

Road surface noise measurements of porous
asphalt on the Waikato Expressway and Tauranga
Eastern Link



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1 Summary

Road surface noise testing was performed using the Close Proximity measurement trailer (CPX trailer). Measurements were performed following the NZ Transport Agency's "Close proximity (CPX) road surface noise measurement trailer guide". This report details the measurements, locations, general observations, and presents the results of testing.

For convenience, the summary results are provided below. The reported sections have four lanes and are all surfaced with PA10.

Table 1 Overall average LCPX:P1,80 by location

Site	LCPX:P1,80	Acoustic variability	Average distance per lane
<i>Tauranga Eastern Link</i>	97.1 dB	0.9 dB	17,877m
<i>Waikato Expressway - Cambridge Section</i>	96.9 dB	0.9 dB	13,403m
<i>Waikato Expressway - Ngaruawahia Section</i>	98.5 dB	1.1 dB	7,075m
<i>Waikato Expressway - Te Rapa section</i>	98.2 dB	1.7 dB	4,578m

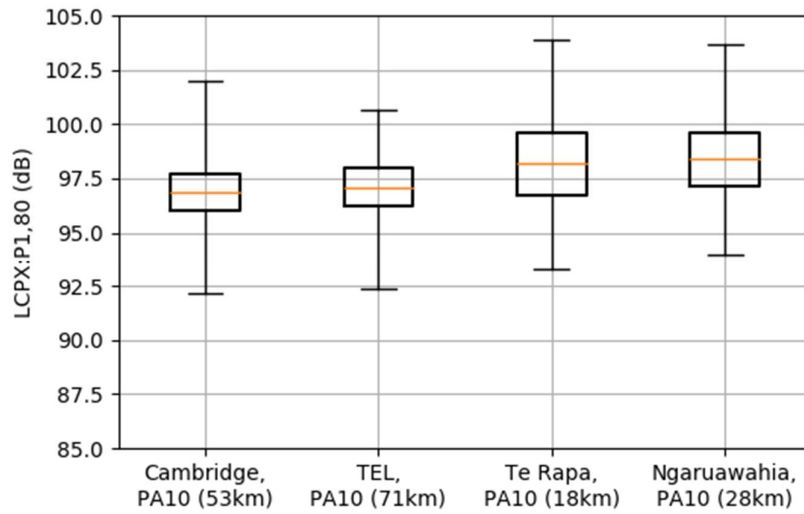


Figure 1 Median, Q1, Q2, maximum and minimum 20 metre road segment data for each location. Distances indicate the total length of surface surveyed.

2 Monitoring locations

The locations detailed in the following table were tested by Robin Wareing of Altissimo Consulting Limited. The sites tested were selected as they had at least 1 km of porous asphalt which was less than 3 years old.

Table 2 Road surface noise measurement sites

Site	Highway	Northern RP	Southern RP
<i>Tauranga Eastern Link</i>	SH2	002-0164/0.200	002-0177/7.140
<i>Waikato Expressway - Cambridge Section</i>	SH1	01N-0557/04.00	01N-0574/04.00
<i>Waikato Expressway - Ngaruawahia Section</i>	SH1	01N-0527/01.40	01N-0534/04.30
<i>Waikato Expressway - Te Rapa section</i>	SH1	01N-0540/00.00	01N-0540/06.40

The following additional sites were considered during planning, but were not tested due the reasons stated:

- Mackays to Peka Peka, Kapiti – road surface degraded due to on-going remediation.
- Waikato Expressway – Rangiriri Section – poor access due to road layout and on-going construction works to the north.
- Auckland Motorways – abandoned due to poor weather.

3 Measurement details

3.1 Tauranga Eastern Link (TEL)

Table 3 Tauranga Eastern Link measurement details

<i>Date</i>	16 October 2018	
<i>Road ID</i>	002-0164 and 002-0177	
<i>Location and number of measurement runs</i>	<ul style="list-style-type: none"> • Northbound, left lane – 3 runs • Northbound, right lane – 3 runs • Southbound, left lane – 3 runs • Southbound, right lane – 3 runs 	
<i>Lateral road position</i>	Left wheel path	
<i>Measurement resolution</i>	20 metre segments	
<i>Surface types</i>	Porous Asphalt (PA10), 03-06/2015	
<i>Reference speed</i>	80 km/h	
<i>Correction factors</i>	Speed coefficient, B	25
	Temperature correction coefficient, γ_t	-0.048
	Tyre hardness	69.7
<i>Equipment</i>	Transport Agency CPX trailer	
<i>Tow vehicle make/model</i>	Ford Ranger 2017 XTL	
<i>Test tyre</i>	Reference tyre P1 (set 1)	
<i>Microphone positions</i>	Positions 1 and 2	
<i>Operator</i>	Robin Wareing	
<i>Driver</i>	Local contractor	
<i>Weather conditions during testing</i>	Wind	10 – 20 km/h
	Temperature	7° – 18° C
	Precipitation	None
<i>Last precipitation</i>	1.6mm at 04:00 on 14 th October 2018 (>24hrs before test)	

Throughout the testing the traffic conditions were light with a limited number of vehicle pass-by events. Traffic management was in place during this testing, this involved two following advanced warning vehicles with attenuators. These vehicles remained approximately 100 metres behind the trailer during testing, this prevented other road users from sitting directly behind the trailer.

The weather was fine and there had been no rain in the previous 24 hours. The road surface was dry throughout the testing. In general, the road surface was in good condition with no large areas of damage.

An overview of the measurement site is presented in Figure 2 below.

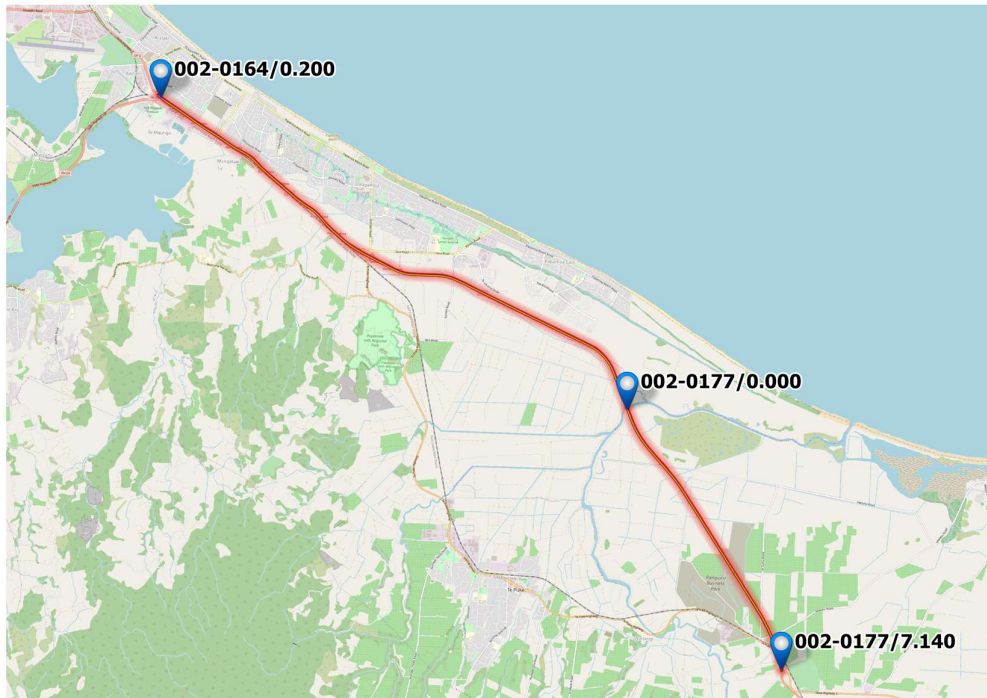


Figure 2: Tauranga Eastern Link

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3.2 Waikato Expressway - Cambridge Section

Table 4: Waikato Expressway - Cambridge Section measurement details

<i>Date</i>	13 & 14 November 2018	
<i>Road ID</i>	01N-0557	
<i>Location and number of measurement runs</i>	<ul style="list-style-type: none"> • Northbound, left lane – 3 runs • Northbound, right lane – 3 runs • Southbound, left lane – 3 runs • Southbound, right lane – 3 runs 	
<i>Lateral road position</i>	Left wheel path	
<i>Measurement resolution</i>	20 metre segments	
<i>Surface types</i>	Porous Asphalt (PA10), 2017	
<i>Reference speed</i>	80 km/h	
<i>Correction factors</i>	Speed coefficient, B	25
	Temperature correction coefficient, γ_t	-0.048
	Tyre hardness	69.7
<i>Equipment</i>	Transport Agency CPX trailer	
<i>Tow vehicle make/model</i>	Ford BT50	
<i>Test tyre</i>	Reference tyre P1 (set 1)	
<i>Microphone positions</i>	Positions 1 and 2	
<i>Operator</i>	Robin Wareing	
<i>Driver</i>	Local contractor	
<i>Weather conditions during testing</i>	Wind	7 – 15 km/h
	Temperature	13° – 14° C
	Precipitation	None
<i>Last precipitation</i>	0.5mm at 00:00 on 10 th November 2018 (>24hrs before test)	

Throughout the testing traffic conditions were light with a limited number of vehicle pass-by events. No specific traffic management was in place during this testing. Occasionally vehicles did remain close behind the trailer for an extended period, typically these events were flagged.

The weather was fine and there had been no rain in the previous 24 hours. The road surface was dry throughout the testing. In general, the road surface was in good condition with no large areas of damage.

An overview of the measurement site is presented in Figure 3 below.

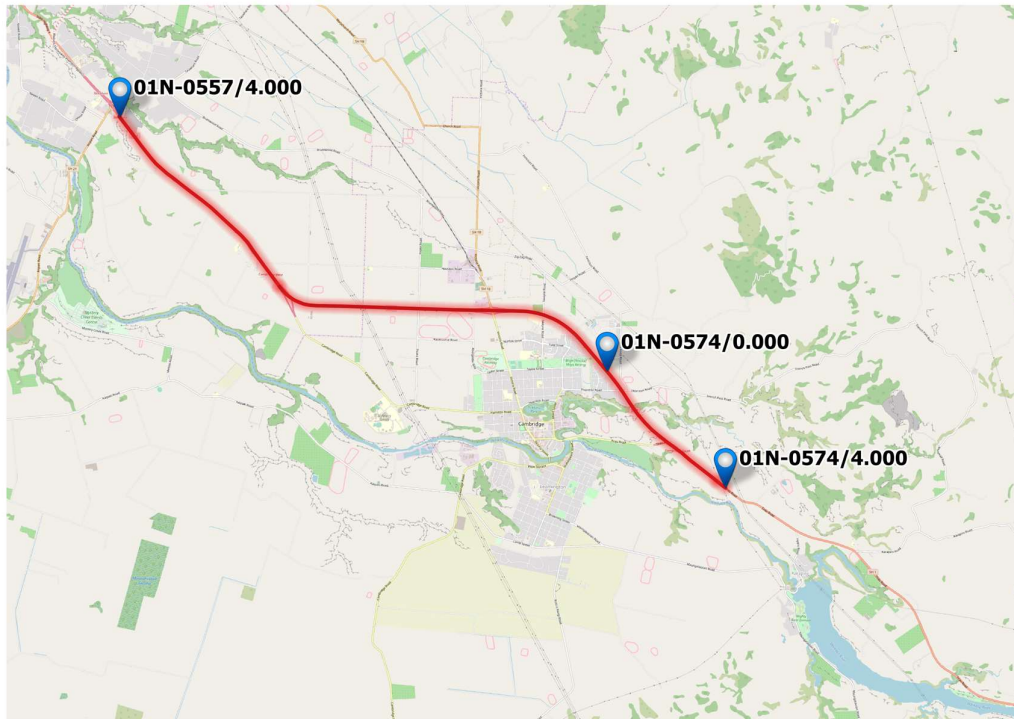


Figure 3: Waikato Expressway - Cambridge Section

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3.3 Waikato Expressway - Ngaruawahia Section

Table 5: Waikato Expressway - Ngaruawahia Section measurement details

<i>Date</i>	13 October 2018	
<i>Road ID</i>	01N-0534 and 01N-0527	
<i>Location and number of measurement runs</i>	<ul style="list-style-type: none"> • Northbound, left lane – 3 runs • Northbound, right lane – 3 runs • Southbound, left lane – 3 runs • Southbound, right lane – 3 runs 	
<i>Lateral road position</i>	Left wheel path	
<i>Measurement resolution</i>	20 metre segments	
<i>Surface types</i>	Porous Asphalt (PA10), 2015	
<i>Reference speed</i>	80 km/h	
<i>Correction factors</i>	Speed coefficient, B	25
	Temperature correction coefficient, γ_t	-0.048
	Tyre hardness	69.7
<i>Equipment</i>	Transport Agency CPX trailer	
<i>Tow vehicle make/model</i>	Mazda BT50	
<i>Test tyre</i>	Reference tyre P1 (set 1)	
<i>Microphone positions</i>	Positions 1 and 2	
<i>Operator</i>	Robin Wareing	
<i>Driver</i>	Local contractor	
<i>Weather conditions during testing</i>	Wind	7 – 15 km/h
	Temperature	13° – 14° C
	Precipitation	None
<i>Last precipitation</i>	0.5mm at 00:00 on 10 th November 2018 (>24hrs before test)	

Throughout the testing traffic conditions were light with a limited number of vehicle pass-by events. No specific traffic management was in place during this testing. Occasionally vehicles did remain close behind the trailer for an extended period, typically these events were flagged.

The weather was fine and there had been no rain in the previous 24 hours. The road surface was dry throughout the testing. The northbound lanes had minimal damage, but the southbound left lane had extensive damage across a long stretch. There were areas on the left southbound lane with large potholes were present. The damaged sections of road were flagged during testing and are excluded from the results.

An overview of the measurement site is presented in Figure 4 below.

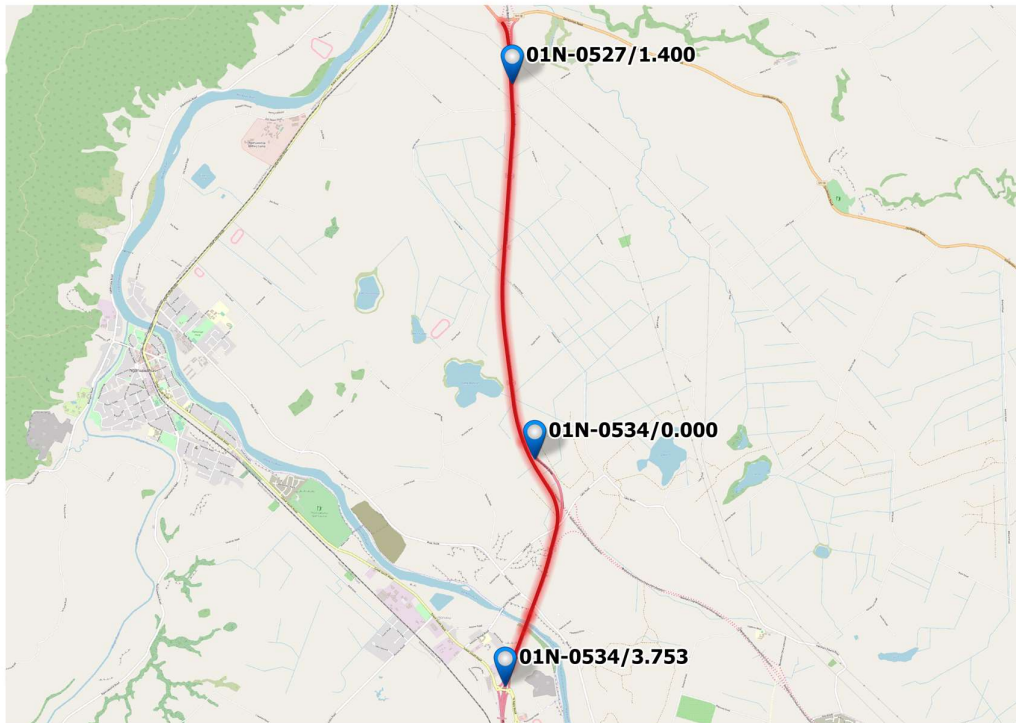


Figure 4: Waikato Expressway - Ngaruawahia Section

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3.4 Waikato Expressway - Te Rapa Section

Table 6: Waikato Expressway – Te Rapa Section measurement details

<i>Date</i>	13 October 2018	
<i>Road ID</i>	01N-0540	
<i>Location and number of measurement runs</i>	<ul style="list-style-type: none"> • Northbound, left lane – 3 runs • Northbound, right lane – 3 runs • Southbound, left lane – 3 runs • Southbound, right lane – 3 runs 	
<i>Lateral road position</i>	Left wheel path	
<i>Measurement resolution</i>	20 metre segments	
<i>Surface types</i>	Porous Asphalt (PA10), 2013/2014	
<i>Reference speed</i>	80 km/h	
<i>Correction factors</i>	Speed coefficient, B	25
	Temperature correction coefficient, γ_t	-0.048
	Tyre hardness	69.7
<i>Equipment</i>	Transport Agency CPX trailer	
<i>Tow vehicle make/model</i>	Mazda BT50	
<i>Test tyre</i>	Reference tyre P1 (set 1)	
<i>Microphone positions</i>	Positions 1 and 2	
<i>Operator</i>	Robin Wareing	
<i>Driver</i>	Local contractor	
<i>Weather conditions during testing</i>	Wind	7 – 15 km/h
	Temperature	13° – 14° C
	Precipitation	None
<i>Last precipitation</i>	0.5mm at 00:00 on 10 th November 2018 (>24hrs before test)	

Throughout the testing traffic conditions were light with a limited number of vehicle pass-by events. No specific traffic management was in place during this testing. Occasionally vehicles did remain close behind the trailer for an extended period, typically these events were flagged.

The weather was fine and there had been no rain in the previous 24 hours. The road surface was dry throughout the testing. The northbound lanes had minimal damage, but the southbound left lane had limited damage across a long stretch. The damaged sections of road were flagged during testing and are excluded from the results.

An overview of the measurement site is presented in Figure 5 below.

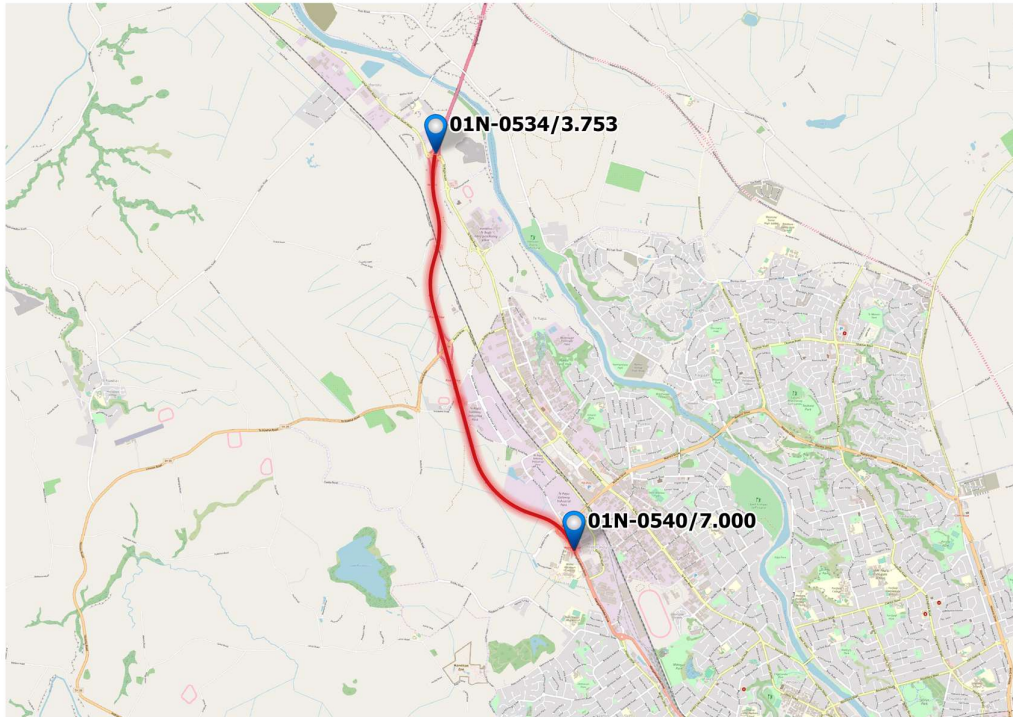


Figure 5: Waikato Expressway - Te Rapa Section

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3.5 Results

The results by lane and direction are included in Table 7 to Table 10, and the overall results for each site (combining all lanes and directions) are given in Table 11. Figure 6 provides the median, Q1, Q2, maximum and minimum 20 metre road segment LCPX:P1,80 values for each location.

The measured levels on the three sections of the Waikato Expressway are all higher than measured in 2017. The cause of this increase has not been investigated, but it is likely due to improvements in the measurement system.

Longitudinal plots are included in the Appendix A.

Table 7 Tauranga Eastern Link

Tauranga Eastern Link (PA10)	LCPX:P1,80	Acoustic variability	Distance
<i>Left lane, NB</i>	98.0 dB	0.8 dB	17,312m
<i>Right lane, NB</i>	96.2 dB	1.0 dB	17,216m
<i>Left lane, SB</i>	97.8 dB	0.9 dB	18,589m
<i>Right lane, SB</i>	96.3 dB	0.8 dB	18,389m

Table 8 Waikato Expressway - Cambridge Section

Waikato Expressway, Cambridge Section (PA10)	LCPX:P1,80	Acoustic variability	Distance
<i>Left lane, NB</i>	96.7 dB	0.8 dB	13,941m
<i>Right lane, NB</i>	96.0 dB	1.0 dB	13,736m
<i>Left lane, SB</i>	97.4 dB	0.9 dB	12,944m
<i>Right lane, SB</i>	97.6 dB	1.0 dB	12,990m

Table 9 Waikato Expressway – Ngaruawahia Section

Waikato Expressway, Ngaruawahia Section (PA10)	LCPX:P1,80	Acoustic variability	Distance
<i>Left lane, NB</i>	99.7 dB	1.0 dB	6,154m
<i>Right lane, NB</i>	98.2 dB	0.9 dB	7,875m
<i>Left lane, SB</i>	99.2 dB	1.3 dB	6,702m
<i>Right lane, SB</i>	96.8 dB	1.0 dB	7,568m

Table 10 Waikato Expressway - Te Rapa Section

Waikato Expressway, Te Rapa Section (PA10)	LCPX:P1,80	Acoustic variability	Distance
<i>Left lane, NB</i>	99.3 dB	1.8 dB	4597m
<i>Right lane, NB</i>	98.0 dB	1.3 dB	4827m
<i>Left lane, SB</i>	98.1 dB	2.3 dB	4241m
<i>Right lane, SB</i>	97.3 dB	1.6 dB	4648m

Table 11 Overall LCPX:P1,80 by location

	LCPX:P1,80	Acoustic variability	Average distance per lane
<i>Tauranga Eastern Link</i>	97.1 dB	0.9 dB	17,877m
<i>Waikato Expressway, Cambridge Section</i>	96.9 dB	0.9 dB	13,403m
<i>Waikato Expressway, Ngaruawahia Section</i>	98.5 dB	1.1 dB	7,075m
<i>Waikato Expressway, Te Rapa section</i>	98.2 dB	1.7 dB	4,578m

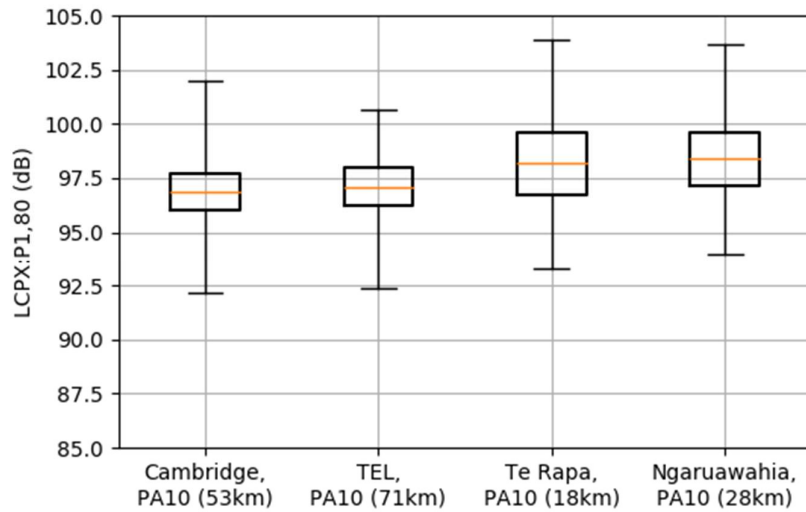
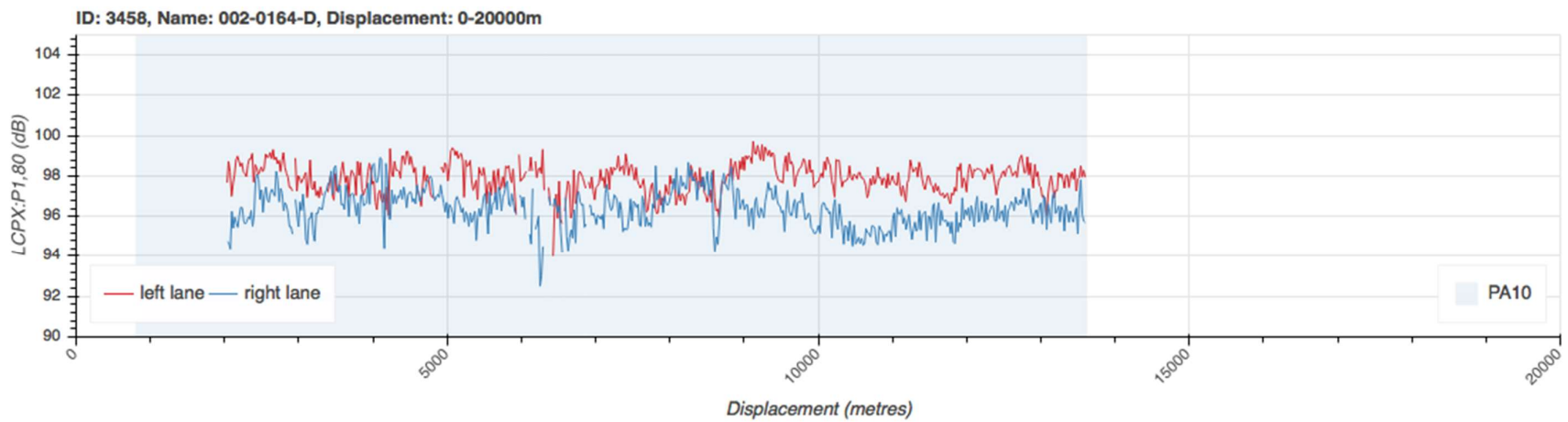
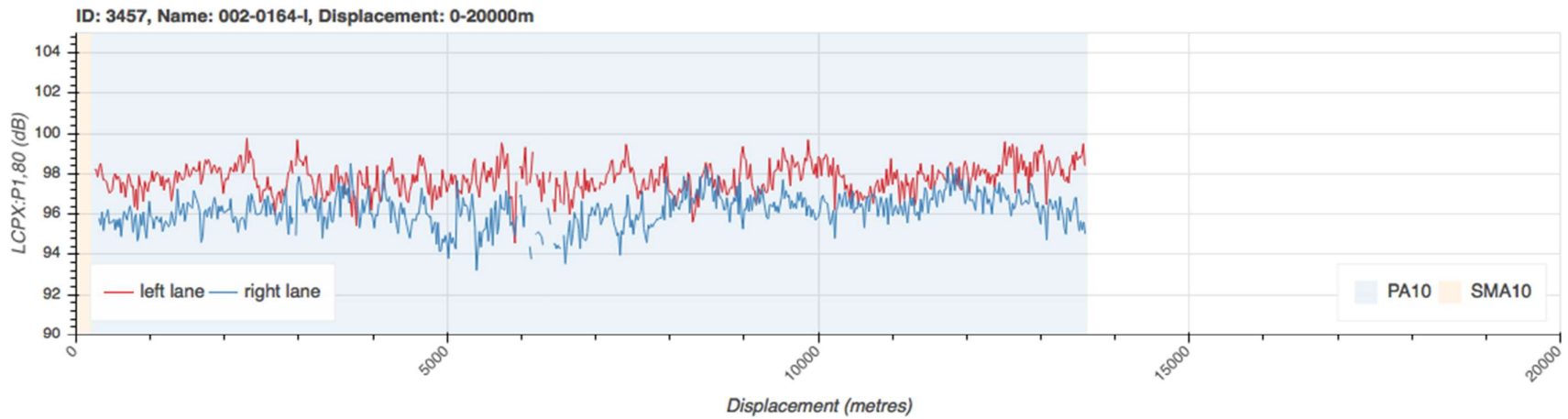
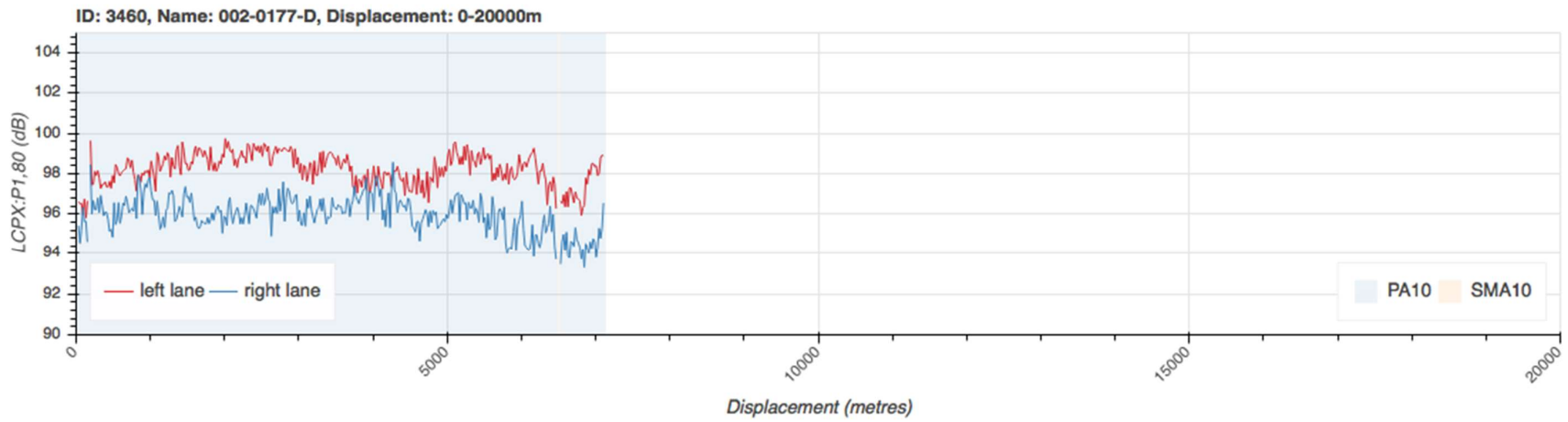
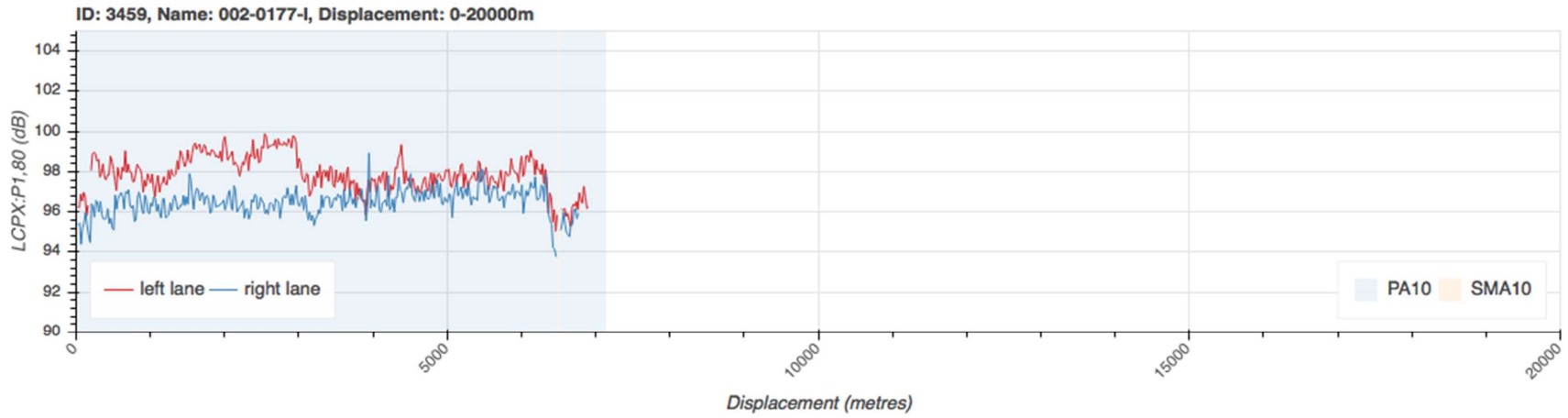


Figure 6 Median, Q1, Q2, maximum and minimum 20 metre road segment data for each location. Distances indicate the total length of surface surveyed.

Appendix A
Detailed Logitudinal Plots

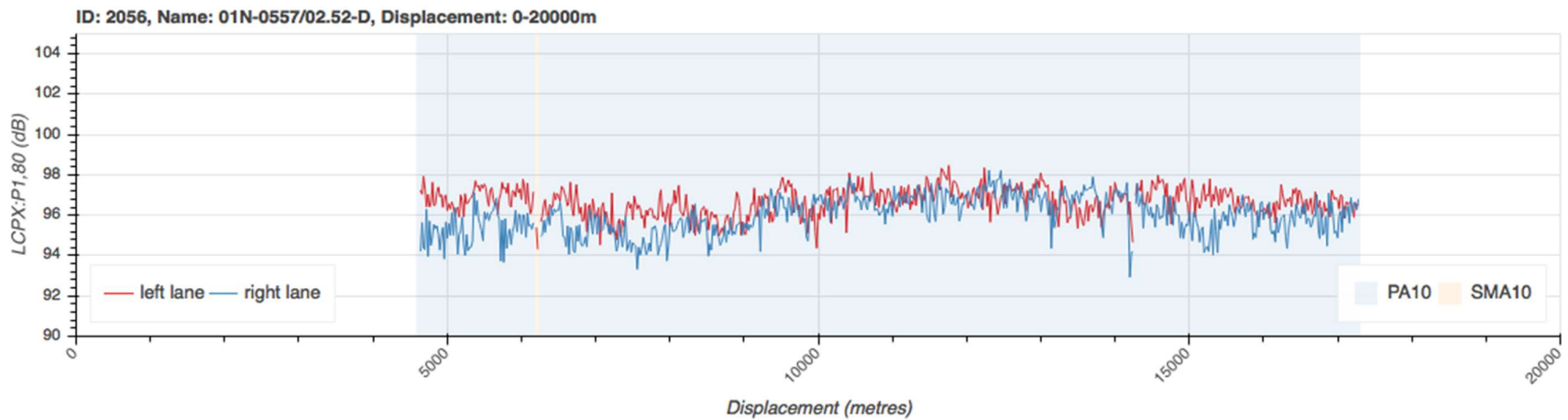
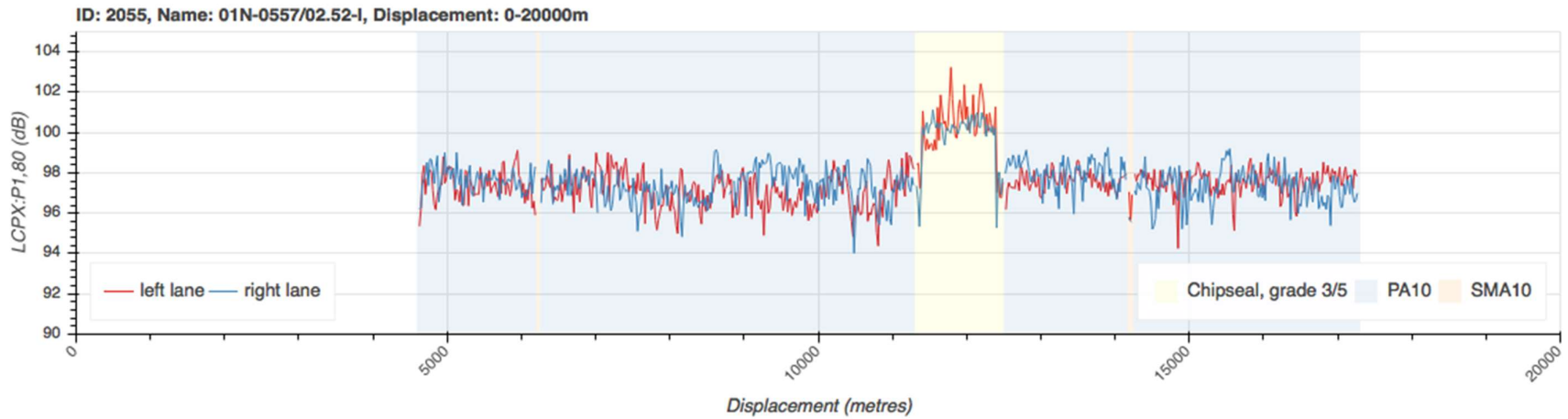
A.1 Tauranga Eastern Link



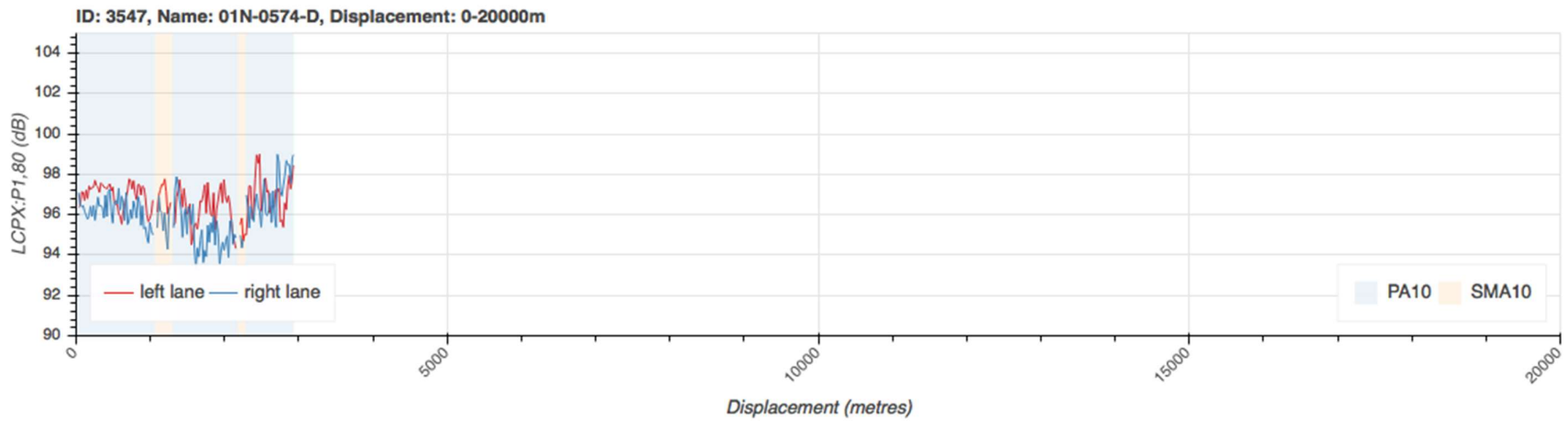
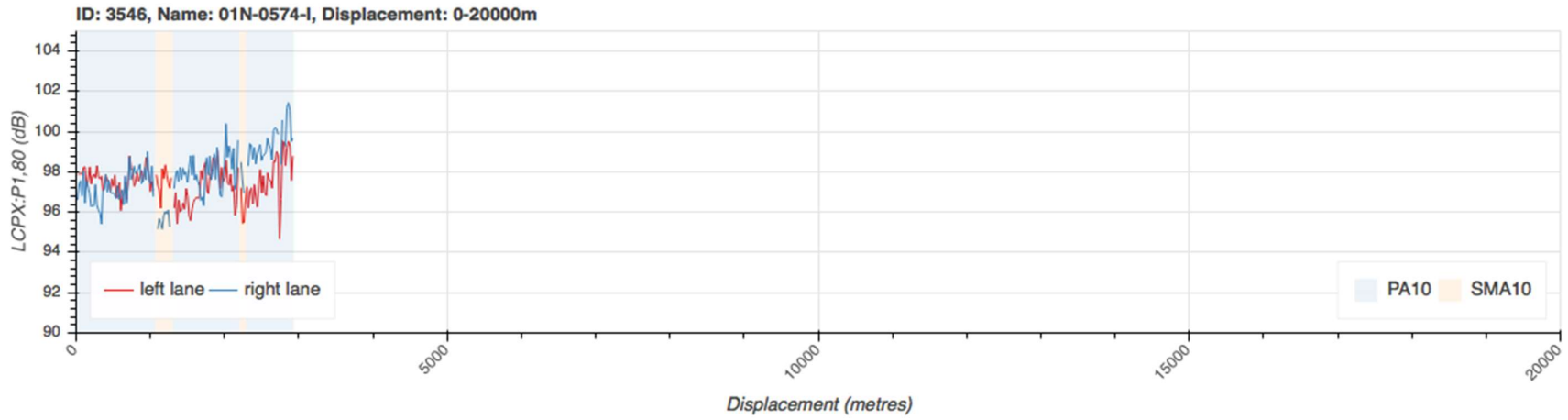


Road surface noise measurements of porous asphalt on the Waikato Expressway and Tauranga Eastern Link

A.2 Waikato Expressway, Cambridge Section

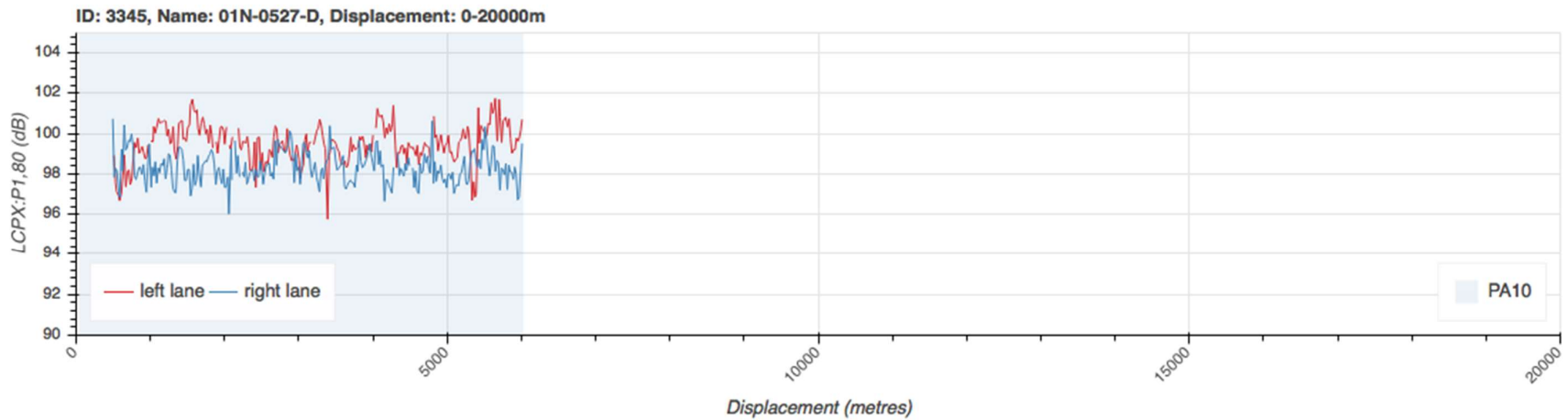
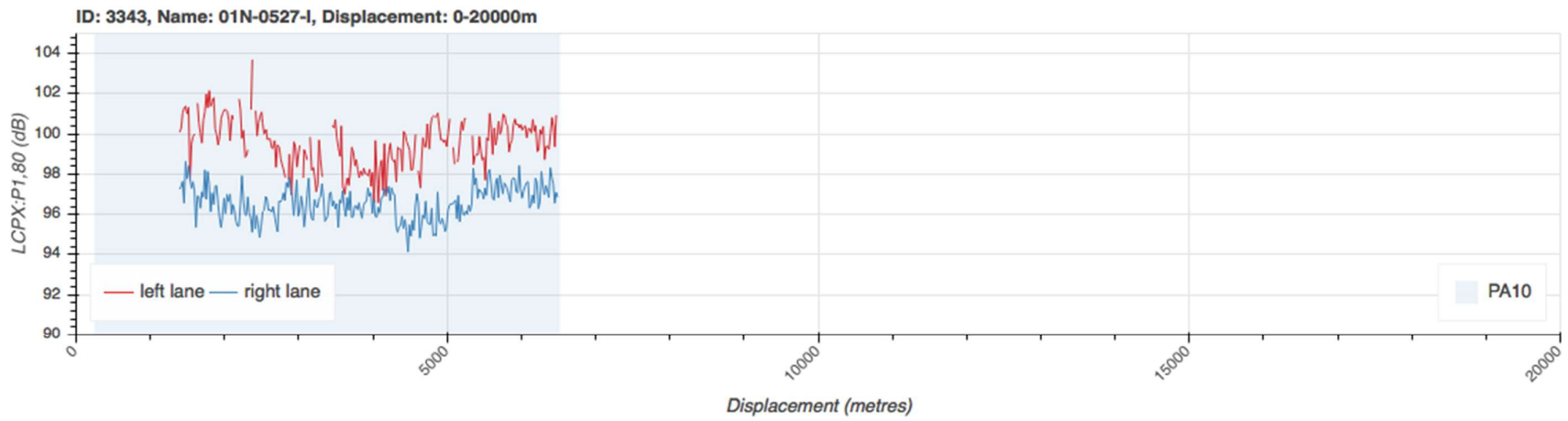


Road surface noise measurements of porous asphalt on the Waikato Expressway and Tauranga Eastern Link

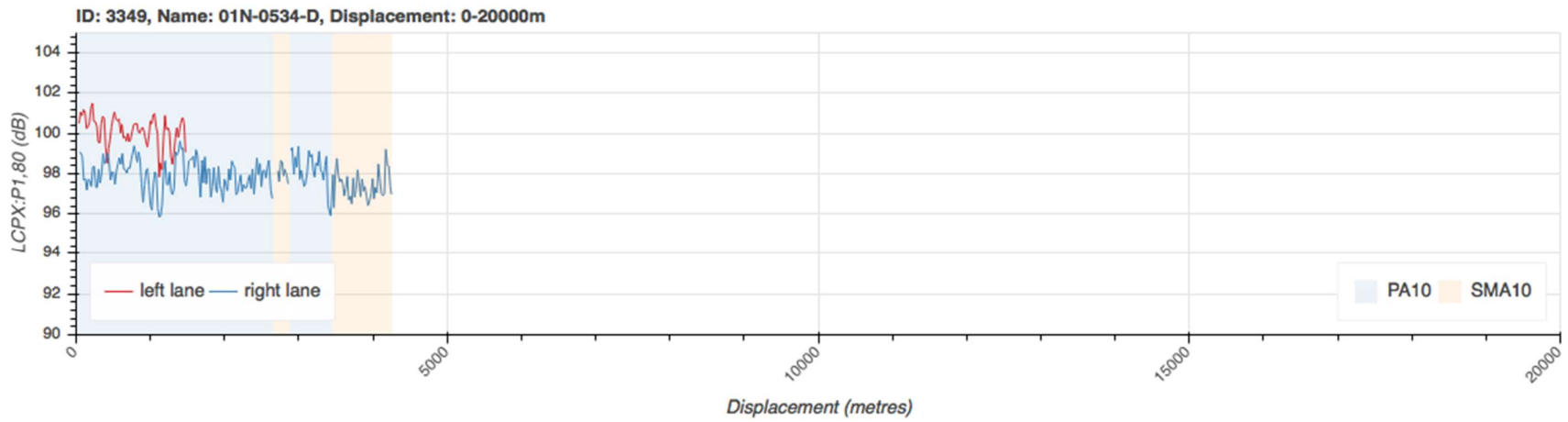
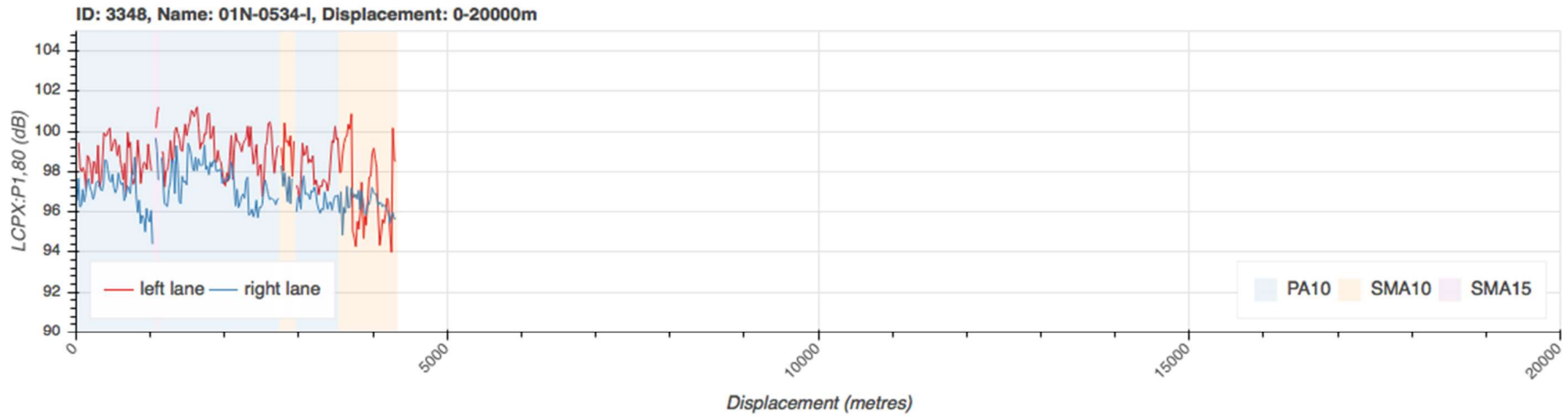


Road surface noise measurements of porous asphalt on the Waikato Expressway and Tauranga Eastern Link

A.3 Waikato Expressway, Ngaruawahia Section

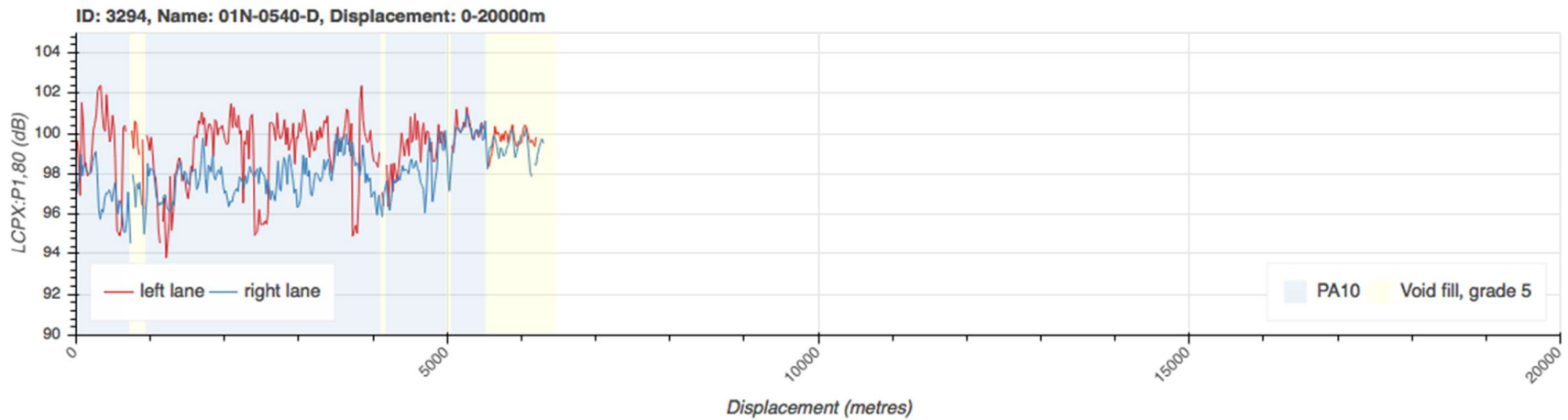
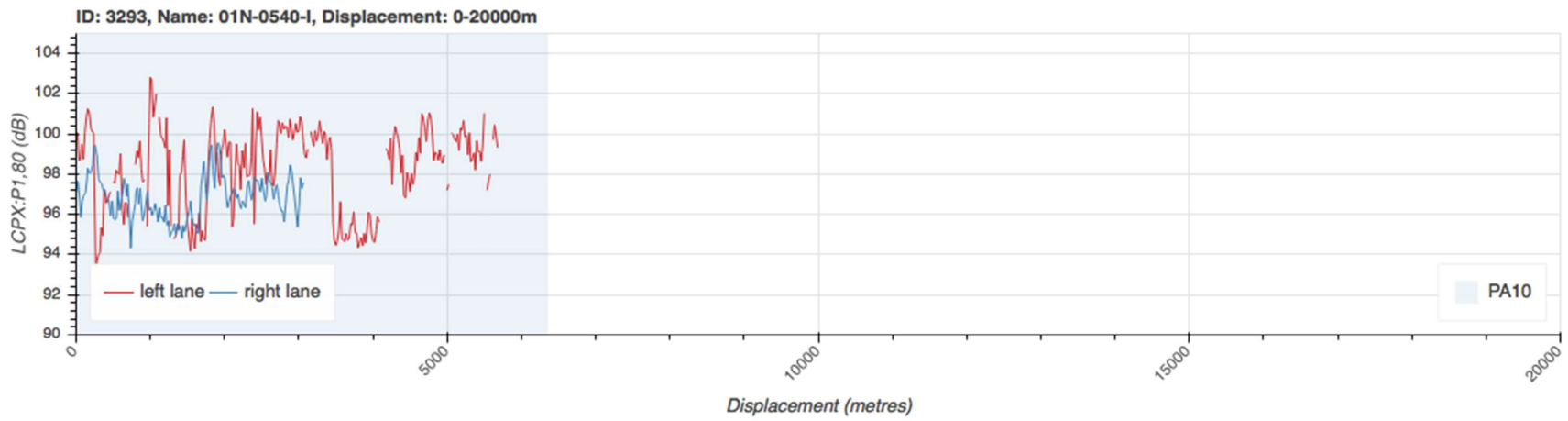


Road surface noise measurements of porous asphalt on the Waikato Expressway and Tauranga Eastern Link



Road surface noise measurements of porous asphalt on the Waikato Expressway and Tauranga Eastern Link

A.4 Waikato Expressway, Te Rapa Section



Road surface noise measurements of porous asphalt on the Waikato Expressway and Tauranga Eastern Link

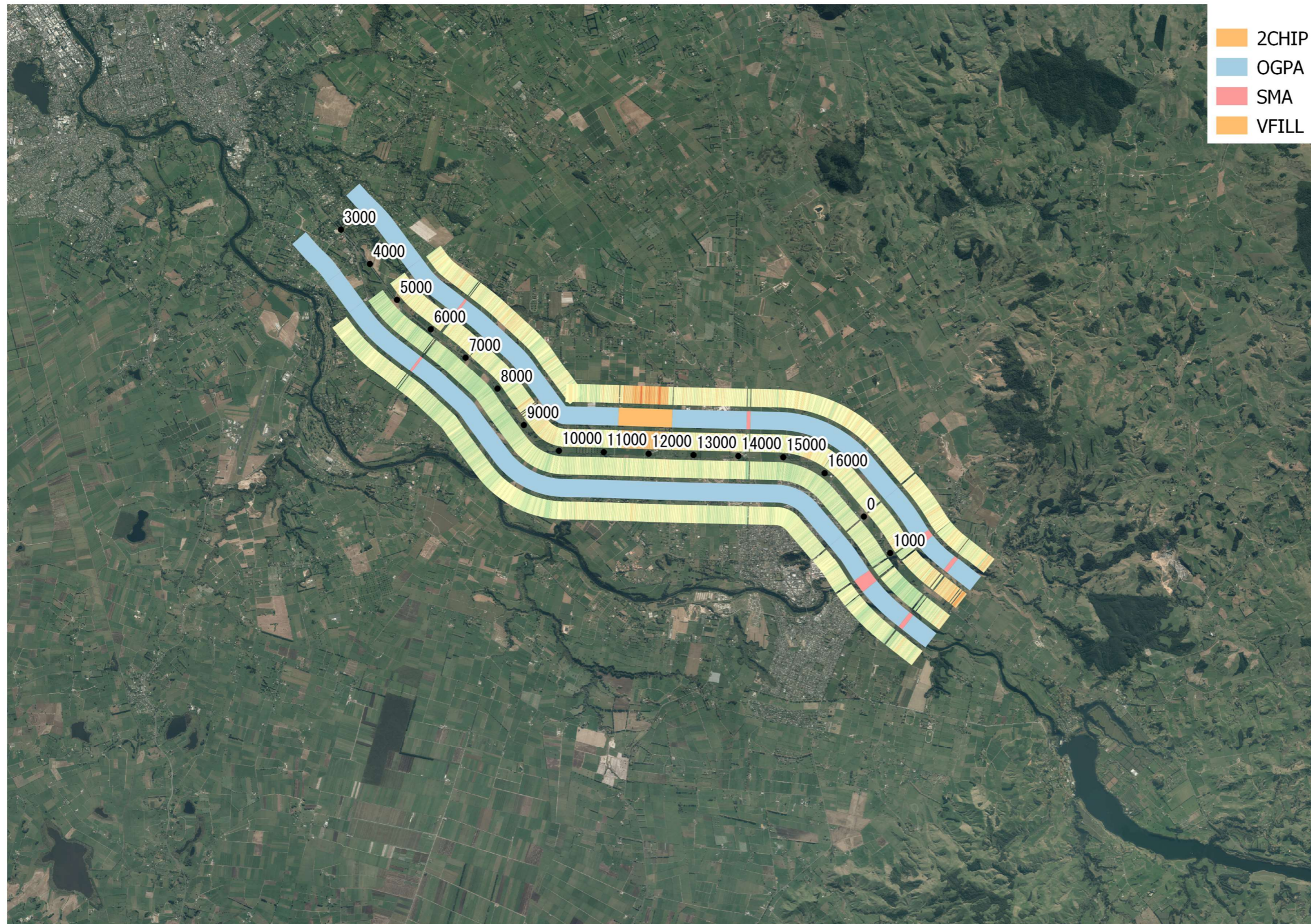
Appendix B Test Locations and Surfaces

B.1 Tauranga Eastern Link



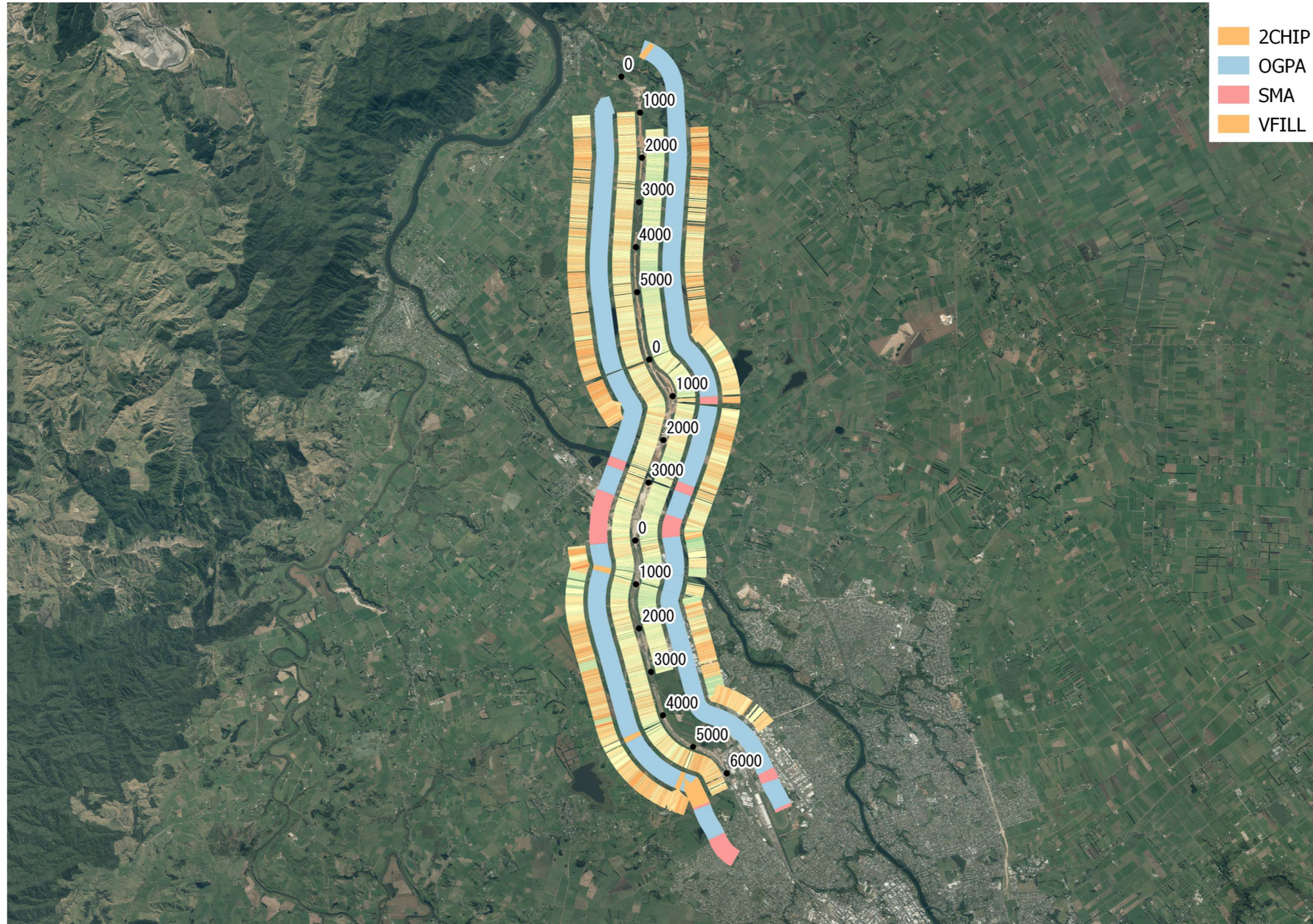
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B.2 Waikato Expressway, Cambridge Section



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B.3 Waikato Expressway – Ngaruawahia and Te Rapa Sections



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