

Appendix U

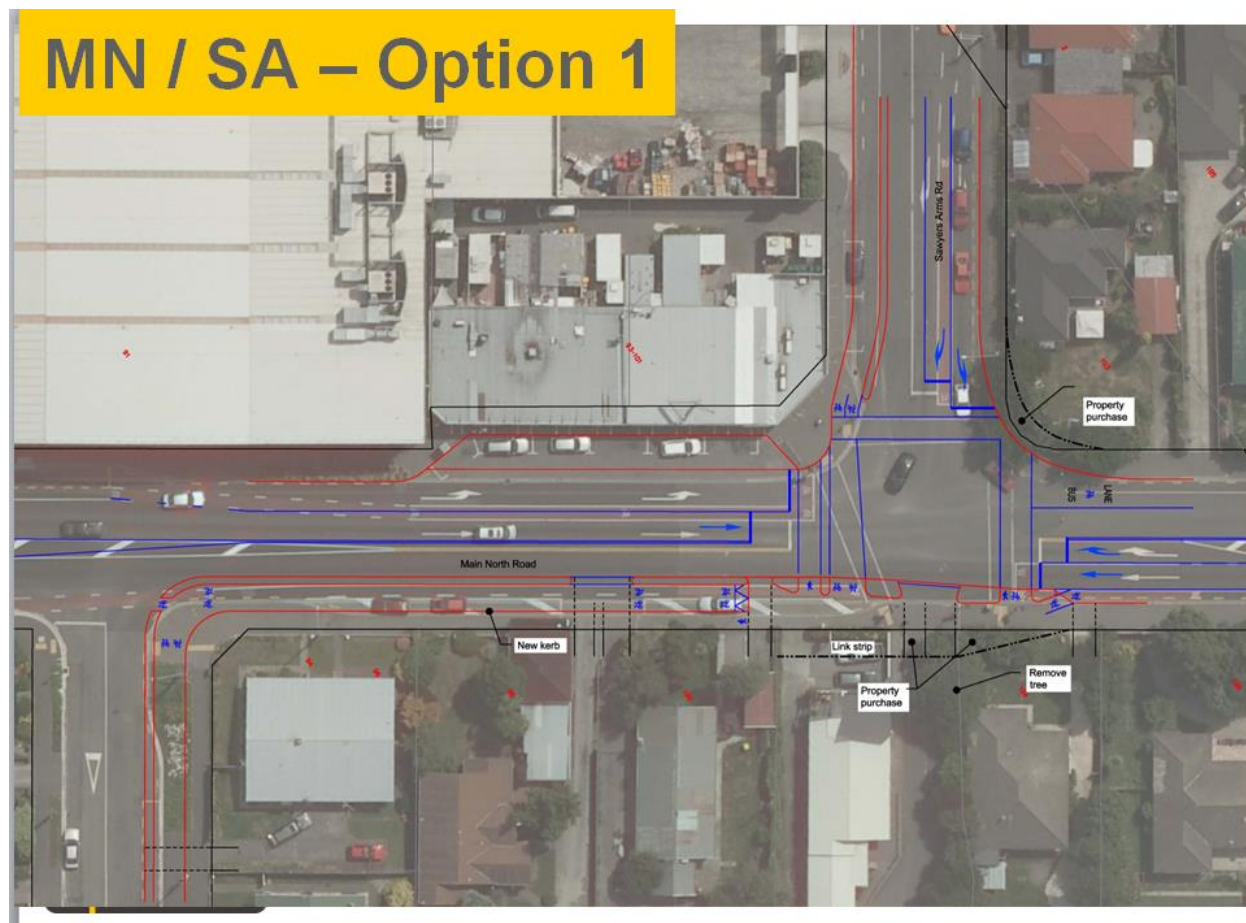
Northern Section modelling results

Appendix B3 – Main North / Sawyers Arms Road

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1.1 Option 1

1.1.1 The layout for Option 1 is shown below:



1.1.2 Key features of the option are:

- Two-way separated cycleway on east side of Main North Road, with crossing to two-way separated cycleway on the south side of Sawyers Arms road.
- All cycle crossing takes place at Main North/Sawyers Arms intersection.

1.1.3 The performance of Main North/Sawyers Arms intersection for Option 1 is shown below:

Main North/Sawyers Arms – Option 1 Morning Peak 2031

Node: 1463		Traffic Signals					2031 AM Main North Road						
A Node	C Node	From		To			Demand	Exit Flow	V/C	Delay	LoS	Queue	
6583	6584	Main North	S	L	Sawyers Arms	W	83	83	9	11	B	1	●
6583	6582	Main North	S	T	Main North	N	433	432	44	21	C	7	●
6582	6583	Main North	N	T	Main North	S	1004	1003	92	38	D	13	●
6582	6584	Main North	N	R	Sawyers Arms	W	287	286	72	39	D	4	●
6584	6582	Sawyers Arms	W	L	Main North	N	145	145	36	33	C	3	●
6584	6583	Sawyers Arms	W	R	Main North	S	48	48	13	42	D	1	●

Total Time: 18.4 veh.hrs, 33 sec average delay, LOS C

Main North/Sawyers Arms – Option 1 Inter Peak 2031

Node: 1463		Traffic Signals					2031 IP Main North Road						
A Node	C Node	From		To			Demand	Exit Flow	V/C	Delay	LoS	Queue	
6583	6584	Main North	S	L	Sawyers Arms	W	160	160	23	12	B	2	●
6583	6582	Main North	S	T	Main North	N	692	692	84	34	C	10	●
6582	6583	Main North	N	T	Main North	S	761	761	76	26	C	10	●
6582	6584	Main North	N	R	Sawyers Arms	W	146	146	44	42	D	3	●
6584	6582	Sawyers Arms	W	L	Main North	N	405	405	83	45	D	6	●
6584	6583	Sawyers Arms	W	R	Main North	S	68	68	16	34	C	1	●

Total Time: 19.9 veh.hrs 32 sec average delay, LOS C

Main North/Sawyers Arms – Option 1 Evening Peak 2031

Node: 1463		Traffic Signals					2031 PM Main North Road						
A Node	C Node	From		To			Demand	Exit Flow	V/C	Delay	LoS	Queue	
6583	6584	Main North	S	L	Sawyers Arms	W	149	148	29	18	B	2	●
6583	6582	Main North	S	T	Main North	N	895	892	95	58	E	15	●
6582	6583	Main North	N	T	Main North	S	758	752	65	19	B	10	●
6582	6584	Main North	N	R	Sawyers Arms	W	96	95	32	52	D	3	●
6584	6582	Sawyers Arms	W	L	Main North	N	427	425	95	85	F	9	●
6584	6583	Sawyers Arms	W	R	Main North	S	92	92	27	50	D	3	●

Total Time: 31.8 veh.hrs 48 sec average delay, LOS D

1.1.4 A summary of potential issues relating to Option 1 is provided below

- High V/C for southbound traffic on Main North Road during AM Peak
- High V/C and marginal LoS for northbound traffic on Main North Road during PM Peak
- High V/C and poor LoS for the left turn from Sayers Arms Road during PM Peak

1.1.5 The performance of Main North/Grassmere Arms intersection for Option 1 is shown below:

Main North/Grassmere – Option 1 Morning Peak 2031

Node: 1462		Traffic Signals				2031 AM Main North Road							
A Node	C Node	From			To		Demand	Exit Flow	V/C	Delay	LoS	Queue	
6580	6583	Main North	S	T	Main North	N	503	502	37	2	A	0	●
6580	1485	Main North	S	R	Grassmere	E	37	37	12	23	C	0	●
1485	6580	Grassmere	E	L	Main North	S	13	13	4	21	C	0	●
1485	6583	Grassmere	E	R	Main North	N	13	13	10	36	D	0	●
6583	1485	Main North	N	L	Grassmere	E	61	61	15	5	A	0	●
6583	6580	Main North	N	T	Main North	S	991	990	74	5	A	0	●

Total Time: 2.2 veh.hrs 5 sec average delay, LOS A

Main North/Grassmere – Option 1 Inter Peak 2031

Node: 1462		Traffic Signals					2031 IP Main North Road						
A Node	C Node	From			To		Demand	Exit Flow	V/C	Delay	LoS	Queue	
6580	6583	Main North	S	T	Main North	N	833	832	61	3	A	0	●
6580	1485	Main North	S	R	Grassmere	E	39	39	8	16	B	0	●
1485	6580	Grassmere	E	L	Main North	S	13	13	3	14	B	0	●
1485	6583	Grassmere	E	R	Main North	N	19	19	15	35	C	0	●
6583	1485	Main North	N	L	Grassmere	E	36	36	6	3	A	0	●
6583	6580	Main North	N	T	Main North	S	792	792	58	3	A	0	●

Total Time: 1.9 veh.hrs 2 sec average delay, LOS A

Main North/Grassmere – Option 1 Evening Peak 2031

Node: 1462		Traffic Signals					2031 PM Main North Road						
A Node	C Node	From		To		Demand	Exit Flow	V/C	Delay	LoS	Queue		
6580	6583	Main North	S	T	Main North	N	1027	1024	79	7	A	0	<div></div>
6580	1485	Main North	S	R	Grassmere	E	103	102	27	19	B	1	<div></div>
1485	6580	Grassmere	E	L	Main North	S	13	13	3	14	B	0	<div></div>
1485	6583	Grassmere	E	R	Main North	N	17	16	25	65	E	0	<div></div>
6583	1485	Main North	N	L	Grassmere	E	43	42	7	3	A	0	<div></div>
6583	6580	Main North	N	T	Main North	S	807	802	59	3	A	0	<div></div>

Total Time: 3.5 veh.hrs 4 sec average delay, LOS A

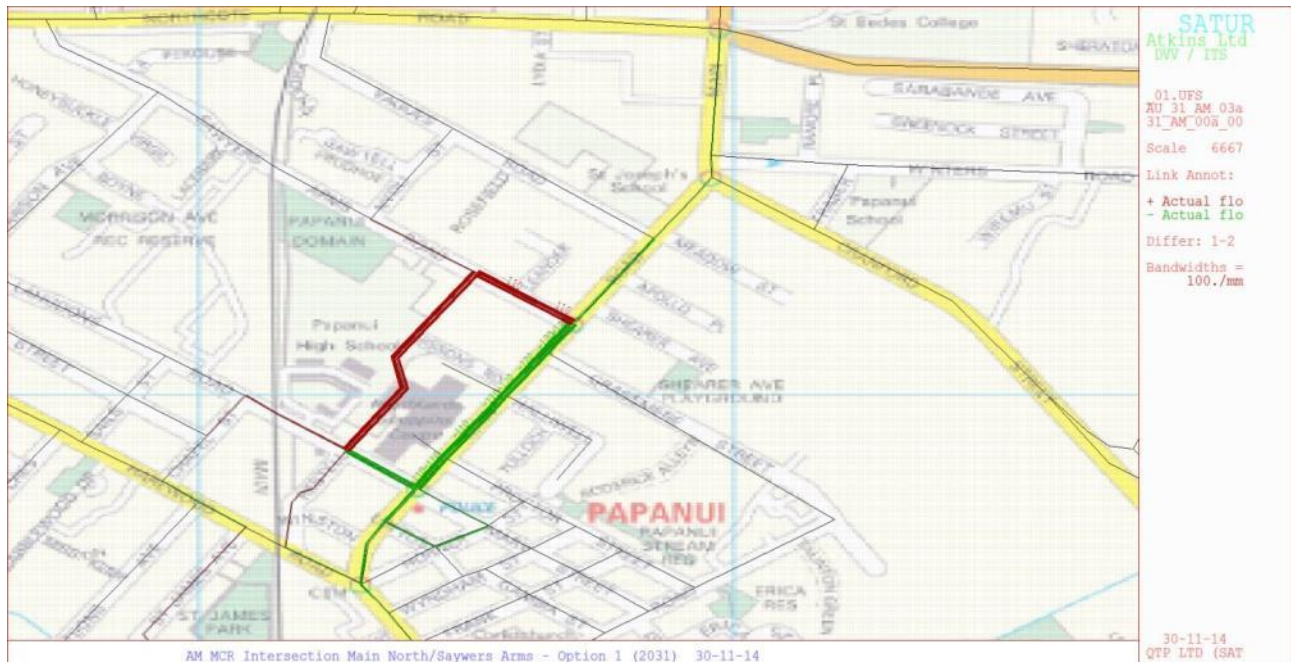
1.1.6 A summary of potential issues relating to Option 1 is provided below

- Marginal LoS for right turn from Grassmere Road during PM Peak

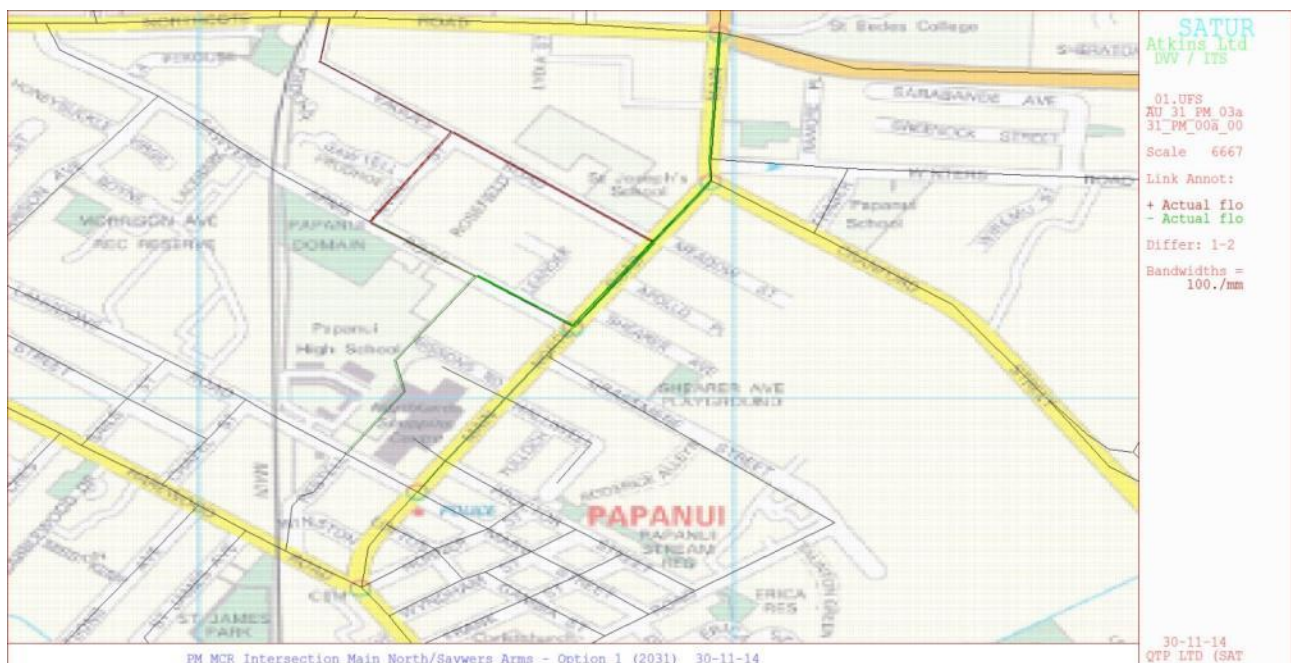
1.2 Potential Traffic Routing Effects

1.2.1 Potential changes in traffic flows (compared to a Do Minimum without MCRs) during morning and evening peak periods are shown below:

Potential Change in Traffic Patterns – Option 1 Morning Peak 2031



Potential Change in Traffic Patterns – Option 1 Evening Peak 2031



1.2.2 The above plots do not indicate any significant changes in traffic patterns. Some minor rat-running along Sission Drive could potentially occur (especially in AM due to a decrease in delay on Sawyers Arms approach to Main North), however this would be less attractive if Sisson/Sawyers Arms intersection was signalised (as per Option 4).

1.3 Potential Traffic Delay Effects

1.3.1 Potential changes in traffic flows (compared to a Do Minimum without MCRs) during morning and evening peak periods are shown below:

Potential Change in Delay – Option 1 Morning Peak 2031



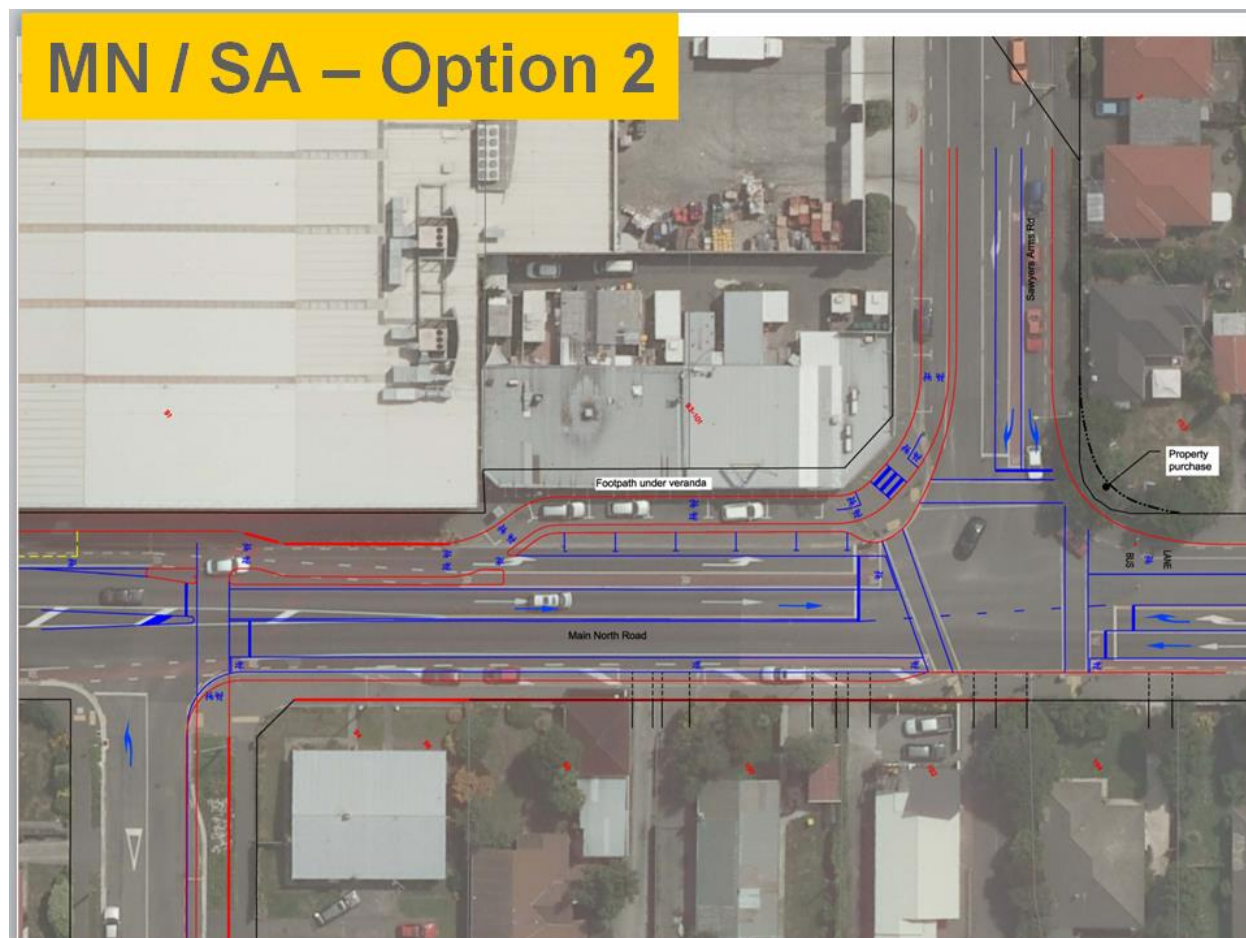
Potential Change in in Delay – Option 1 Evening Peak 2031



1.3.2 The above plots indicate average delays on Main North Road could increase up to 20 seconds per vehicle in the peak flow direction (both AM and PM) as a result of Option 1

1.4 Option 2

1.4.1 The layout for Option 1 is shown below:



1.4.2 Key features of the option are:

- Two-way separated cycleway on west side of Main North Road, directly connecting to a two-way separated cycleway on the south side of Sawyers Arms road.
- Grassmere change to left out right in for motorised traffic.
- A cycle crossing is located adjacent (to the north) of Grassmere Road.
- Signals at Main North/Sawyers assumed only to have minor changes to geometry that do not require changes in signal timing.

1.4.3 The performance of Main North/Sawyers Arms intersection for Option 1 is shown below:

Main North/Sawyers Arms – Option 2 Morning Peak 2031

Node: 1463		Traffic Signals					2031 AM Main North Road						
A Node	C Node	From		To			Demand	Exit Flow	V/C	Delay	LoS	Queue	
6583	6584	Main North	S	L	Sawyers Arms	W	82	82	10	5	A	0	●
6583	6582	Main North	S	T	Main North	N	535	535	41	6	A	3	●
6582	6583	Main North	N	T	Main North	S	1086	1084	93	25	C	5	●
6582	6584	Main North	N	R	Sawyers Arms	W	230	230	73	30	C	2	●
6584	6582	Sawyers Arms	W	L	Main North	N	46	46	20	55	D	1	●
6584	6583	Sawyers Arms	W	R	Main North	S	27	27	16	61	E	1	●

Total Time: 11.4 veh.hrs, 21 sec average delay, LOS C

Main North/Sawyers Arms – Option 2 Inter Peak 2031

Node: 1463		Traffic Signals					2031 IP Main North Road						
A Node	C Node	From		To			Demand	Exit Flow	V/C	Delay	LoS	Queue	
6583	6584	Main North	S	L	Sawyers Arms	W	131	131	21	10	A	1	●
6583	6582	Main North	S	T	Main North	N	779	779	69	13	B	6	●
6582	6583	Main North	N	T	Main North	S	805	805	64	10	B	6	●
6582	6584	Main North	N	R	Sawyers Arms	W	147	147	52	34	C	2	●
6584	6582	Sawyers Arms	W	L	Main North	N	324	324	73	48	D	7	●
6584	6583	Sawyers Arms	W	R	Main North	S	59	59	20	44	D	1	●

Total Time: 11.8 veh.hrs 19 sec average delay, LOS B

Main North/Sawyers Arms – Option 2 Evening Peak 2031

Node: 1463		Traffic Signals					2031 PM Main North Road						
A Node	C Node	From		To			Demand	Exit Flow	V/C	Delay	LoS	Queue	
6583	6584	Main North	S	L	Sawyers Arms	W	132	132	25	18	B	2	●
6583	6582	Main North	S	T	Main North	N	878	875	85	32	C	12	●
6582	6583	Main North	N	T	Main North	S	780	775	59	12	B	8	●
6582	6584	Main North	N	R	Sawyers Arms	W	97	96	35	50	D	2	●
6584	6582	Sawyers Arms	W	L	Main North	N	475	474	85	59	E	11	●
6584	6583	Sawyers Arms	W	R	Main North	S	78	78	23	50	D	2	●

Total Time: 21.1 veh.hrs 31 sec average delay, LOS C

1.4.4 A summary of potential issues relating to Option 1 is provided below

- High V/C for southbound traffic on Main North Road during AM Peak
- Marginal LoS for the right turn (low flow) from Sayers Arms Road during AM Peak
- Marginal LoS for the left turn from Sayers Arms Road during PM Peak

1.4.5 The performance of Main North/Grassmere Arms intersection for Option 2 is shown below:

Main North/Grassmere – Option 2 Morning Peak 2031

Node: 1462		Traffic Signals					2031 AM Main North Road						
A Node	C Node	From			To		Demand	Exit Flow	V/C	Delay	LoS	Queue	
6580	6583	Main North	S	T	Main North	N	618	617	55	8	A	3	●
6580	1485	Main North	S	R	Grassmere	E	30	30	46	8	A	0	●
1485	6580	Grassmere	E	L	Main North	S	13	13	5	24	C	0	●
1485	6583	Grassmere	E	R	Main North	N	0	0	0	0	A	0	●
6583	1485	Main North	N	L	Grassmere	E	0	0	0	0	A	0	●
6583	6580	Main North	N	T	Main North	S	1113	1111	79	7	A	2	●

Total Time: 3.5 veh.hrs 7 sec average delay, LOS A

Main North/Grassmere – Option 2 Inter Peak 2031

Node: 1462		Traffic Signals					2031 IP Main North Road						
A Node	C Node	From			To		Demand	Exit Flow	V/C	Delay	LoS	Queue	
6580	6583	Main North	S	T	Main North	N	911	910	75	17	B	5	●
6580	1485	Main North	S	R	Grassmere	E	29	29	31	14	B	0	●
1485	6580	Grassmere	E	L	Main North	S	13	13	3	13	B	0	●
1485	6583	Grassmere	E	R	Main North	N	0	0	0	0	A	0	●
6583	1485	Main North	N	L	Grassmere	E	0	0	0	0	A	0	●
6583	6580	Main North	N	T	Main North	S	864	864	62	4	A	1	●

Total Time: 5.2 veh.hrs 10 sec average delay, LOS B

Main North/Grassmere – Option 2 Evening Peak 2031

Node: 1462		Traffic Signals					2031 PM Main North Road						
A Node	C Node	From			To		Demand	Exit Flow	V/C	Delay	LoS	Queue	
6580	6583	Main North	S	T	Main North	N	1010	1007	72	7	A	4	<div></div>
6580	1485	Main North	S	R	Grassmere	E	14	14	13	5	A	0	<div></div>
1485	6580	Grassmere	E	L	Main North	S	13	13	3	14	B	0	<div></div>
1485	6583	Grassmere	E	R	Main North	N	0	0	0	0	A	0	<div></div>
6583	1485	Main North	N	L	Grassmere	E	0	0	0	0	A	0	<div></div>
6583	6580	Main North	N	T	Main North	S	858	853	61	3	A	0	<div></div>

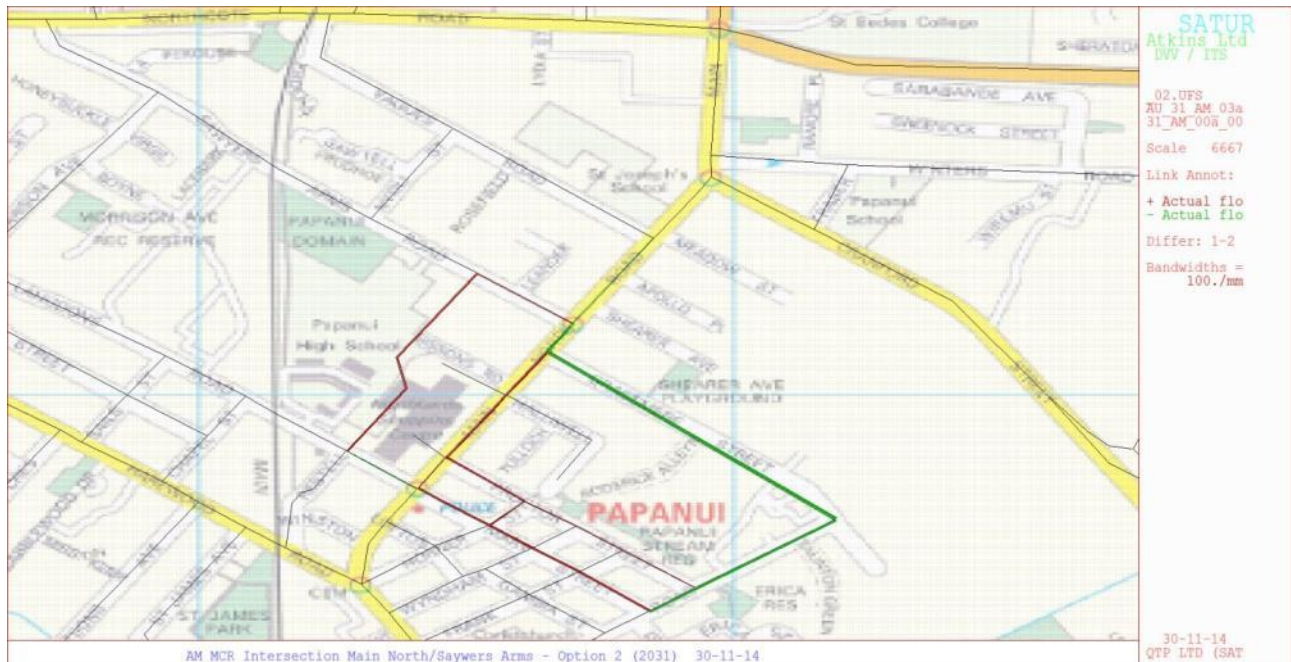
Total Time: 3.0 veh.hrs 6 sec average delay, LOS A

1.4.6 No potential issues relating to intersection performance for Option 2 are indicated.

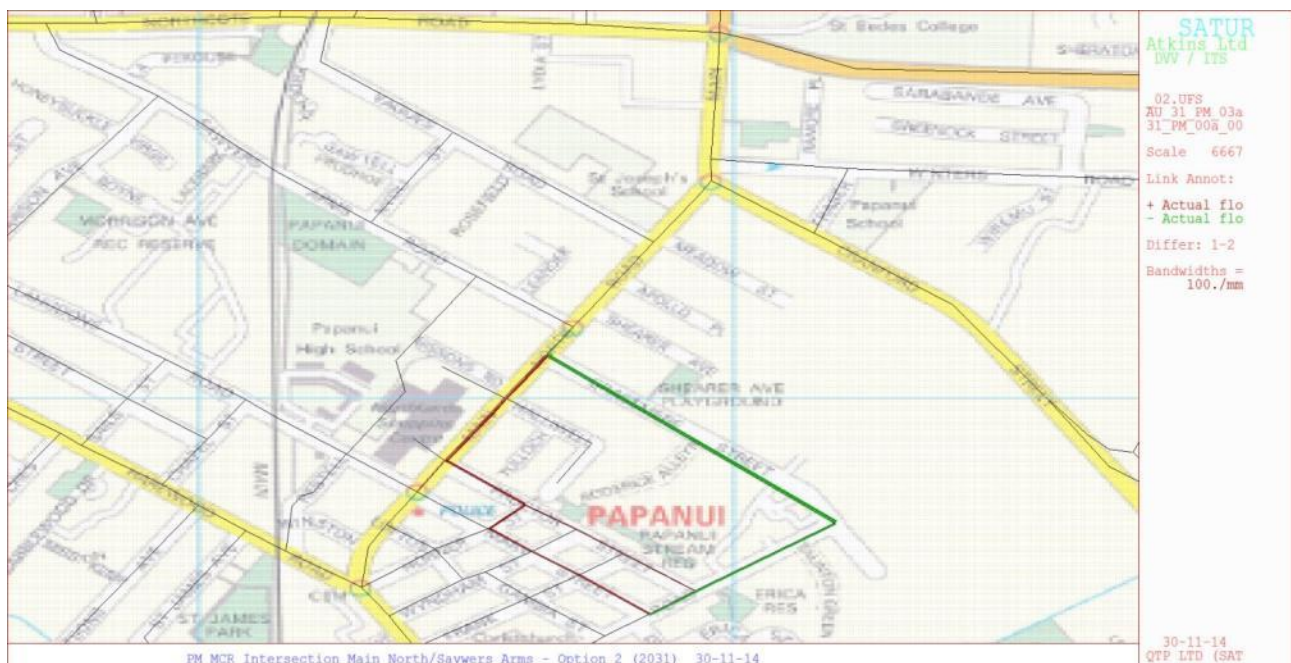
1.5 Potential Traffic Routing Effects

1.5.1 Potential changes in traffic flows (compared to a Do Minimum without MCRs) during morning and evening peak periods are shown below:

Potential Change in Traffic Patterns – Option 2 Morning Peak 2031



Potential Change in Traffic Patterns – Option 2 Evening Peak 2031

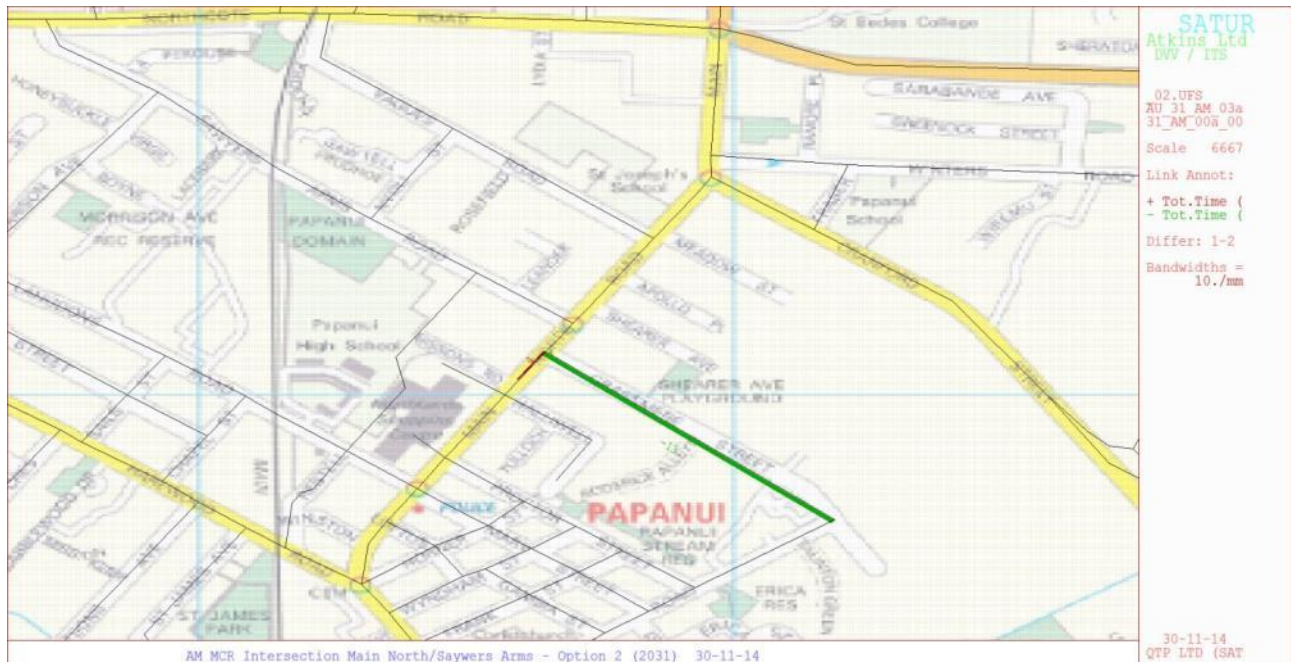


1.5.2 The above plots do not indicate any significant changes in traffic patterns. Some minor diversion is associated with Grassmere being restricted to left out right in only, however the number of effected vehicle is very low (less than 100 vph) and other suitable routes exist.

1.6 Potential Traffic Delay Effects

1.6.1 Potential changes in traffic flows (compared to a Do Minimum without MCRs) during morning and evening peak periods are shown below:

Potential Change in in Delay – Option 2 Morning Peak 2031



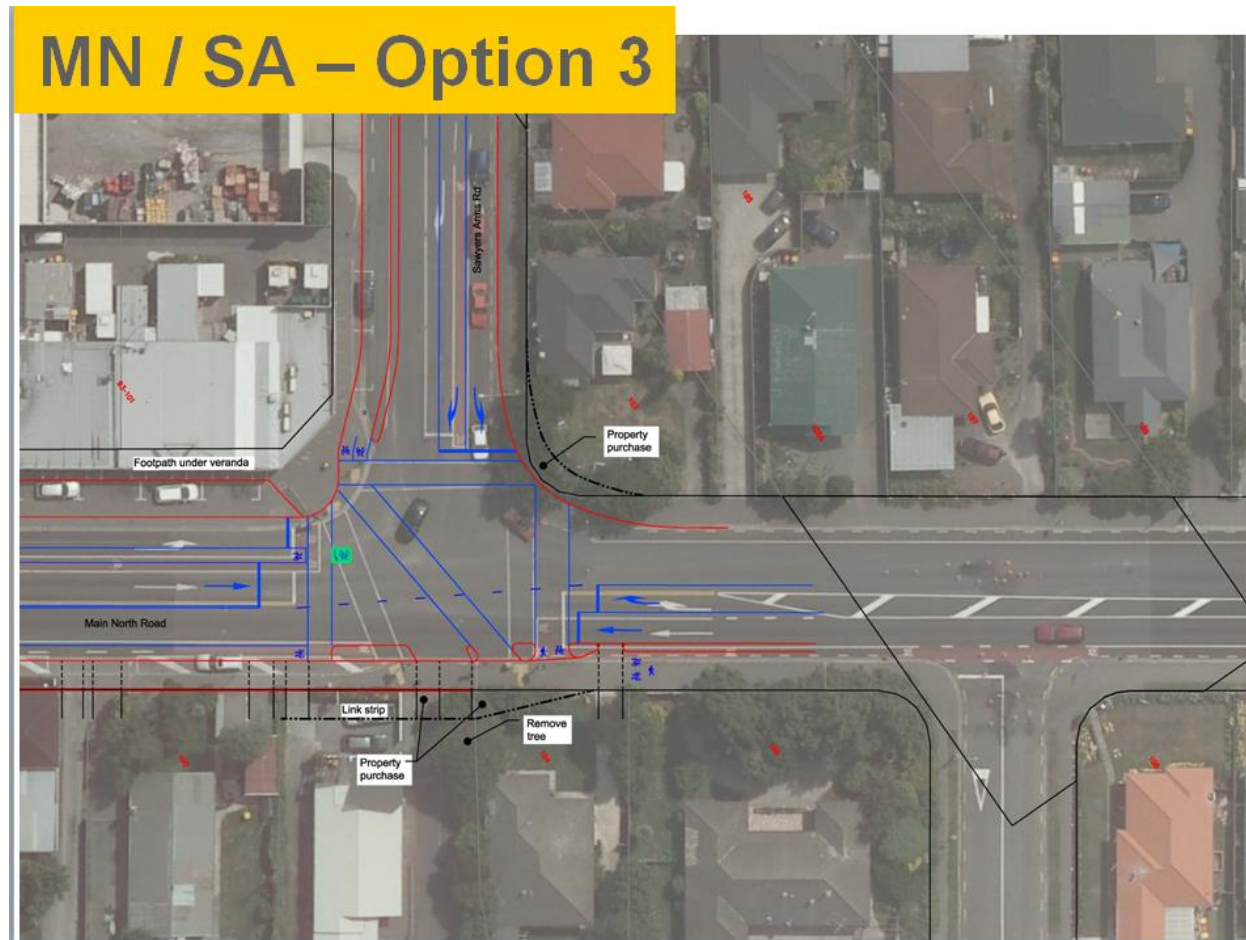
Potential Change in in Delay – Option 2 Evening Peak 2031



1.6.2 The above plots indicate no significant increase in delay on Main North Road. Left turn delays from Grassmere Street reduce due to the MCR crossing creating gaps when called.

1.7 Option 3

1.7.1 The layout for Option 3 is shown below:



1.7.2 Key features of the option are:

- Two-way separated cycleway on east side of Main North Road, with a diagonal crossing to two-way separated cycleway on the south side of Sawyers Arms road.
- All cycle crossing takes place at Main North/Sawyers Arms intersection.

1.7.3 The performance of Main North/Sawyers Arms intersection for Option 3 is shown below:

Main North/Sawyers Arms – Option 1 Morning Peak 2031

Node: 1463		Traffic Signals					2031 AM Main North Road						
A Node	C Node	From		To			Demand	Exit Flow	V/C	Delay	LoS	Queue	
6583	6584	Main North	S	L	Sawyers Arms	W	87	87	10	10	B	1	●
6583	6582	Main North	S	T	Main North	N	499	499	43	13	B	6	●
6582	6583	Main North	N	T	Main North	S	1060	1058	92	31	C	10	●
6582	6584	Main North	N	R	Sawyers Arms	W	246	245	72	34	C	3	●
6584	6582	Sawyers Arms	W	L	Main North	N	90	90	27	46	D	2	●
6584	6583	Sawyers Arms	W	R	Main North	S	41	41	16	51	D	1	●

Total Time: 15.2 veh.hrs, 27 sec average delay, LOS C

Main North/Sawyers Arms – Option 1 Inter Peak 2031

Node: 1463		Traffic Signals					2031 IP Main North Road						
A Node	C Node	From		To			Demand	Exit Flow	V/C	Delay	LoS	Queue	
6583	6584	Main North	S	L	Sawyers Arms	W	155	155	23	14	B	2	●
6583	6582	Main North	S	T	Main North	N	711	711	80	28	C	9	●
6582	6583	Main North	N	T	Main North	S	784	784	70	19	B	9	●
6582	6584	Main North	N	R	Sawyers Arms	W	147	147	40	37	D	3	●
6584	6582	Sawyers Arms	W	L	Main North	N	402	402	74	42	D	7	●
6584	6583	Sawyers Arms	W	R	Main North	S	66	66	17	36	D	1	●

Total Time: 17.1 veh.hrs 27 sec average delay, LOS C

Main North/Sawyers Arms – Option 1 Evening Peak 2031

Node: 1463		Traffic Signals					2031 PM Main North Road						
A Node	C Node	From		To			Demand	Exit Flow	V/C	Delay	LoS	Queue	
6583	6584	Main North	S	L	Sawyers Arms	W	152	151	26	25	C	3	●
6583	6582	Main North	S	T	Main North	N	813	811	96	69	E	16	●
6582	6583	Main North	N	T	Main North	S	756	751	66	20	B	10	●
6582	6584	Main North	N	R	Sawyers Arms	W	100	99	29	48	D	3	●
6584	6582	Sawyers Arms	W	L	Main North	N	542	540	87	55	D	11	●
6584	6583	Sawyers Arms	W	R	Main North	S	100	99	24	43	D	3	●

Total Time: 31.6 veh.hrs 46 sec average delay, LOS D

1.7.4 A summary of potential issues relating to Option 1 is provided below

- High V/C for southbound traffic on Main North Road during AM Peak
- High V/C and marginal LoS for northbound traffic on Main North Road during PM Peak

1.7.5 The performance of Main North/Grassmere intersection for Option 3 is shown below:

Main North/Grassmere – Option 3 Morning Peak 2031

Node: 1462		Traffic Signals					2031 AM Main North Road						
A Node	C Node	From		To			Demand	Exit Flow	V/C	Delay	LoS	Queue	
6580	6583	Main North	S	T	Main North	N	573	573	42	2	A	0	●
6580	1485	Main North	S	R	Grassmere	E	34	34	13	24	C	0	●
1485	6580	Grassmere	E	L	Main North	S	13	13	5	23	C	0	●
1485	6583	Grassmere	E	R	Main North	N	13	13	13	41	D	0	●
6583	1485	Main North	N	L	Grassmere	E	61	61	17	6	A	0	●
6583	6580	Main North	N	T	Main North	S	1041	1039	78	6	A	0	●

Total Time: 2.6 veh.hrs 5 sec average delay, LOS A

Main North/Grassmere – Option 3 Inter Peak 2031

Node: 1462		Traffic Signals					2031 IP Main North Road						
A Node	C Node	From		To			Demand	Exit Flow	V/C	Delay	LoS	Queue	
6580	6583	Main North	S	T	Main North	N	847	847	62	3	A	0	●
6580	1485	Main North	S	R	Grassmere	E	39	39	9	17	B	0	●
1485	6580	Grassmere	E	L	Main North	S	13	13	3	14	B	0	●
1485	6583	Grassmere	E	R	Main North	N	19	19	17	36	D	0	●
6583	1485	Main North	N	L	Grassmere	E	36	36	6	3	A	0	●
6583	6580	Main North	N	T	Main North	S	814	814	60	3	A	0	●

Total Time: 2.0 veh.hrs 4 sec average delay, LOS A

Main North/Grassmere – Option 3 Evening Peak 2031

Node: 1462		Traffic Signals					2031 PM Main North Road						
A Node	C Node	From		To			Demand	Exit Flow	V/C	Delay	LoS	Queue	
6580	6583	Main North	S	T	Main North	N	948	946	73	5	A	0	●
6580	1485	Main North	S	R	Grassmere	E	108	108	25	18	B	1	●
1485	6580	Grassmere	E	L	Main North	S	13	13	3	14	B	0	●
1485	6583	Grassmere	E	R	Main North	N	16	16	22	54	D	0	●
6583	1485	Main North	N	L	Grassmere	E	43	42	7	3	A	0	●
6583	6580	Main North	N	T	Main North	S	814	808	60	3	A	0	●

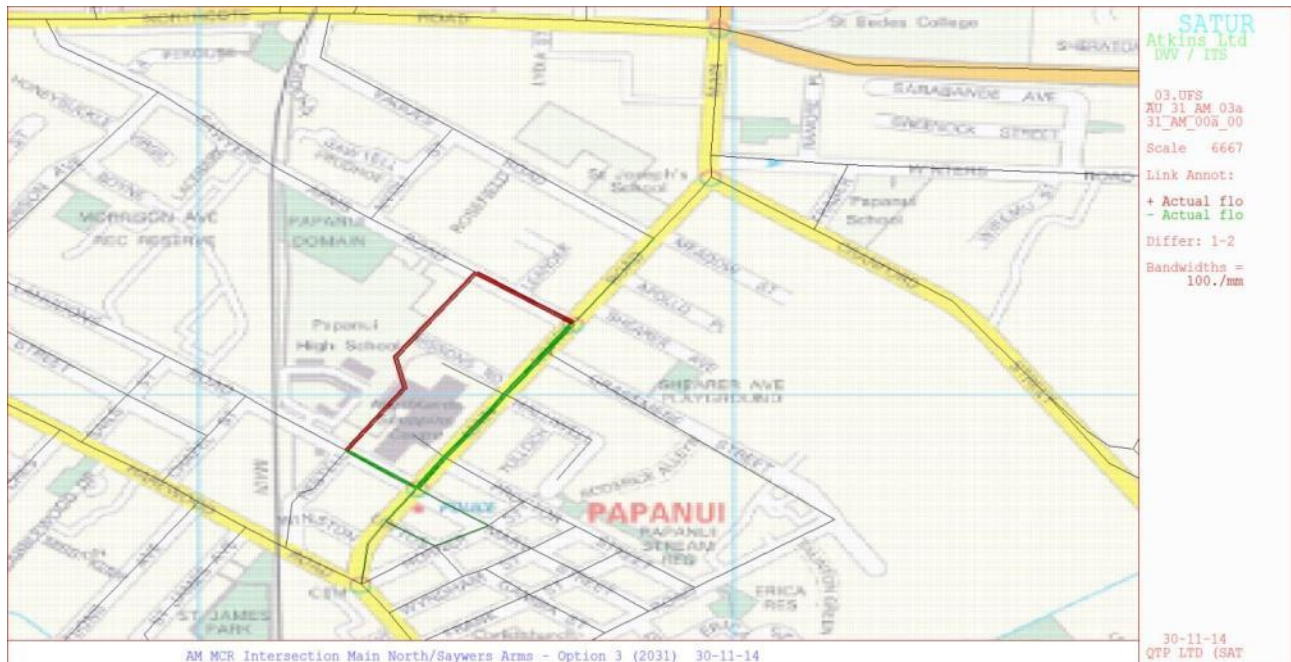
Total Time: 3.0 veh.hrs 6 sec average delay, LOS A

1.7.6 No potential issues relating to Option 3 are indicated

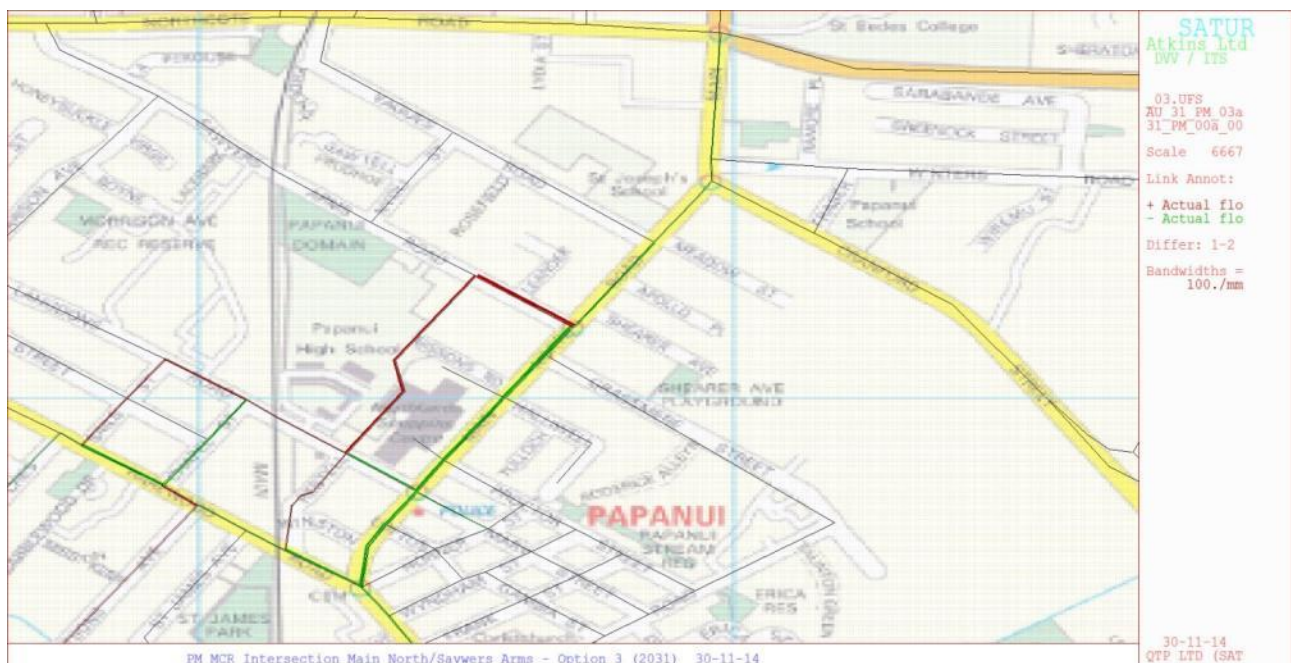
1.8 Potential Traffic Routing Effects

1.8.1 Potential changes in traffic flows (compared to a Do Minimum without MCRs) during morning and evening peak periods are shown below:

Potential Change in Traffic Patterns – Option 3 Morning Peak 2031



Potential Change in Traffic Patterns – Option 3 Evening Peak 2031

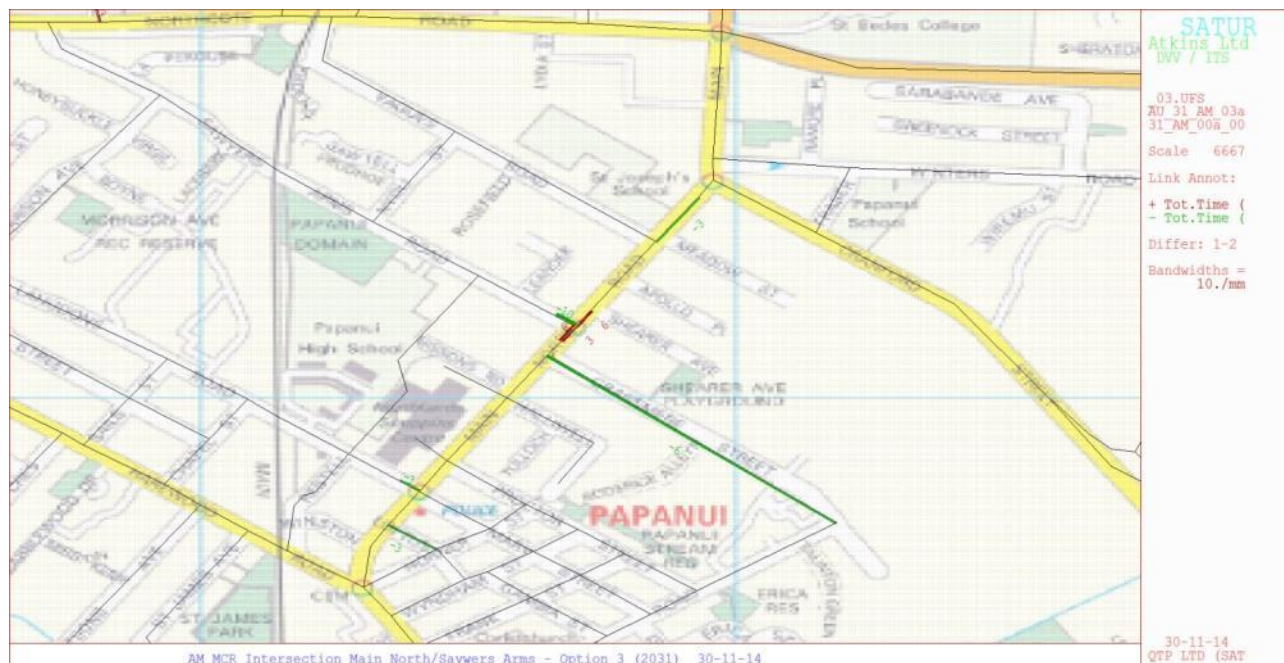


1.8.2 The above plots do not indicate any significant changes in traffic patterns. Some minor rat-running along Sission Drive could potentially occur (especially in AM due to a decrease in delay on Sawyers Arms approach to Main North), however this would be less attractive if Sisson/Sawyers Arms intersection was signalised (as per Option 4).

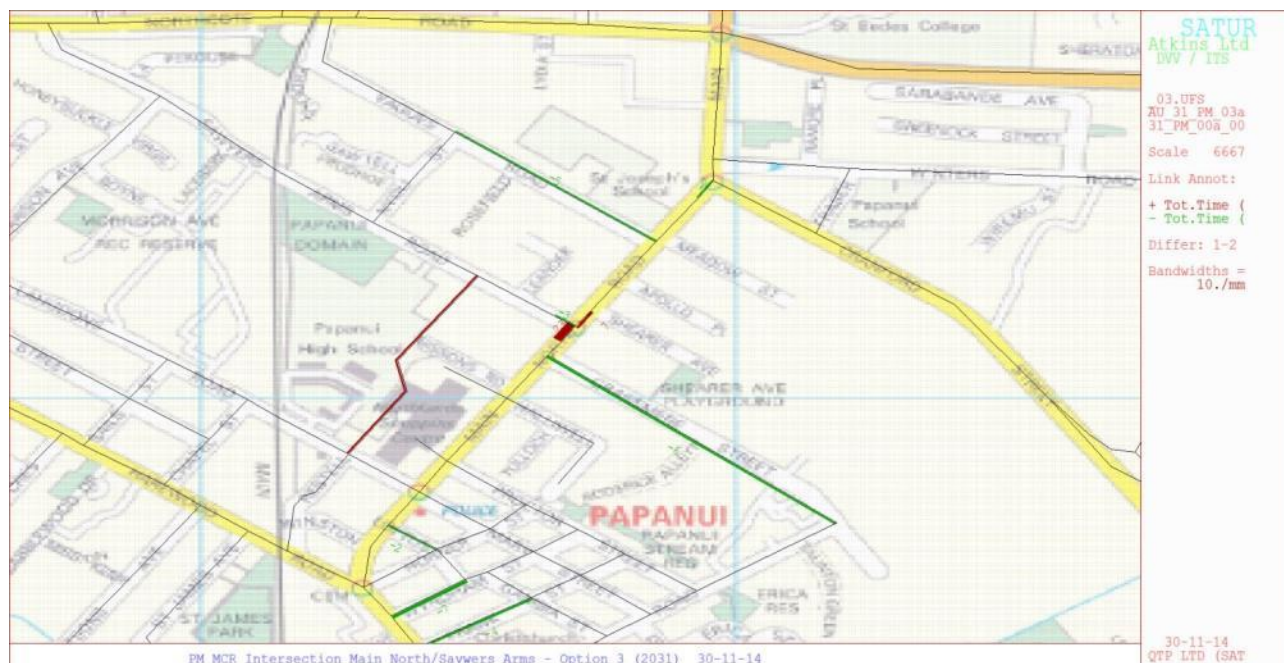
1.9 Potential Traffic Delay Effects

1.9.1 Potential changes in traffic flows (compared to a Do Minimum without MCRs) during morning and evening peak periods are shown below:

Potential Change in in Delay – Option 3 Morning Peak 2031



Potential Change in in Delay – Option 3 Evening Peak 2031



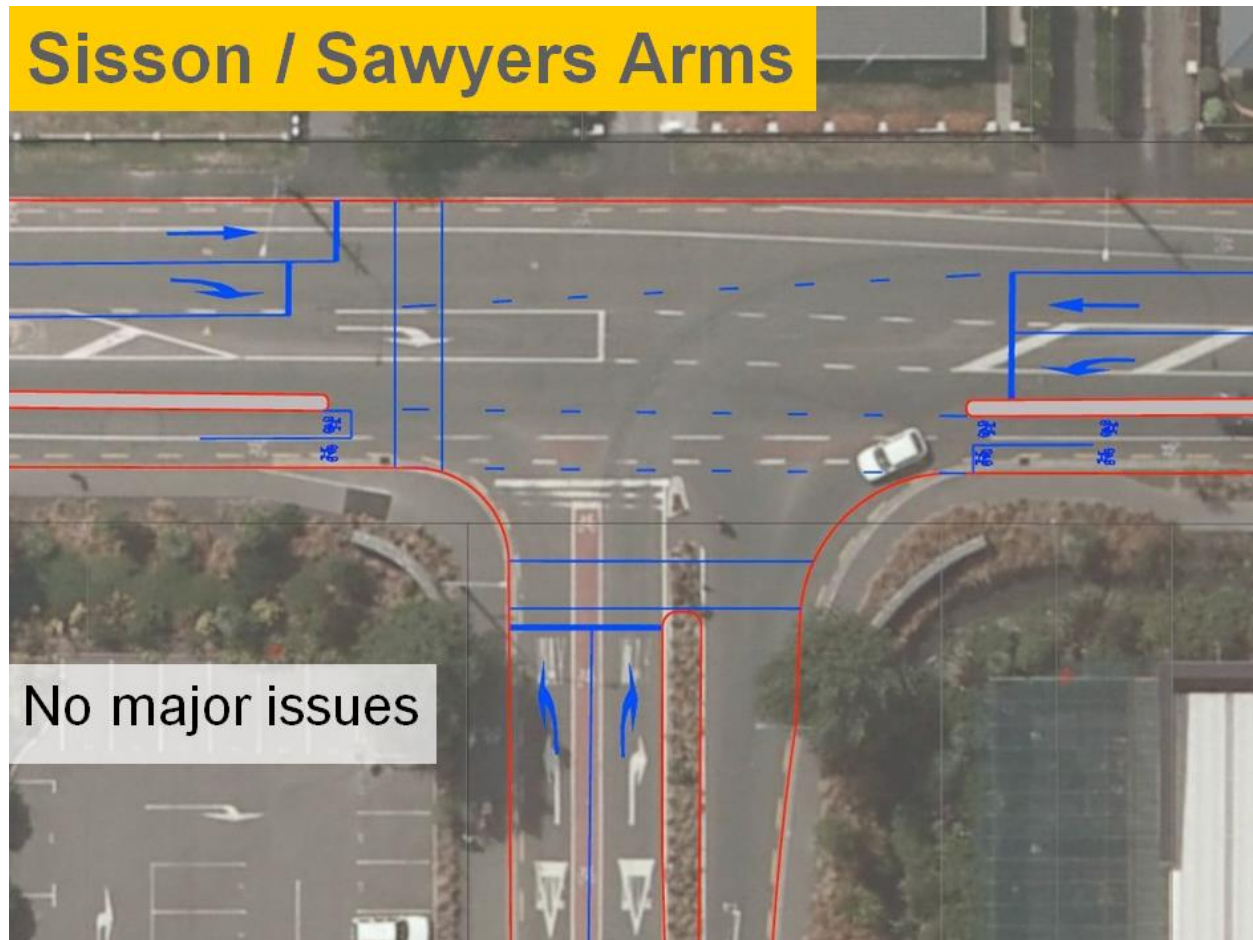
1.9.2 The above plots indicate average delays on Main North Road could increase up to 10 seconds per vehicle in the morning peak and up to 25 seconds per vehicle in the evening peak flow direction as a result of Option 3.

Appendix B4 – Sawyers Arms / Sisson

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1.1 Option 1

1.1.1 The layout for Option 1 is shown below:



1.1.2 Key features of the option are:

- A separated cycleway on the south side of Sawyers Arms Road.
- The intersection (currently a priority 'T') will be signalised, with phasing to ensure cycle movements are protected.

1.1.3 The performance of Sawyers Arms/Sisson intersection for Option 1 is shown below:

Sawyers Arms/Sisson – Option 1 Morning Peak 2031

Node: 6413		Traffic Signals					2031 AM Sissons/Sawyers Arms						
A Node	C Node	From		To			Demand	Exit Flow	V/C	Delay	LoS	Queue	
1913	3574	Sisson	S L	Sawyers Arms	W		26	26	5	23	C	0	●
1913	6584	Sisson	S R	Sawyers Arms	E		38	38	15	37	D	1	●
6584	1913	Sawyers Arms	E L	Sisson	S		184	184	18	5	A	1	●
6584	3574	Sawyers Arms	E T	Sawyers Arms	W		31	31	3	9	A	0	●
3574	6584	Sawyers Arms	W T	Sawyers Arms	E		61	61	5	4	A	0	●
3574	1913	Sawyers Arms	W R	Sisson	S		12	12	9	47	D	0	●

Total Time: 1.1 veh.hrs, 11 sec average delay, LOS B

Sawyers Arms/Sisson – Option 1 Inter Peak 2031

Node: 6413		Traffic Signals					2031 IP Sissons/Sawyers Arms						
A Node	C Node	From		To			Demand	Exit Flow	V/C	Delay	LoS	Queue	
1913	3574	Sisson	S L	Sawyers Arms	W		59	59	13	24	C	1	●
1913	6584	Sisson	S R	Sawyers Arms	E		137	137	53	45	D	3	●
6584	1913	Sawyers Arms	E L	Sisson	S		133	133	13	4	A	1	●
6584	3574	Sawyers Arms	E T	Sawyers Arms	W		148	148	14	9	A	1	●
3574	6584	Sawyers Arms	W T	Sawyers Arms	E		98	98	7	4	A	1	●
3574	1913	Sawyers Arms	W R	Sisson	S		21	21	15	48	D	0	●

Total Time: 3.1 veh.hrs, 19 sec average delay, LOS B

Sawyers Arms/Sisson – Option 1 Evening Peak 2031

Node: 6413		Traffic Signals					2031 PM Sissons/Sawyers Arms						
A Node	C Node	From		To			Demand	Exit Flow	V/C	Delay	LoS	Queue	
1913	3574	Sisson	S L	Sawyers Arms	W		142	141	30	26	C	2	●
1913	6584	Sisson	S R	Sawyers Arms	E		207	207	79	64	E	4	●
6584	1913	Sawyers Arms	E L	Sisson	S		107	106	11	4	A	0	●
6584	3574	Sawyers Arms	E T	Sawyers Arms	W		129	129	12	9	A	1	●
3574	6584	Sawyers Arms	W T	Sawyers Arms	E		171	170	13	5	A	1	●
3574	1913	Sawyers Arms	W R	Sisson	S		30	30	21	49	D	1	●

Total Time: 5.8 veh.hrs, 27 sec average delay, LOS C

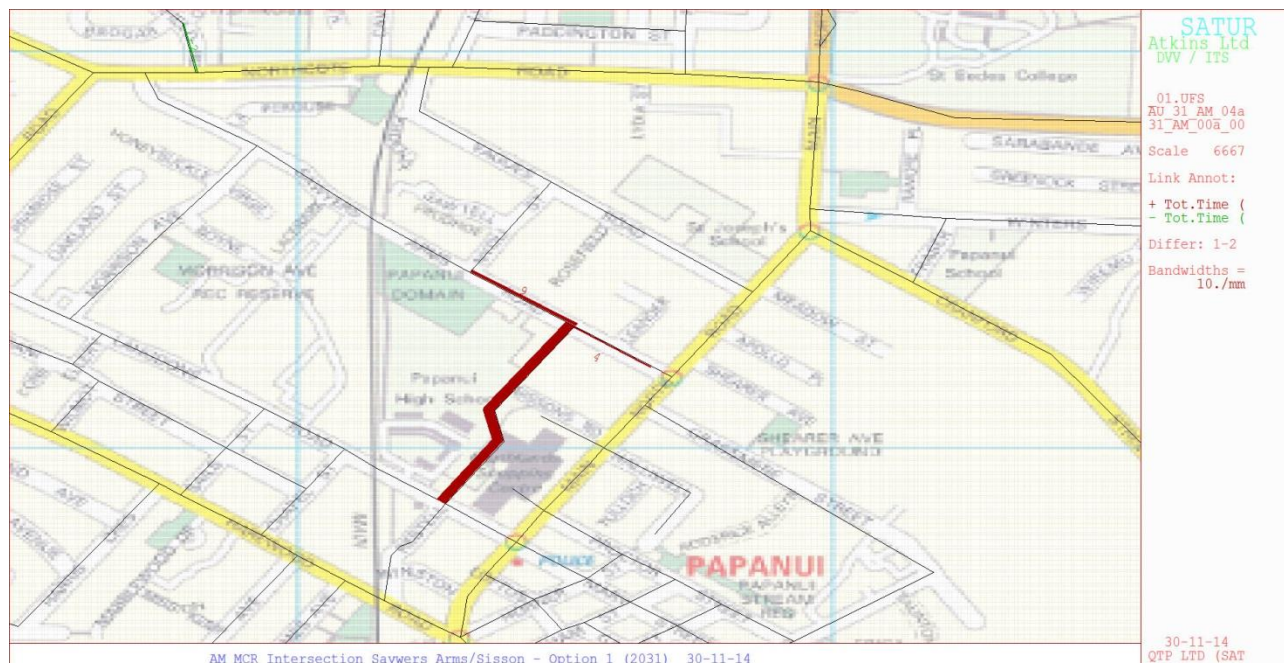
1.1.4 A summary of potential issues relating to Option 1 is provided below

- Marginal LoS for the right turn from Sisson to Sawyers Arms west during the PM Peak.

1.3 Potential Traffic Delay Effects

1.3.1 Potential changes in traffic flows (compared to a Do Minimum without MCRs) during morning and evening peak periods are shown below:

Potential Change in Delay – Option 1 Morning Peak 2031



Potential Change in in Delay – Option 1 Evening Peak 2031



1.3.2 The above plots indicate average delays on all approaches (but especially Sisson Drive) increase due to introduction of traffic signals, however the resulting LoS is acceptable in all cases.

Appendix V

Sawyers Arms Road conflict points

Appendix D - Sawyers Arms Road Conflict Points

The following table identifies the various conflict locations, their parameters (including the direction of cycle flow, presence / absence of adjacent on-street parking and the corresponding vehicle flows to be used) their standard assigned factors and the reasoning for these choices:

Table 8-18-1: Sawyers Arms Road conflict points

Conflict location and parameters	Considerations	Factor
Driveways <ul style="list-style-type: none"> • cycling in correct direction • no parking • driveway flow in and out – based on number of residential properties serviced by driveway 	Base case Main traffic is from residents who are familiar with the cycle facility and understand the risks involved. May involve some reversing vehicles. Note: it has been assumed that a residential driveway servicing multiple households is equivalent to multiple driveways servicing individual households.	1
Driveways <ul style="list-style-type: none"> • contra-flow cycling • no parking • driveway flow in and out – based on number of residential properties serviced by driveway 	Evidence (from USA and Scandinavia) to show that contra-flow cycling is 2.5 – 3.5 times more at risk than with-flow cycling. Many drivers don't expect to see cyclists coming in the opposite direction to the general traffic flow.	3
Driveways <ul style="list-style-type: none"> • cycling in correct direction • adjacent parking • driveway flow in and out – based on number of residential properties serviced by driveway 	Restricted inter-visibility as cyclists may be hidden from view behind parked vehicles Assumed less risky than contra-flow case, however.	2
Side streets (priority controlled) <ul style="list-style-type: none"> • cycling in correct direction • no parking • vehicle flow in and out of side street 	Greater crossing width, therefore higher exposure than for a standard driveway. Likely to include higher proportions of less familiar users than driveway traffic. Will not involve reversing traffic, however. Assumed that cyclists would give way to other traffic.	2*
Side streets (priority controlled) <ul style="list-style-type: none"> • contra-flow cycling • no parking • vehicle flow in and out of side street 	Same factor between contra- and correct flow as used in driveways assumption.	
Side streets (signal controlled) <ul style="list-style-type: none"> • cycling in correct direction • no parking • vehicle flow into side street only 	Assumes phasing will be designed to give full protection to cyclists. Very low crash occurrence, related to drivers disobeying the traffic lights (generally because they make their turn after the red arrow and extend beyond the inter-green time) or cyclists	0.001

Conflict location and parameters	Considerations	Factor
	disobeying the red light and conflicting with turning traffic.	
Side streets (signal controlled) <ul style="list-style-type: none"> • contra-flow cycling • no parking • vehicle flow into side street only 	As above, with factor for uncertainties relating to contra-flow cycling.	0.003
Driveways on head of T at a signalised intersection <ul style="list-style-type: none"> • cycling in correct direction • no parking • driveway flow in and out – based on number of residential properties serviced by driveway 	Uncertainties for those entering or exiting a driveway in this location regarding in what phase of the signalisation they can safely and legally do so, combined with lack of understanding about the operation of the cycle facility phase.	3
Large car parks <ul style="list-style-type: none"> • cycling in correct direction • no on-street parking • flow in and out – based on number of car parks and occupancy during peak hour 	Higher risk than a driveway as can involve higher numbers of less familiar motorists and greater crossing distances. Both of these factors are less critical than for side streets, however.	1.5
Large car parks <ul style="list-style-type: none"> • contra-flow cycling no parking • no on-street parking • flow in and out – based on number of car parks and occupancy during peak hour 	As above, with factor for uncertainties relating to contra-flow cycling.	4.5
Commercial heavy vehicle accesses <ul style="list-style-type: none"> • cycling in correct direction • no on-street parking • flow in and out – assumed 	Higher risk related to larger vehicles with limited visibility.	5*
Commercial heavy vehicle accesses <ul style="list-style-type: none"> • contra-flow cycling • no on-street parking • flow in and out – assumed 	As above, with factor for uncertainties relating to contra-flow cycling.	15*

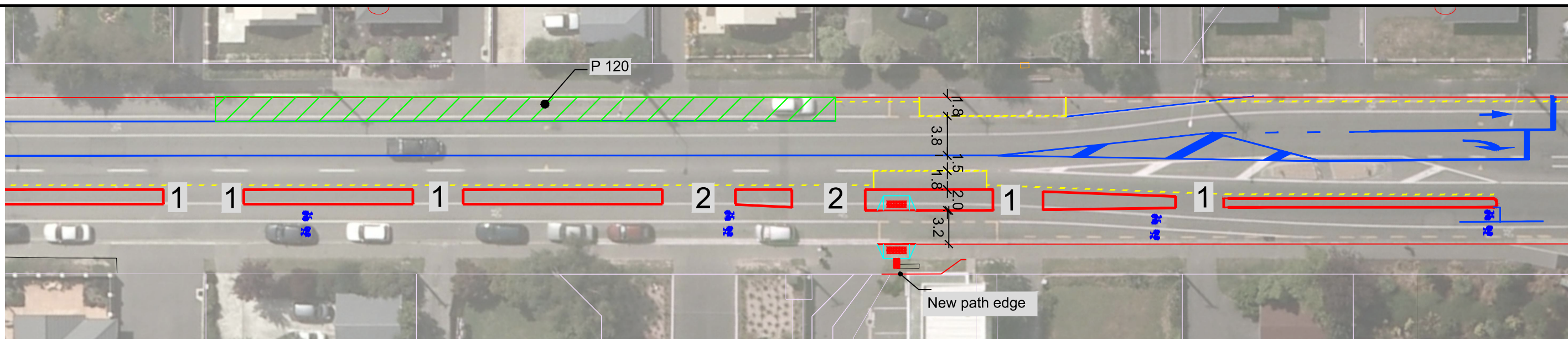
** denotes those factors where the value assigned is the least certain – to be analysed with sensitivity testing*

Appendix W

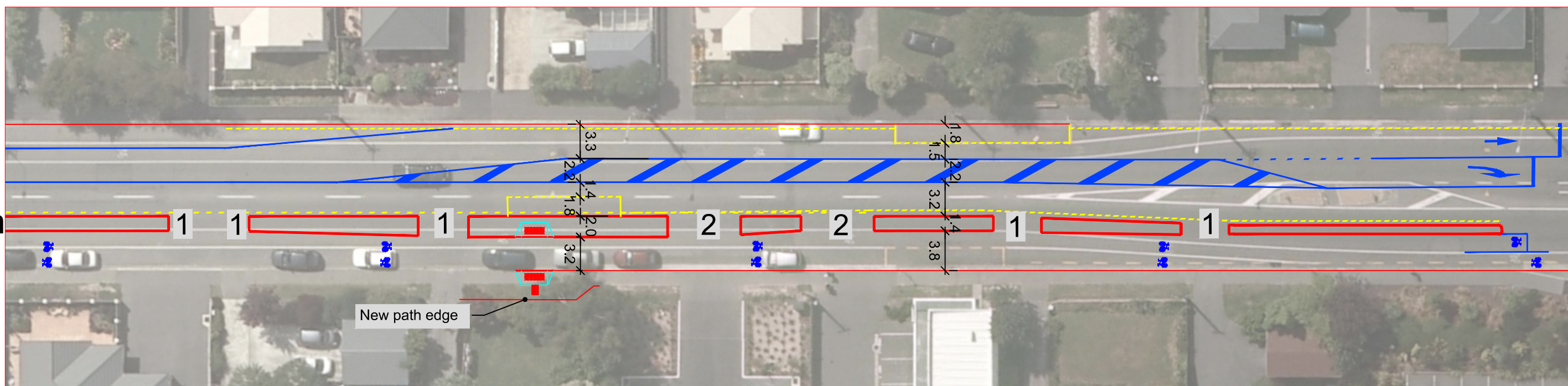
Bus stop options – Sawyers Arms Road



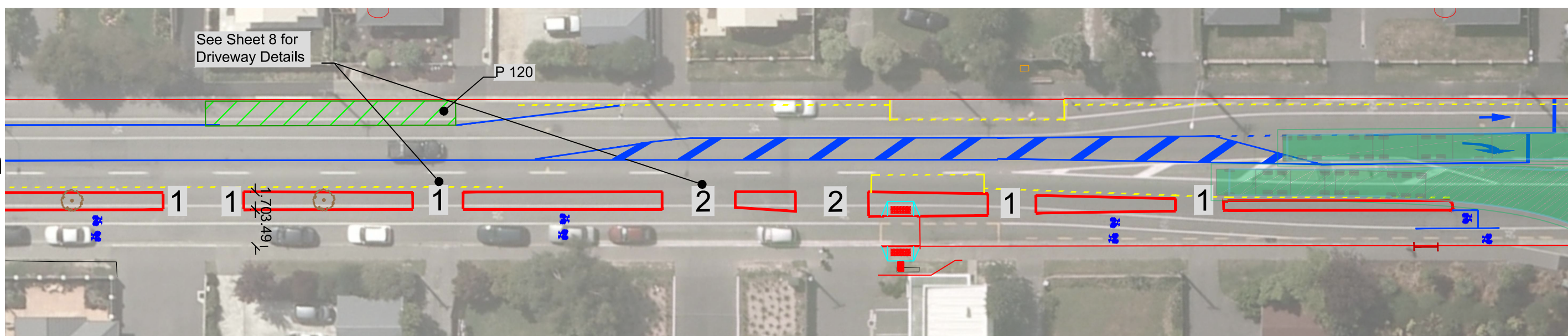
Option
(3)



Option
(2)



Option
(1)



Appendix X

Property purchase memos



Organisation: Christchurch City Council

Attn: Gemma Dioni

Date: 06 May 2015

From: ViaStrada

Re: Investigations of Main North Road / Sawyers Arms Road north corner realignment options.

Quality Assurance Statement		
<i>This document has been prepared for the benefit of Christchurch City Council. No liability is accepted by ViaStrada Ltd, or any of its employees or sub-consultants with respect to its use by any other party.</i>	Prepared by: Megan Fowler	Reviewed by: Axel Wilke
	Version: 01	Project No: 1037-10

1. Outline

Further to the proposed design of the Main North Road / Sawyers Arms Road intersection, ViaStrada has been asked to re-assess the need for property purchase on the northern corner.

Three scenarios that affect truck positioning within the intersection layout, signal phasing and kerb alignment have been identified.

1.1. Scenario 1 – original MCR scheme

This is the intersection design originally proposed for the MCR scheme. It enables the current phasing and operation to be used and incorporates CCC's plans to extend the left turn lane on Sawyers Arms Road. This scenario requires kerb realignment (and therefore property purchase) on the northern corner as a result of the removal of the existing on-road cycle lane which is currently used by trucks turning left from Sawyers Arms Road.

1.2. Scenario 2 – trucks swing wide

This scenario seeks to eliminate the need for property purchase by allowing the left turning truck from Sawyers Arms Road to “swing out” further into the intersection. However, this puts this truck movement in conflict with that of the truck turning right from Main North Road into Sawyers Arms Road. These two movements are currently operated simultaneously; previous investigations of the efficiency of this intersection



indicate that changing the phasing to operate these turns during different phases will result in a significant decrease in efficiency of the intersection.

1.3. Scenario 3 – trucks use right turn lane

This scenario seeks to maintain the current phasing and existing kerb alignment by assuming that trucks turning left from Sawyers Arms Road will utilise part of the right turn lane so as not to conflict with the opposing turning movement. This is consistent with the existing operation, where trucks utilise the existing cycle lane. However, under the proposed layout (where the existing cycle lane must be removed to accommodate the MCR on the other side of the road), left turning trucks will block the traffic in the right turn lane. This will have significant effects on the intersection's LOS as the left and right turns from Sawyers Arms Road are not operated during the same phase. It seems to contradict the principle of lengthening the left turn lane, as the left turn lane will not in fact be sufficient in providing for the trucks' turning requirements. It also requires truck drivers to understand the intersection operation and realise that they must move into the right turn lane before reaching the limit line so as to be able to perform the required turning movement.

1.4. Comparison

Table 1-1: Summary of scenarios and consequences

	Scenario 1 MCR scheme	Scenario 2 Trucks swing wide	Scenario 3 Trucks use right turn lane
Kerb	New kerb alignment Property purchase	Retains existing kerb No property purchase	Retains existing kerb No property purchase
Layout	Existing cycle lane removed No major changes to limit lines	Existing cycle lane removed Limit lines for right turn lane on Main North north approach shifted back significantly.	Existing cycle lane removed No major changes to limit lines
Operation	Trucks turning left from Sawyers Arms use left turn lane	Trucks turning left from Sawyers Arms use left turn lane Potential conflict with truck turning right into Sawyers Arms	Trucks turning left from Sawyers Arms use part of right turn lane so as to not conflict with right turn from Main North; prevents right turning traffic from moving – significant loss of efficiency as the right and left turns operate during separate phases.



Phasing	Current phasing retained.	Cannot operate right turn into Sawyers Arms and left turn out of Sawyers Arms simultaneously – significant impacts on current phasing operation and efficiency of intersection.	Current phasing retained.
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2. Designers' conclusions

There are no options available that accommodate the left turning trucks from Sawyers Arms Road within the left turning lane provided and according to the current phasing requirements without property purchase. If property purchase is not required, CCC must consider an option that will significantly decrease the intersection's efficiency and have flow-on effects along the rest of the Main North Road corridor and, less critically, Sawyers Arms Road.

3. Safety Auditor's response

The above text of this memo (Outline and Designers' conclusions) and the associated plans for the three options have been included in the independent safety audit for the entire scheme. The safety auditors were asked to specifically consider the three options presented for the northern corner of the Main North Road / Sawyers Arms Road intersection, with the various layouts and operational principles for the Sawyers Arms Road approach to the intersection.

The safety auditors concluded that:

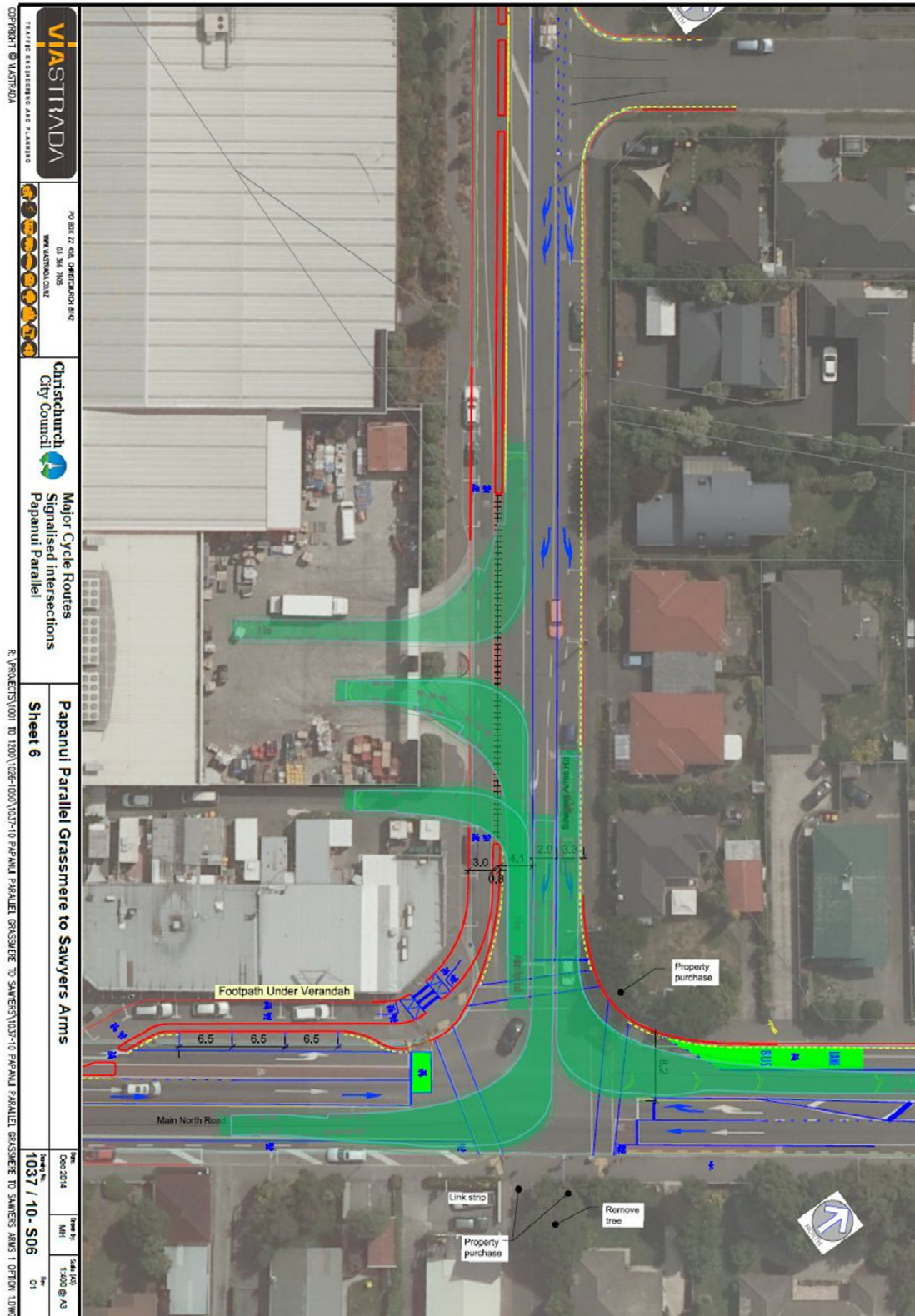
” From a safety (and operational) for all users perspective, Option 1 is preferred.”

The safety auditors' response on this issue accords with the designers' conclusions made above and therefore property purchase at 103 Main North Road is necessary.

Note that, due to other items identified in the safety audit, additional changes were made to the scheme design. None of these changes affect the northern corner of the intersection or the requirement to purchase property; however, for completeness, the revised scheme design is given in Appendix D.

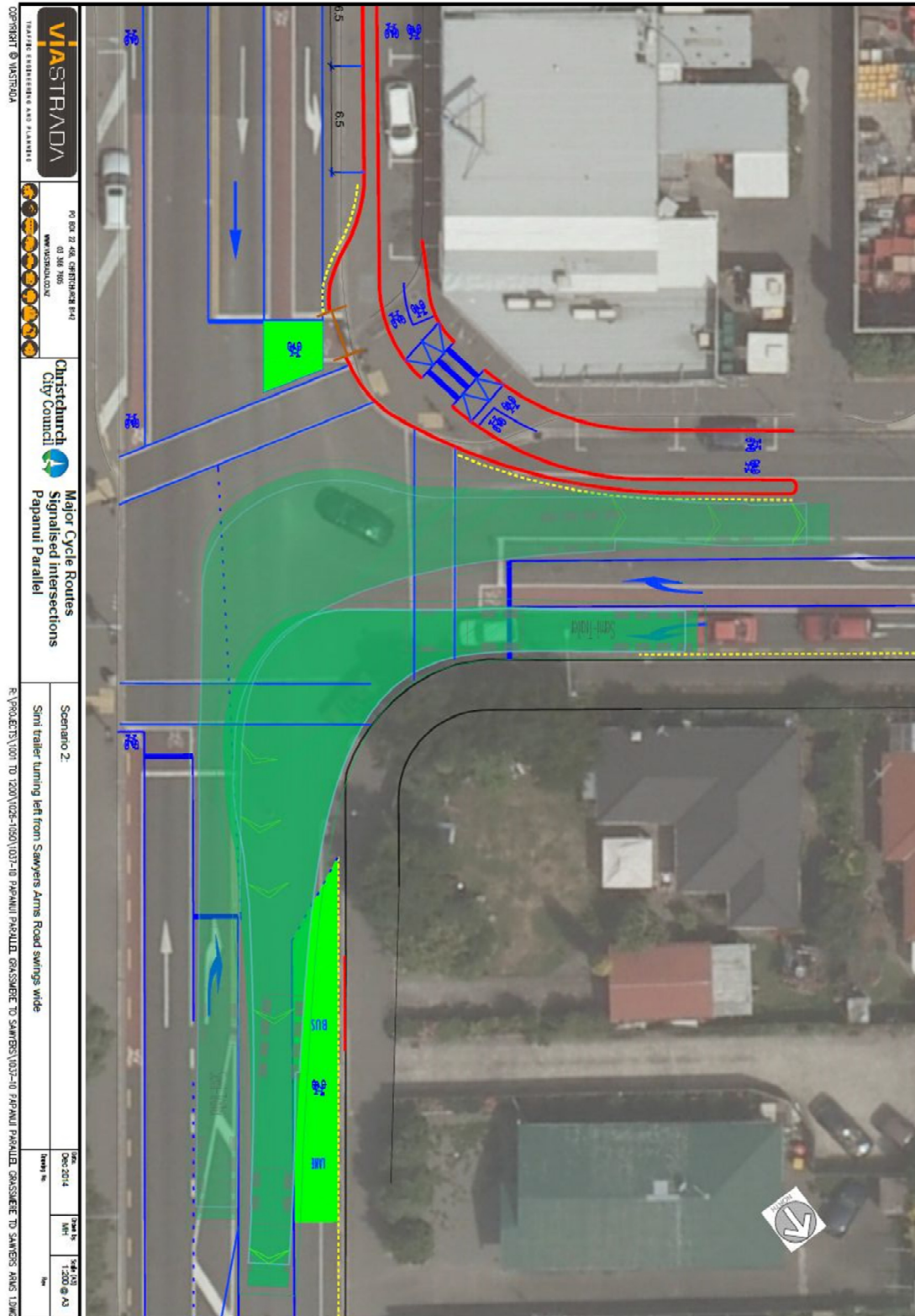


Appendix A Original MCR scheme



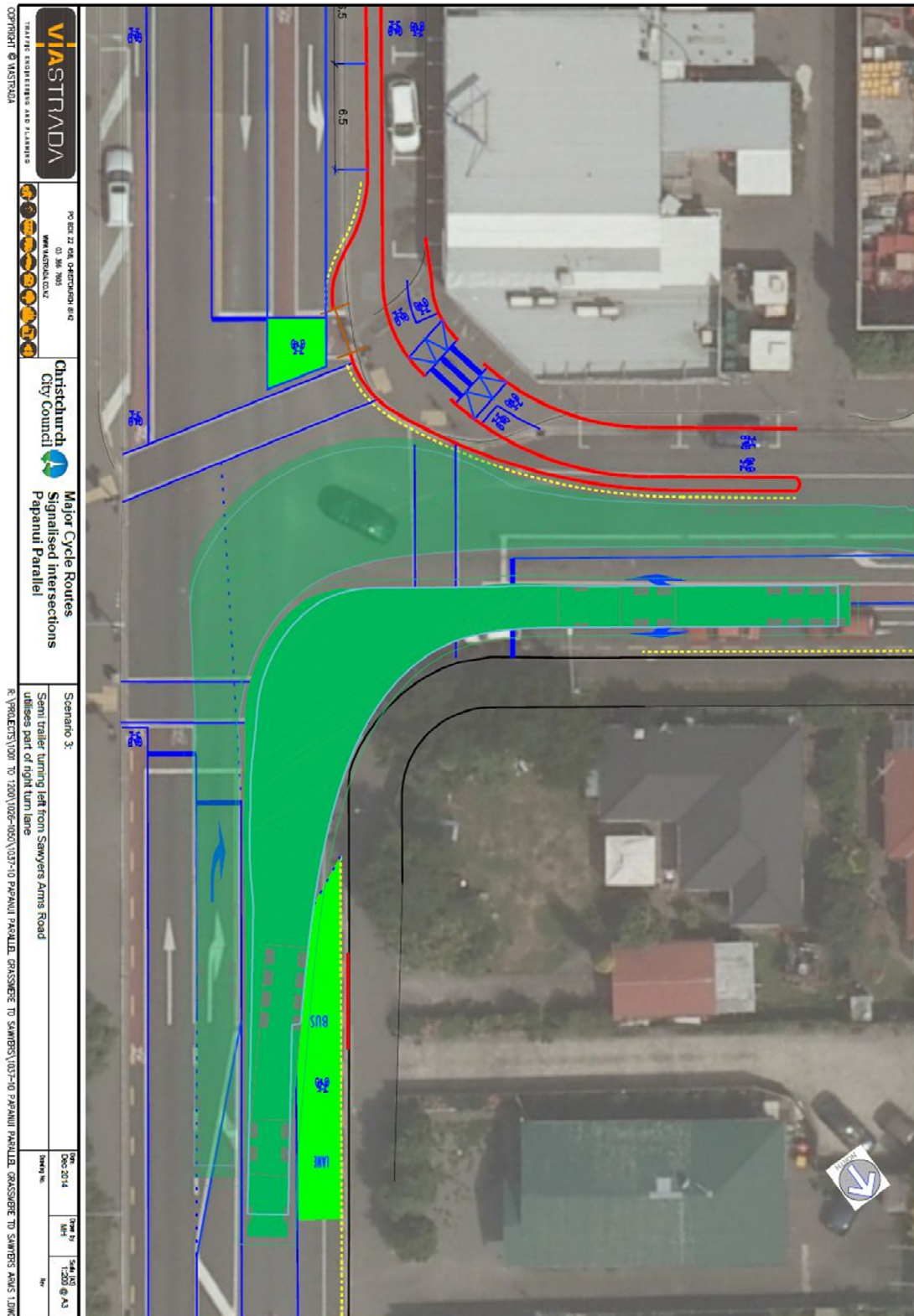


Appendix B Trucks swing wide



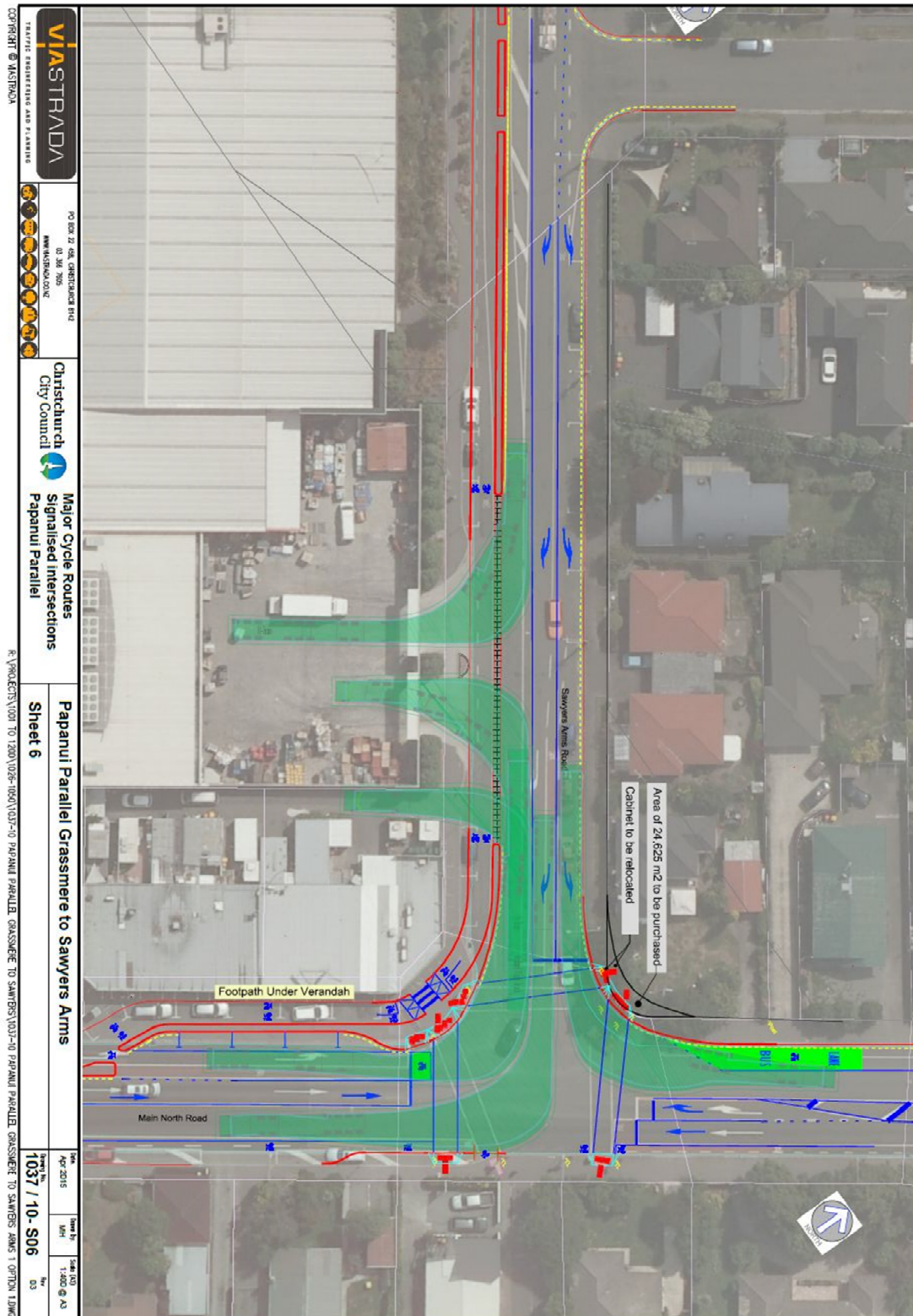


Appendix C Trucks use right turn lane





Appendix D Plan finalised after Safety Audit





Papanui Parallel MCR – options to avoid property purchase on Grassmere Street

Organisation: Christchurch City Council

Attn: Gemma Dioni

Date: 20 May 2015

From: ViaStrada

Re: Options to avoid property purchase on Papanui Parallel Major Cycle Route at 45 Grassmere Street.

Quality Assurance Statement		
<i>This document has been prepared for the benefit of Christchurch City Council. No liability is accepted by ViaStrada Ltd, or any of its employees or sub-consultants with respect to its use by any other party.</i>	Prepared by: Megan Fowler	Reviewed by: Axel Wilke
	Version: 02	Project No: 1037-10

1. Introduction

ViaStrada has developed a scheme for the Grassmere Street to Sawyers Arms Road section of the Papanui Parallel Major Cycle Route. This scheme involves a shared path on the north-western side of Grassmere Street, which runs between 31A and 57 Grassmere Street. Generally the road reserve is sufficient to accommodate this shared path, apart from at 45a and 45 Grassmere Street where the existing property boundary extends to the kerbline. Thus the preferred scheme, as detailed in Appendix A, requires property purchase.

ViaStrada has been asked to investigate alternative options to avoid property purchase in this location should the land purchase be unsuccessful or compulsory purchase through the public works act be required; two options have been developed. Following investigations, it is concluded that the preferred option is to pursue property purchase at 45 and 45a to deliver the Major Cycleway Scheme.

2. Alternative options

2.1. Option 2 – remove south-eastern footpath

The first alternative option, as detailed in Appendix B, involves:

- Shared path continued along the north-eastern side of Grassmere Street, in alignment with the existing property boundary at 45a and 45 Grassmere Street.
- Carriageway width of 5.5 m, sufficient for two-way traffic.



- Shared path width of 3.4 m;
 - in conjunction with a 0.5 m wide paving stone strip along the kerbline at path level, which serves as horizontal separation between the shared path and general traffic lane, but can be ridden or walked on by path users if necessary;
 - thus the total useable width of the shared path can be taken as 3.9 m. 0.3 m separation between the shared path and the adjacent property boundary
- Removal of the footpath on the south-western side of Grassmere Street.
 - This may disadvantage the residents of the adjacent Ngaio Marsh Retirement Village, especially those with vision or mobility impairments, as they may feel uncomfortable having to cross the road and share a path with cyclists. However, it is noted that there is an extensive path network within the retirement village and other links where residents can access footpaths outside the village.
 - It may be possible to negotiate land acquisition to provide a replacement public footpath on land currently owned by the retirement village.
 - Some residents walking from Grants Road towards the Northlands Key Activity Centre will also feel disadvantaged by having to cross the road to continue their journey. Those residents who are less agile may not be able to cross Main North Road at the existing crossing island west of Grassmere Street and would want to cross at the proposed signals at the northern end of Grassmere Street, and for that, they will have to cross Grassmere Street anyway. But they may also not like to use a shared path, and the proposal would not give them any other option, as the exclusive footpath in this area is to be removed under this option, and the pathway shared with cyclists is their only available option. A Major Cycle Route project should not reduce levels of service to pedestrians, especially in the vicinity of a Key Activity Centre as Council is trying to encourage journeys on foot to these locations.
 - This also involves a section of low kerb at the point where the cross section transitions between having a footpath and not having a footpath on the southwest side at the Ngaio Marsh Retirement Village driveway (illustrated in Figure 2-1). There is a risk that westbound drivers may not notice this kerb, fail to follow the alignment and instead drive onto the footpath at the buildout. The footpath at the corner of 70 Grassmere Street (immediately west of the Ngaio Marsh driveway) is narrower than what is desirable, but as this is in the area with a dropped kerb, this does not present an unsurmountable obstacle for wide mobility scooters, for example.
- Requires all on-street parking to be removed.
- Crossing points on raised platforms with kerb build-outs either side of the modified section.
 - To allow pedestrians who may have otherwise walked along the south-western footpath access to the shared path; and
 - To act as traffic calming devices.

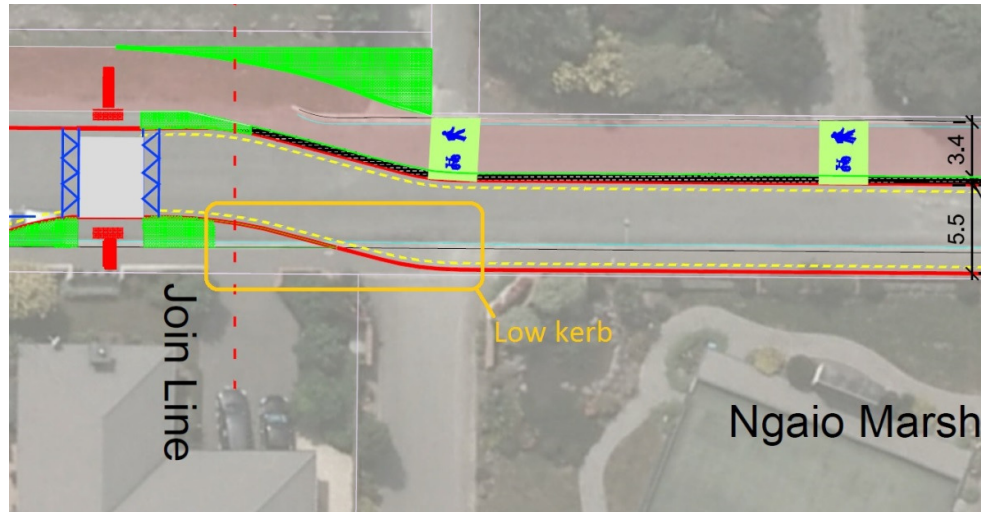


Figure 2-1: potentially hazardous section of low kerb at transition point

2.2. Option 3 – one-lane motor traffic

The second alternative option is also detailed in Appendix B, it involves:

- Shared path continued along the north-eastern side of Grassmere Street, in alignment with the existing property boundary at 45a and 45 Grassmere Street.
- Carriageway width of 3.5 m, sufficient for one-lane traffic only.
 - Drivers approaching the bend will not be able to see completely around the bend to check for on-coming traffic; if two vehicles travelling in opposite directions encounter each other within this section one will either have to reverse or pull into an adjacent driveway; this latter option is more likely and has potential to cause conflict with path users, especially if drivers reverse into the driveway.
 - A safety audit should therefore be undertaken on this scheme if it is to be progressed further.
- Shared path width of 4.0 m;
 - With an additional 0.6 m wide grass berm providing horizontal separation between the shared path and general traffic lane.
 - 0.3 m separation between the shared path and the adjacent property boundary
- No changes to the footpath on the south-western side of Grassmere Street.
- Requires all on-street parking to be removed.
- Crossing points on raised platforms with kerb build-outs either side of the modified section.
 - To act as traffic calming devices; and
 - To improve visibility for northbound drivers in particular, due to the alignments of the kerb buildouts on the south-western side.

2.3. Comparison

Table 2-1~~Table 1-1~~ compares the original scheme and the two alternative options.



Papanui Parallel MCR – options to avoid property purchase on Grassmere Street

Table 2-1: Summary of scenarios and consequences

	Original MCR scheme with property purchase	Option 2 – remove south-eastern footpath	Option 3 – one-lane motor traffic
Property purchase	Requires property purchase	Does not require property purchase	Does not require property purchase
Shared path provision	<p>Achieves the desirable minimum shared path width of 4 m.</p> <p>Horizontal separation between path and general traffic achieved by painted buffer on carriageway (less desirable than horizontal separation at path level as provided by the grass berm in option 3).</p> <p>1.0 m separation between the shared path and the adjacent property boundary.</p>	<p>Useable path width (i.e. including paving stone buffer) of 3.9 m, which is just under the desirable minimum shared path width of 4 m.</p> <p>Horizontal separation between path and general traffic achieved by paving stone strip on shared path, which is useable for path users if required.</p> <p>0.3 m separation between the shared path and the adjacent property boundary.</p>	<p>Achieves the desirable minimum shared path width of 4 m.</p> <p>Horizontal separation between path and general traffic achieved by grass berm (most desirable form of horizontal separation).</p> <p>0.3 m separation between the shared path and the adjacent property boundary.</p>
South-west footpath	No changes to existing footpath on south-western side of Grassmere Street.	<p>Removal of footpath on south-western side of Grassmere Street, which may disadvantage residents from the Ngaio Marsh Retirement Village.</p> <p>Potential hazard due to low kerb immediately adjacent to Ngaio Marsh driveway.</p>	No changes to existing footpath on south-western side of Grassmere Street.
General traffic	Two-way general traffic.	Two-way general traffic.	<p>One-lane only for general traffic, with limited visibility around the bend to check for oncoming traffic.</p> <p>This may result in vehicles having to reverse or pull into an adjacent driveway and</p>



Papanui Parallel MCR – options to avoid property purchase on Grassmere Street

			possibly conflict with path users.
Parking	Parking provided on south-west side.	No on-street parking. This is unlikely to be a large disadvantage, as the adjacent properties provide sufficient parking for residents and visitors.	No on-street parking. This is unlikely to be a large disadvantage, as the adjacent properties provide sufficient parking for residents and visitors.
Consistency with rest of Grassmere Street	Consistent provision for: <ul style="list-style-type: none"> • Path users • Motorists • Pedestrians on southwest side 	Consistent provision for: <ul style="list-style-type: none"> • Motorists Inconsistent provision for: <ul style="list-style-type: none"> • Path users • Pedestrians on southwest side 	Consistent provision for: <ul style="list-style-type: none"> • Path users • Pedestrians on southwest side Inconsistent provision for: <ul style="list-style-type: none"> • Motorists
Cost	Requires property purchase	Does not require property purchase Highest construction cost due to kerb relocation and removal of footpath	Does not require property purchase

3. Designers' conclusions

Each of the two alternative options proposed are viable, but neither is ideal and both involve significant compromises and risks. **The preferred course of action is to continue purchase property at 45a and 45 Grassmere Street as per the original scheme;** this would allow for adequate provision for all users and would maintain consistency with the rest of the Grassmere Street.

If it is determined that property purchase is not an option, it is suggested that Council consult with the Ngaio Marsh Retirement Village managers and residents to determine their position regarding the possibility of removing the south-western footpath. It is anticipated that removing this footpath will not overly disadvantage residents as they have other opportunities for walking within and adjacent to the retirement village. If this is confirmed, Option 2 is the preferred of the two alternative options as it provides for two-way motor traffic and thus avoids the problems associated with limited visibility and the possibility of motorists pulling into the driveways across the shared path associated with Option 3.

The construction cost of relocating the kerb and removing the footpath in Option 2 will however be significant and it may be found that property purchase (if the land is reasonably priced), as well as providing the highest level of provision to all users, is also more cost-effective than Option 2.



Grassmere Street

Ngaio Marsh retirement village

Grants Road

New seal

Join Line

NOTE:
DO NOT PROVIDE ANY OTHER
TRAFFIC CONTROL DEVICES
THAN SHOWN

Join Line

Scale: 2.00, 5.40, 0.75

North Arrow

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 Christchurch City Council
 Major Cycle Routes
 Signalised Intersections
 Papanui Parallel
 Papanui Parallel Grassmere to Sawyers Arms
 Sheet 12
 1037 / 10 - S012
 01
 1037 / 10 - S012
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Appendix Y

Arborists report