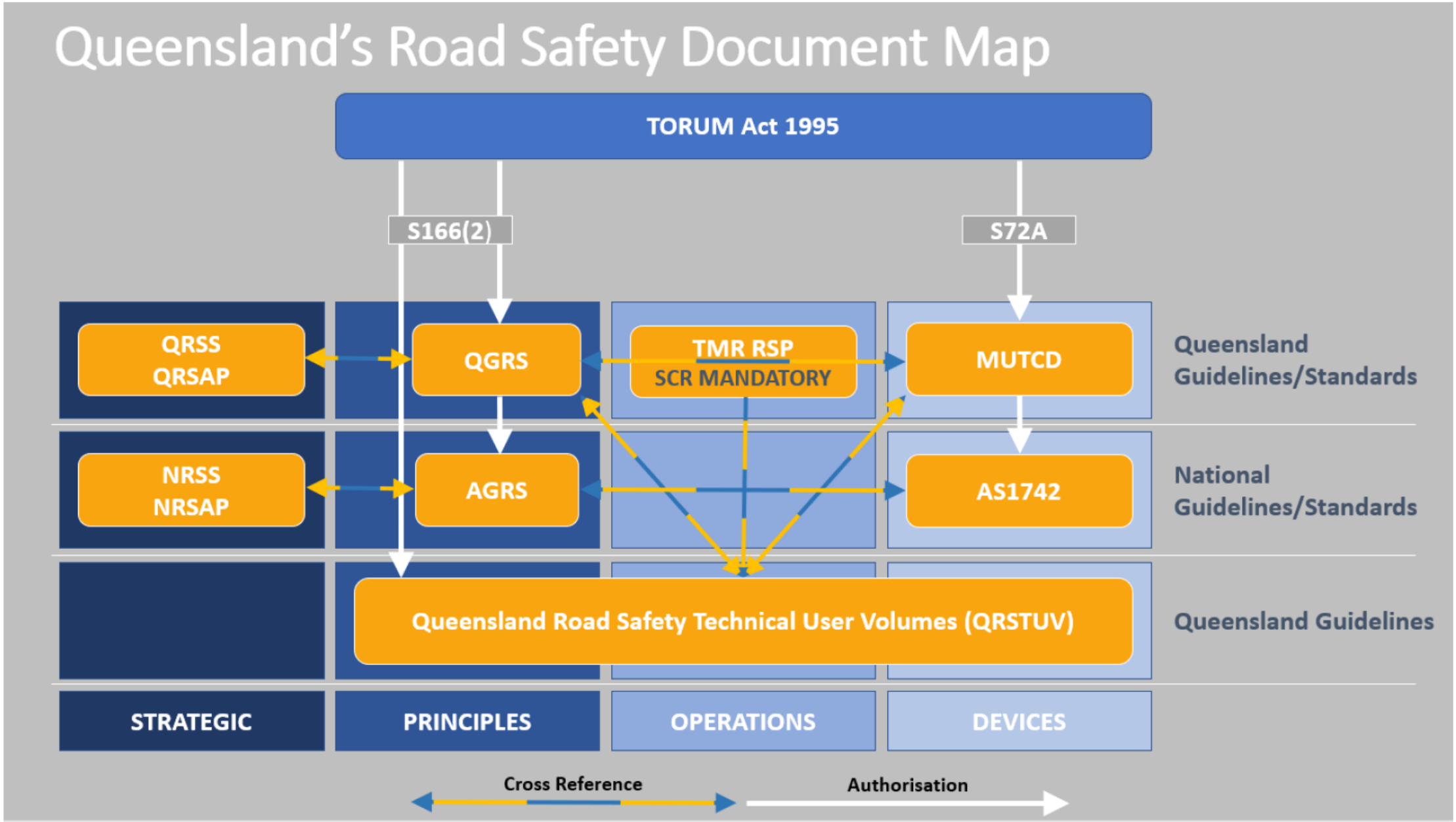


Background

- Austroads published AP-R509-16 *Safe System Assessment Framework in 2016* - assessment framework to help road agencies methodically consider Safe System objectives in road infrastructure projects.
- An SSA is a tool that has been developed to assess the extent to which a proposed infrastructure project aligns with Safe System principles and the objective to eliminate fatal and serious injuries (FSI's).
- TMR's Road Safety Policy calls out that SSAs are to be conducted on all TMR projects.
- TMR's *Queensland Road Safety Technical User Volumes: Guide to Safe System Assessment* (Guide to SSA) published in 2024 - outlines the process for undertaking a Safe System Assessment in Queensland.



Overview of Safe System Assessment



Overview of Safe System Assessment

- Safe System Assessment (SSA) are most valuable when conducted during the early stages of a project when adjustments to the design and / or scope of the project are more readily accommodated.

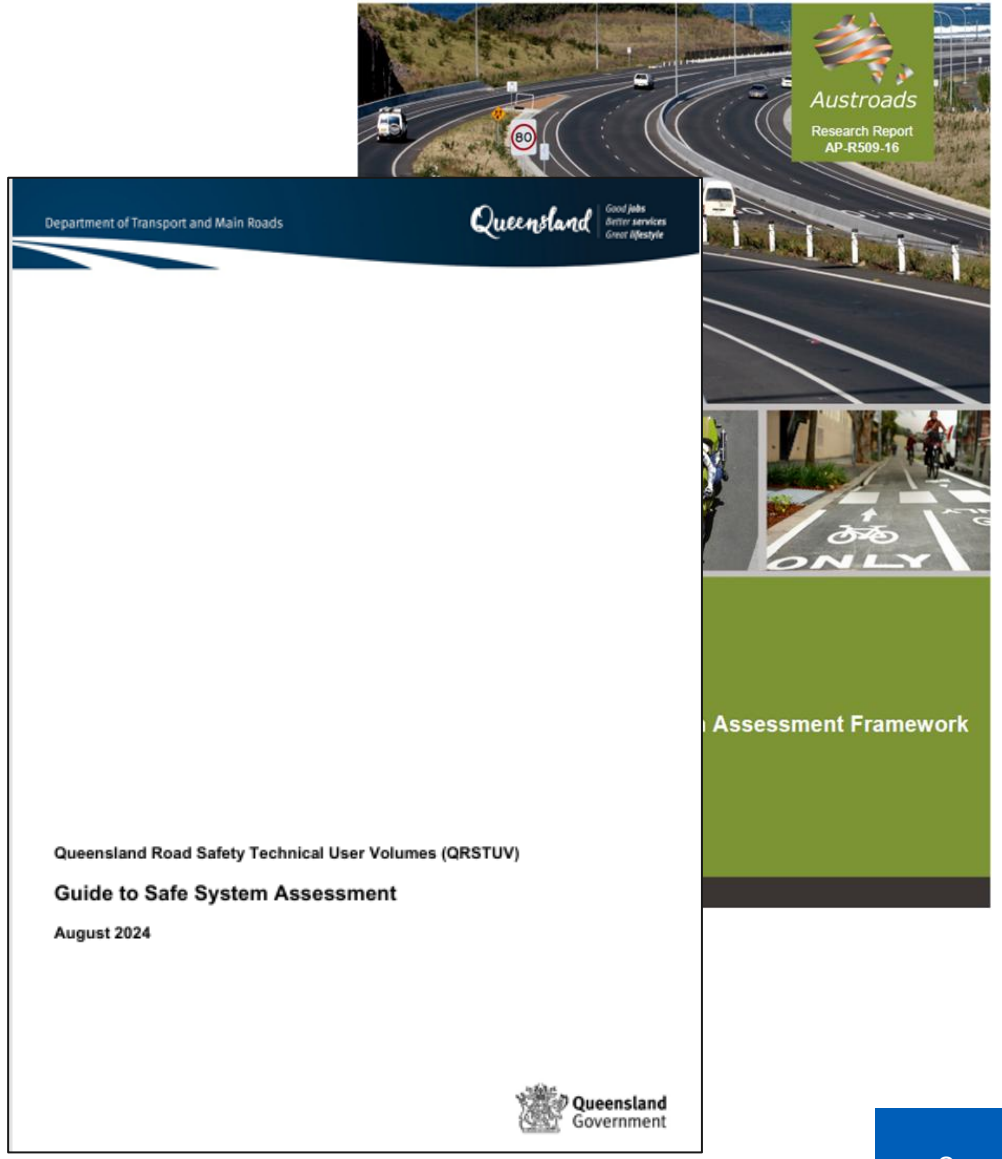
- Each jurisdiction / agency may have their own specific policy or requirements as to when an SSA is to be completed.

- The SSA has several applications:

    - the assessment of road infrastructure project options,
    - informing multi criteria analysis,
    - assisting planning and route selection, and
    - for the assessment of treatment options for Black Spot and Safer Roads Sooner nominations.

QRSTUV: Guide to Safe System Assessment

- Guide to SSA is the “how” to complete an SSA.
- Provide Queensland specific information in line with the Austroads framework.
- Applicable to TMR and Local Governments.
- Supporting template and tools available for use.



Safe System Assessment v Road Safety Audit

SSA:

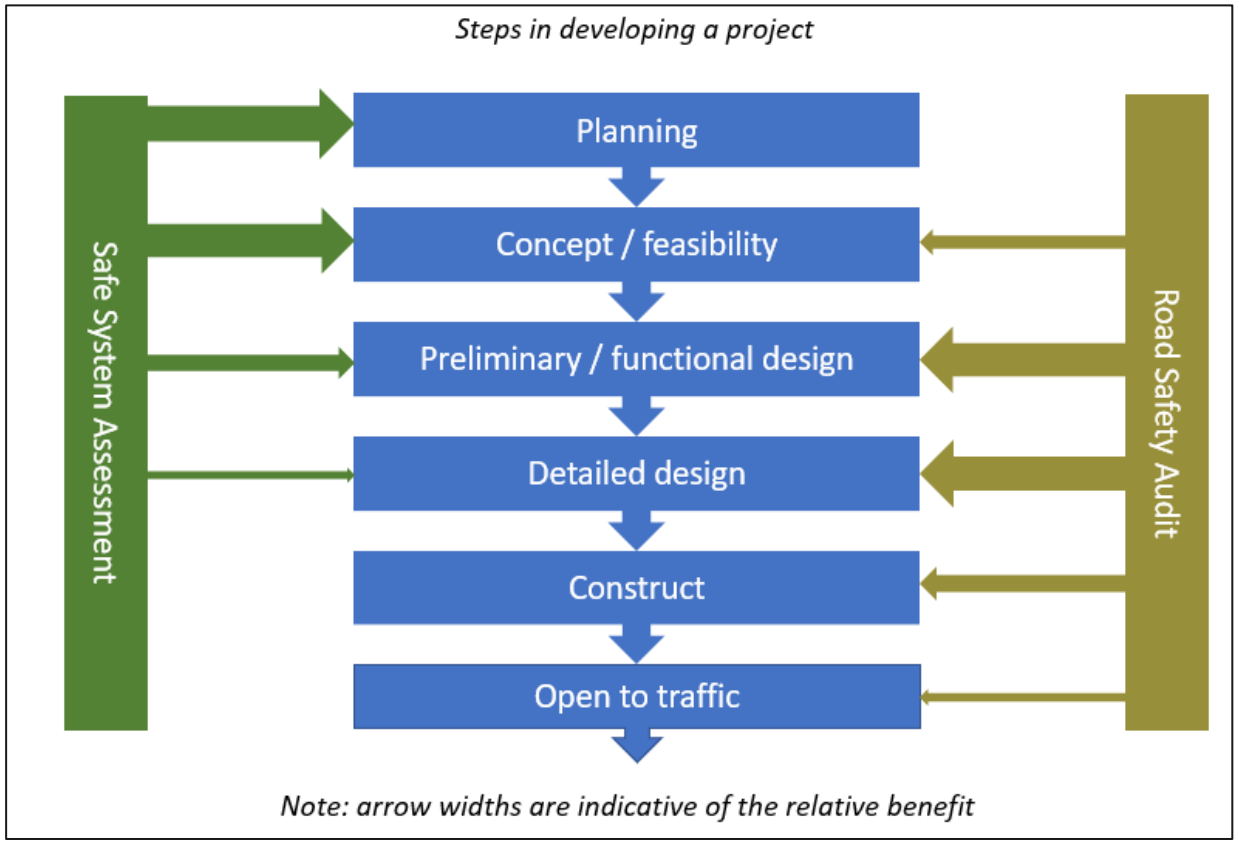
- ***evaluates a project's alignment with Safe System principles and identifies ways to improve the alignment with a focus on minimising fatal and serious injuries.***
- ***investigates the inherent risk of the infrastructure and includes consideration of road user exposure.***
- ***produces an aggregated risk score which is used to compare project options, with a focus on identifying strategies that address all pillars of the Safe System.***

RSA:

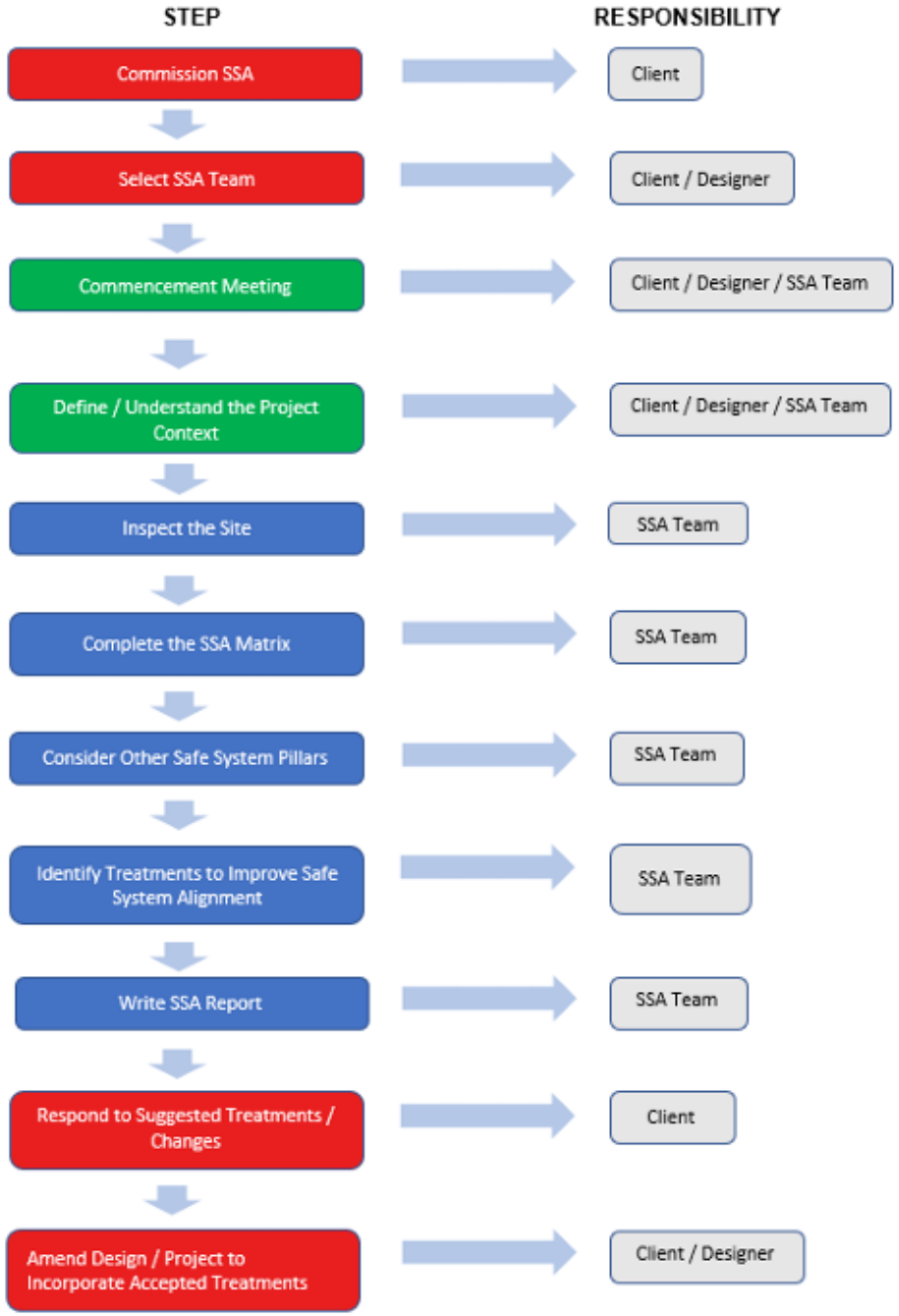
- ***is a formal examination of a road or road project, which usually focuses on the likelihood of a crash, regardless of severity, to ensure that no hazards are built into the road environment when a project is implemented.***
- ***identifies individual deficiencies of a road or road project and assigns a risk rating for each explicit item.***
- ***provides specific recommendations to mitigate the identified road safety risk considering Safe System speed thresholds.***

SSA v RSA

- An SSA does not replace the need for an RSA to be conducted for a project.
- An SSA and RSA should complement each other to maximise the road safety outcomes of a project.
- The SSA assesses the overarching scope of a project at the earlier stages where significant alterations can be made, with the RSA following.



Safe System Assessment Process



Source: Adapted from VicRoads, 2018.

SSA Team

- An SSA team should include personnel who are experienced in undertaking SSAs.
- An SSA should be undertaken by a team of two to four members – this should include at least one member who must be knowledgeable regarding the Safe System and its application.
- Where possible should be independent of the project being assessed.
- Circumstances where SSA may be undertaken by a single person:
  - would need agreement with the client and all members of the project team.
  - person must also have experience in conducting SSAs.
  - should be peer reviewed.

Context

- They key intention of these prompts is to help ensure that each pillar in the Safe System is considered as part of the assessment.

- Even though the focus of the framework is to assess infrastructure-related projects, there are many ways that professionals may be able to influence safety outcomes besides infrastructure-specific changes.

Figure 6.5 – Template for setting the project context

Prompts	Comments
What is the reason for the **project**? Is there a specific crash type risk? Is it addressing specific issues such as poor speed limit compliance, road access, congestion, future traffic growth, freight movement, amenity concerns from the community, maintenance/asset renewal, etc.	
What is the **function** of the road? Consider location, roadside land use, area type, speed limit, intersection type, presence of parking, public transport services and vehicle flows. What traffic features exist nearby (e.g. upstream and downstream)? What alternative routes exist?	
What is the **speed** environment? What is the current speed limit? Has it changed recently? Is it similar to other roads of this type? How does it compare to Safe System speeds? What is the acceptability of lowering the speed limit at this location?	
What **road users** are present? Consider the presence of elderly, school children and cyclists. Also note what facilities are available to vulnerable road users (e.g. signalised crossings, bicycle lanes, school zone speed limits, etc.).	
What is the **vehicle** composition? Consider the presence of heavy vehicles (and what type), motorcyclists and other vehicles using the roadway.	

Source: Austroads (2016).

Site Visit

- A daytime site inspection should be undertaken.
- A site visit can provide deeper insight into the nature of any safety issues and provide an understanding of the context of the project.
- Night-time inspections could also be considered, particularly if activity/network use changes after dark or if the SSA team considers that there may be an elevated risk of crashes involving any road users at night.

Safe System Matrix

	Run-off-road	Head-on	Intersection	Other	Pedestrian	Cyclist	Motorcyclist
Exposure	AADT; length of road segment	AADT; length of road segment	AADT for each approach; intersection size	AADT; length of road segment	AADT; pedestrian numbers; crossing width; length of road segment	AADT; cyclist numbers; pedestrians	AADT; motorcycle numbers; length of road segment
Likelihood	Speed; geometry; shoulders; barriers; hazard offset; guidance and delineation	Geometry; separation; guidance and delineation; speed	Type of control; speed; design, visibility; conflict points	Speed; sight distance; number of lanes; surface friction	Design of facilities; separation; number of conflicting directions; speed	Design of facilities; separation; speed	Design of facilities; separation; speed
Severity	Speed; roadside features and design (e.g. flexible barriers)	Speed	Impact angles; speed	Speed	Speed	Speed	Speed

Table 4.3: Safe System matrix for safe roads and roadsides and safe speeds

	Run-off-road	Head-on	Intersection	Other	Pedestrian	Cyclist	Motorcyclist	
Exposure	/4	/4	/4	/4	/4	/4	/4	
Likelihood	/4	/4	/4	/4	/4	/4	/4	
Severity	/4	/4	/4	/4	/4	/4	/4	
Product	/64	/64	/64	/64	/64	/64	/64	/448

Safe System Matrix

- Matrix used to assess the extent to which existing conditions and project options align with Safe System principles.
- Scoring system which considers crash types and the exposure, likelihood and severity associated with each crash type.
- Each assigned a score out of 4.
- The score for exposure, likelihood and severity are multiplied to give a score.
- Idea is that you want to score to trend towards zero.
- Complete matrix for existing scenario and for design options to determine safe system alignment.
- Consider treatments to improve alignment.
- Important subjective assessment and you cannot compare scores against other projects.

Safe System Matrix

Exposure, likelihood and severity (the rows of the matrix) are defined as follows:

- **Road user exposure:** this refers to which road users, in what numbers and for how long are using the road and are thus exposed to a potential crash.
- **Crash likelihood:** groups of factors affecting the probability of a crash occurring. They can be elements which moderate opportunity for conflict (e.g. number of conflict points, offset to roadside hazards, separation between opposing traffic). They can also include elements of road user behaviour and/or road environment.
- **Crash severity:** groups of factors affecting the probability of severe injury outcomes should a crash occur.

Table 6.7 – Safe System Assessment Matrix

	Run-off road	Head-on	Intersection	Other	Pedestrian	Cyclist	Motorcyclists
Exposure Comments							
Exposure Score	/4	/4	/4	/4	/4	/4	/4
Likelihood Comments	Factors that increase the likelihood include: • Factors that decrease the likelihood include: •	Factors that increase the likelihood include: • Factors that decrease the likelihood include: •	Factors that increase the likelihood include: • Factors that decrease the likelihood include: •	Factors that increase the likelihood include: • Factors that decrease the likelihood include: •	Factors that increase the likelihood include: • Factors that decrease the likelihood include: •	Factors that increase the likelihood include: • Factors that decrease the likelihood include: •	Factors that increase the likelihood include: • Factors that decrease the likelihood include: •
Likelihood Score	/4	/4	/4	/4	/4	/4	/4
Severity Comments	Factors that increase the severity include: • Factors that decrease the severity include: •	Factors that increase the severity include: • Factors that decrease the severity include: •	Factors that increase the severity include: • Factors that decrease the severity include: •	Factors that increase the severity include: • Factors that decrease the severity include: •	Factors that increase the severity include: • Factors that decrease the severity include: •	Factors that increase the severity include: • Factors that decrease the severity include: •	Factors that increase the severity include: • Factors that decrease the severity include: •
Severity Score	/4	/4	/4	/4	/4	/4	/4
Product (multiply scores above for crash type)	/64	/64	/64	/64	/64	/64	/64
						Total	**/448**

Safe System Matrix – Additional pillars

Additional Safe System components	
Pillar	**Prompts**
Road user	Are road users likely to be alert and compliant? Are there factors that might influence this? What are the expected compliance and enforcement levels (alcohol/drugs, speed, road rules, and driving hours)? What is the likelihood of driver fatigue? Can enforcement of these issues be conducted safety? Are there special road uses (e.g. entertainment precincts, elderly, children, on-road activities, motorcyclist route), distraction by environmental factors (e.g. commerce, tourism), or risk-taking behaviours?
Vehicle	What level of alignment is there with the ideal of safer vehicles? Are there factors which might attract large numbers of unsafe vehicles? Is the percentage of heavy vehicles too high for the proposed/existing road design? Is this route used by recreational motorcyclists? Are there enforcement resources in the area to detect non-roadworthy, overloaded or unregistered vehicles and thus remove them from the network? Can enforcement of these issues be conducted safety? Has vehicle breakdown been catered for?
Post-crash care	Are there issues that might influence safe and efficient post-crash care in the event of a severe injury (e.g. congestion, access stopping space)? Do emergency and medical services operate as efficiently and rapidly as possible? Are other road users and emergency response teams protected during a crash event? Are drivers provided the correct information to address travelling speeds on the approach and adjacent to the incident? Is there reliable information available via radio, VMS etc. Is there provision for e-safety (i.e. safety systems based on modern information and communication technologies, C-ITS)?

Safe System Matrix – Scoring System

Road user exposure	Crash likelihood	Crash severity
0 = there is no exposure to a certain crash type. This might mean there is no side flow or intersecting roads, no cyclists, no pedestrians, or motorcyclists).	0 = there is only minimal chance that a given crash type can occur for an individual road user given the infrastructure in place. Only extreme behaviour or substantial vehicle failure could lead to a crash. This may mean, for example, that two traffic streams do not cross at grade, or that pedestrians do not cross the road.	0 = should a crash occur, there is only minimal chance that it will result in a fatality or serious injury to the relevant road user involved. This might mean that kinetic energies transferred during the crash are low enough not to cause a fatal or serious injury (FSI), or that excessive kinetic energies are effectively redirected/dissipated before being transferred to the road user. Users may refer to Safe System-critical impact speeds for different crash types, while considering impact angles, and types of roadside hazards/barriers present.
1 = volumes of vehicles that may be involved in a particular crash type are particularly low, and therefore exposure is low. For run-of-road, head-on, intersection and 'other' crash types, AADT is < 1 000 per day. For cyclist, pedestrian and motorcycle crash types, volumes are < 10 units per day.	1 = it is highly unlikely that a given crash type will occur.	1 = should a crash occur, it is highly unlikely that it will result in a fatality or serious injury to any road user involved. Kinetic energies must be fairly low during a crash, or the majority is effectively dissipated before reaching the road user.
2 = volumes of vehicles that may be involved in a particular crash type are moderate, and therefore exposure is moderate. For run-of-road, head-on, intersection and 'other' crash types, AADT is between 1 000 and 5 000 per day. For cyclist, pedestrian and motorcycle crash types, volumes are 10–50 units per day.	2 = it is unlikely that a given crash type will occur.	2 = should a crash occur, it is unlikely that it will result in a fatality or serious injury to any road user involved. Kinetic energies are moderate, and the majority of the time they are effectively dissipated before reaching the road user.
3 = volumes of vehicles that may be involved in a particular crash type are high, and therefore exposure is high. For run-of-road, head-on, intersection and 'other' crash types, AADT is between 5 000 and 10 000 per day. For cyclist, pedestrian and motorcycle crash types, volumes are 50–100 units per day.	3 = it is likely that a given crash type will occur.	3 = should a crash occur, it is likely that it will result in a fatality or serious injury to any road user involved. Kinetic energies are moderate, but are not effectively dissipated and therefore may or may not result in an FSI.
4 = volumes of vehicles that may be involved in a particular crash type are very high, or the road is very long, and therefore exposure is very high. For run-of-road, head-on, intersection and 'other' crash types, AADT is > 10 000 per day. For cyclist, pedestrian and motorcycle crash types, volumes are > 100 units per day.	4 = the likelihood of individual road user errors leading to a crash is high given the infrastructure in place (e.g. high approach speed to a sharp curve, priority movement control, filtering right turn across several opposing lanes, high speed).	4 = should a crash occur, it is highly likely that it will result in a fatality or serious injury to any road user involved. Kinetic energies are high enough to cause an FSI crash, and it is unlikely that the forces will be dissipated before reaching the road user.

Treatment Selection and hierarchy

- Identify treatments that may look to reduce matrix scores, leading to fatal and serious injury (FSI) crash risk reductions.
- Treatment suggestions made by the SSA team are to be classified as primary or supporting treatments.
- Primary treatments are those that have the potential to eliminate or come close to eliminating the risk of FSI crashes. Supporting treatments are effective in reducing the risk of FSI crashes but not to the extent of a primary treatment (i.e. there is a residual moderate or significant FSI crash risk).
- Primary treatments should be given priority; however, it is recognised that some may not be feasible due to constraints such an environmental, other project objectives and cost.

Hierarchy and Selection

- If high levels of risk were identified for one or more crash types, the solutions for that crash type should be reviewed (e.g. for run-off-road or head-on).

Table 4.5: Run-off-road (to left or right) treatments

Hierarchy	Treatment	Influence (E = exposure L = likelihood S = severity)
Safe System options ('primary' or 'transformational' treatments)	• Flexible roadside and median barriers (or equally/better performing future equivalent) • Very high quality compacted roadside surface, very gentle to flat side slopes and exceptionally wide run-off areas • Very low speed environment/speed limit.	S S L, S
Supporting treatments which move towards better Safe System alignment (compatible with future implementation of Safe System options)	• Wide run-off areas, with well-maintained shallow drainage and gentle side slopes • Wide sealed shoulders with audio-tactile edgeline • Lower speed limit.	S L L, S
Supporting treatments (does not affect future implementation of Safe System options)	• Non-flexible safety barrier • Consistent design along the route (i.e. no out-of-context curves) • Consistent delineation for route • Skid resistance improvement • Improved superelevation • Audio-tactile centreline • Audio-tactile edgeline • Vehicle activated signs.	S L L L L L L L L
Other considerations	• Speed enforcement • Rest area provision • Lane marking compatible with in-vehicle lane-keeping technology.	L, S L L

Table 4.6: Head-on treatments

Hierarchy	Treatment	Influence (E = exposure L = likelihood S = severity)
Safe System options ('primary' or 'transformational' treatments)	• One-way traffic • Flexible median barrier • Very wide median • Very low speed environment/speed limit.	L S S L, S
Supporting treatments (compatible with future implementation of Safe System options)	• Wide median • Painted median/wide centrelines.	L L
Supporting treatments (does not affect future implementation of Safe System options)	• Non-flexible barrier provision • Lower speed environment/speed limit • Ban overtaking • Skid resistance improvement • Audio-tactile centreline • Audio-tactile edgeline • Roadside barriers • Consistent design along the route (i.e. no out-of-context curves) • Consistent delineation for route • Overtaking lanes • Improved superelevation.	S L, S L L L L S L L L L
Other considerations	• Speed enforcement • Rest area provision • Lane marking compatible with vehicle-lane-keeping technology.	L, S L L

Respond to Suggestions

- Client and designers should give due consideration to suggestions.
- it is important that the project team also responds to any potential design change they do not support with robust reasoning.
- To close out the assessment and provide feedback, the SSA team should be advised of any proposed changes to the design or scope in response to the SSA report and should re-score the project, incorporating the design and scope changes that have been accepted.
- The revised score can be compared to the other project options to determine if the adopted changes have improved the Safe System alignment of the project and whether any of the adopted design changes increased the risk of other crash types.

Safe System Assessment Framework - Example

- Existing Situation:

Safe System Assessment Framework - Example

Example: Existing Situation

SS Score:

$\frac{176}{448}$

Safe System matrix

	ROR	HO	INT	OTHER	PED	CYC	M/C	
Exposure	High volume ×	High volume ×	High vol. on Burwood Hwy × Moderate vol. on Terrara Rd –	High volume ×	Low pedestrian volumes ✓	Low cyclist volumes ✓	Low motorcyclist volumes ✓	
	$^4/_4$	$^4/_4$	$^4/_4$	$^4/_4$	$^1/_4$	$^1/_4$	$^1/_4$	
Likelihood	Steep grade × Deceleration lane ✓ Presence of intersection × No shoulders × Moderate clear zone – No barriers ×	Divided, wide/raised median ✓ Intersection movements/conflict points minimal for HO crash ✓	% turning movements × No. of lanes and conflict points × High speed × Poor sight distance × Protected turn lanes ✓	High no. of lanes × Protected turn lanes ✓ Short decel. lanes × Buses stopping ×	Service lane with footpath ✓ No crossing facilities at intersection × Many lanes to cross ×	Service lane – some separation ✓ No crossing facilities at intersection ×	No delineation × Well surfaced ✓ Straight road ✓	
	$^3/_4$	$^1/_4$	$^3/_4$	$^3/_4$	$^4/_4$	$^4/_4$	$^3/_4$	
Severity	High speed × No barriers × Steep grade × Poles and trees to hit ×	High speed × Low speed in side road ✓	High speed × Bad conflict angles ×	High speed ×	High speed × No crossing facilities ×	High speed ×	High speed × Some roadside hazards ×	**Total**
	$^3/_4$	$^3/_4$	$^4/_4$	$^3/_4$	$^4/_4$	$^4/_4$	$^4/_4$	
Product	$4*3*3=^{36}/_{64}$	$4*1*3=^{12}/_{64}$	$4*3*4=^{48}/_{64}$	$4*3*3=^{36}/_{64}$	$1*4*4=^{16}/_{64}$	$1*4*4=^{16}/_{64}$	$1*3*4=^{12}/_{64}$	$^{176}/_{448}$

Safe System Assessment Framework - Example

Option 1: Signals

SS Score:

$\frac{128}{448}$

Safe System matrix

	ROR	HO	INT	OTHER	PED	CYC	M/C	
Exposure	High volume ×	High volume ×	High vol. on Burwood Hwy × Moderate vol. on Terarra Rd –	High volume ×	Low pedestrian volumes ✓	Low cyclist volumes ✓	Low motorcyclist volumes ✓	
	$^4/_4$	$^4/_4$	$^4/_4$	$^4/_4$	$^1/_4$	$^1/_4$	$^1/_4$	
Likelihood	Steep grade × Deceleration lane ✓ Presence of intersection × No shoulders × Moderate clear zone – No barriers ×	Divided, wide/raised median ✓ No intersection movements/conflict points that could result in HO crash ✓	% turning movements × No. of lanes and conflict points × High speed × Poor sight distance × Protected turn lanes ✓	High no. of lanes × Protected turn lanes ✓ Extended decel. lanes ✓ Need to stop at signals × Buses stopping ×	Service lane with footpath ✓ No crossing facility across Terrara Rd (low speed) × Zebra crossing ✓	Service lane – some separation ✓ No bicycle crossing facilities at intersection ×	No delineation × Well surfaced ✓ Straight road ✓	
	$^3/_4$	$^0/_4$	$^3/_4$	$^4/_4$	$^2/_4$	$^4/_4$	$^3/_4$	
Severity	High speed × No barriers × Steep grade × Poles and trees –	High speed × Low speed in side road ✓	High speed × Reduced conflict angles ✓	High speed × Visible intersection ✓ Resurfaced ✓	High speed ×	High speed ×	High speed × Some roadside hazards ×	**Total**
	$^3/_4$	$^3/_4$	$^2/_4$	$^2/_4$	$^4/_4$	$^4/_4$	$^4/_4$	
Product	$4*3*3 = {}^{36}/_{64}$	$4*0*3 = {}^{0}/_{64}$	$4*3*2 = {}^{24}/_{64}$	$4*4*2 = {}^{32}/_{64}$	$1*2*4 = {}^{8}/_{64}$	$1*4*4 = {}^{16}/_{64}$	$1*3*4 = {}^{12}/_{64}$	$^{128}/_{448}$

Safe System Assessment Framework - Example

Option 2: LILO

SS Score:

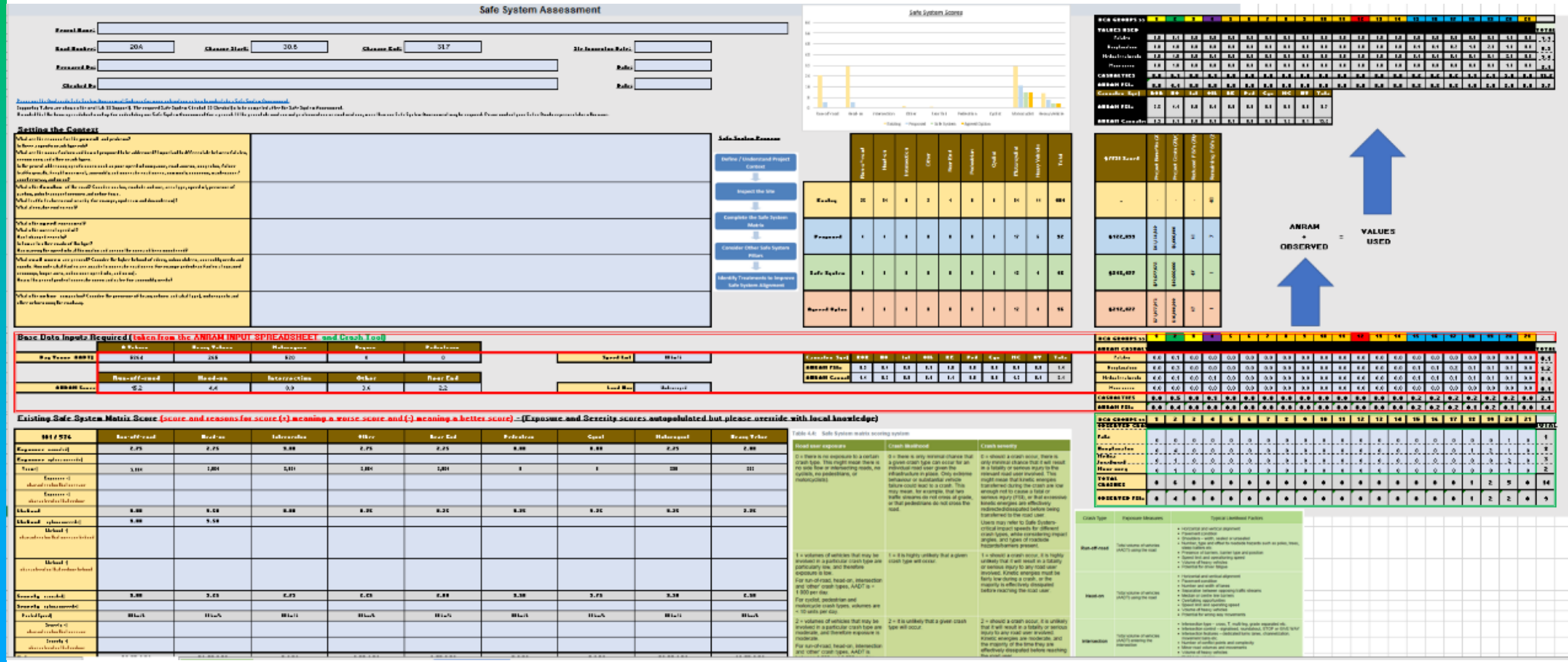
85

448

Safe System matrix

	ROR	HO	INT	OTHER	PED	CYC	M/C	
Exposure	High volume ×	High volume ×	High vol. on Burwood Hwy × Low vol. on Terrara Rd ✓	High volume × Low vol. on Terrara Rd ✓	Low pedestrian volumes ✓	Low cyclist volumes ✓	Low motorcyclist volumes ✓	
	4/4	4/4	1/4	3/4	1/4	1/4	1/4	
Likelihood	Steep grade × Deceleration lane ✓ No intersection ✓ No shoulders × Moderate clear zone – No barriers ×	Divided, wide/raised median ✓ Divided, wide/raised median ✓ No intersection movements/conflict points that could result in HO crash ✓	No turning movements ✓ High speed × Protected turn lanes ✓	No. of lanes × Protected turn lanes ✓ Decel. lanes no longer needed ✓ Buses stopping ×	Service lane with footpath ✓ No crossing facilities at intersection ×	Service lane – some separation ✓ No crossing facilities at intersection ×	No delineation required ✓ Good sight distance ✓ Well surfaced ✓ Straight road ✓	
	2/4	0/4	1/4	2/4	4/4	4/4	2/4	
Severity	High speed × No barriers × Moderate clear zone –	High speed × Low speed in side road ✓	High speed × Few conflict angles ✓	High speed ×	High speed ×	High speed ×	High speed × Some roadside hazards ×	Total
	3/4	3/4	3/4	3/4	4/4	4/4	4/4	
Total	4 * 2 * 3 = 24/64	4 * 0 * 3 = 0/64	1 * 1 * 3 = 3/64	3 * 2 * 3 = 18/64	1 * 4 * 4 = 16/64	1 * 4 * 4 = 16/64	1 * 2 * 4 = 8/64	85/448

SSA eLite+


Safe System Assessment
Setting the Context
Basic Data Inputs Required (taken from the ANRAM INPUT SPREADSHEET and Crash Tool)
Existing Safe System Matrix Score (score and reasons for score (+) meaning a worse score and (-) meaning a better score) - (Exposure and Severity scores autopopulated but please overside with local knowledge)
ANRAM + OBSERVED = VALUES USED

Supporting Materials

- Austroads published AP-R509-16 *Safe System Assessment Framework in 2016* Framework document and VicRoads Guidelines (available on Austroads website: Publications | Austroads)
- QRSTUV: Guide to Safe System Assessment (2024) (available on TMR's technical publication website: QRSTUV: Guide to Safe System Assessment (Department of Transport and Main Roads)
- Safe System Assessment report template (available on TMR's technical publication website: QRSTUV: Guide to Safe System Assessment (Department of Transport and Main Roads)
- TMR's eLite+ Tool (available on request from TMR Safer Roads team)

Acknowledgements

All digital media, including photos and videos featured are property of TMR, with the exception of:

- Austroads (2016), *Safe System Assessment Framework*, Austroads Ltd.,Sydney. (Slides 13, 21, 23, 26-28, 30 and 32-36)
- Vicroads and Transport for Victoria (2018), *Safe System Assessment Guidelines v1.0*, Vicroads, Victoria (Slide 17)

Thank you and stay connected

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