flow TRANSPORTATION SPECIALISTS

technical note

PROJECT	**AUCKLAND SPEED MANAGEMENT PLAN**
SUBJECT	**HIGH LEVEL ECONOMIC ASSESSMENT OF STRATEGIC APPROACHES**
TO	**SPEED MANAGEMENT TEAM**
FROM	PHIL HARRISON
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DATE	19 DECEMBER 2022

1 SUMMARY

This Technical Note summarises the high level economic assessment of four strategic approaches to speed management around schools in Auckland. The economic assessment considers forecasts of crash reduction benefits in terms of savings in deaths and serious injuries (DSI), plus the forecast effects on travel times, vehicle operating costs and emissions. These are factored by the capital and maintenance costs of the approaches, to calculate expected Benefit: Cost Ratios (BCR).

The four approaches evaluated, and the estimated benefits and economic impacts are:

- Approach 1: 30 km/h permanent speed limits on all non-arterial roads within 1,000m of a school gate; 30 km/h variable speed limits all arterial roads within 400m of a school gate; plus 40/30 km/h permanent speed limits on 30 selected high risk arterial roads across Auckland. This approach is forecast to save **539 DSI** over the next 10 years and has an estimated **BCR of 9.0**
- Approach 2: As approach 1 without the additional arterial roads. This approach is forecast to save **468 DSI** over the next 10 years and has an estimated **BCR of 7.0**
- Approach 4: 30 km/h permanent speed limits on all non-arterial roads within 400m of a school gate and 30 km/h variable (eg 30 mins before and after school) speed limits on all arterial roads within 400m of a school gate. This approach is forecast to save **184 DSI** over the next 10 years and has an estimated **BCR of 3.6**
- Approach 5: 30 km/h variable speed limits during school start and end periods on all roads within 400m of a school gate. This approach is forecast to save **29 DSI** over the next 10 years and has an estimated **BCR of 0.2.**

Note that a BCR for Approach 3 was not requested. Approach 3 is a mixture of 30km/h permanent speed limits on local roads with a school in the residential block, and 40km/h permanent speed limits on in residential blocks without a school.

The expected outcomes of the approaches are summarised in Table 1.1.

Table 1.1 Expected Outcomes of Approaches				
	Approach 1	**Approach 2**	**Approach 4**	**Approach 5**
Average Trip time increase	14.2 seconds*	13.9 seconds*	12 seconds**	12 seconds***
DSI Savings (10 years)	**539**	**468**	**184**	**29**
DSI Savings / $100m	**1344**	**1248**	**590**	**65**

*Network wide, all day times **For journeys within school zone, ***For journeys within school zone during variable operating

The economic analysis is summarised in Table 1.2.

Table 1.2 Economic Assessment, Present Values ($million)				
	Approach 1	**Approach 2**	**Approach 4**	**Approach 5**
Travel Times	-$663	-$631	-$154	-$30
Vehicle Operating Costs	$222	$197	$7	$0.2
Emissions	$46	$39	$0.4	$0.001
Crash Costs	$758	$658	$258	$40
Total Benefits	**$362**	**$263**	**$112**	**$11**
Construction Costs	$24.2	$22.7	$18.9	$26.8
Maintenance Costs	$15.8	$14.8	$12.3	$17.5
Total Costs	**$40.1**	**$37.5**	**$31.2**	**$44.3**
Benefit/Cost Ratio	**9.0**	**7.0**	**3.6**	**0.2**
DSI Savings (10 years)	**539**	**468**	**184**	**29**
DSI Savings / $100m	**1344**	**1248**	**590**	**65**

2 INTRODUCTION

Auckland Transport commissioned Flow Transportation Specialists to provide a high level economic assessment of four potential strategic approaches to the next phase of speed management for Auckland roads and streets.

The assessment follows the procedures set out in the NZ Transport Agency's Monetised Benefits and Costs Manual (MBCM). It is worth noting that this is a high-level economic assessment, which compares the approaches considered against the Do Minimum scenario. This note is not intended as an economic assessment for funding purposes, as the Waka Kotahi procedures for safety projects involving reduced speed limits do not require the calculation of impacts on travel time.

The following approaches have been suggested this time:

- Do Minimum: This includes Phases 1-3 of speed limit reviews, implemented between June 2020 and June 2023.
- Approach 1: 30 km/h permanent speed limits on all non-arterial roads within 1,000m of a school gate and 30 km/h variable speed limits during school start and end periods on all arterial roads within 400m of a school gate, plus introducing 40 km/h (and some 30 km/h) permanent speed limits on 30 selected high risk arterial roads across Auckland. These road sections are listed in Appendix A
- Approach 2: 30 km/h permanent speed limits on all non-arterial roads within 1,000m of a school gate and 30 km/h variable speed limits during school start and end periods on all arterial roads within 400m of a school gate
- Approach 3: The Christchurch model which proposes a mixture of 30 km/h and 40 km/h zones. This approach has not been assessed in this report
- Approach 4: 30 km/h permanent speed limits on all non-arterial roads within 400m of a school gate and 30 km/h variable speed limits during school start and end periods on all arterial roads within 400m of a school gate
- Approach 5: limited to meeting the requirement of the Land Transport Rule: 17 Setting of Speed Limits 2022, and involves introducing 30 km/h variable speed limits during school start and end periods (typically 08:25 to 08:55 and 14:55 to 15:15 weekdays) on all roads within 400m of a school gate

Maps showing the approximate extents of coverage of each approach are included in Appendix B.

3 CRASH REDUCTION BENEFITS ASSESSMENT

The assessment has considered the potential crash cost savings associated with the various approaches.

3.1 Crash History

The Crash Analysis System (CAS) database was interrogated for crash records during the five-year period from 1 January 2017 to 31 December 2021, and these crash records were used to calculate the expected crash costs of all Auckland Transport roads, for the Do Minimum scenario. Is it worth acknowledging that this includes periods of COVID lockdowns, but the analysis provides a conservative, like for like comparison.

The expected annual crash reductions for each of the Approaches proposed have also been calculated as follows:

- For all Approaches, crashes that occurred on roads where the speed limit is lowered to 30 km/h within Phases 1-3 of the speed management programme were filtered out. The roads covered by 30 km/h limits in Phases 1-3 are shown in Appendix C
- For Approach 1, the crash history for the last five years on those local roads within 1000m of a school gate was identified. For arterial roads, these crashes were further filtered to identify only those crashes that occurred between the hours of 08:25 and 08:55 and 14:55 and 1515 on weekdays., with the addition of all crashes that occurred on the selected arterial road lengths over the five year period
- For Approach 2, the crash history was as per Approach 1 with the removal of the selected arterial roads.
- For Approach 4, the full crash history for the last five years on those local roads within 400m of a school gate was identified. For arterial roads the crash history was the same as for Approach 5. To account for crashes that occurred during school and public holidays and therefore would not be addressed by school variable speed limits, the number of recorded crashes on the arterial roads was factored by 75%.
- For Approach 5, the crash history for the last five years on those roads within 400m of a school gate was identified. These crashes were further filtered to identify only those crashes that occurred between the hours of 08:25 and 08:55 and 14:55 and 15:15 on weekdays to represent the typical operating hours of a school variable speed limit, again factored by 75%.

A summary of the number of crashes and deaths and serious injuries (DSI) (5 years) on those roads (and time periods where applicable) that would be included within each Approach is provided in Table 3.1. The DSI equivalent (DSI eq) figure has been estimated by factoring the total number of injury crashes by 0.21.

Table 3.1: Crash history (2017-2021) included within each Approach				
	Approach 1	**Approach 2**	**Approach 4**	**Approach 5**
Injury Crashes	3819	2930	1151	179
Fatal Crashes	43	27	10	1
Serious Crashes	595	457	176	24
Minor Crashes	3181	2446	965	155
Total DSI	697	529	203	27
ARU DSI	214	153	68	15
DSI eq (mid)	**803**	**616**	**242**	**38**

The above table illustrates the wide range in the historic number of crashes, deaths and serious injuries that the four approaches would address.

We note that while approaches 4 and 5 both cover roads within 400m of a school gate, the DSI equivalent of approach 5 is around 15% of approach 4. This indicates that around 85% of the DSI that occurs within 400m of a school gate, occur when variable school signs are not expected to be operating.

3.2 Crash Reduction Factors

The forecast crash reduction potential of each Approach has been assessed using crash modification factors (CMF) consistent with the Wellington City Council's speed management plan economic assessment as detailed in Table 3.2. Note that a 0.81 CMF equates to a 19% reduction in crashes. Sensitivity testing has been undertaken to examine the effects of lower or higher crash reduction assumptions.

Table 3.2: Crash modification factors (Wellington CC December 2021)		
Intervention	**CMF**	**Rationale/Source**
50 km/h to 40 km/h	0.81	Differences in differences analysis of implementation of lower speed limit from 50 km/h to 30 km/h in town centres in Wellington City. CMF assumed to be half value of 50 km/h to 30 km/h change. Methodology outlined in *LGWM Safer Speeds Case for Change (2019)*
50 km/h to 30 km/h	0.62	Differences in differences analysis of implementation of 30 km/h zones implemented in Wellington City. Methodology outlined in *LGWM Safer Speeds Case for Change (2019)*

The benefits assessment has focussed on the DSI equivalent (DSI eq) number addressed by each approach. The forecast five year reduction in crashes is summarised in Table 3.3 for the central benefits range from Table 3.2 and also shows the sensitivity testing that we have done, using 20% higher and 20% lower crash reduction forecasts.

Note that for Approach 1, the arterial roads included have been assessed for crash reduction using the 50km/h to 40 km/h crash modification factor, even though some of these within town centres may be 30 km/h. This would result in a conservative estimate of the crash benefits for this option.

Table 3.3: Forecast five year crash reduction range by approach				
	Approach 1	**Approach 2**	**Approach 4**	Approach 5
Total DSI eq addressed	803	616	242	38
Central	**269**	**234**	**92**	14
20 % Higher	401	308	121	19
20% Lower	183	117	46	7

In annual terms, the central forecast is that the following DSI savings would be expected each year post implementation (Table 3.4).

Table 3.4: Forecast annual DSI saving by Approach				
	Approach 1	**Approach 2**	**Approach 4**	Approach 5
Central DSI reduction	53.9	46.8	18.4	2.9

At the current social cost of approximately $1.1 million per DSI, the annual crash reduction benefits are summarised in Table 3.5.

Table 3.5: Forecast annual DSI saving benefit by Approach				
	Approach 1	**Approach 2**	**Approach 4**	**Approach 5**
Central DSI savings / year	**$59.3m**	**$51.5m**	**$20.2m**	**$3.1m**
Range (Low-High)	$47.2m - $71.1m	$41.1 – $61.8m	$16.2 - $24.2m	$2.5 - $3.8m

3.3 Future Crash reduction forecasts

The economic analysis of the approaches has used a 20 year forecast benefit period. We recognise the range of road safety improvements expected across New Zealand over the next 20 years associated with vehicle safety improvements and network safety improvements associated with Road to Zero initiatives. Consequently we have assumed that there will be a gradual reduction in the number of deaths and serious injuries across Auckland, with or without the speed management plan, and not assumed further benefits beyond 20 years.

To account for this we have reduced the forecast crash savings benefit by 1% per year over the 20 year benefit period in calculating the net present value.

4 TRAVEL TIME ASSESSMENT

4.1 Approaches 1 and 2

4.1.1 Methodology

The impact of lower speed limits on travel times has been estimated for Approaches 3 and 4 using the Auckland Forecasting Centre's (AFC) Macro Strategic Model (MSM) as the only suitable tool available which covers the entire region.

The MSM model covers all the state highway, arterial and collector road network but does not include all local and access roads. However, the vast majority of the kilometres driven in Auckland are on roads included within the model and the local roads that are not included are expected to see only small reductions in average speed as a result of the lowered speed limits due to existing speeds being relatively low and the road lengths being relatively short.

The only current forecast model year is 2031, which assumes transport network upgrades included in the current Regional Land Transport Plan. All tests were undertaken for this year, with the current forecast growth scenario (named I11.6). Modelling was undertaken in the am and pm peak periods and the interpeak.

Three MSM tests were specified to assess the impacts of Approaches 1 and 2 as follows:

Test 1:

Do Minimum scenario which included changing the free flow speeds on all links included in Phases 1-3 of the speed management programme. Based on international experience, the modelled free flow speed reduction has been estimated as a 3.5% reduction in average speed for every 10% reduction in posted speed limit, for example a speed limit reduction from 50 km/h to 30 km/h (40% reduction) would result in a 14% reduction in average speed. This affected 2,180 model links.

Test 2: (Approach 2)

This test simulated Approach 2 and lowered modelled free flow speeds on 5,600 links within 1000m of a school (except arterial roads)

Test 3: (Approach 1)

As Test 2, plus lowered speed limits (30 and 40 km/h) on 470 arterial road links covering the sections as listed in Appendix A.

4.1.2 Modelling Outputs

The results of the MSM modelling of the three options are summarised in Table 4.1.

Table 4.1: Approaches 1 and 2 MSM modelling outputs			
AM Peak			
	Do Minimum	Approach 1	Approach 2
Veh Km Travelled (/2hr)	6,561,024	6,537,798	6,539,320
Veh Minutes (/2hr)	11,098,193	11,203,380	11,209,534
Vehicle trips (/2hr)	618,162	616,972	617,069
Av Trip length (km)	11.37	11.36	11.36
Av trip time (min)	19.23	19.47	19.48
Av trip speed (kph)	35.47	35.01	35.00
Interpeak			
	Do Minimum	Approach 1	Approach 2
Veh Km Travelled (/2hr)	5,669,726	5,660,194	5,661,288
Veh Minutes (/2hr)	7,450,544	7,550,557	7,547,215
Vehicle trips (/2hr)	574,036	573,172	573,264
Av Trip length (km)	10.83	10.84	10.84
Av trip time (min)	14.23	14.46	14.45
Av trip speed (kph)	45.66	44.98	45.01
PM Peak			
	Do Minimum	Approach 1	Approach 2
Veh Km Travelled (/2hr)	7,005,172	6,978,755	6,979,532
Veh Minutes (/2hr)	11,639,626	11,763,704	11,760,977
Vehicle trips (/2hr)	668,317	667,085	666,991
Av Trip length (km)	11.29	11.28	11.29
Av trip time (min)	18.76	19.02	19.02
Av trip speed (kph)	36.11	35.59	35.61

4.1.3 Interpreting the Outputs

The MSM modelling indicates that on a Region-wide basis the proposed lower speed limits with Approaches 1 and 2 will only have a modest impact on the network wide statistics. A large factor in this result is the high proportion of vehicle kilometres that is travelled on Auckland's motorways, state highways and arterial roads which is unchanged by the proposals, apart from a small number of arterial roads in Approach 1.

The modelling indicates the following effects:

- The total vehicle kilometres travelled are predicted to decrease by between 0.15% and 0.38%. The reduced number of vehicle trips is partly from increased rail and ferry trips, as the MSM model is able to assign trips to different modes where the relative travel costs are lower. However the MSM model does not include walking ad cycling modes so it cannot reassign trips to those modes.
- The total time spent driving increases by between 0.95% and 1.34%
- The total number of vehicle trips decreases by between 0.13% and 0.20%
- The average trip length stays within 10 metres of the Do Minimum at between 10.3 and 11.4 km.
- The average trip time increases by between 13.4 and 15.4 seconds on an average trip time of between 14 and 19 minutes.
- The average trip speed (35-45km/h) decreases by between 0.5 and 0.7 km/h

4.1.4 School Travel Mode Shift

In Auckland, about 120,000 children are driven to and from school each day, equating to about 100,000 vehicle trips on the network. We expect that providing 1,000 m safe speed neighbourhoods around all schools will result in some of those car trips being avoided with children being able to walk scoot or cycle to school in a lower speed environment. As the MSM model is unable to predict this shift, we have assumed a moderate target of 10% of these drive to school trips will change to walk and cycle trips and we have applied the consequent reductions in vehicle travel in the am and inter peak periods to the economic assessment.

4.1.5 Results

Using this methodology, the estimated effect of Approaches 1 and 2 on network travel times is summarised on Table 4.2.

Table 4.2: Forecast Travel time changes Approaches 1 and 2		
Parameter	**Approach 1**	**Approach 2**
Additional Travel time hours / day	6,156	5,939
Additional Travel time cost $/Day	$162,500	$155,900
TT Cost per year	$48,942,000	$46,571,000

4.2 Approaches 4 and 5

Approach 5 is limited to lower variable speed limits (30 km/h) for 400m around schools. The lower speed limits tested were signs operating for 30 minutes in the morning (typically 08:25 to 08:55) and 20 minutes in the afternoon (typically 14:55 to 15:15). Approach 4 would introduce permanent 30 km/h limits on all local roads within the same area, with variable speed limits on the arterial roads within the catchments.

4.2.1 Methodology

Of the approximately 500 schools in Auckland, there are approximately 180 whose adjacent road network within 400m is already substantially covered by 30 km/h speed limit areas (including Phase 3). We have therefore based the assessment on an estimated 320 individual school zones.

Many other schools are combined into tight clusters, whose walkable 400m zones would be identical or substantively overlap. To estimate the average lengths of arterial and local roads around Auckland schools, and the average traffic flows on each, analysis of the 400m walkable catchment around six schools / school clusters was completed. The six school zones used were spread across Auckland to cover a range of neighbourhoods. The Mobile Road website was used to retrieve traffic flows on the roads around the schools. The six areas and the characteristics used to assess the economic inputs are summarised on Table 4.3.

Table 4.3: Schools assessed and surrounding road and traffic data							
School(s)	**Manurewa High / Homai Sch**	**Glenfield College**	**Buckland Beach Cluster**	**Kaipara College / Helensville School**	**Pukekohe High /nt**	**Clevedon School**	Average
Schools	2	1	4	2	2	1	2
Road Length Tot	2050	1500	5550	4410	4350	1640	3250
Length / School	1025	1500	1388	2205	2175	1640	1655
Length Arterial	1100	1130	1600	0	2190	940	1160
Length Local	950	370	3950	2205	2160	700	1723
AADT Arterial	11990	10119	10203	n/a	10357	3357	9205
AADT Local	1584	780	1571	1175	2432	410	1325
Length Arterial /school	550	1130	400	0	1095	940	686

Length Local /school	475	370	987.5	1102.5	1080	700	786

In summary, the adopted factors used in assessing the travel time impacts of Approaches 4 and 5 are:

- Number of schools included 320
- Average Length of road in 400m school zone 1.655 km
  - Of which arterial 0.686 km
  - Of which local 0.786 km
- Average daily traffic on Arterial roads 9,205 vpd
- Average daily traffic on Local Roads 1,325 vpd

To calculate the additional travel time on the roads around schools in Approaches 4 and 5, the following parameters have also been adopted (Table 4.4). The average speed reduction has been estimated as a 3.5% reduction in average speed for every 10% reduction in posted speed limit (reference), hence a speed limit reduction from 50 km/h to 30 km/h (40% reduction) would result in a 14% reduction in average speed within the school zone. The values of time are taken from the MBCM and represent and average vehicle and its occupants, the value changes in different time periods reflecting a different mix of trip purposes.

Table 4.4: Approach 4 and 5 travel time assessment parameters

Parameter	**Approach 4**		**Approach 5**	
	Arterial	**Local**	**Arterial**	**Local**
Do min average speed km/h	50	40	50	40
Approach average speed km/h	43	34.4	43	34.4
Hours per day	0.5 morning, 0.33 afternoon	24	0.5 morning, 0.33 afternoon	
Days per year	180	365	180	
Value of time ($ per vehicle hour)	$24.06 morning, $28.54 afternoon	$25.81	$24.06 morning, $28.54 afternoon	

The forecast mode shift discussed under Approaches 1 and 2 would also be expected under Approaches 4 and 5, albeit to a substantially lesser extent. Approach 4, with permanent 400m safe speed zones around schools, is expected to result in some transfer of school run trips from car to walking, cycling or micro-mobility modes. Compared to the 10% of car school run trips forecast to transfer in Approaches 1 and 2, a more modest 2% shift has been assumed in Approach 4 and 1% for Approach 5.

4.2.2 Results

Using this methodology, the estimated effect of Approaches 4 and 5 is summarised in Table 4.5.

Table 4.5: Travel time Economic Assessment Results

Parameter	**Approach 4**		**Approach 5**	
	Arterial	**Local**	**Arterial**	**Local**

Additional Travel time hours / day	282	1,036	348	113
Additional Travel time cost $/Day	$7,300	$26,700	$8,900	$2,900
TT Cost per year	$1,315,000	$9,763,000	$1,603,000	$526,000
Approach TT Cost per year	$11,078,000		$2,130,000	

5 VEHICLE OPERATING COST SAVINGS

Vehicle operating cost (VOC) differences are derived as a result of changes in travel distances, or due to differences in travel speeds. VOC per kilometre values have been derived from the MBCM.

For Approaches 1 and 2, the forecast changes in vehicle kilometres travelled from the MSM model, together with the expected mode shift of journey to school trips as detailed previously, were used to calculate the change in annual vehicle operating costs across the region. For the purpose of determining change to vehicle kilometres driven, each journey to school trip has been assumed to be 1.5km on average, noting some trips will be "there and back again" while others will be linked trips which may include a diversion of a parent/caregiver's journey to work.

For Approach 4, the predicted 2% mode shift to walking and cycling for journey to school trips was applied to the Do Something vehicle km travelled in the am and inter peak periods on weekdays, while a 1% reduction was assumed for Approach 5. For both approaches, the MBCM forecasts a slightly higher cost per kilometre at lower travel speeds, which have been used in the BCR calculation, despite emerging international evidence that lower speed limits in urban areas have a neutral or potentially lower fuel use effect. The forecast vehicle operating costs for each approach are summarised on Table 5.1.

Table 5.1: Forecast vehicle operating cost savings by Approach

	Approach 1	**Approach 2**	**Approach 4**	Approach 5
AM peak	$12,400	$11,900	$860	-$110
Inter peak	$7,600	$7,250	$1,270	$180
PM peak	-$2,700	-$3,000	-$350	$0
Daily	$47,600	$45,100	$6,690	$74
Annual	$15,294,000	$14,535,000	$380,000	$13,300

6 EMISSIONS BENEFITS

For Approaches 1 and 2, emissions were calculated directly from the MSM outputs including mode shift assumptions, applying MBCM parameters for the emission and value of PM10, CO_2, CO and NOx emissions. For Approaches 4 and 5, a small emissions benefit are expected as a result of small reductions in vehicle kilometres travelled, and in line with MBCM these have been assessed as 5% of the vehicle operating cost change. The forecast annual saving from emissions reductions for each option is summarised in Table 6.1. Auckland Transport has commissioned further research into the likely emissions effects of lowered speed limits, expected to be complete early in 2023.

Table 6.1 Forecast emissions cost savings by Approach				
Item	**Approach 1**	**Approach 2**	**Approach 4**	**Approach 5**
Annual savings	$3,287,000	$3,111,000	$25,000	$700

7 WALKING AND CYCLING BENEFITS

No walking and cycling benefits have been assumed for this assessment. As noted in previous sections we expect that lower speeds will result in increased use of active modes and including the resulting health benefits would increase the economic benefits of Approaches 1 and 2 in particular, and Approaches 4 and 5 to a lesser extent.

8 RELIABILITY BENEFITS

No reliability benefits have been assumed for this assessment. Approaches 1 and 2 could be expected to have a benefit on travel time reliability by reducing the number of short school run car trips on the network in the am peak period.

9 COSTS

The following sections identify the main implementation and maintenance costs, and how these have been assessed.

9.1 Cost Inputs

To estimate the number of variable and static signs required for each approach, the sample schools used in the Approach 1 and 2 travel time forecast calculations were analysed to calculate the average number of variable and static signs required for each of the 320 schools under each approach.

The following information was used to build up the cost estimates:

- Signs (including installation)
  - R1-6 Variable school zone $13,000 each
  - R1-6.1 static school zone $1,200 each
  - R1 “30” pair $1,200 each
  - R1 “50” $600 each
- Threshold Treatments $20,000 each
- School Controller Upgrades $5,000 each
- Investigation and Design 10%
- AT Costs (inc consultation and legal) 20%
- Monitoring and Evaluation 10%
- Contingency 30%

The calculated infrastructure requirements for each option are summarised in Table 9.1.

Table 9.1 Infrastructure assumptions by Approach

Item	Approach 1	Approach 2	Approach 4	Approach 5
Variable signs R1-6	372	384	540	940
Static school signs R1-6.1	-	-	1260	860
R1 fixed signs	8080	7760	1800	1800
School controller upgrades	320	320	320	320
Threshold Treatments	43	0	0	0

The estimated total implementation cost for each approach is provided in Table 9.2 below:

Table 9.2 Construction Cost Summary

	Approach 1	Approach 2	Approach 4	Approach 5
Construction Base	$ 14,409,600.00	$ 13,460,800.00	$ 11,212,000.00	$ 15,932,000.00
Investigation and Design (10%)	$ 1,440,960.00	$ 1,346,080.00	$ 1,121,200.00	$ 1,593,200.00
AT Costs (20%)	$ 2,881,920.00	$ 2,692,160.00	$ 2,242,400.00	$ 3,186,400.00
Monitoring and Evaluation 10%	$ 1,440,960.00	$ 1,346,080.00	$ 1,121,200.00	$ 1,593,200.00
Contingency (30%)	$ 6,052,032.00	$ 5,653,536.00	$ 4,709,040.00	$ 6,691,440.00
Total Estimate	**$ 26,225,472.00**	**$ 24,498,656.00**	**$ 20,405,840.00**	**$ 28,996,240.00**

The scenario tested assumed construction starting in July 2023 and taking three years, so the costs are assumed to be incurred equally over the three year period 2023-2026.

9.2 Maintenance Costs

As signs are subject to damage and in the case of the electronic variable message signs used for school variable limits technological breakdown, the entire signage is assumed to have an effective life of 20 years. Thus an annual maintenance cost of 5% of the installation cost has been included to allow for renewal and repair.

10 ECONOMIC ASSESSMENT

Implementation is assumed to be undertaken over three years, equally divided, thus both costs and benefits are presumed to accumulate in 1/3 steps over the three years.

10.1 Future Traffic forecasts

As noted, the travel time assessment has used 2031 forecasts for travel demands. The 2031 peak hour traffic forecast is about 15% higher than the 2016 base, consequently we have reduced the traffic demand by 1% per year to calculate the economic effects between 2023 and 2031 in terms of travel time, vehicle operating costs and emissions.

Beyond 2031, we have not assumed any further traffic growth to the end of the 20 year benefit period.

Table 10.1 below sets out the costs and benefits of these Approaches over the assessed 20 year return period.

Table 10.1: Economic Assessment, Present Values (millions)

	Approach 1	Approach 2	Approach 4	Approach 5
Travel Times	-$663	-$631	-$154	-$30
Vehicle Operating Costs	$222	$197	$7	$0.2
Emissions	$46	$39	$0.4	$0.001
Crash Costs	$758	$658	$258	$40
Walking and Cycling	-	-	-	-
Reliability	-	-	-	-
Total Benefits	**$362**	**$263**	**$112**	**$11**
Construction Costs	$24.2	$22.7	$18.9	$26.8
Maintenance Costs	$15.8	$14.8	$12.3	$17.5
Total Costs	**$40.1**	**$37.5**	**$31.2**	**$44.3**
Benefit/Cost Ratio	**9.0**	**7.0**	**3.6**	**0.2**
DSI Savings (10 years)	**539**	**468**	**184**	**29**
DSI Savings / $100m	**1344**	**1248**	**590**	**65**

10.2 Sensitivity Tests

As mentioned in section 3, we have completed sensitivity testing using the 20% higher and 20% lower crash modification factors.

The results of these tests are shown in Table 10.2.

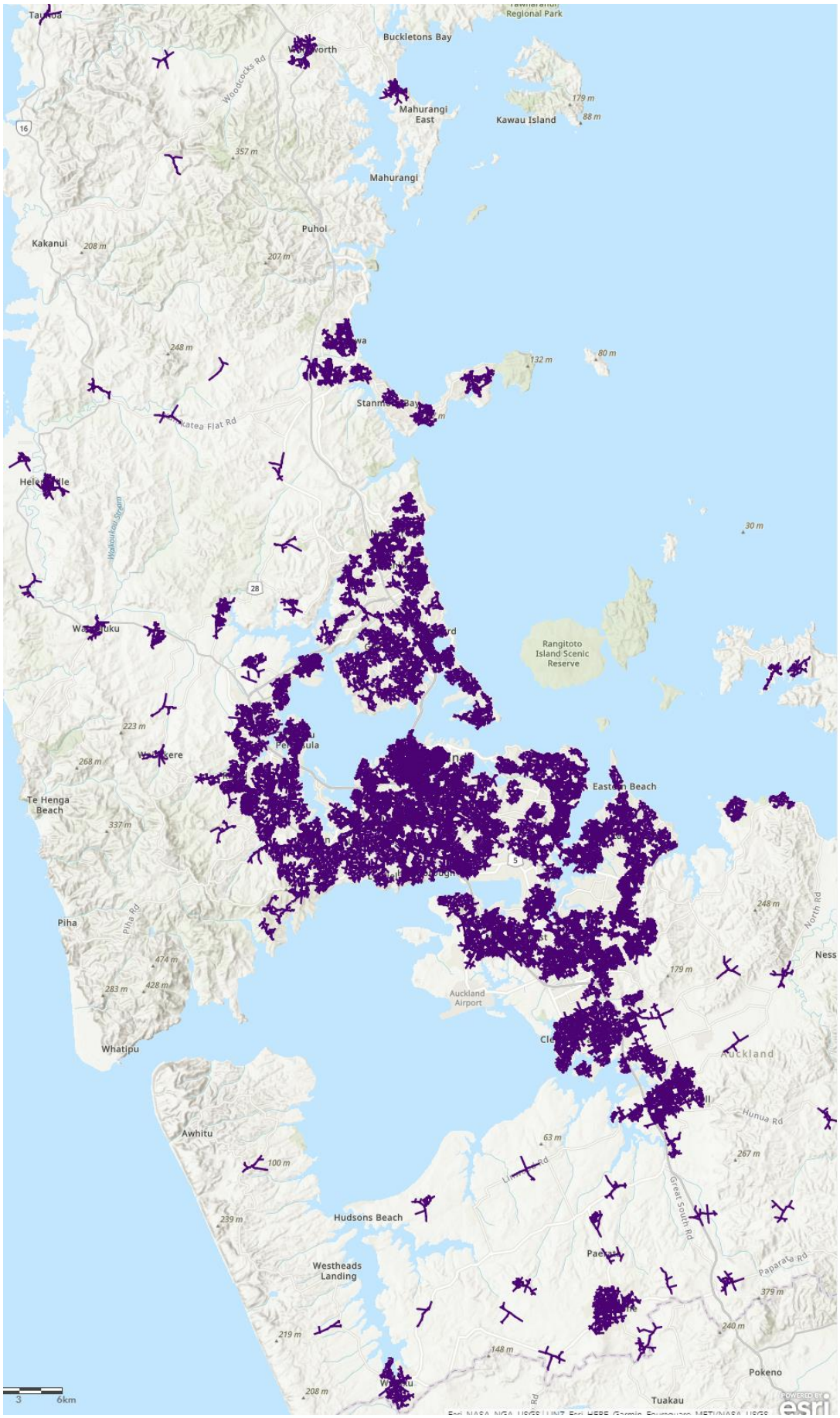
Table 10.2: Sensitivity Economic Assessments, Present Values (millions)				
	Approach 1	**Approach 2**	**Approach 4**	**Approach 5**
Crash Costs - Central	$758	$658	$258	$40
Crash Costs – Low	$607	$527	$207	$32
Crash Costs – High	$910	$790	$310	$48
Benefit/Cost Ratio - Central	**9.0**	**7.0**	**3.6**	**0.2**
Benefit/Cost Ratio - Low	**5.3**	**3.5**	**1.9**	**0.1**
Benefit/Cost Ratio - High	**12.8**	**10.5**	**5.2**	**0.4**

Appendix A – List of High Risk Arterial Roads included in Approach 1

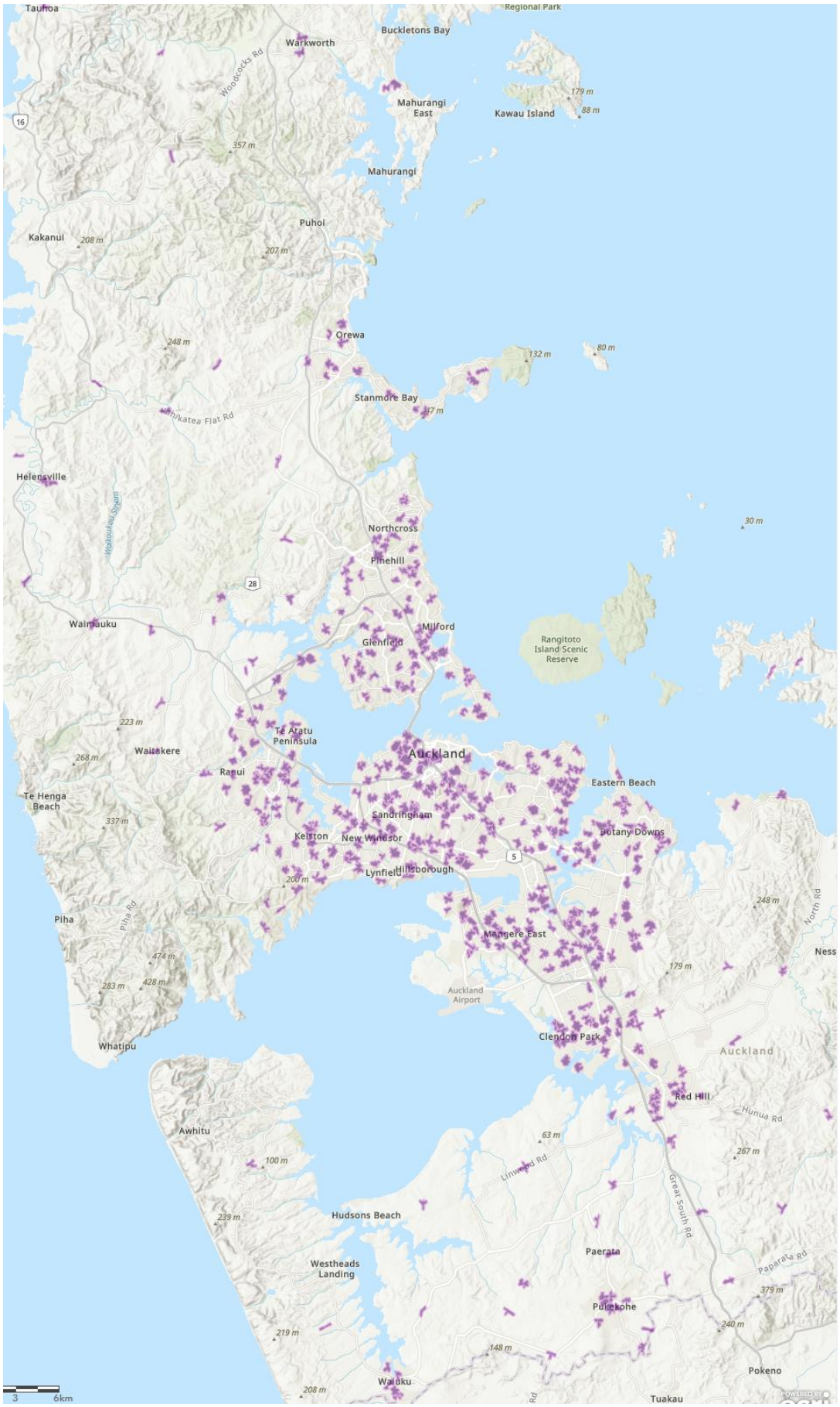
Road Name	Local board	Road section description	Speed limit scenario tested
Mt Eden Road	Albert Eden	New North to Normanby Rd	30
		Normanby Rd to Valley Rd	40
		Valley Road to Grange Road	30
		Grange Road to Balmoral Road	40
Dominion Road	Albert Eden	Horopito Street to Grange Road	30
		Grange Road to Balmoral Road	40
		Balmoral Road to Marsden Ave	30
		Marsden Ave to Landscape Road	40
Woodward Road	Albert Eden	full length	40
New North Road	Albert Eden	Woodward Rd to Asquith Ave	30
		Asquith Ave to Kingsland Ave	40
		Kingsland Ave to Mostyn Street	30
Manukau Road	Albert Eden	between Broadway and Empire Road	40
Great South Road	Albert Eden	between Broadway and Main Hwy	40
Green Ln W	Albert Eden	between Manukau Road and Great south Road	40
Browns Road	Manurewa	full length	40
Russell Road	Manurewa	full length	40
Great South Road	Manurewa	between Kelvyn Gr and 100m south of Alfriston Road	30
	Manurewa	between 100m south of Alfriston Road and Mahia Road	40
Tripoli Road	Maungakiekie Tamaki	full length	40
Symonds St	Waitemata	between Grafton Bridge and Newton Road	30
College Hill	Waitemata	full length (between Victoria St W and Ponsonby Road)	40
Newton Road	Waitemata	between Ponsonby Road and Symonds St	40
Williamson Ave	Waitemata	full length	40
Great North Road	Waitemata	between Coleridge St and Surrey Cres	30
	Waitemata	between Surrey Cres and Point Chevalier Road	40
Gladstone Road	Waitemata	full length	40
St Stephens Ave	Waitemata	between Gladstone Road and Parnell Road	40
Parnell Road	Waitemata	between Parnell Rise and Saint Stephens Ave	30
	Waitemata	between Saint Stephens Ave and Maunsell Road	40
	Waitemata	between Maunsell Road and Broadway	30
Dawson Road	Otara Papatoetoe	between Prestons Road and Te Irirangi Dr	40
Puhinui Road	Otara Papatoetoe	between SH 20 and Kenderdine Road	40
Great South Road	Otara Papatoetoe	between Reagan Road and Maxwell Ave	40

Appendix B: Maps of Approaches

B1- Coverage of Approaches 1 and 2 (roads within 1000m walk of school gate)



B2- Coverage of Approaches 4 and 5 (roads within 400m walk of school gate)



Appendix C: 30 km/h speed limits introduced within Phases 1-3