NZ TRANSPORT AGENCY
WAKA KOTAHI

# MEMO

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| **To** | Norman Collier, James Kaye |
| **Cc** | Graham O'Connell |
| **From** | Safety and System Performance, System Design |
| **Date** | 18 February 2022 |
| **Subject** | Auckland Harbour Bridge shared path safety assessment |



**Purpose**
The project involves repurposing traffic lanes on the Auckland Harbour Bridge (AHB) for vulnerable road users.

**Recap**
Mid last year the infrastructure management consultancy, Resolve Group, was tasked with exploring possible options to utilise the existing structure to accommodate a shared path and create a pedestrian and cycle link. Subsequently Resolve Group in total have explored 11 options and provided a high-level input on indicative costing.

System Performance team and traffic modelling team at ASM have also carried out network analysis and options were provided.

**Learnings**
- Whilst the report identified 11 options, the options on the eastern side of AHB were preferred due to impact on the wider network resulting from ramp closures that occur with the western options.
- Structural capacity is an issue for some options and refinement of the analysis is needed to determine how the heavy vehicles will be managed for each option.
- Further refined analysis of user safety systems should be undertaken before implementing any option. These systems should work together to provide maximum protection for shared path users.

**Safe System Assessment (SSA)**
- A safe system assessment is an assessment of relative Death and Serious injury (DSi) risk (between options) for commonly occurring crash types. As the SSA uses a relative scoring system, it is used to compare options to each other, rather that used to meet a minimum standard.
- Using the SSA framework two options were assessed, Option 1: consisted of 1x south bound lane, & Option 2: consisted of 2x southbound lane. The above two options were compared against existing scenario.
- Existing scenario acted as a baseline scoring (33/448) over 1 lane option (214/448) and 2 lane option (202/448). Please refer to appendix for a detailed analysis carried out using Austroads recommended SSAF.
- Reasons for the deteriorated scores include:
    1. Northern Express (NEX) bus services will be forced to use bull run lanes, which are far narrower than clip-on lanes in 2 lane repurposing option. Buses are prone to yaw-steer (a well-known characteristic of single-box vehicles with a rear weight

bias), which increases their chances of colliding with the barrier or a bridge truss member.

2. NEX bus services will have to operate under bull run lane condition between a barrier and bridge truss even with the 1 lane repurposing option. Clip-on widths were better compared to bridge lanes, however NEX will still have to operate in a bull run conditions.
3. Cyclist vs cyclist head-on collision with impact speeds exceeding 60km/hr is highly likely. According to Austroads standards bicycle operating speeds for a 5% downhill, commuting traffic (85th percentile) could travel at 60km/hr downhill and 20km/hr uphill, while recreational traffic would travel at 15km/hr downhill and 5km/hr uphill.
4. Cyclist vs pedestrian high speed collision is highly likely due to the exposure (increase in volume).
5. Cyclist vs cyclist sideswipe or Cyclist vs e-scooters/skateboarders sideswipe is likely.

**Exclusions from the SSA**

1. All options involve severe weather risk, which cannot be assessed in the rapid SSA. Severe weather conditions also present dynamic risks for vehicles, cyclists and pedestrians. In this report cyclist aerodynamics is not considered in detail, therefore factors like headwind, tailwind and crosswinds are not discussed here in greater detail. Standards from UK shows that it becomes unfavourable conditions for cyclists when winds are over 20mph(32km/hr) and cycling becomes impossible at wind speeds of 40mph (64km/hr). As per Weather Watch website, Auckland City often have windy weather lingering longer all year round simply because of the Roaring Forties. Which is why Auckland has westerly or south-westerly winds/gusts all around the year that poses constant threat of closing the AHB for cyclists. Wild wing gust incident on AHB in the month of September 2020 occurred without a warning. Recurrence of such incidents will cause greater inconvenience to the vulnerable users who are already present on the AHB at that instance. Barriers may help reduce the wind effects to some extent, since winds get to 80km/hr speeds on AHB all around the year will pose a constant threat to operational safety of users.
2. Structural resilience is excluded from the rapid SSA – the reduction in the number of trafficable lanes will increase the usage (live load) on the truss structure and western side clip-on. The “two lanes” option will place the clip-ons under an eccentric load.

**Operational Safety Risks of the Proposal**

*Vehicle safety –*

- Less capacity to recover from congestion if there is a crash and less room for traffic to pass a site if there is a crash, leading to increased queue lengths which will necessitate more thorough and widespread delays. Likelihood of increase in weaving crashes.
- Two bull runs (in “one lane” option) can lead to reduced capacity and the onset of sudden braking and increased rear-end crash risk.

*Active mode safety –*

- Speed differentials between commuter traffic and e-cyclists downhills and recreational traffic uphill increases the severity of crashes. There is a high chance of a collision between opposing users in the one-lane scenario given the mixed

abilities of uphill users leading to passing in the uphill directions. This has already led to a serious crash on the north western shared path and is one of the most serious concerns here.

- 1xlane southbound option increases the risk of hitting roadside object at a speed greater than 25km/hr.
- The high operating speeds likely with the active modes create a serious risk to elderly and kids in collisions.
- Increased usage of micro-mobility (electric scooters and e-bikes) are capable of high speeds which create behaviour and stability issues. There is a surge in e-scooters usage in Auckland, which currently is not quantified and assessed due to lack of data. However, recent trends in pedestrian and e-scooter crashes are on the rise.
- Any crash will require containment and a 0.9m barrier will not contain a cyclist (due to a high centre of gravity) from overtopping the parapet or the dividing barrier between traffic active modes. These barriers usually required a minimum of 1.4m, but given the extreme danger and height, 1.6m is the minimum recommended.
- Emergency service needs access to attend to crash victims or medical incidents.
- Barriers should be high enough s 9(2)(g)(i)

*Infrastructure Safety* –

- Structural resilience – the reduction in the number of trafficable lanes will increase the live load on the truss structure and the western side clip-on.
- There will be less lateral space for vehicle trajectory correction in the event of high winds.
- NEX running in bull run lane increase the likelihood of a collision with the barrier or part of the truss structure.
- The 2x lane option will place the clip-ons under an eccentric load. With a higher density of traffic on the north bound clip-on and next to no load on the south bound clip-on, the fatigue resilience of the structures and their connections may require careful assessment.
- Bridge needs to be structurally assessed to ensure the additional load of either concrete barrier or steel barrier will be able to be supported by the bridge.

**Network Impact**

It will require a Herculean effort to reduce vehicle volumes across the Harbour Bridge to a level where the congestion caused by a 12.5% capacity loss (the one lane option) or a 25% capacity loss (two lane option) would have minimal effect. Long term traffic volume reduction is more likely to occur with a viable travel alternative for the displaced traffic, which the active mode facility is unlikely to provide. The result is likely to be greater redistribution of traffic onto the SH18/16 corridor and onto less suitable local streets. There is therefore likely to be a consequential reduction in safety through crashes.

**Recommendation**

This memo from Safety and System Performance team supports the Waka Board's decision given the complexities and consequences involved in repurposing the traffic lane. Major risks noted are in structural resilience, network impact, and a significant risk of a death or serious injury of active users. There are also unresolved operational risks of traffic management and incident management.

This memo however doesn't cover operational and reputational risk nor the legal or ITS requirement. Safety at the tie-ins at either end of the bridge are not covered in this memo.

## Appendix A

### Safe System Assessment Framework (SSAF)

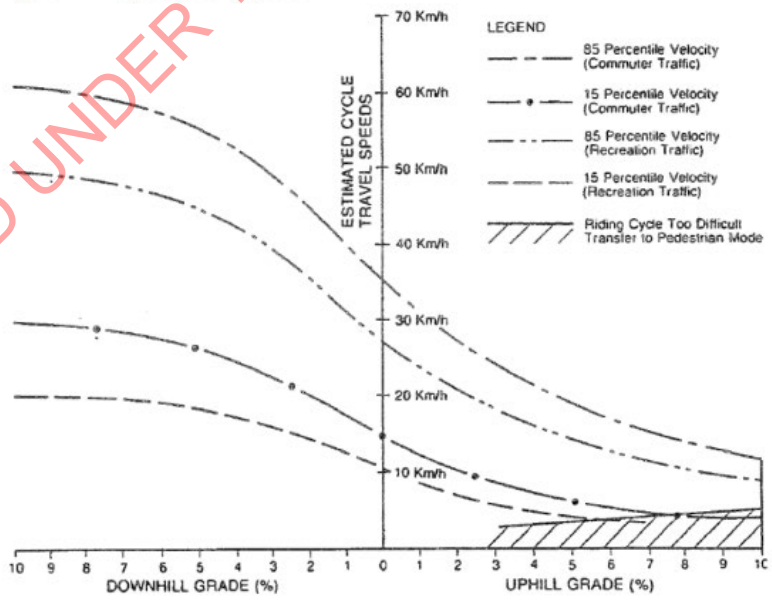
The rapid SSAF process is based on Austroads Safe System Assessment Framework (Austroads 2016, Research Report AP-R509-16, *Safe System Assessment Framework*). For this assessment southbound (SBD) one lane vs SBD two lane option is compared.

AHB is an iconic structure that provides a critical function connecting Northshore to the City Centre yet performing a role of national significant corridor. AHB in its current operational conditions is providing excellent safety benefits due to the disciplined operations achieved via segregated direction of travel, barrier systems, straight alignment, ITS, signage and road markings, and monitored 24/7.

Austroads SSAF assessment needs to be modified slightly to meet the bespoke nature of the proposal. Therefore, following assumptions or amendments made:

1. Runoff – no change in runoff road type of crashes for existing situation, option 1 and option 2.
2. Head-on –
    a. For existing, this is not applicable,
    b. For option 1 and option 2 – cyclists head-on is considered. Under SSAF classification if impact speeds exceed 70 km/hr then a DSi is certain. Referring to Austroads bicycle operating speeds chart for a 6% gradient it is noted that commuter cyclists could reach up to 60km/hr speed on downhill. Recreational cyclist or physically not so fit cyclist speeds going uphill assumed to be 15-20km/hr. Narrow the SUP, risk of a head-on collision increases; wider the SUP operational speed increases but the likelihood would be somewhat reduced due to the increased sightlines.

**Figure 4.1: Bicycle operating speeds**




Further information regarding gradients for cyclists on paths can be found in AGRD06A (Austroads 2017c).

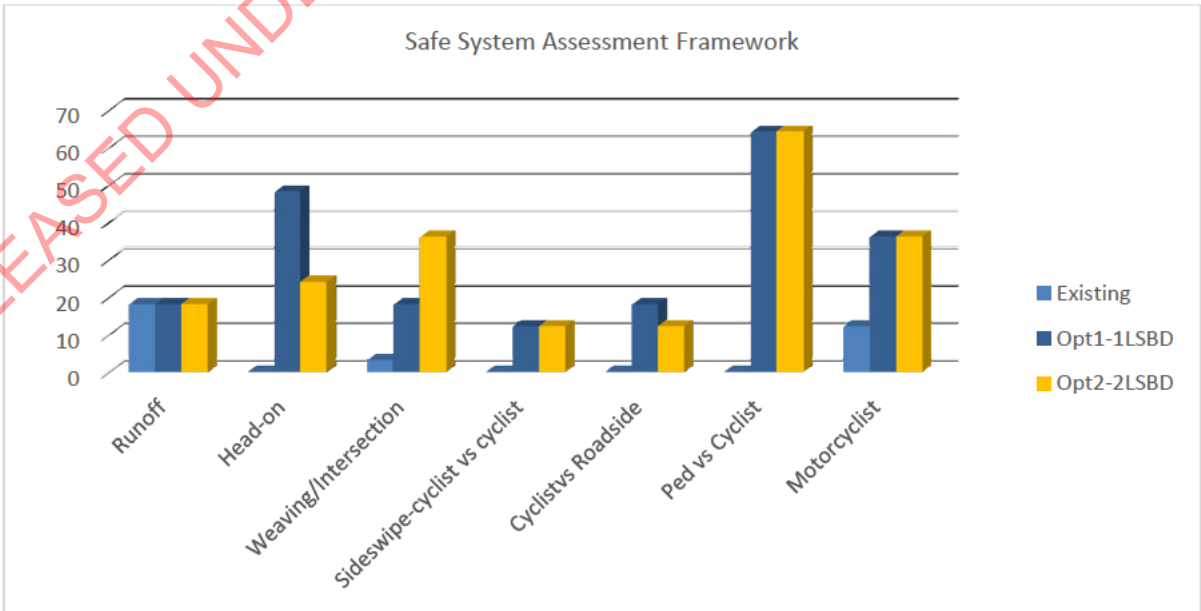
3. Intersection – for existing arrangement, this is not applicable.

4. Other – weaving and lane changing is considered. Modifications to lanes be made northern side of AHB to make the entry to the bicycle path safe. This includes tapered barriers and termination of bus lane from its existing termination point.
5. Cyclist – two additional scenarios envisaged,
    a. Side swiping – cyclist vs cyclist.
    b. Impact with roadside barrier (25km/hr operational speed is assumed to cause a serious injury to the cyclist), or cyclist vs e-scooter or skateboard.
6. Pedestrian – pedestrian vs cyclists vs e-scooters.
7. Motorcycle – mostly remain unchanged for existing condition, which is straight alignment. But in option 1 and option 2 scenarios, exposure and likelihood would increase due to the tapers added northern side of AHB.

The scoring exercise was carried out and the results are plotted in the chart below. For detailed scoring refer to tables provided at the end of this report.
Overall, option 1 – converting one lane SBD into an SUP shows worst results due to head-on likelihood and severity, and pedestrian vs cyclist crash severity.
Option 2– converting two lane SBD into a SUP still shows DSi risks associated with lane changing, cyclists sideswiping, pedestrians and cyclists, cyclists and e-scooters/skateboarders.

Point to be noted here that the scoring is likely to increase due to the addition of tie-ins safety scores.

**Assessment:**
The SSAF assessment is generally carried out on concepts to understand the nature of risks, likelihood of a DSi crash occurring and severity of the crash. This would give early indication to the decision makers indication whether the solution is fit-for-purpose or not. A high scoring defeats the purpose of the facility and a low scoring aligns to the Vision Zero strategy. In a bespoke design these scores provides an early opportunity to focus on eliminating those safety risks which has a potential to cause a DSi, and thus bringing the total score as close as possible to Zero from a score of 448.



Currently AHB is operating closer to that Zero value. By removing two lane SBD and repurposing it to SUP would worsen the safety score. This assessment only looks at the safety aspects of the options. Please note deduction of two lanes removes capacity of 1800veh/lane and adds that back into the queue. It is hard to measure the impact of losing those two lanes and any incident on WRR would add additional congestion onto the network.

The point highlighted here is that the temporary or interim solution that involves repurposing the existing facility is not build for vulnerable users purpose and it cannot be tailored to a great extent to make it safe for shared use path operations. In other words, there'll be crashes involving vulnerable users resulting in high severity outcome.

Key items excluded from the assessment:

1. In Option 2, North-western Express (NEX) buses will have to operate on narrow bull run lane. This would significantly increase the risk of a double decker bus hitting the main truss under the windy conditions. This will have a major implication to Auckland State Highway/Motorway network.
2. s 9(2)(g)(i)
3. Effect on net carbon – greenhouse gas emissions (GHG) due to shockwaves created over the network is hard to measure. SSAF don't take into consideration benefits of active modes vs motor vehicles.
4. Tie-in connections at Sulphur Beach, Tennyson underpass, Shelly Beach offramp, and Westhaven Drive, are not assessed.

## SSA Matrix – Existing Conditions

| | Run- off road | Head- on | Intersection | Other (lane changing/weaving) | Pedestrian | Cyclist | Motorcyclists |
|---|---|---|---|---|---|---|---|
| **Exposure Comments:** | Chances are low, there could be a possibility of run-off. High traffic volume. | Chances of a head-on is removed due to controlled access. | There are no intersections that'd enable a t-boning crashes. | Either end of the AHB weaving is minimised | Peds and cyclists prohibited on AHB | Peds and cyclists restricted on AHB | Motorcyclists exposure is slightly high considering severe weather or mechanical failure |
| **Exposure Score:** | 3/4 | 0/4 | 0/4 | 1/4 | 0/4 | 0/4 | 3/4 |
| **Likelihood Comments:** | Although, exposure from a runoff is high due to speed but the likelihood of that happening is unlikely. | Likelihood is nil. | Likelihood is nil. | Likelihood of weaving on AHB is unlikely, vehicle lane discipline is increased much before they enter AHB | Peds and cyclists prohibited on AHB | Peds and cyclists restricted on AHB | Observation shows motorcyclists impacting rear end of other vehicles, but likelihood are low |
| **Likelihood Score:** | 2/4 | 0/4 | 0/4 | 1/4 | 0/4 | 0/4 | 2/4 |
| **Severity Comments:** | Severity is medium high due to impact angles assumed in worst case scenario | Not applicable | Not applicable | Severity in a side swipe crash is moderate. | Not applicable | Not applicable | Severity is considered low due to insignificant data around severity. |
| **Severity Score:** | 3/4 | 4/4 | 0/4 | 3/4 | 0/4 | 0/4 | 2/4 |
| **Product (multiply scores above for crash type)** | **18/64** | **0/64** | **0/64** | **3/64** | **0/64** | **0/64** | **12/64** |
| | | | | | | **TOTAL** | **33/448** |

## SSA Matrix –Proposed shared use path - one lane southbound clip-on

| | Run- off road | Head- on Cyclist vs Cyclist | Other (lane changing/weaving) due to sup arrangement | Side sweeping - Cyclist vs Cyclist | Cyclist vs roadside hazard/barrier | Pedestrian vs Cyclist | Motorcyclists |
|---|---|---|---|---|---|---|---|
| **Exposure Comments:** 450-850 cyclists/day<br>100 peds/day | High traffic volume | High due to the gradient and wind factor. | Either end of AHB exposure for lane changing is increased. | Narrow lane increases the exposure. | Barriers segregating sup creates a risk of impact due to narrow width | Highly likely due to the tourists/peds vs commuter cyclists. | Exposure remains same. |
| **Exposure Score:** | 3/4 | 4/4 | ¾ | 3/4 | 3/4 | 4/4 | 4/4 |
| **Likelihood Comments:** | Remain same as highlighted in Table 1 | Highly likely based on the crash trends observed elsewhere on AKL's network | Onewa citybound onramp merger will have to be managed to protect sup users using barriers and lane modifications. | Occurs during peak hours and severe wind weather conditions/loss of ctrl. | Moderate to low occurrence - commuter cyclists avoid peds or in severe weather conditions | Highly likely based on the data and trends on AKL's SUP | Remains same as above. It is possible that likelihood would increase due to the lane change arrangement upstream and downstream of AHB |
| **Likelihood Score:** | 2/4 | 3/4 | 2/4 | 2/4 | 2/4 | 4/4 | 3/4 |
| **Severity Comments:** | Remain same as highlighted in Table 1 | Due to the 6% downhill gradient, assuming a worst-case scenario of 60km/hr cyclist hitting 15km/hr uphill cyclist would increase DSi risk | Severity at inter-peak or late night is moderate to high | Severity is moderate if there are multiple commuter cyclists are involved. | Any speed over 25km/hr would result in serious injury crash | Severity is high if an elderly or a kid is hit by a commuter cyclist travelling at 60km/hr downhill | Severity is moderate to high |
| **Severity Score:** | 3/4 | 4/4 | ¾ | 2/4 | 3/4 | 4/4 | 3/4 |
| **Product (multiply scores above for crash type)** | **18/64** | **48/64** | **18/64** | **12/64** | **18/64** | **64/64** | **36/64** |
| | | | | | | **TOTAL** | **214/448** |

**SSA Matrix –Proposed shared use path - two lane southbound clip-on**

| | Run- off road | Head- on Cyclist vs Cyclist | Other (lane changing/weaving) due to sup arrangement | Side swiping - Cyclist vs Cyclist | Cyclist vs roadside hazard/barrier | Pedestrian vs Cyclist | Motorcyclists |
|---|---|---|---|---|---|---|---|
| **Exposure Comments:** 450-850 cyclists/day 100 peds/day | Remain same as highlighted in Table 1 | Moderately high due to the gradient and wind factor | Either end of AHB exposure for lane changing is increased | Wider lane mitigates exposures however increases the speed | Wider path reduces the exposure given wider space | Highly likely due to the tourists/peds vs commuter cyclists | Exposure remains same. |
| **Exposure Score:** | 3/4 | 3/4 | ¾ | 2/4 | 2/4 | 4/4 | 4/4 |
| **Likelihood Comments:** | Remain same as highlighted in Table 1 | Likely, based on the crash trends. | Onewa citybound onramp merger will have to be managed to protect sup users using barriers and lane modifications. PT buses running in bull run creates a likelihood scenario of hitting the truss member in severe weather. | Occurs during peak hours and severe wind weather conditions/loss of ctrl. Also increases the likelihood of cyclist sideswiping skateboarders or e-scooters | Moderate to low occurrence - commuter cyclists avoid peds or in severe weather conditions | Highly likely based on the data and trends on AKL's SUP | Remains same as above. It is possible that likelihood would increase due to the lane change arrangement upstream and downstream of AHB |
| **Likelihood Score:** | 2/4 | 2/4 | 4/4 | 2/4 | 2/4 | 4/4 | 3/4 |
| **Severity Comments:** | Remain same as highlighted in Table 1 | Due to the 6% downhill gradient, assuming a worst-case scenario of 60km/hr cyclist hitting 15km/hr uphill cyclist would increase DSi risk | Severity at inter-peak or late night is moderate to low. | Severity is moderate to high due to the speeds | Any speed over 25km/hr would result in serious injury crash | Severity is high if an elderly or a kid is hit by a commuter cyclist travelling at 60km/hr downhill | Severity is moderate to high |
| **Severity Score:** | 3/4 | 4/4 | ¾ | 3/4 | 3/4 | 4/4 | 3/4 |
| **Product (multiply scores above for crash type)** | **18/64** | **24/64** | **36/64** | **12/64** | **12/64** | **64/64** | **36/64** |
| | | | | | | **TOTAL** | **202/448** |