

Road surface noise – Measurements of porous asphalt on the Auckland Motorways



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NZ Transport Agency
Victoria Arcade, 50 Victoria Street
Wellington.

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Prepared by (the Consultant):
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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 $L_{CPX:P1,80}$ by location

Site	$L_{CPX:P1,80}$	Acoustic variability	Average distance per lane
Southwestern Motorway – Waterview tunnel approach	98.0 dB	1.4 dB	4,215 m
Northwestern Motorway – Waterview to Lincoln Road	97.3 dB	1.8 dB	6,483 m
Upper Harbour Motorway – Hobsonville to Albany Highway	97.9 dB	1.8 dB	6,770 m
Northern Motorway – Wairau Valley to Silverdale	98.6 dB	1.4 dB	12,970 m
Southern Motorway – Greenlane to Otara	99.9 dB	1.9 dB	7,370 m
Harbour Bridge – Clip-on lanes	99.0 dB	1.9 dB	1,687 m
Curran Street – Northbound on-ramp	-	-	-
SE Highway to SH1 northbound ramp	-	-	-
Northwestern Motorway – Through Waterview exchange	-	-	1,170 m

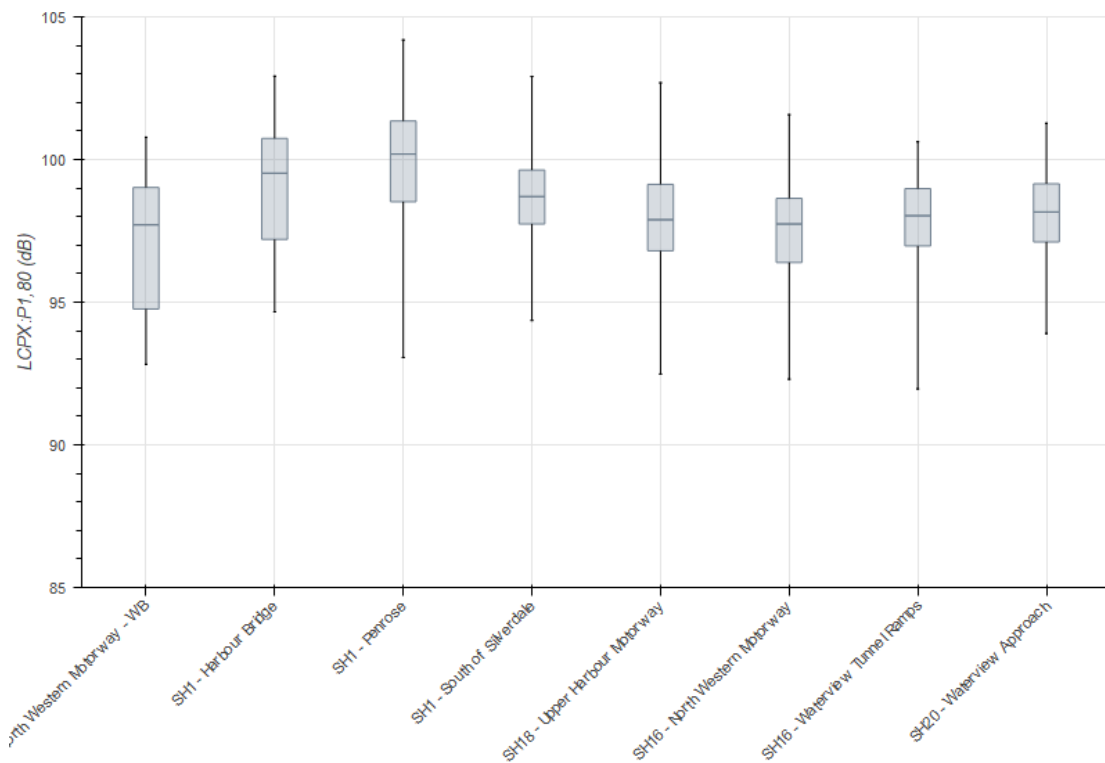


Figure 1 Median, Q1, Q2, maximum and minimum 20 metre road segment data for all locations.

2 Measurement locations

The locations detailed in the following table were tested by Robin Wareing (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. Additional sites were tested at the request of the Auckland Motorways Alliance.

Table 2 Road surface noise measurement sites

Site	Highway	Southern RP	Northern RP
Southwestern Motorway – Waterview tunnel approach	SH20	020-0020-D/1.378 020-0020-I/1.378	020-0010-D/6.479 020-0010-I/6.479
Northwestern Motorway – Waterview to Te Atatu	SH16	016-0007-D/5.679 016-0007-I/5.679	016-0000-D/6.600 016-0000-I/6.600
Upper Harbour Motorway – Hobsonville to Albany Highway	SH18	018-0007-D/3.168 018-0007-I/3.168	018-0000-I/2.796 018-0000-D/2.796
Northern Motorway – Wairau Valley to Silverdale	SH1	01N-098-D/13.152 01N-098-I/13.152	01N-0398-I/0.442 01N-0398-D/0.442
Southern Motorway – Greenlane to Otara	SH1	01N-0431-I/12.815 01N-0431-D/12.815	01N-0431-D/2.400 01N-0431-I/2.400
Harbour Bridge – Clip-on lanes	SH1	01N-0414-D/0.423 01N-0414-I/0.423	01N-0414-D/9.232 01N-0414-I/9.232
Curran Street – Northbound on-ramp	SH1	01N-0425-R2/0.000	01N-0425-R2/0.200
Waterview tunnel northern ramps	SH20/SH16	N/A	N/A
SE Highway to SH1 northbound ramp	SH1	01N-0437-R3/0.000	01N-0437-R3/0.304

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

- SH1 – Between Pokeno and Mercer – Ongoing roadworks.



Figure 2 Measurement sites for 2019 Auckland CPX study

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3 Results

The results by lane and direction are included in Table 3 to Table 9, and the overall results for each site (combining all lanes and directions) are given in Table 10.

Figures are included for each location showing:

- Median, Q1, Q2, maximum and minimum 20 metre road segment $L_{CPX:P1,80}$,
- Distribution of 20 metre road segment data for each carriageway, and
- Mean and 95% confidence interval one-third octave band $L_{CPX:P1,80}$.

Longitudinal plots are included in the Appendix A and maps in Appendix B.

Table 3 Southwestern Motorway – Waterview tunnel approach

Southwestern Motorway – Waterview tunnel approach (PA10)	L _{CPX:P1,80}	Acoustic variability	Distance
Left lane (3), NB	98.7 dB	1.2 dB	4,400 m
Centre lane (2), NB	98.6 dB	1.2 dB	4,180 m
Right lane (1), NB	97.6 dB	1.1 dB	4,080 m
Left lane (3), SB	97.3 dB	1.4 dB	4,200 m
Centre lane (2), SB	-	-	-
Right lane (1), SB	-	-	-

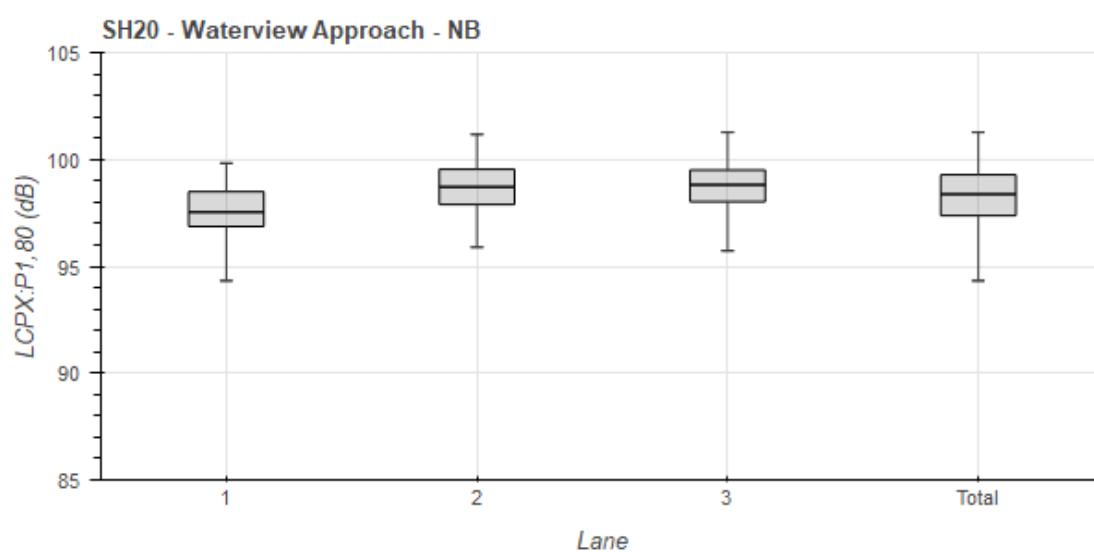


Figure 3 Median, Q1, Q2, maximum and minimum 20 metre road segment data for northbound Waterview approach.

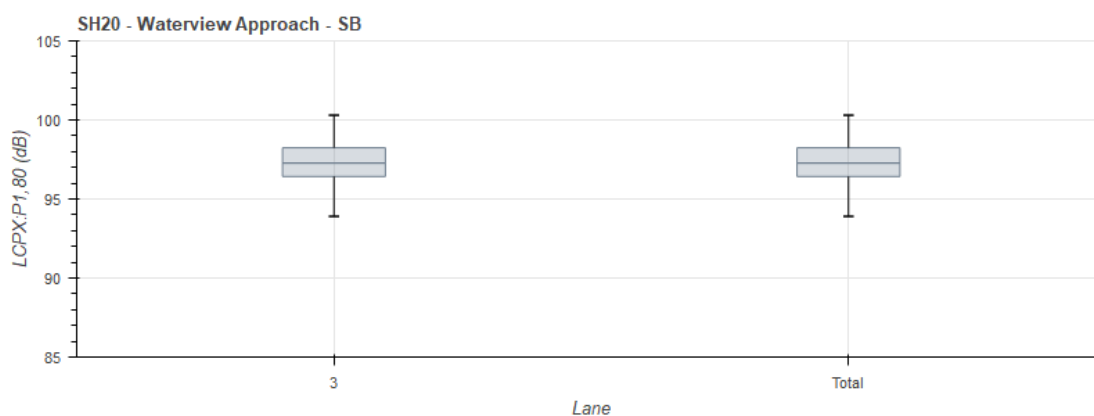


Figure 4 Median, Q1, Q2, maximum and minimum 20 metre road segment data for southbound Waterview approach.

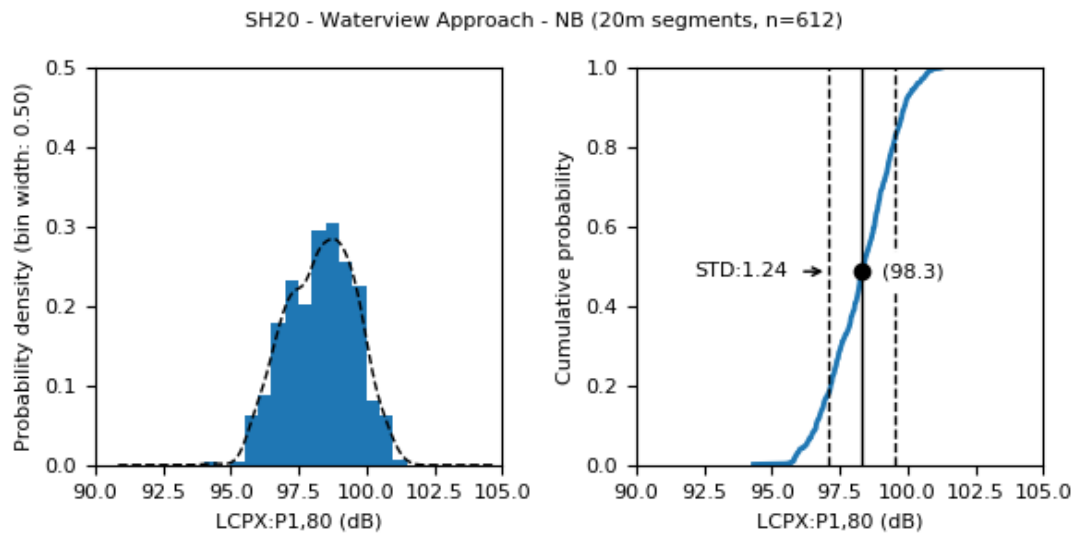


Figure 5 Distribution of 20 metre road segment data for the northbound Waterview approach.

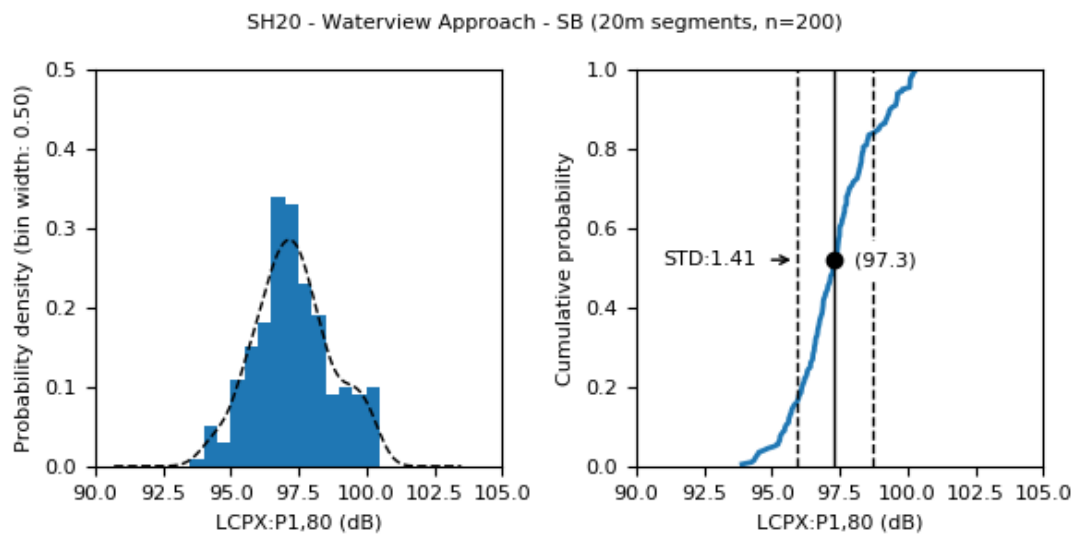


Figure 6 Distribution of 20 metre road segment data for the southbound Waterview approach.

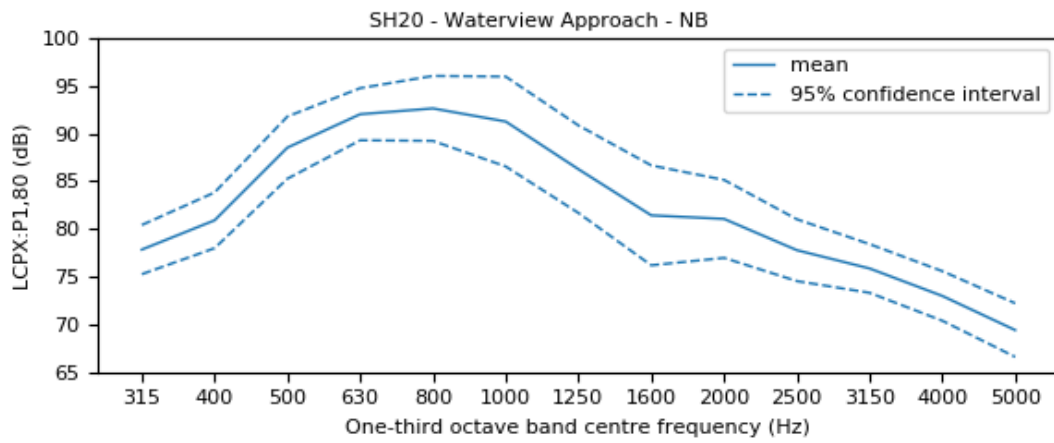


Figure 7 One-third octave band $L_{CPX:P1,80}$ for the northbound Waterview approach.

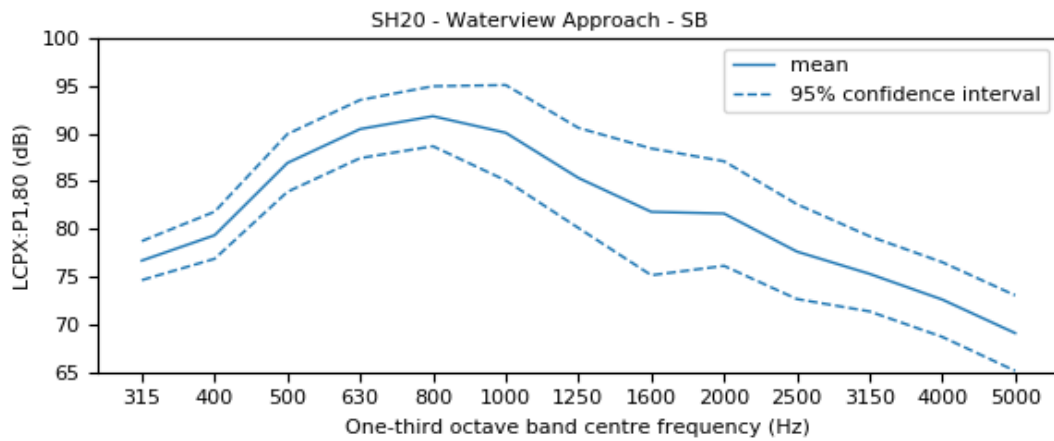


Figure 8 One-third octave band $L_{CPX:P1,80}$ for the southbound Waterview approach.

Table 4 Northwest Motorway – Waterview to Te Atatu

Northwest Motorway – Waterview to Te Atatu (PA10/PA14)	L _{CPX:P1,80}	Acoustic variability	Distance
Lane 5 (left), WB	97.1 dB	2.3 dB	3,780 m
Lane 4, WB	97.5 dB	1.9 dB	5,920 m
Lane 3, WB	97.3 dB	2.0 dB	7,900 m
Lane 2, WB	97.6 dB	1.8 dB	5,600 m
Lane 1 (right), WB	-	-	-
Lane 4 (left), EB	97.9 dB	1.2 dB	4,020 m
Lane 3, EB	97.5 dB	1.7 dB	8,160 m
Lane 2, EB	97.5 dB	1.6 dB	8,140 m
Lane 1 (right), EB	96.5 dB	1.7 dB	8,340 m

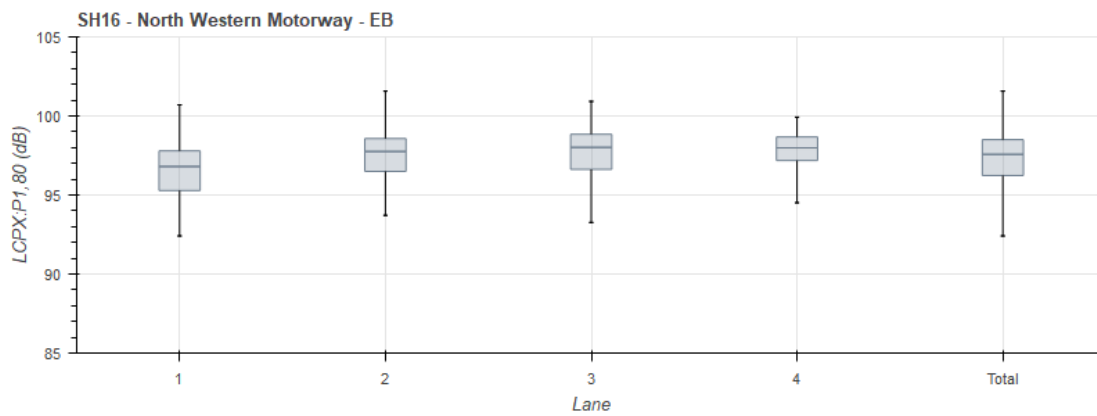


Figure 9 Median, Q1, Q2, maximum and minimum 20 metre road segment data for eastbound lanes of northwestern motorway.

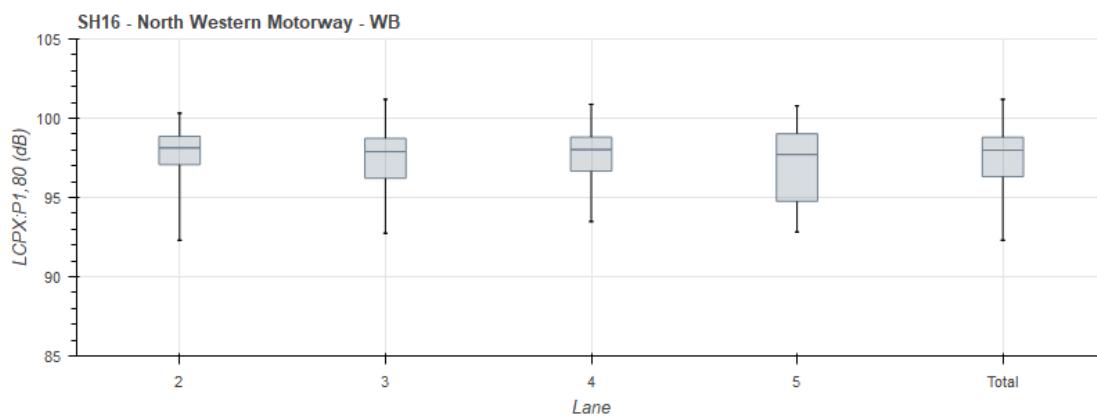


Figure 10 Median, Q1, Q2, maximum and minimum 20 metre road segment data for westbound lanes of northwestern motorway.

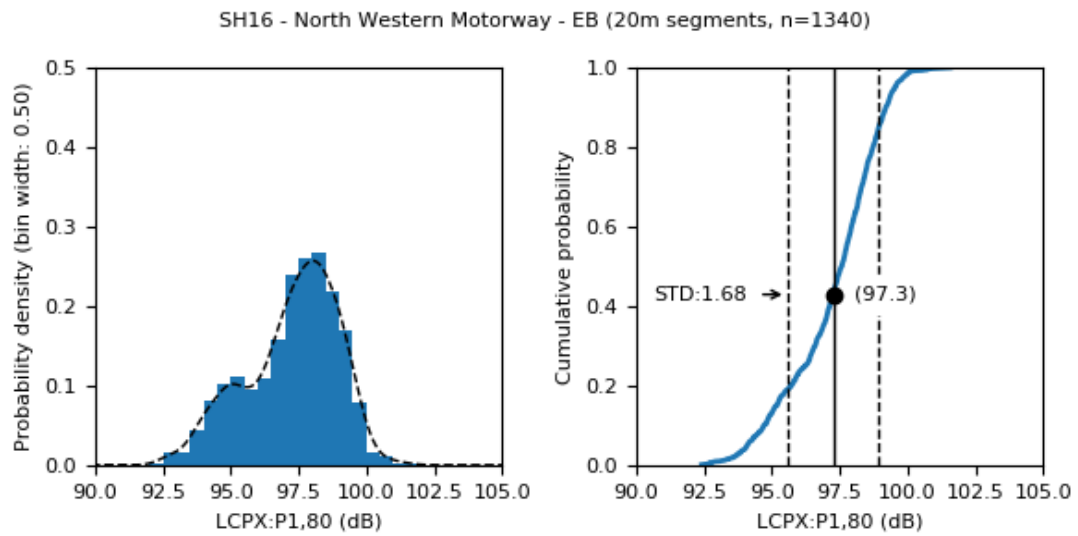


Figure 11 Distribution of 20 metre road segment data for the eastbound lanes of northwestern motorway.

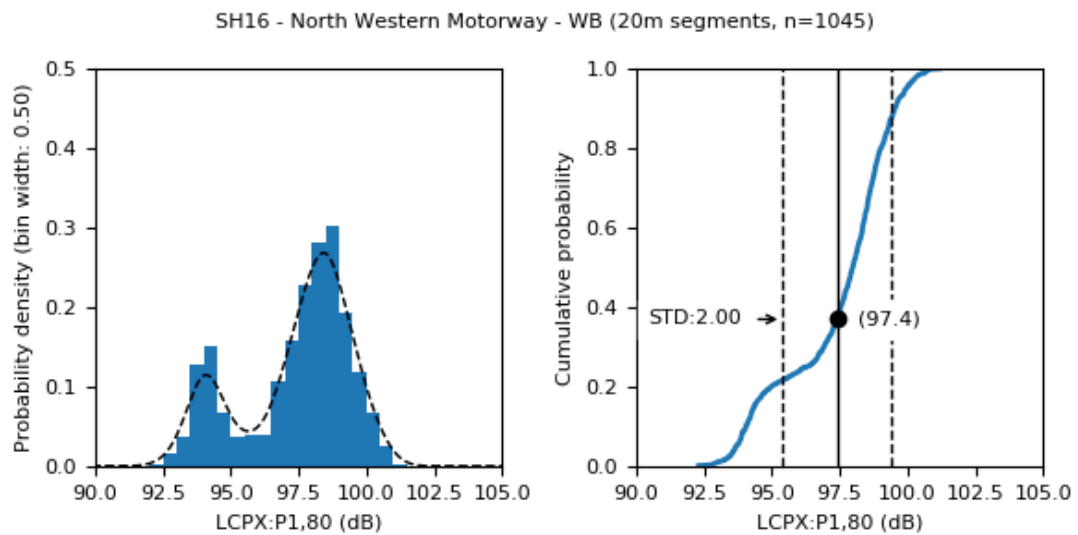


Figure 12 Distribution of 20 metre road segment data for the westbound lanes of northwestern motorway.

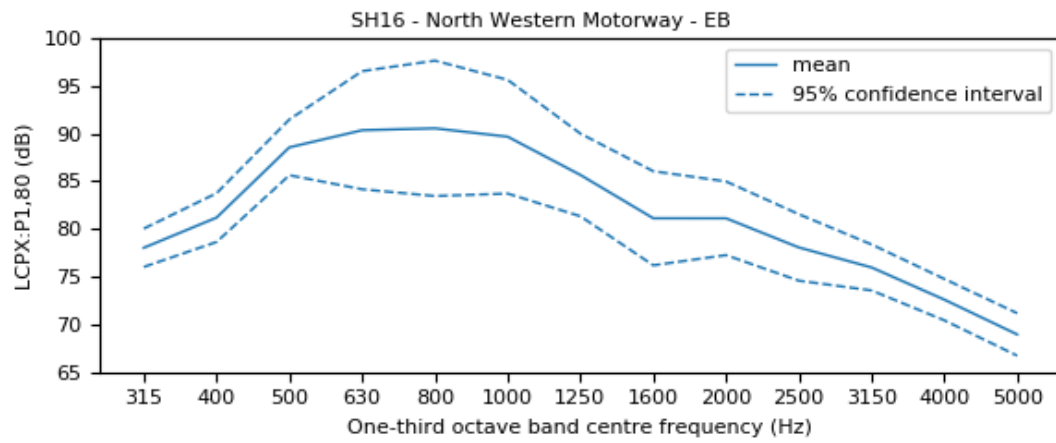


Figure 13 One-third octave band $L_{CPX:P1,80}$ for the eastbound lanes of northwestern motorway.

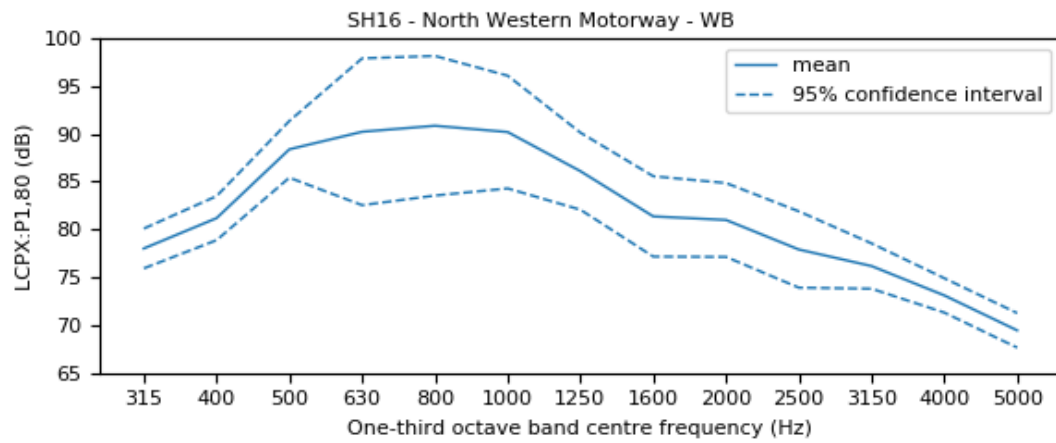


Figure 14 One-third octave band $L_{CPX:P1,80}$ for the westbound lanes of northwestern motorway.

Table 5 Northwest Motorway – Lanes through Waterview Exchange

Northwest Motorway – Through Waterview exchange (Twin Layer)	L _{CPX;P1,80}	Acoustic variability	Distance
Lane 5 (left), WB	94.7 dB	1.1 dB	1,180 m
Lane 4, WB	94.7 dB	1.0 dB	1,180 m
Lane 3, WB	93.9 dB	0.8 dB	1,180 m
Lane 3, EB	94.6 dB	0.9 dB	1,160 m
Lane 2, EB	95.0 dB	0.9 dB	1,160 m
Lane 1 (right), EB	94.2 dB	1.1 dB	1,160 m

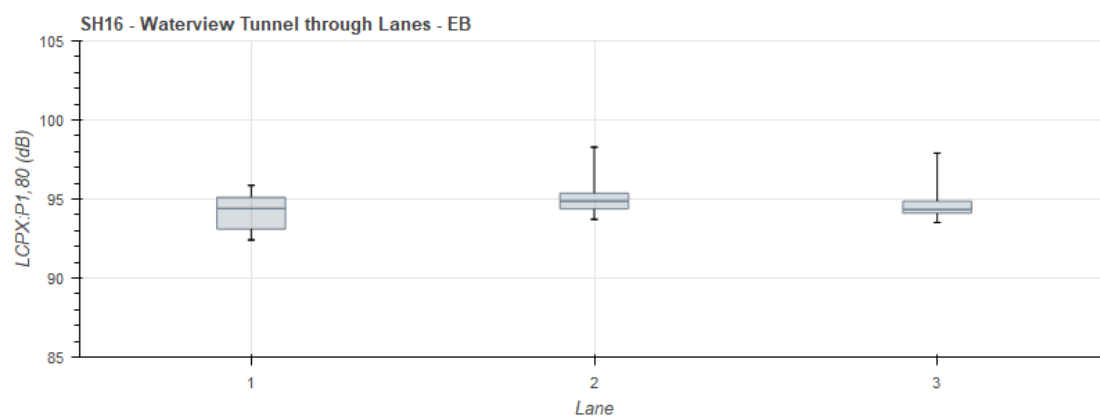


Figure 15 Median, Q1, Q2, maximum and minimum 20 metre road segment data for eastbound lanes of northwestern motorway through Waterview exchange.

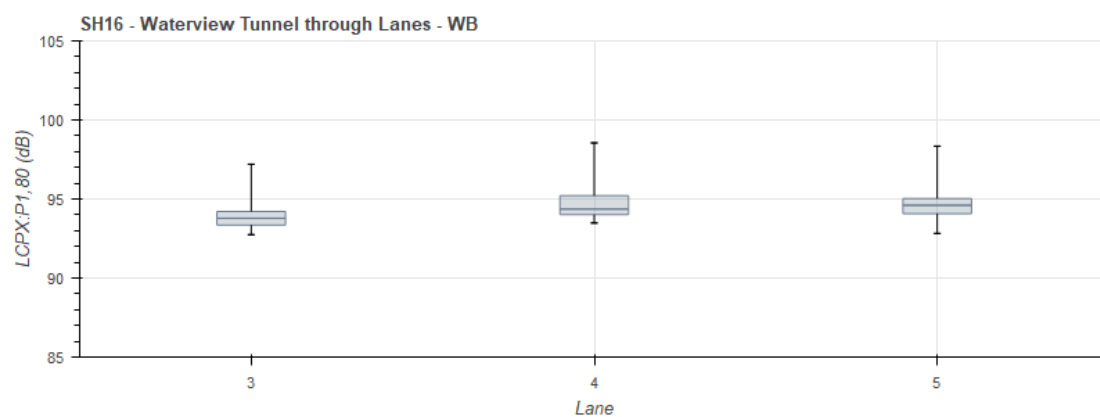


Figure 16 Median, Q1, Q2, maximum and minimum 20 metre road segment data for westbound lanes of northwestern motorway through Waterview exchange.

Table 6 Upper Harbour Motorway – Hobsonville to Albany Highway

Upper Harbour Motorway – Hobsonville to Albany Highway (PA10)	L _{CPX:P1,80}	Acoustic variability	Distance
Left lane (2), NB	97.7 dB	1.6 dB	6,940 m
Right lane (1), NB	96.6 dB	1.7 dB	6,980 m
Left lane (2), SB	99.0 dB	1.4 dB	6,620 m
Right lane (1), SB	98.3 dB	1.2 dB	6,540 m

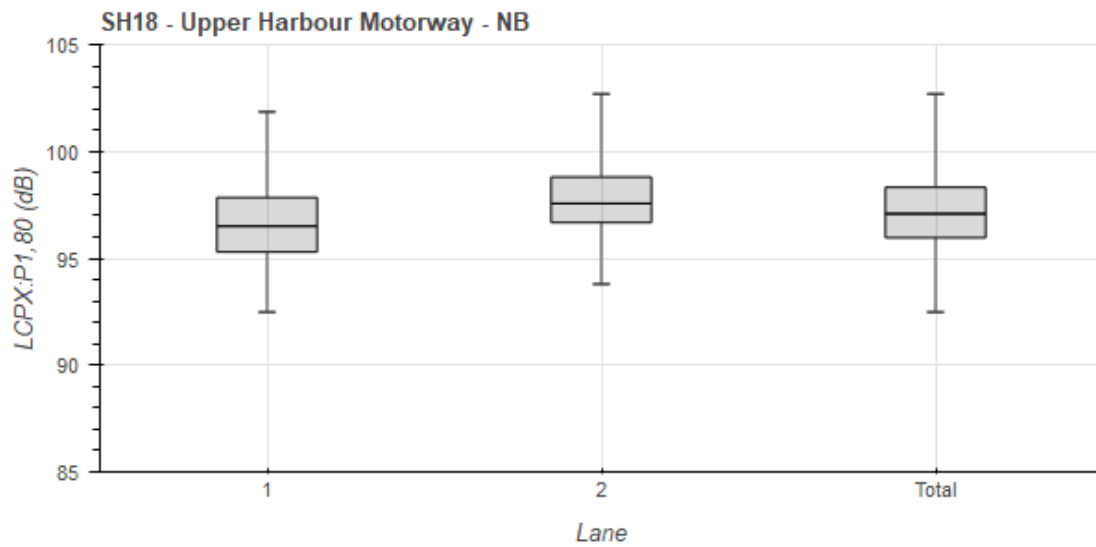


Figure 17 Median, Q1, Q2, maximum and minimum 20 metre road segment data for northbound lanes of upper harbour motorway.

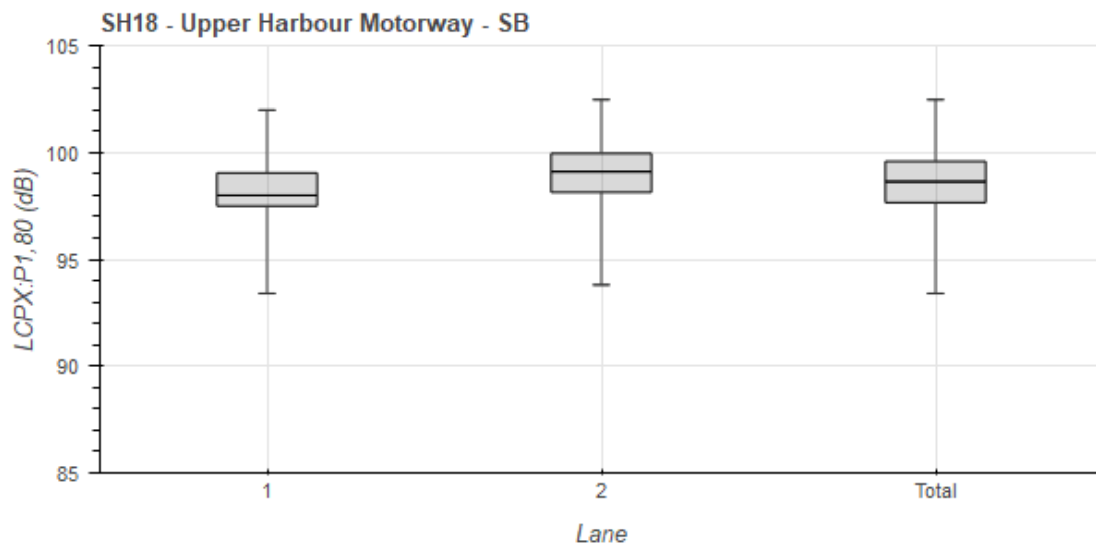


Figure 18 Median, Q1, Q2, maximum and minimum 20 metre road segment data for southbound lanes of upper harbour motorway.

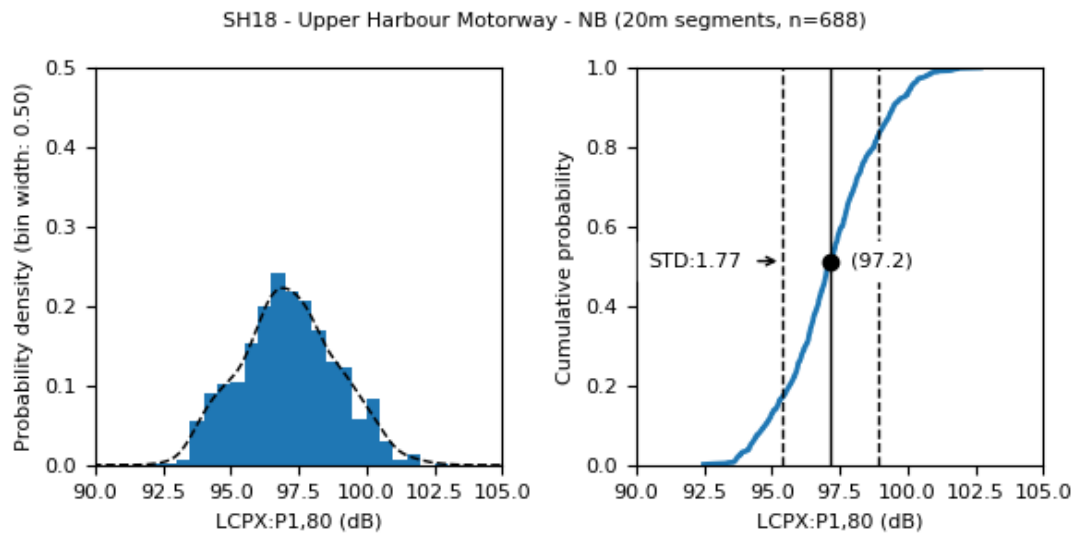


Figure 19 Distribution of 20 metre road segment data for the northbound lanes of upper harbour motorway.

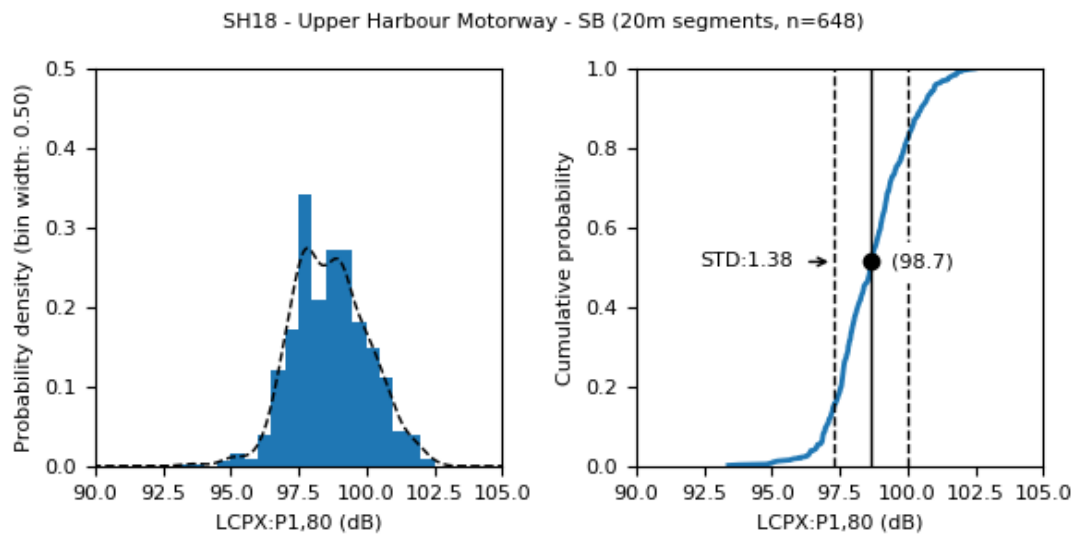


Figure 20 Distribution of 20 metre road segment data for the southbound lanes of upper harbour motorway.

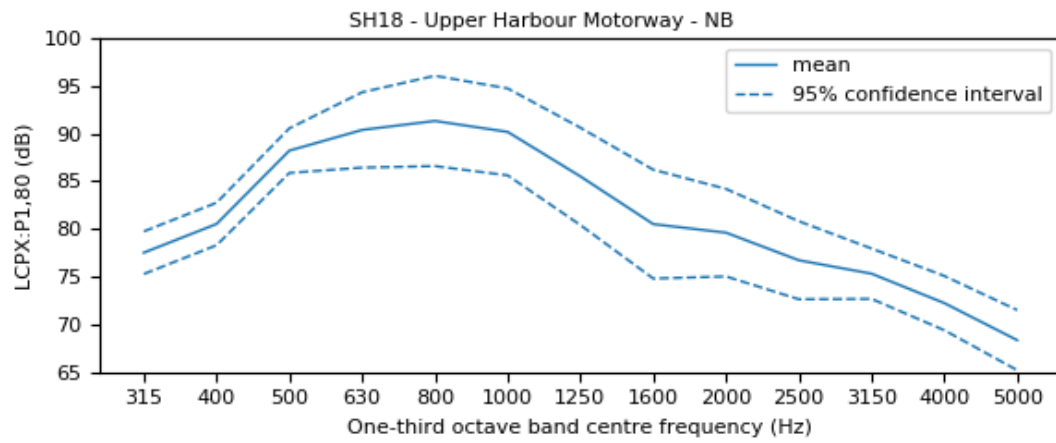


Figure 21 One-third octave band $L_{CPX:P1,80}$ for the northbound lanes of upper harbour motorway.

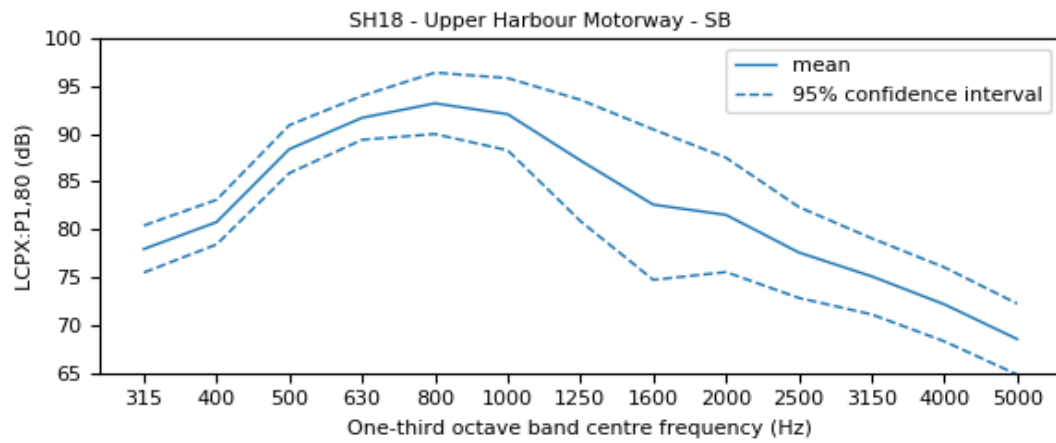


Figure 22 One-third octave band $L_{CPX:P1,80}$ for the southbound lanes of upper harbour motorway.

Table 7 Northern Motorway – Wairau Valley to Silverdale

Northern Motorway – Wairau Valley to Silverdale (PA10)	L _{CPX:P1,80}	Acoustic variability	Distance
Left lane(2), NB	99.3 dB	1.4 dB	13,320 m
Right lane(1), NB	98.3 dB	1.4 dB	13,320 m
Left lane(2), SB	99.0 dB	1.1 dB	12,620 m
Right lane(1), SB	97.8 dB	1.4 dB	12,620 m

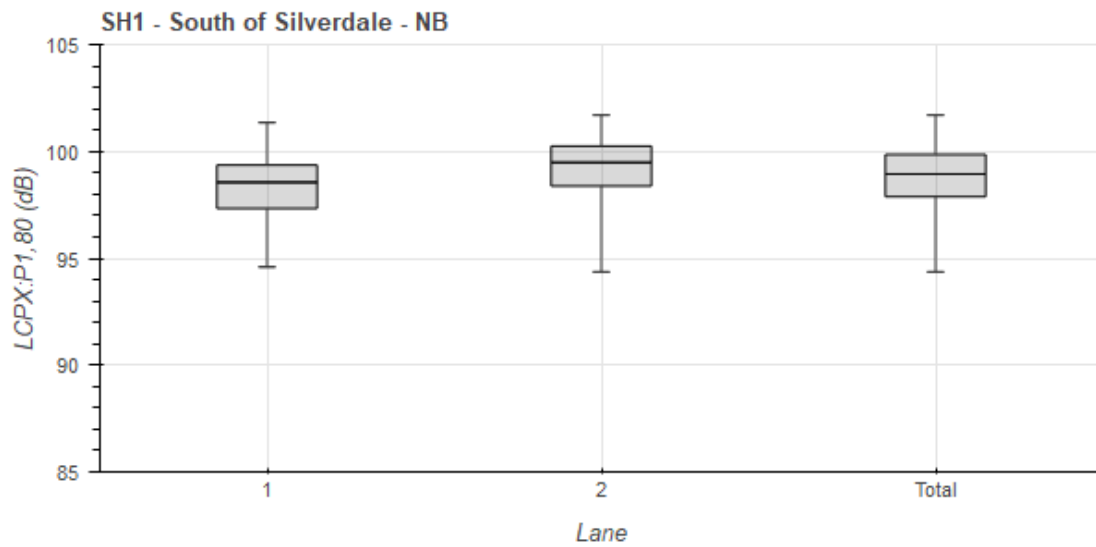


Figure 23 Median, Q1, Q2, maximum and minimum 20 metre road segment data for the northbound lanes of northern motorway.

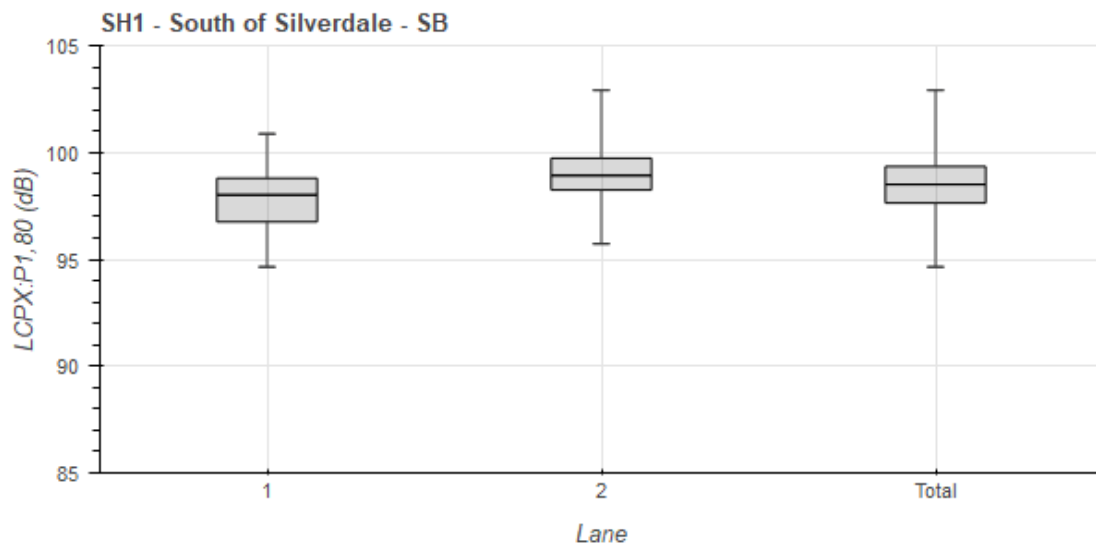


Figure 24 Median, Q1, Q2, maximum and minimum 20 metre road segment data for the southbound lanes of northern motorway.

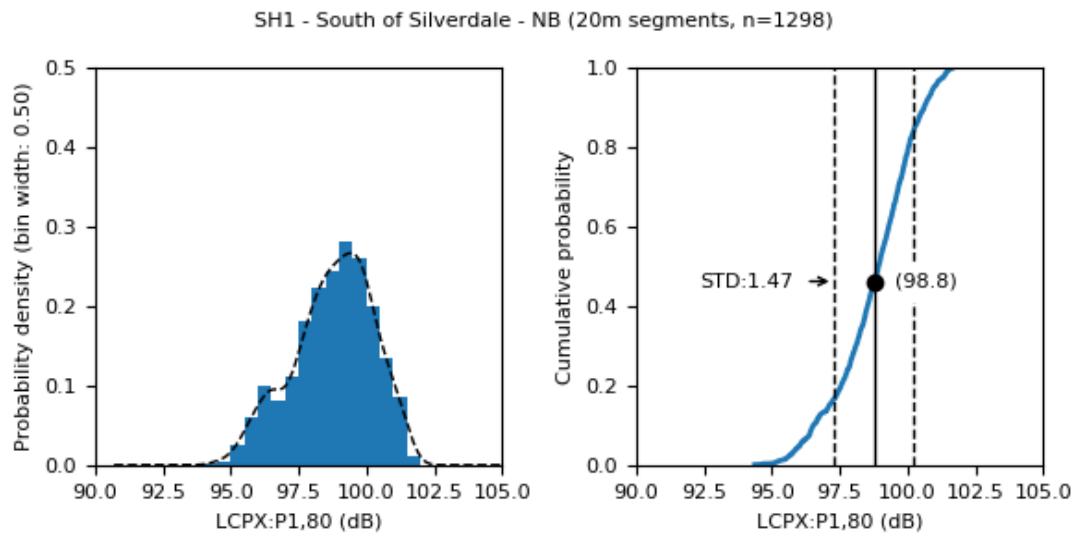


Figure 25 Distribution of 20 metre road segment data for the northbound lanes of northern motorway.

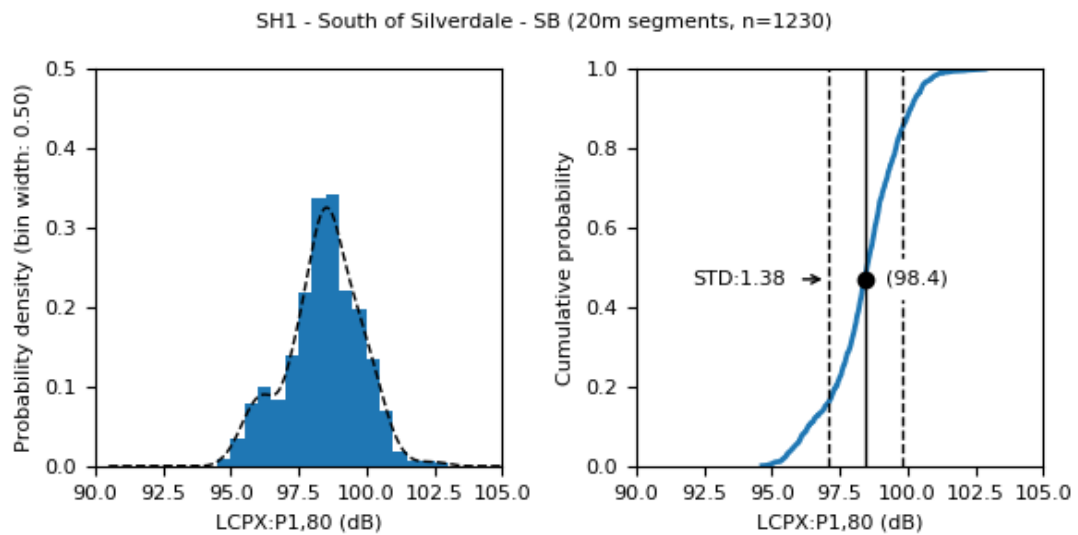


Figure 26 Distribution of 20 metre road segment data for the southbound lanes of northern motorway.

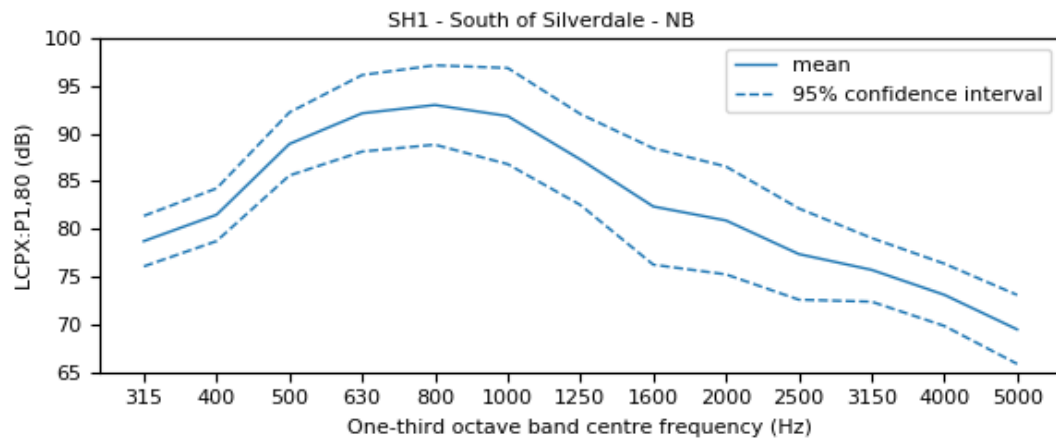


Figure 27 One-third octave band $L_{CPX:P1,80}$ for the northbound lanes of northern motorway.

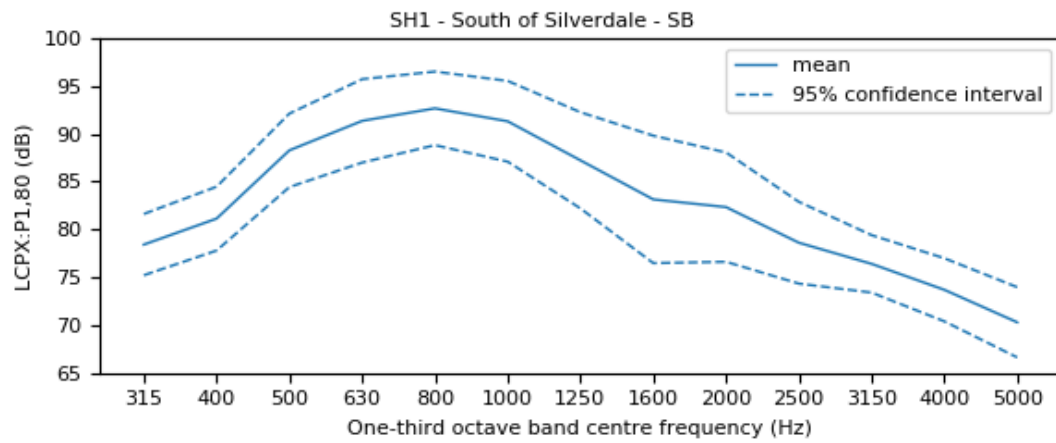


Figure 28 One-third octave band $L_{CPX:P1,80}$ for the southbound lanes of northern motorway.

Table 8 Southern Motorway – Greenlane to Otara

Southern Motorway – Greenlane to Otara (PA10/PA14)	L _{CPX:P1,80}	Acoustic variability	Distance
Left lane (3), NB	101.2 dB	1.3 dB	8,140 m
Centre lane (2), NB	101.6 dB	1.2 dB	8,020 m
Right lane (1), NB	99.5 dB	1.4 dB	8,280 m
Left lane (3), SB	99.2 dB	2.0 dB	6,660 m
Centre lane (2), SB	99.2 dB	1.7 dB	6,460 m
Right lane (1), SB	98.3 dB	1.2 dB	6,660 m

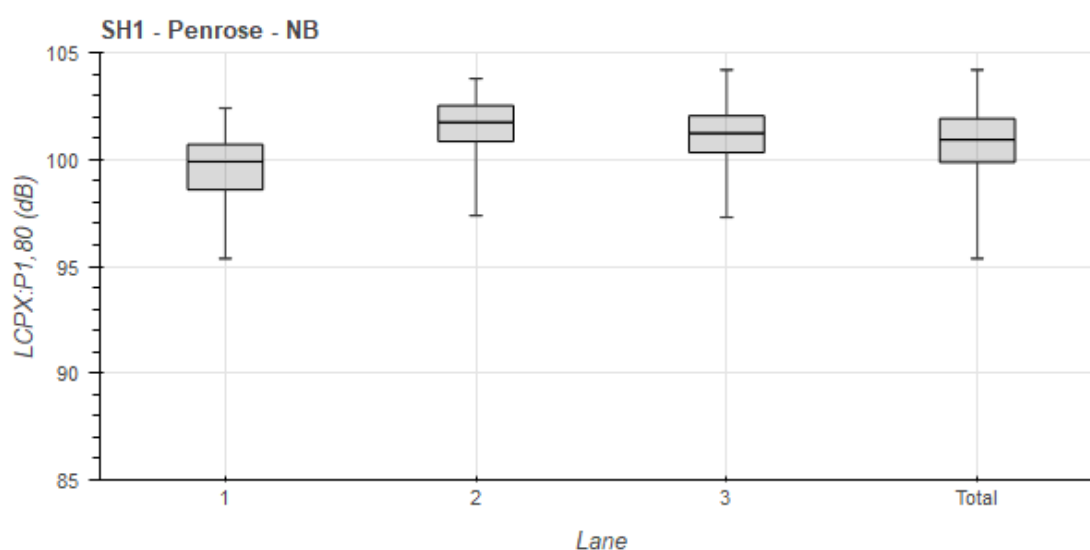


Figure 29 Median, Q1, Q2, maximum and minimum 20 metre road segment data for the northbound lanes of southern motorway.

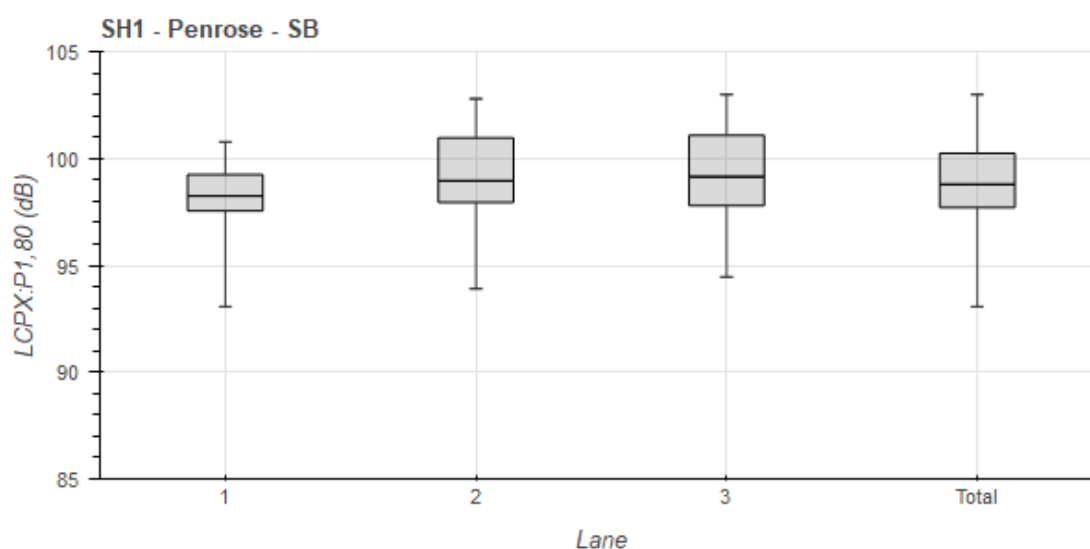


Figure 30 Median, Q1, Q2, maximum and minimum 20 metre road segment data for the southbound lanes of southern motorway.

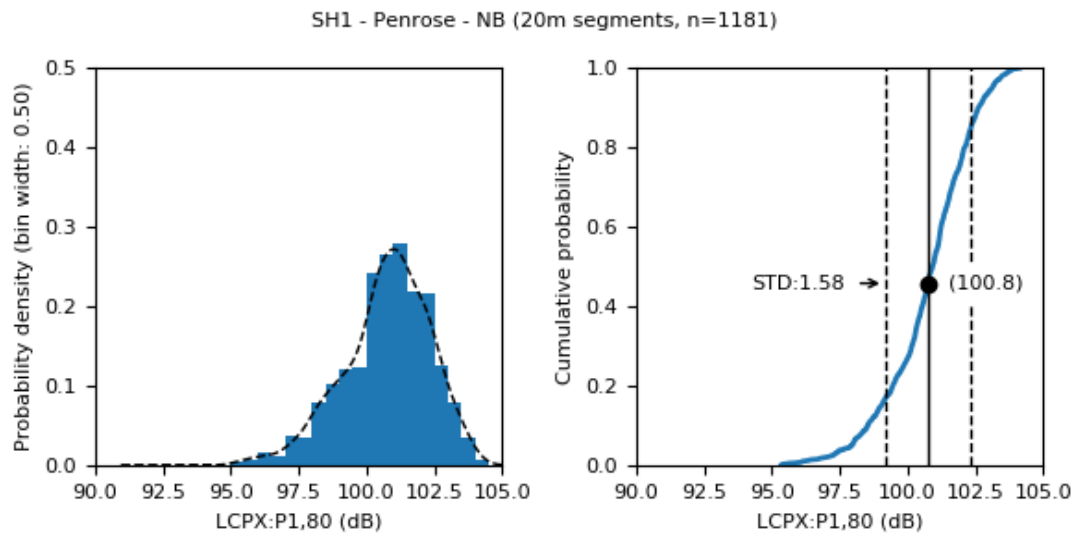


Figure 31 Distribution of 20 metre road segment data for the northbound lanes of southern motorway.

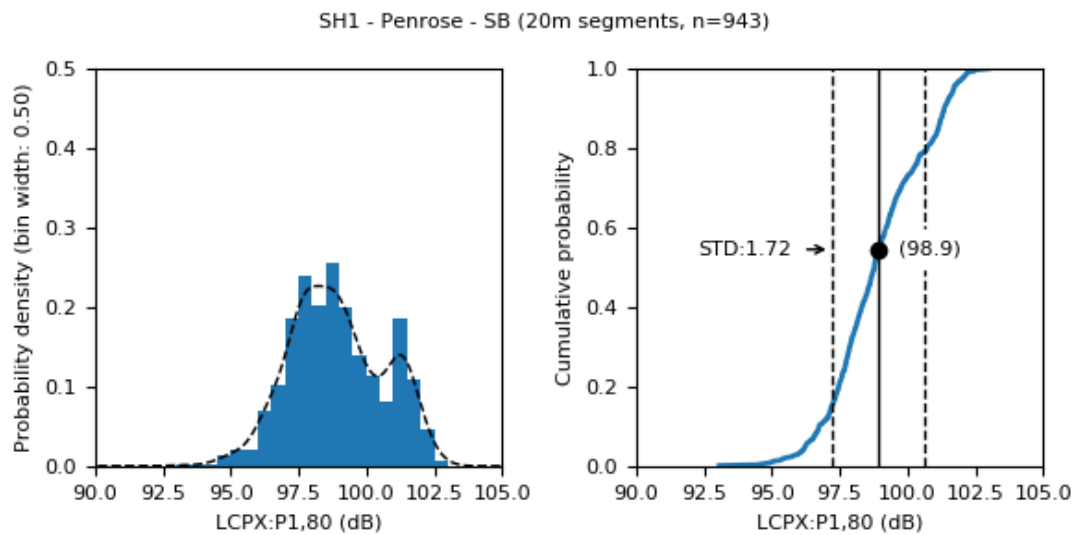


Figure 32 Distribution of 20 metre road segment data for the southbound lanes of southern motorway.

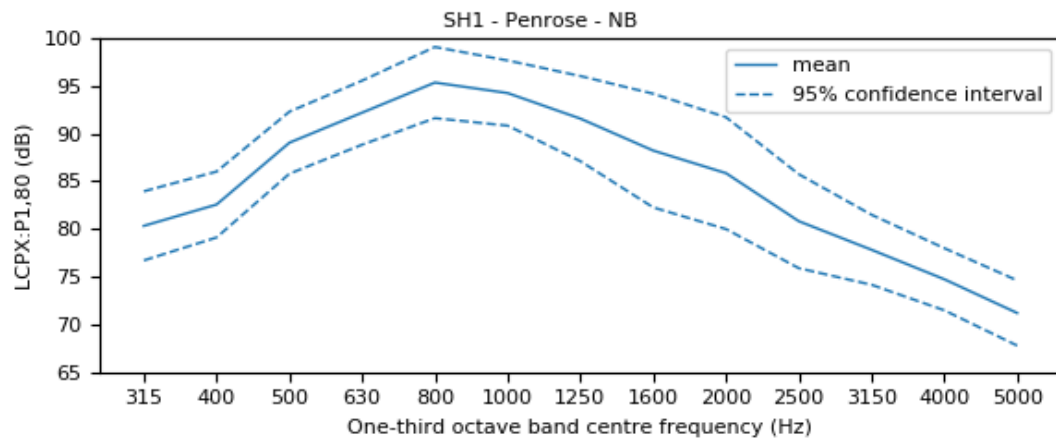


Figure 33 One-third octave band $L_{CPX:P1,80}$ for the northbound lanes of southern motorway.

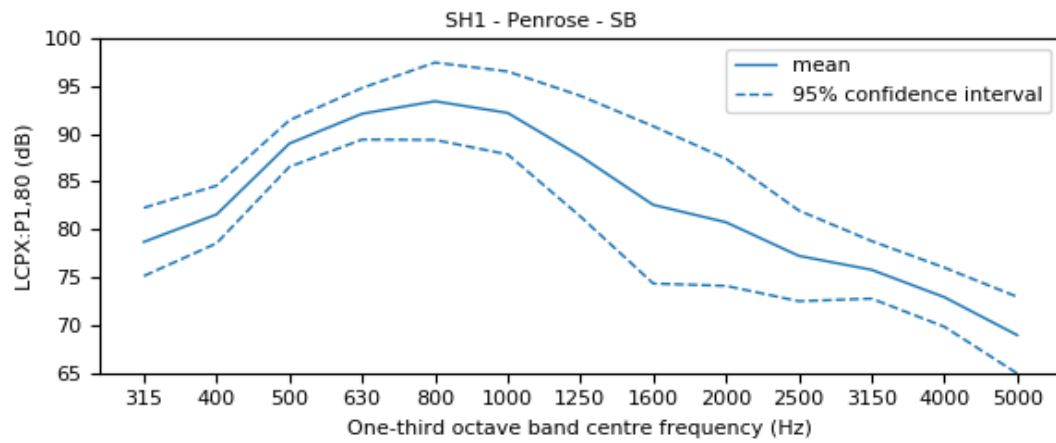


Figure 34 One-third octave band $L_{CPX:P1,80}$ for the southbound lanes of southern motorway

Table 9 Harbour Bridge – Clip On Lanes

Harbour Bridge – Clip On Lanes (BOLID)	L _{CPX:P1,80}	Acoustic variability	Distance
Left lane (2), NB	99.0 dB	2.2 dB	1,580 m
Left lane (2), SB	98.7 dB	1.5 dB	1,740 m
Right lane (1), SB	99.2 dB	1.9 dB	1,740 m

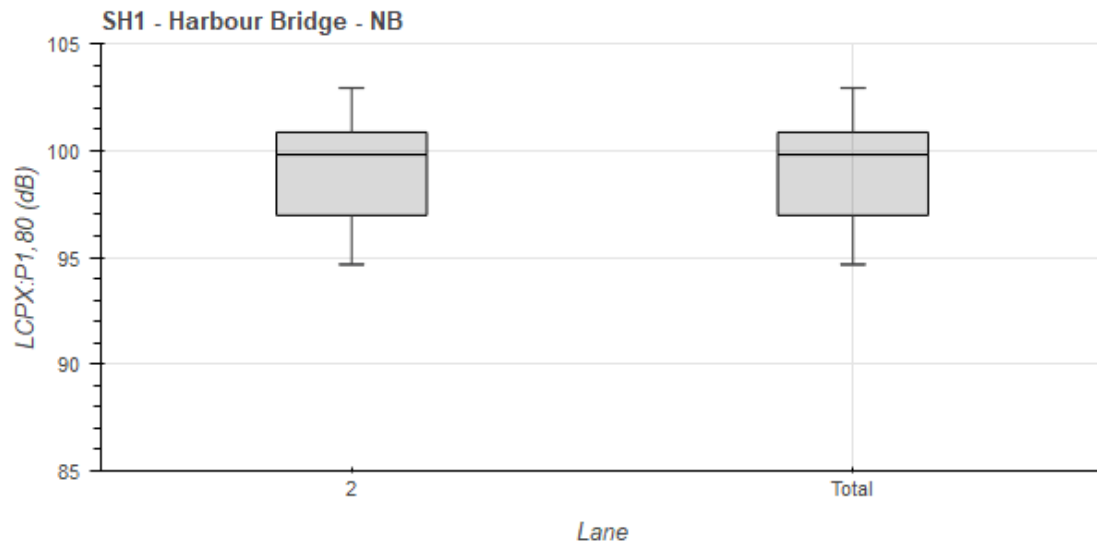


Figure 35 Median, Q1, Q2, maximum and minimum 20 metre road segment data for northbound lanes of harbour bridge.

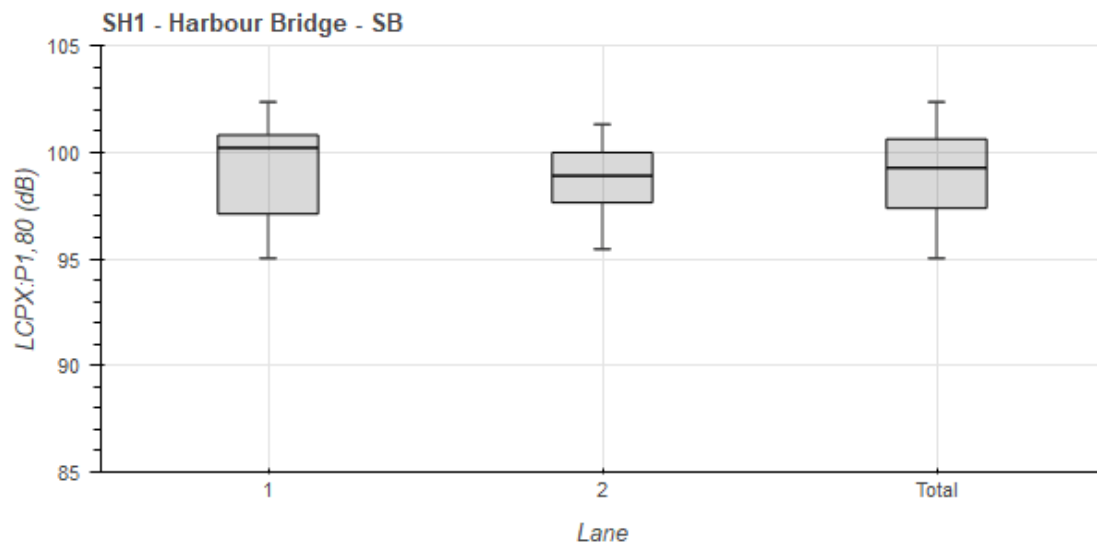


Figure 36 Median, Q1, Q2, maximum and minimum 20 metre road segment data for southbound lanes of harbour bridge.

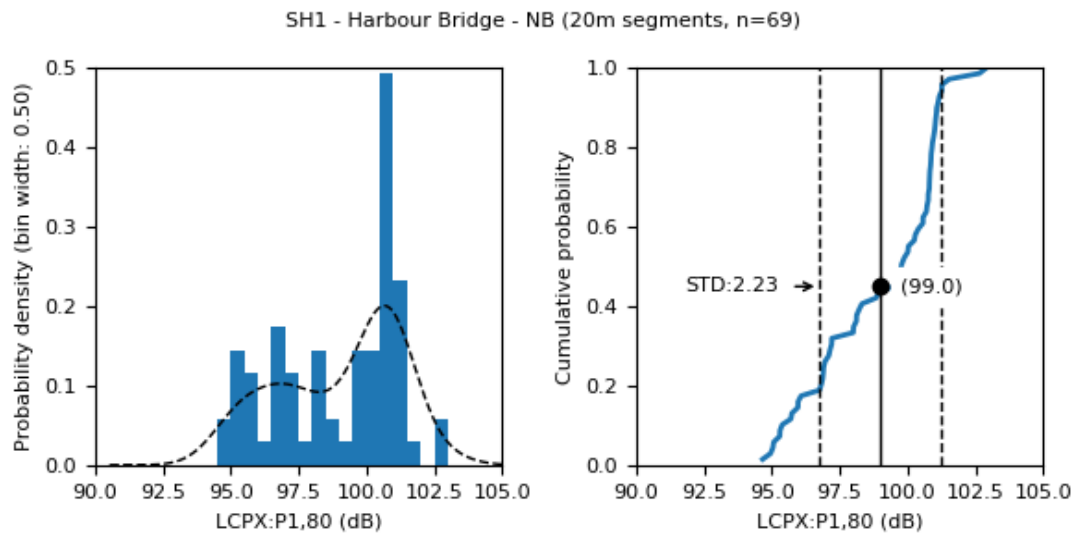


Figure 37 Distribution of 20 metre road segment data for the northbound lanes of harbour bridge.

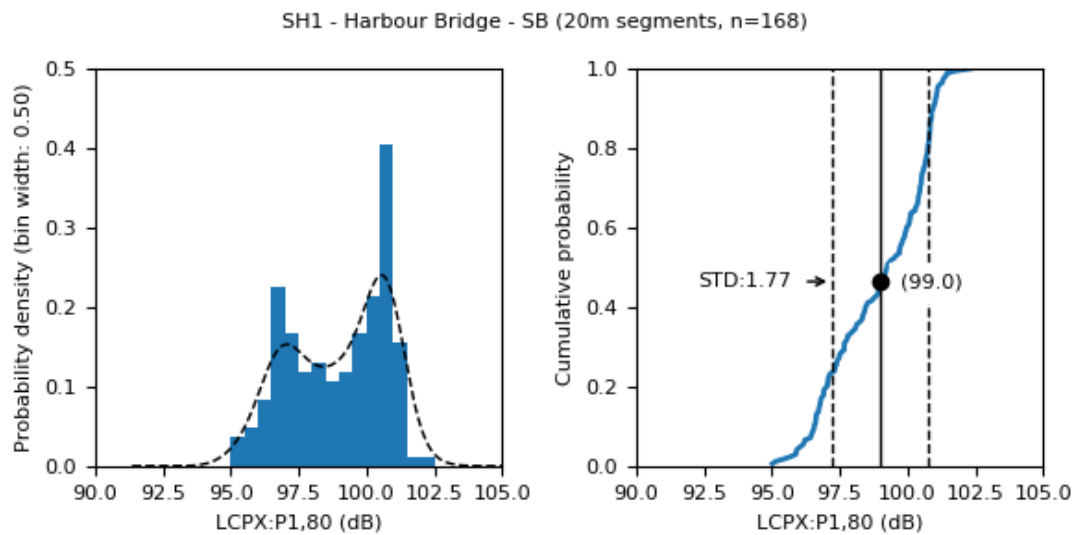


Figure 38 Distribution of 20 metre road segment data for the southbound lanes of harbour bridge.

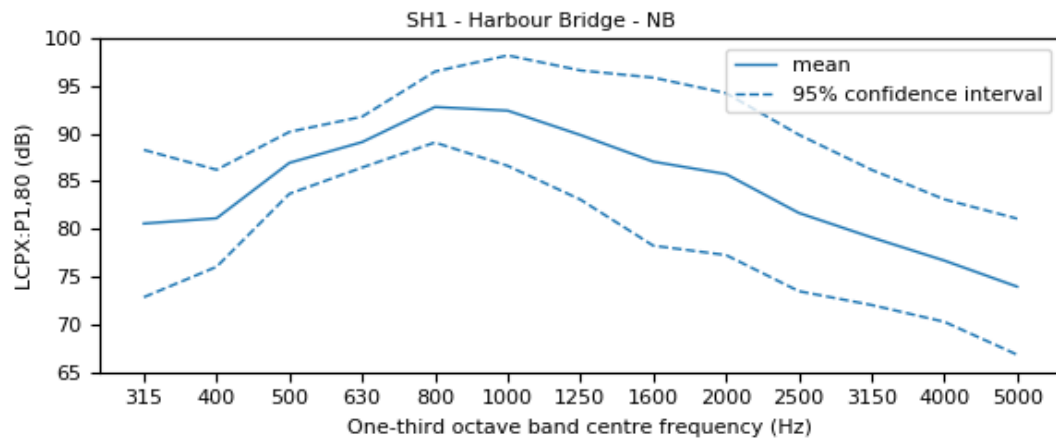


Figure 39 One-third octave band $L_{CPX:P1,80}$ for the northbound lanes of harbour bridge.

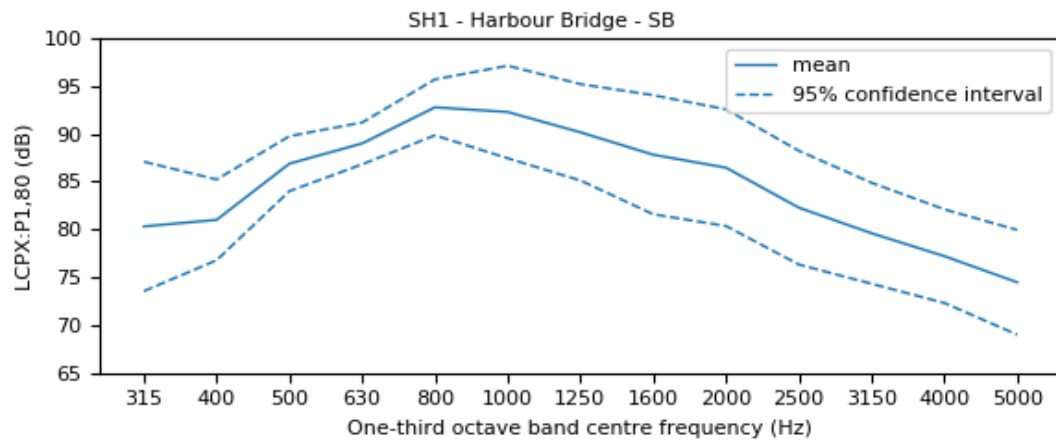


Figure 40 One-third octave band $L_{CPX:P1,80}$ for the southbound lanes of harbour bridge.

Table 10 Overall $L_{CPX:P1,80}$ by location

Site	$L_{CPX:P1,80}$	Acoustic variability	Average distance per lane
Southwestern Motorway – Waterview tunnel approach	98.0 dB	1.4 dB	4,215 m
Northwestern Motorway – Waterview to Lincoln Road	97.3 dB	1.8 dB	6,483 m
Upper Harbour Motorway – Hobsonville to Albany Highway	97.9 dB	1.8 dB	6,770 m
Northern Motorway – Wairau Valley to Silverdale	98.6 dB	1.4 dB	12,970 m
Southern Motorway – Greenlane to Otara	99.9 dB	1.9 dB	7,370 m
Harbour Bridge – Clip-on lanes	99.0 dB	1.9 dB	1,687 m
Curran Street – Northbound on-ramp	-	-	-
SE Highway to SH1 northbound ramp	-	-	-
Northwestern Motorway – Through Waterview exchange	-	-	1,170 m

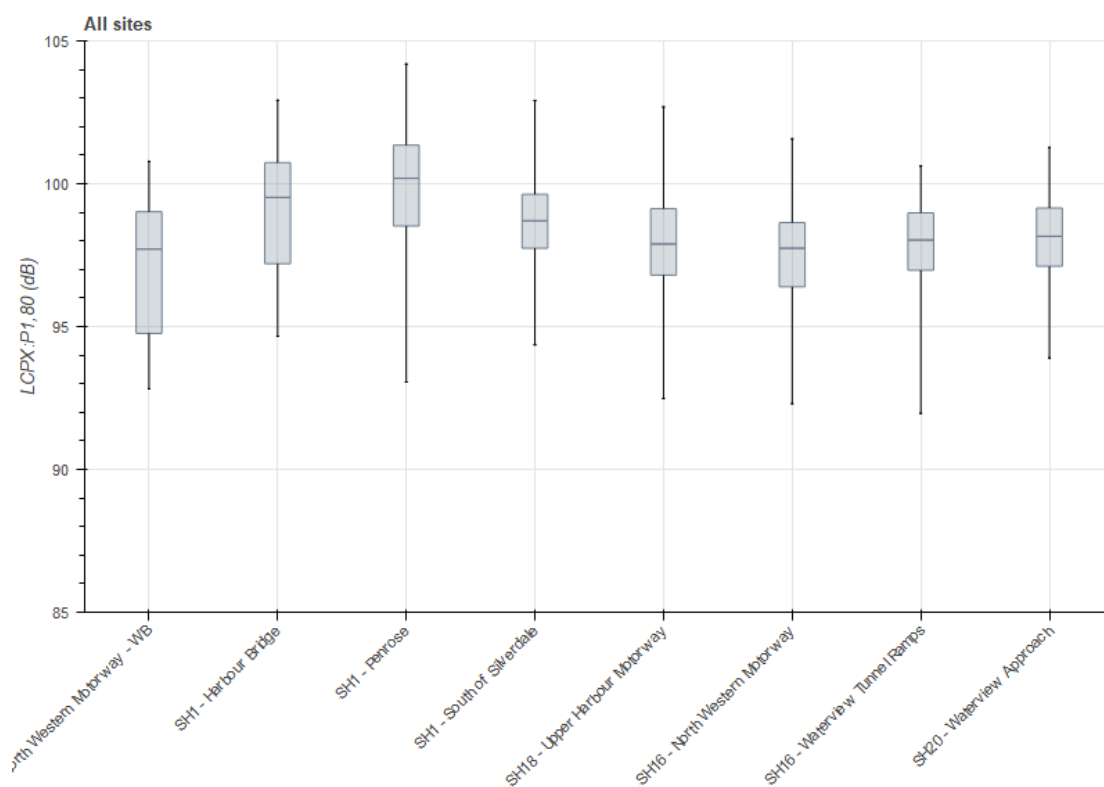
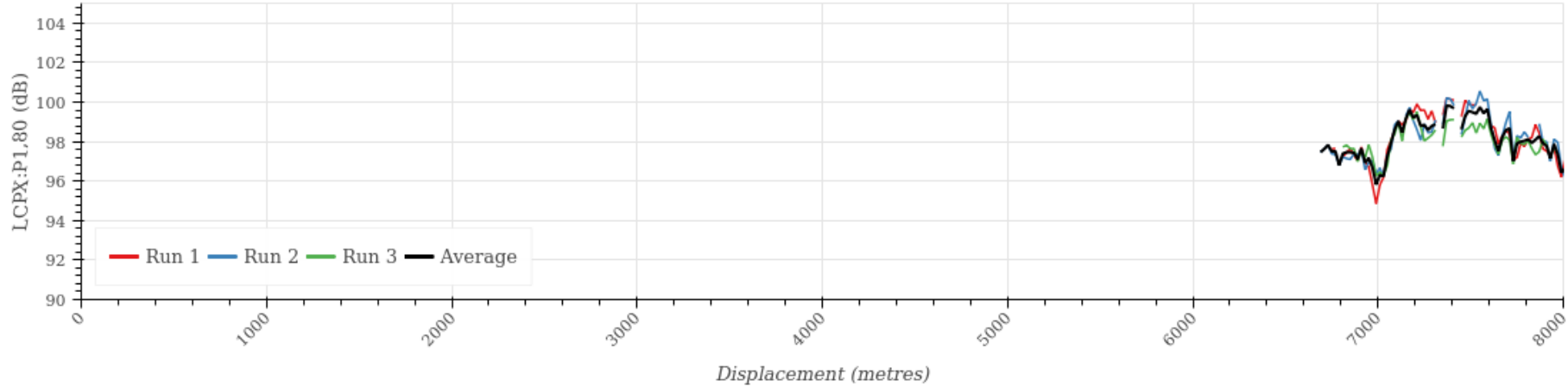


Figure 41 Median, Q1, Q2, maximum and minimum 20 metre road segment data for each location.

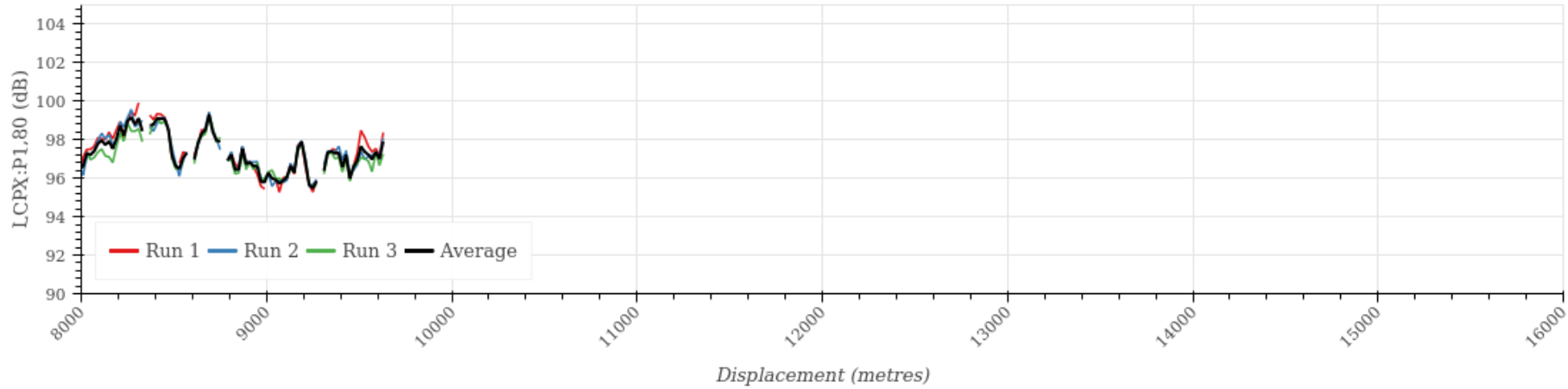
Appendix A Detailed Longitudinal Plots

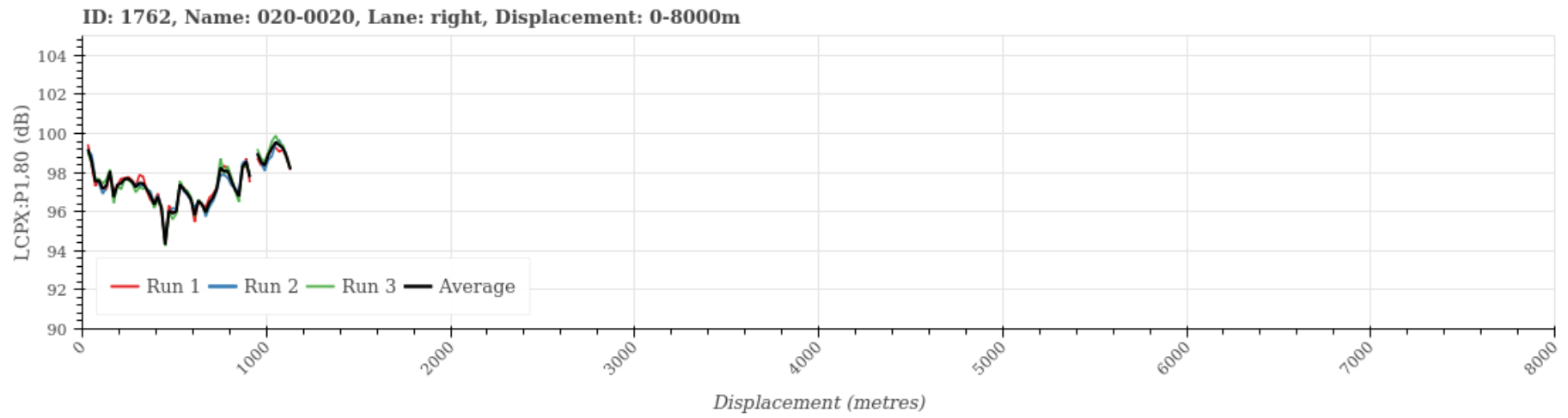
A.1 Southwestern Motorway – Waterview tunnel approach – SH20 – NB

ID: 1761, Name: 020-0010, Lane: right, Displacement: 0-8000m

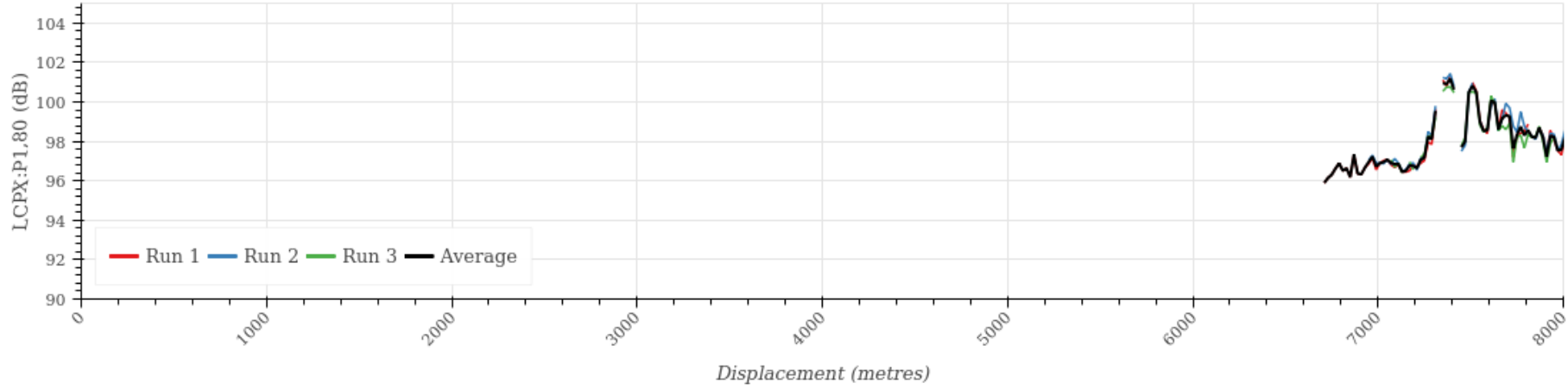


ID: 1761, Name: 020-0010, Lane: right, Displacement: 8000-16000m

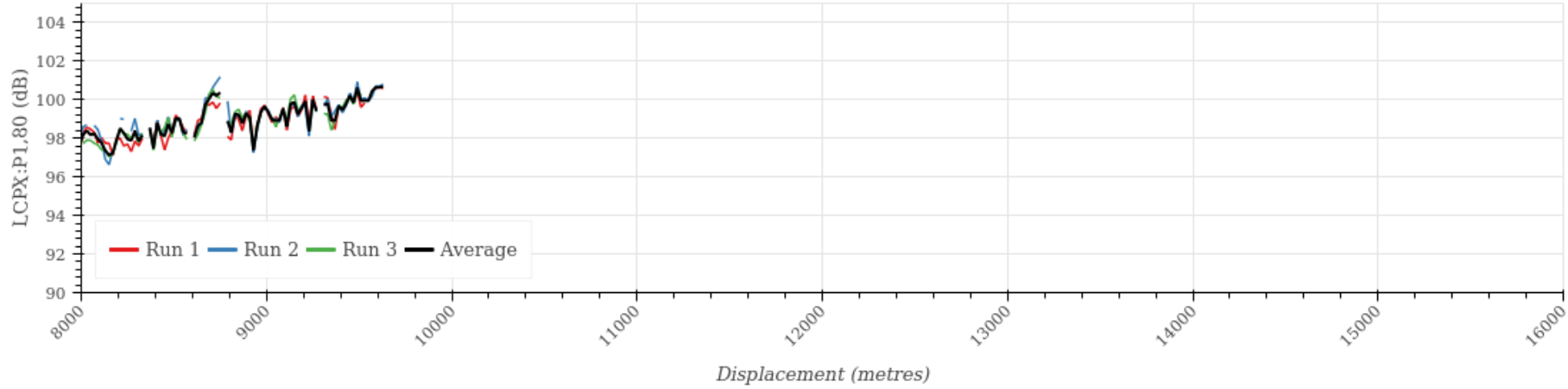


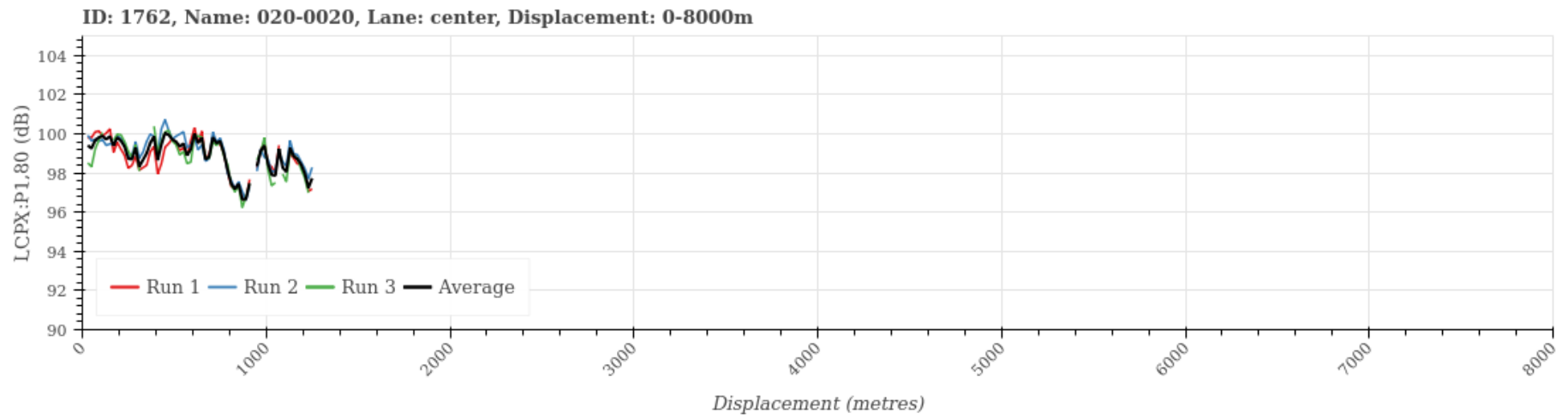


ID: 1761, Name: 020-0010, Lane: center, Displacement: 0-8000m

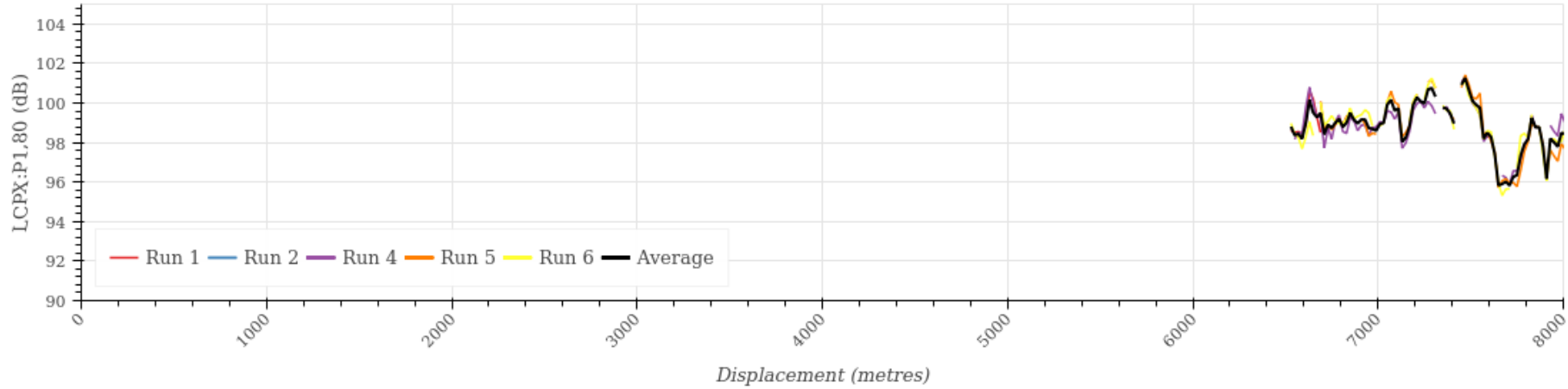


ID: 1761, Name: 020-0010, Lane: center, Displacement: 8000-16000m

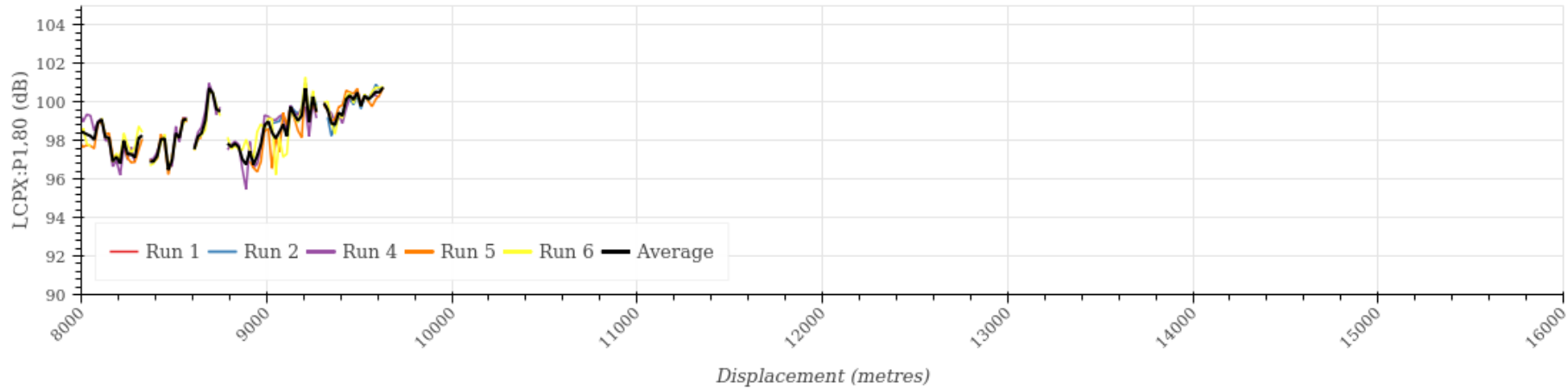


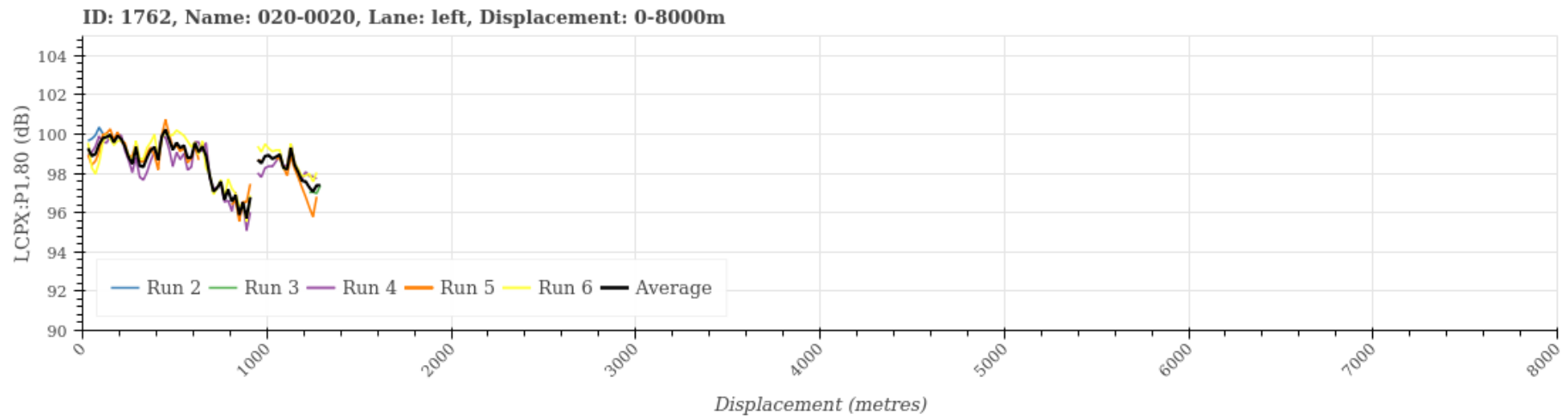


ID: 1761, Name: 020-0010, Lane: left, Displacement: 0-8000m



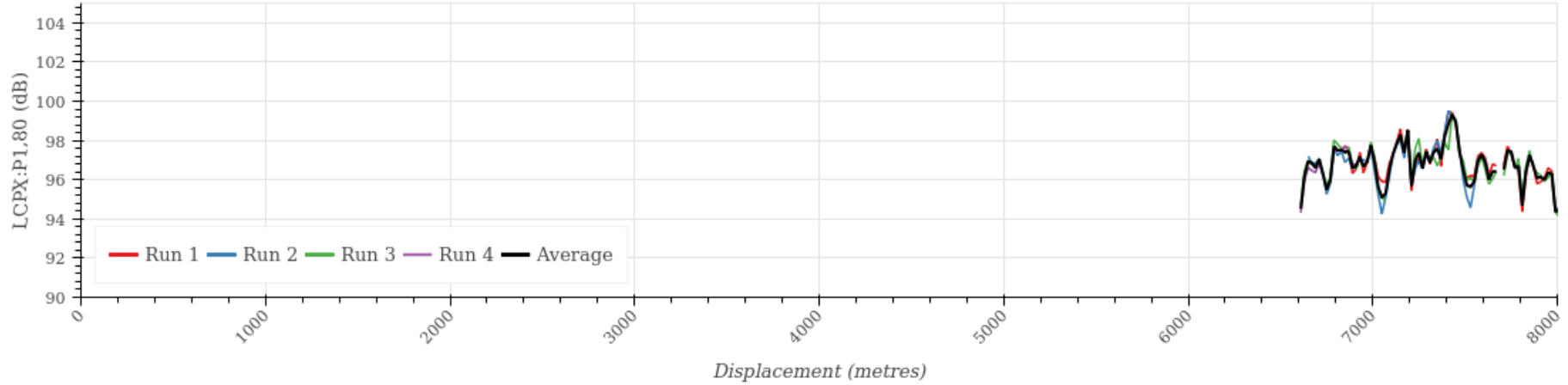
ID: 1761, Name: 020-0010, Lane: left, Displacement: 8000-16000m



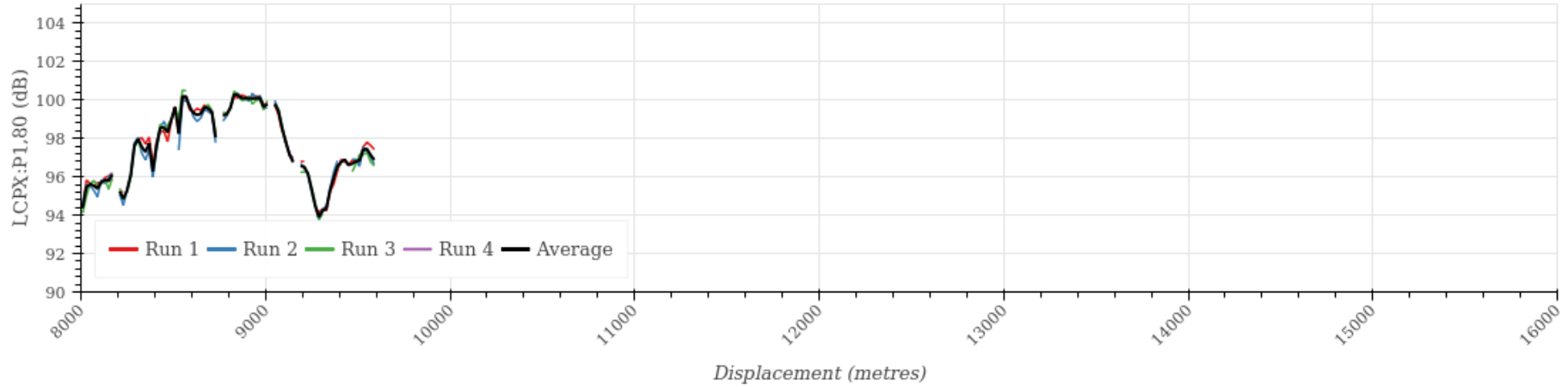


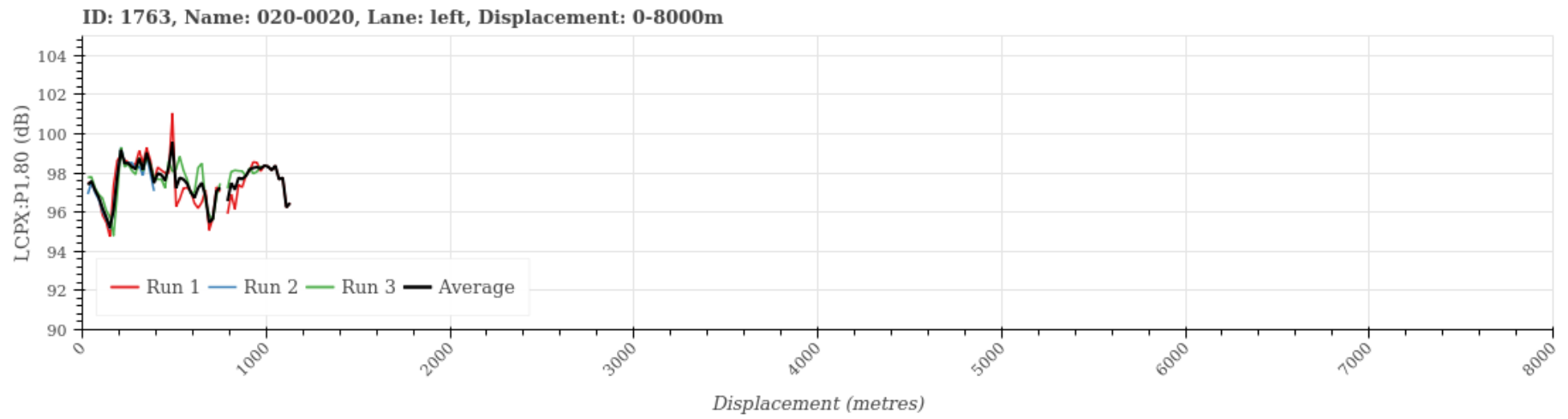
A.2 Southwestern Motorway – Waterview tunnel approach – SH20 – SB

ID: 1760, Name: 020-0010, Lane: left, Displacement: 0-8000m



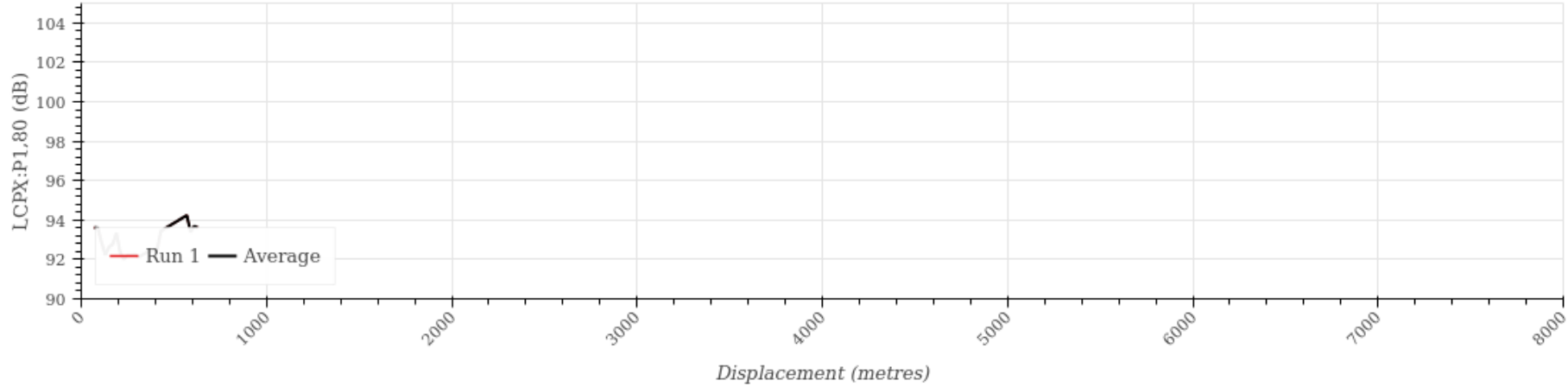
ID: 1760, Name: 020-0010, Lane: left, Displacement: 8000-16000m



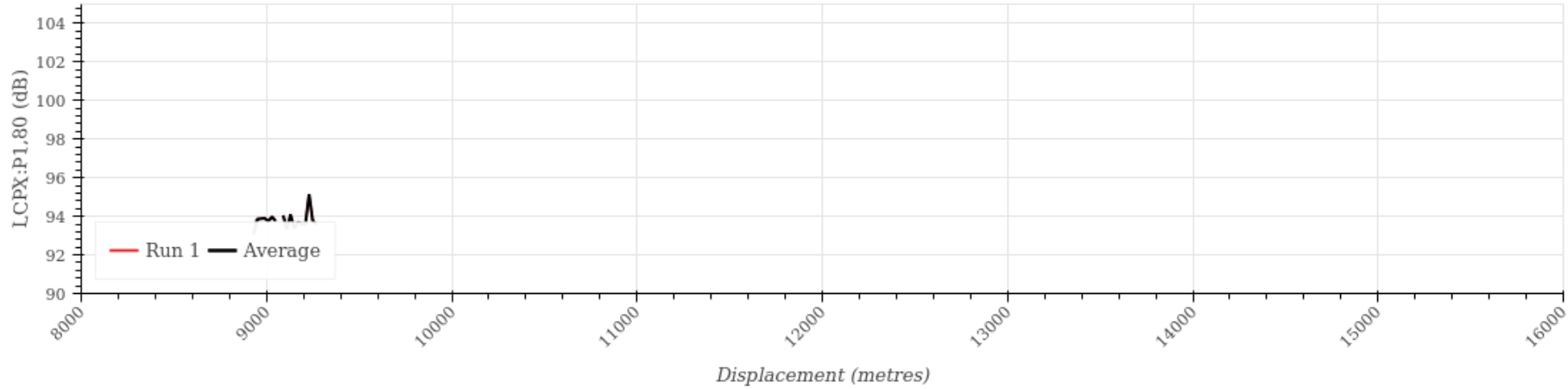


A.3 Northwestern Motorway – Waterview to Lincoln Road – SH16 – WB

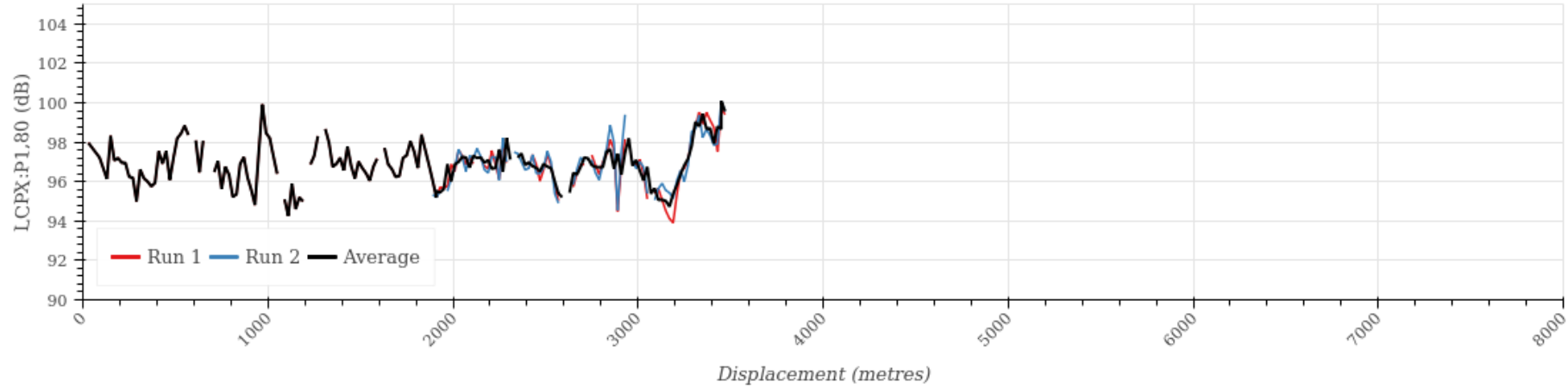
ID: 2579, Name: 016-0000, Lane: WB5, Displacement: 0-8000m



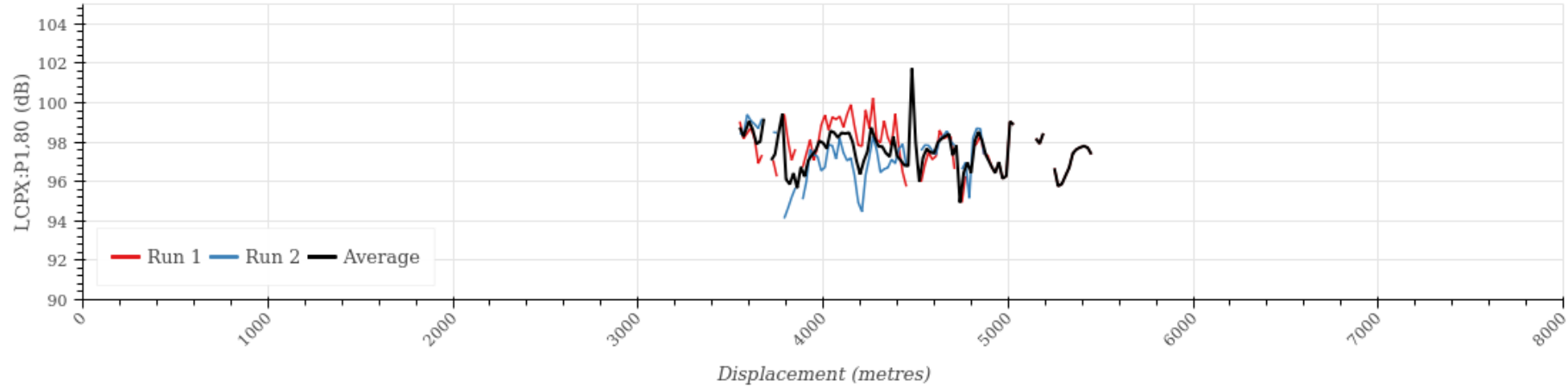
ID: 1932, Name: 016-0000, Lane: WB5, Displacement: 8000-16000m



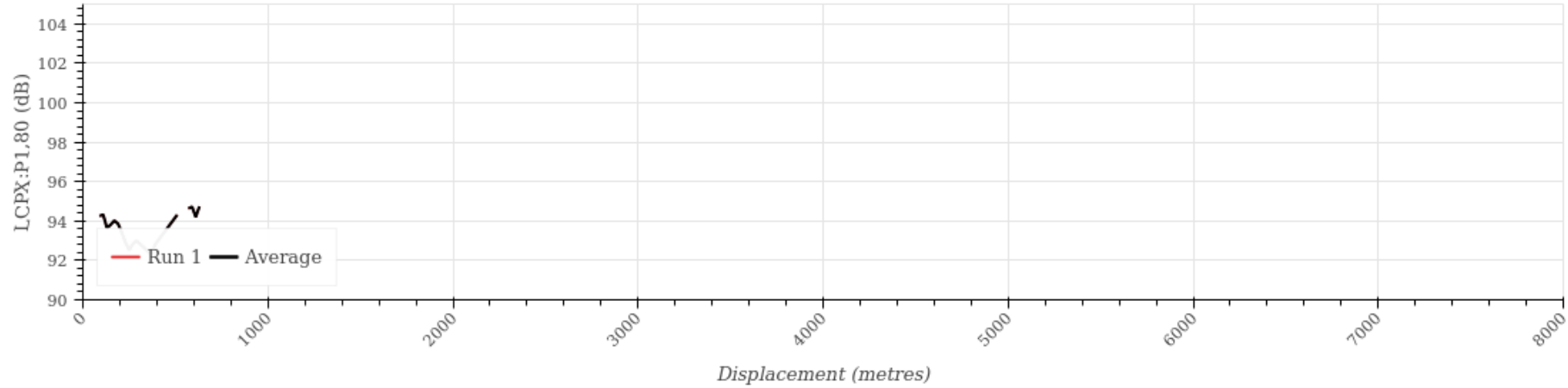
ID: 245, Name: 016-0007, Lane: WB5, Displacement: 0-8000m



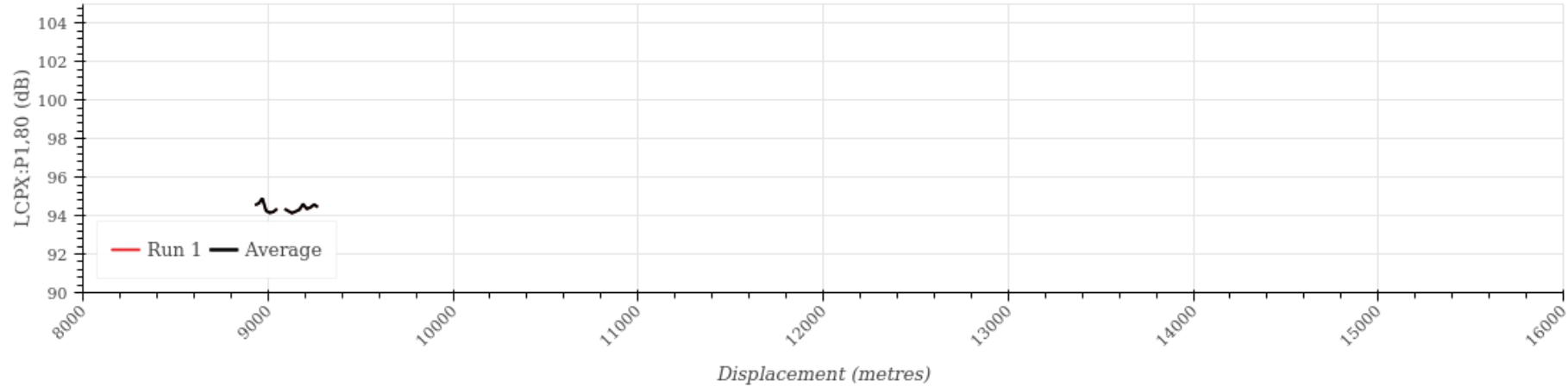
ID: 2638, Name: 016-0007, Lane: WB5, Displacement: 0-8000m



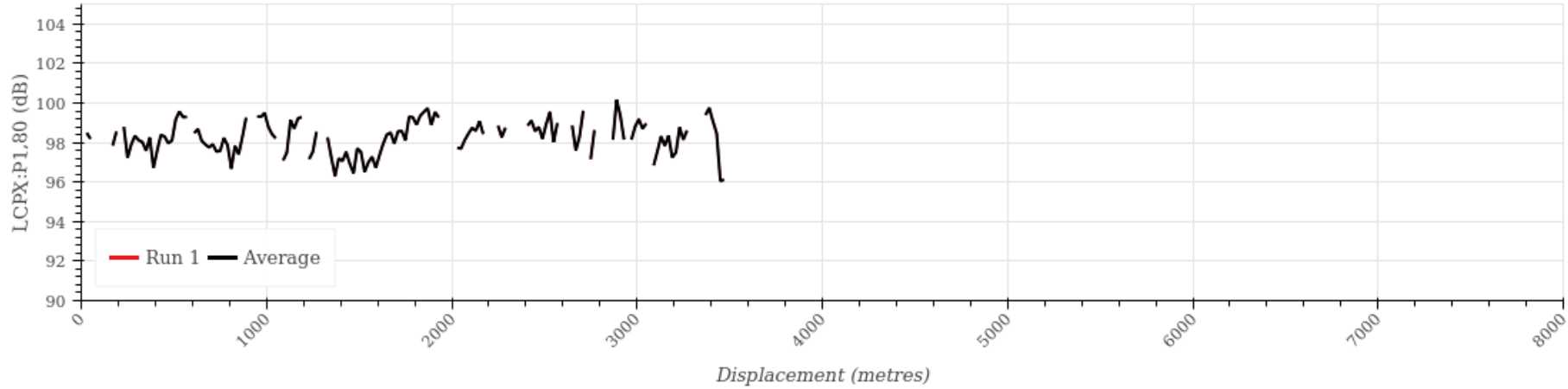
ID: 2579, Name: 016-0000, Lane: WB4, Displacement: 0-8000m



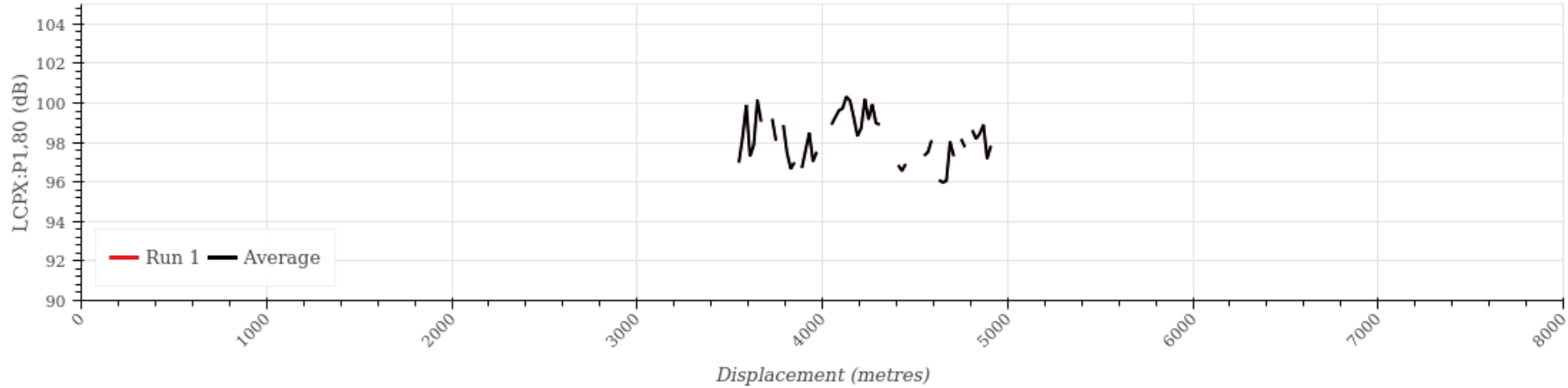
ID: 1932, Name: 016-0000, Lane: WB4, Displacement: 8000-16000m



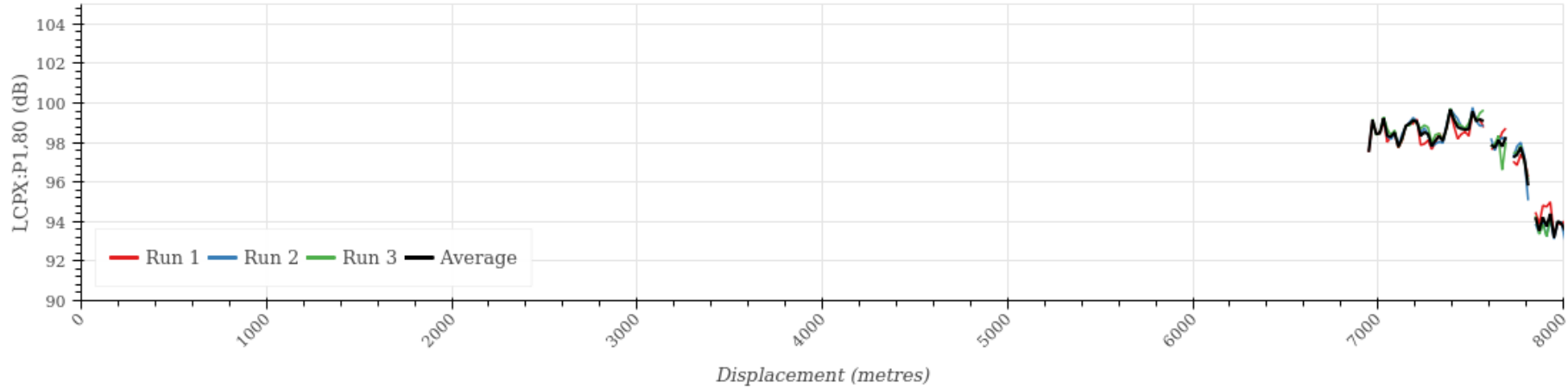
ID: 245, Name: 016-0007, Lane: WB4, Displacement: 0-8000m



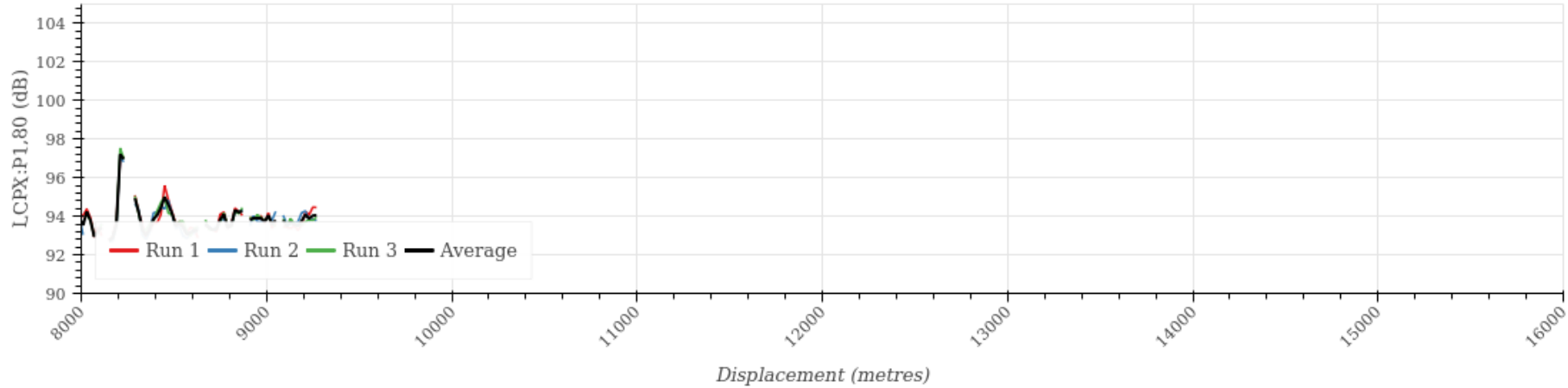
ID: 2638, Name: 016-0007, Lane: WB4, Displacement: 0-8000m



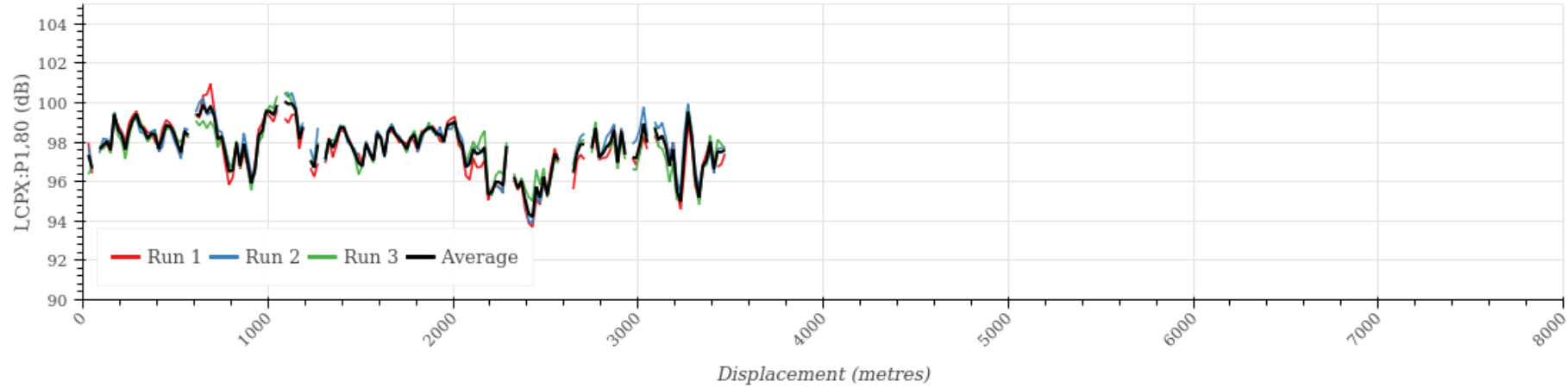
ID: 1932, Name: 016-0000, Lane: WB3, Displacement: 0-8000m



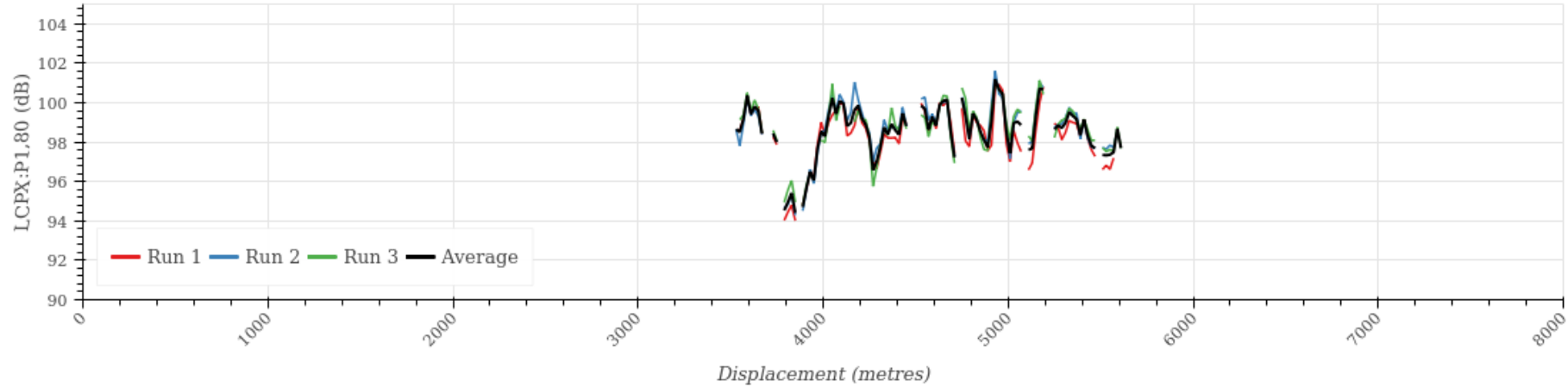
ID: 1932, Name: 016-0000, Lane: WB3, Displacement: 8000-16000m



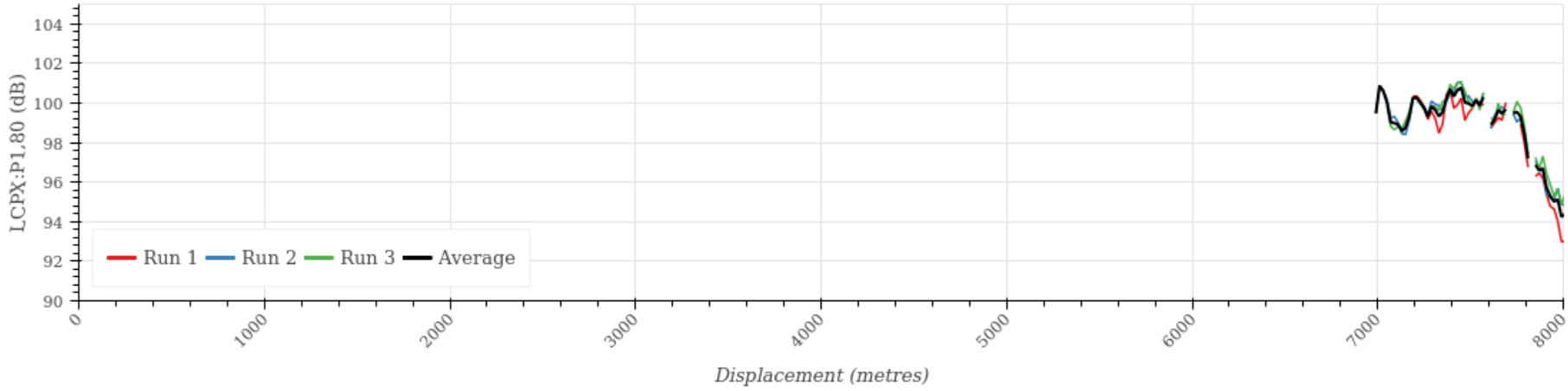
ID: 245, Name: 016-0007, Lane: WB3, Displacement: 0-8000m



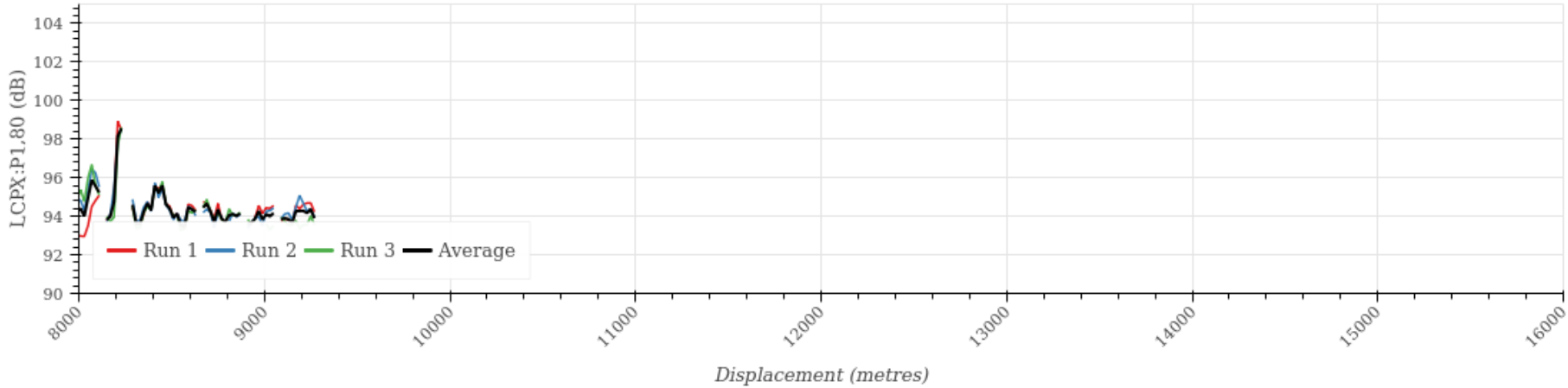
ID: 2638, Name: 016-0007, Lane: WB3, Displacement: 0-8000m



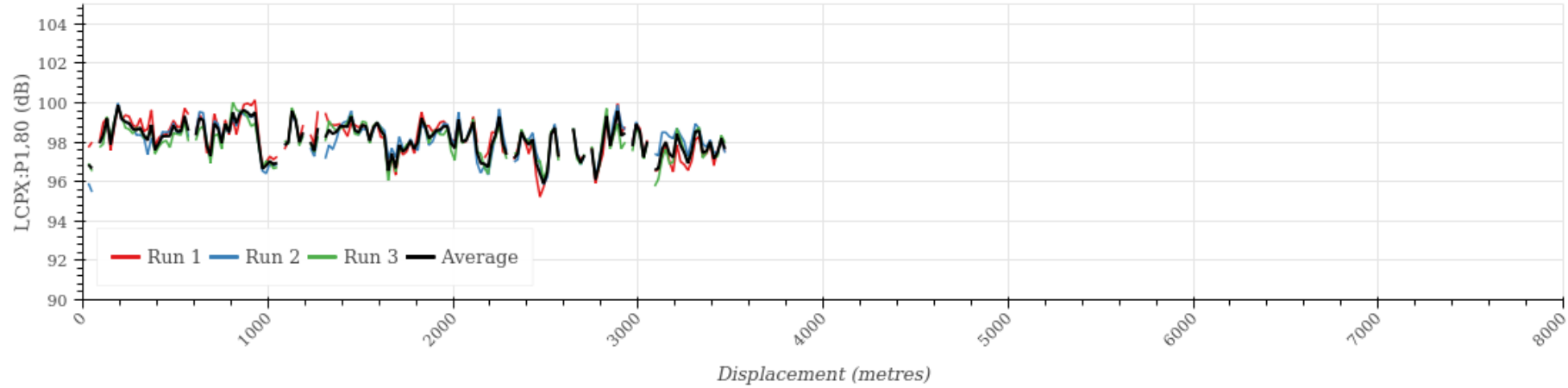
ID: 1932, Name: 016-0000, Lane: WB2, Displacement: 0-8000m



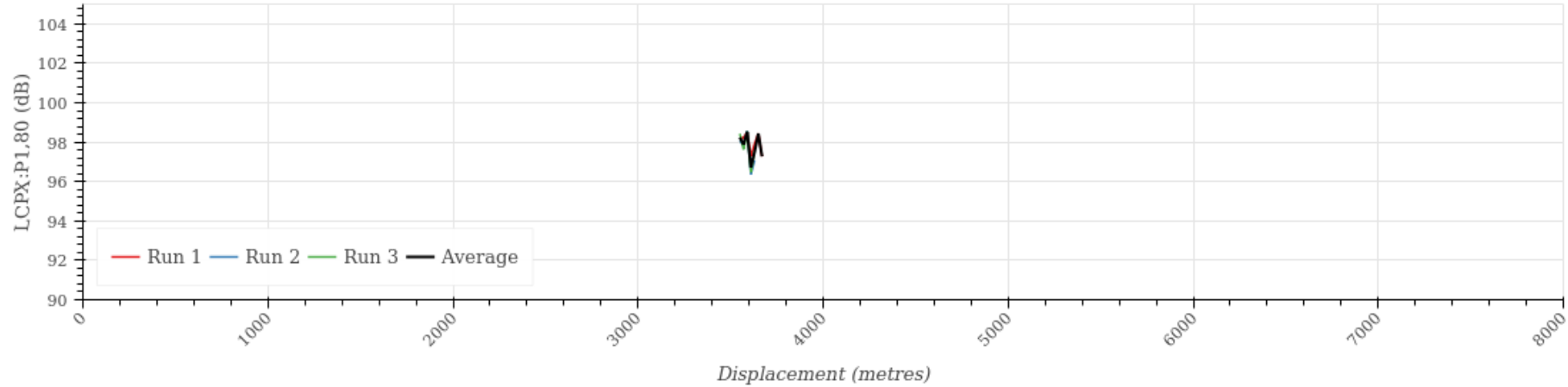
ID: 1932, Name: 016-0000, Lane: WB2, Displacement: 8000-16000m



ID: 245, Name: 016-0007, Lane: WB2, Displacement: 0-8000m

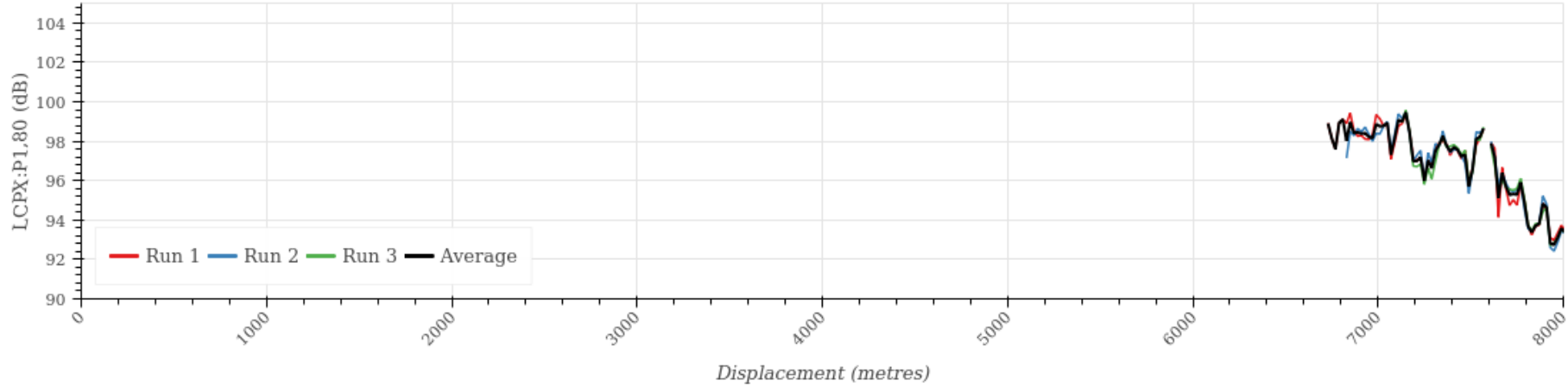


ID: 2638, Name: 016-0007, Lane: WB2, Displacement: 0-8000m

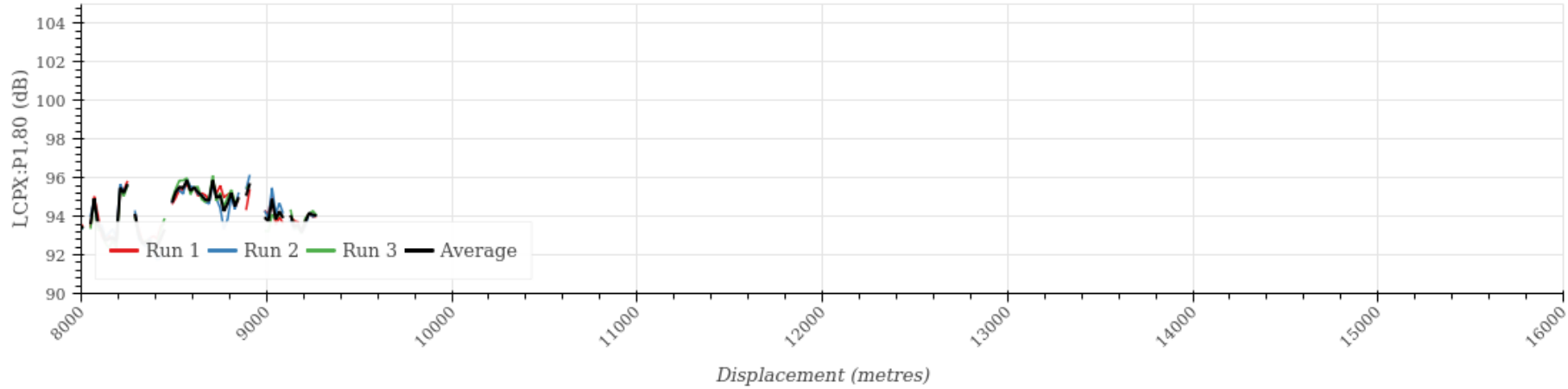


A.4 Northwestern Motorway – Waterview to Lincoln Road – SH16 – EB

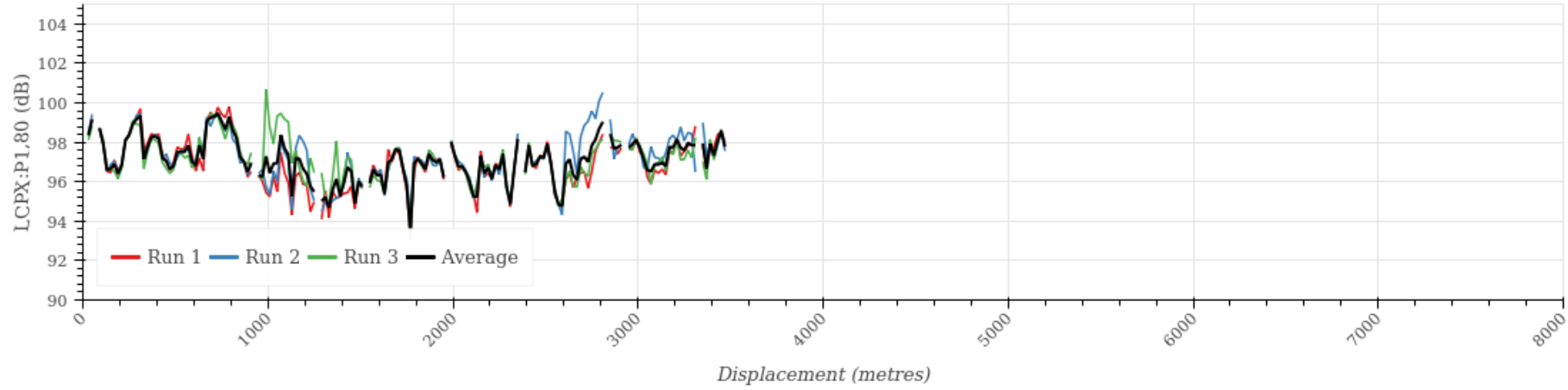
ID: 1934, Name: 016-0000, Lane: EB4, Displacement: 0-8000m



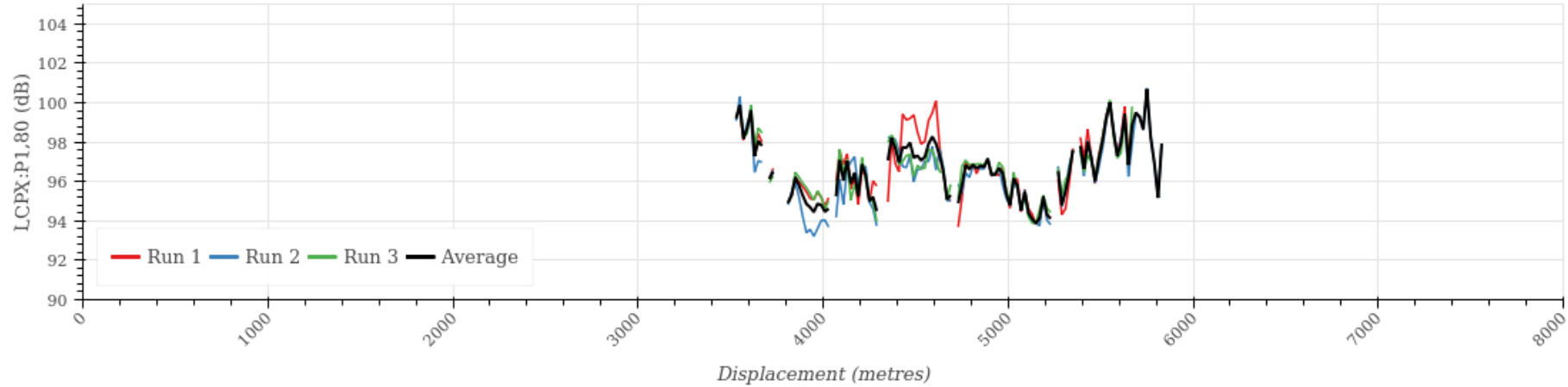
ID: 1934, Name: 016-0000, Lane: EB4, Displacement: 8000-16000m



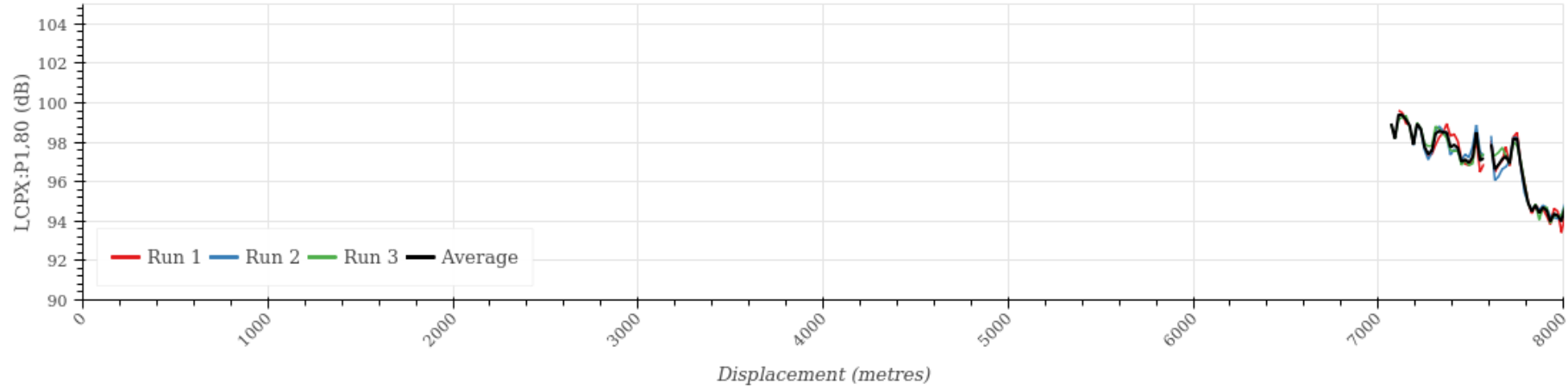
ID: 246, Name: 016-0007, Lane: EB4, Displacement: 0-8000m



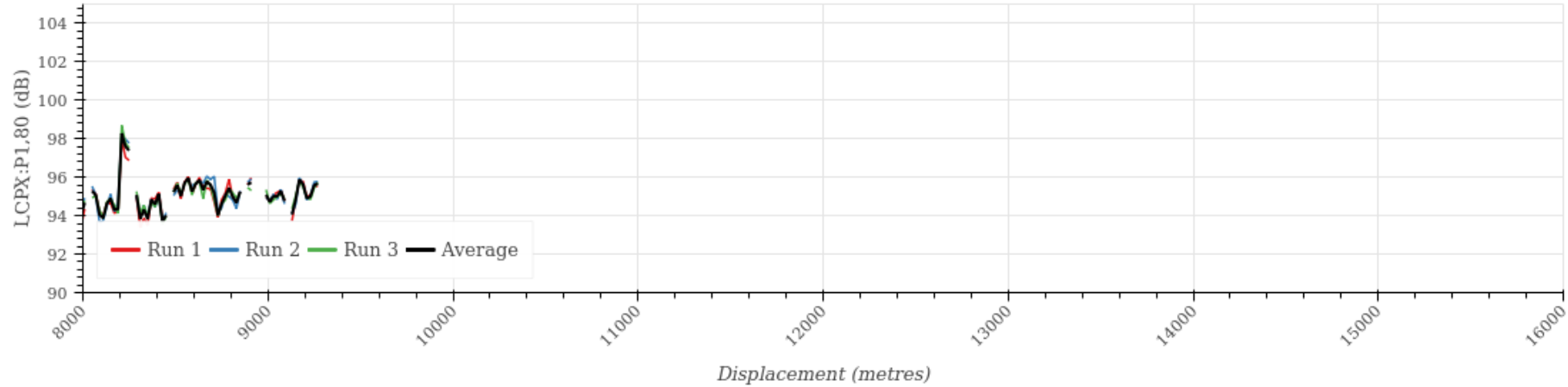
ID: 1747, Name: 016-0007, Lane: EB4, Displacement: 0-8000m



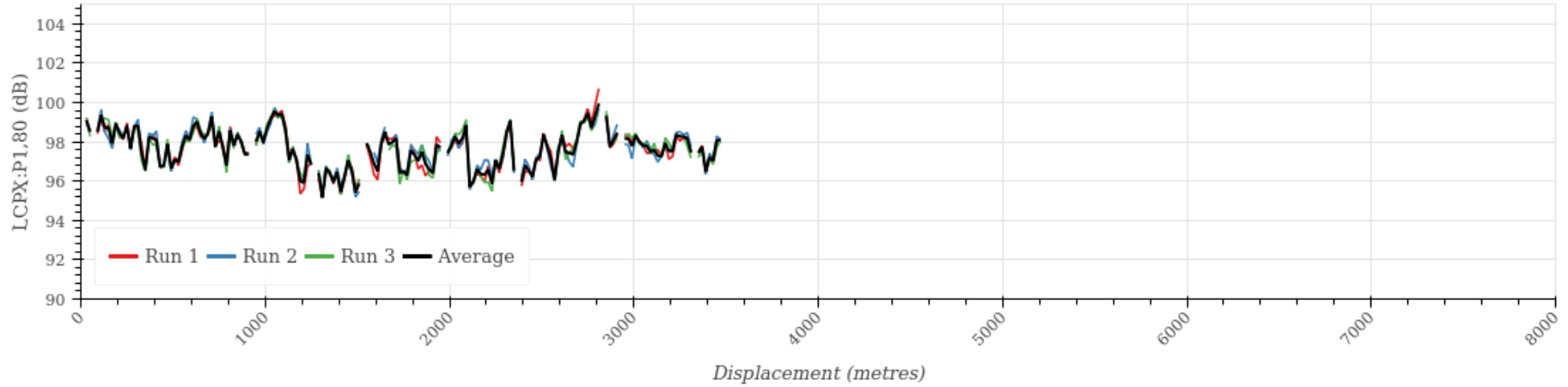
ID: 1934, Name: 016-0000, Lane: EB3, Displacement: 0-8000m



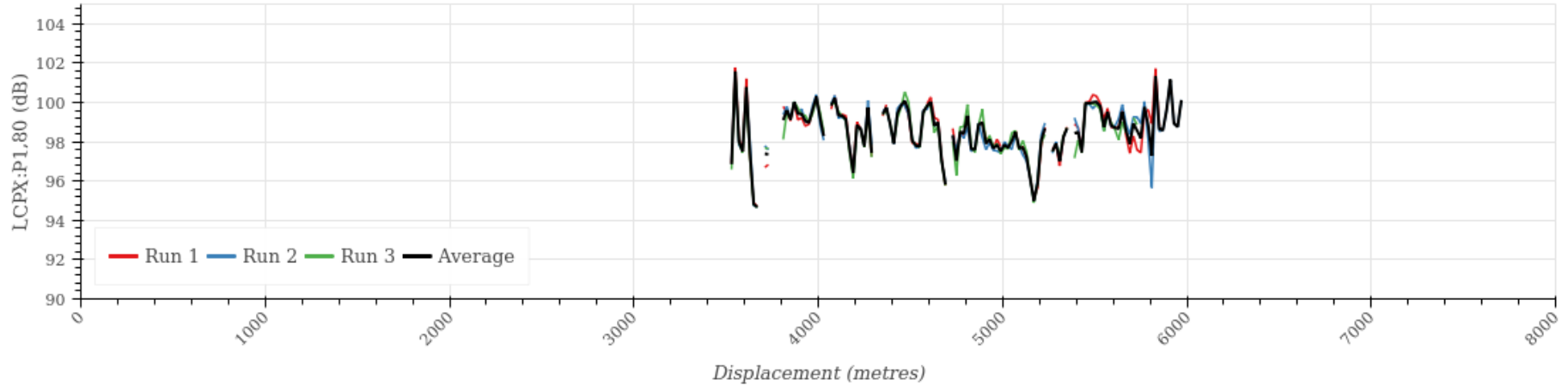
ID: 1934, Name: 016-0000, Lane: EB3, Displacement: 8000-16000m



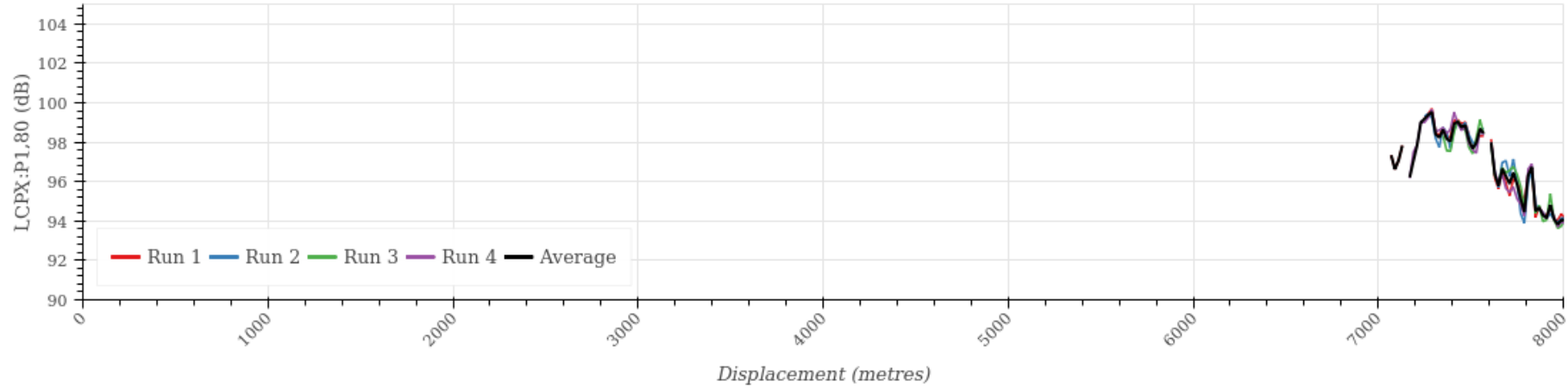
ID: 246, Name: 016-0007, Lane: EB3, Displacement: 0-8000m



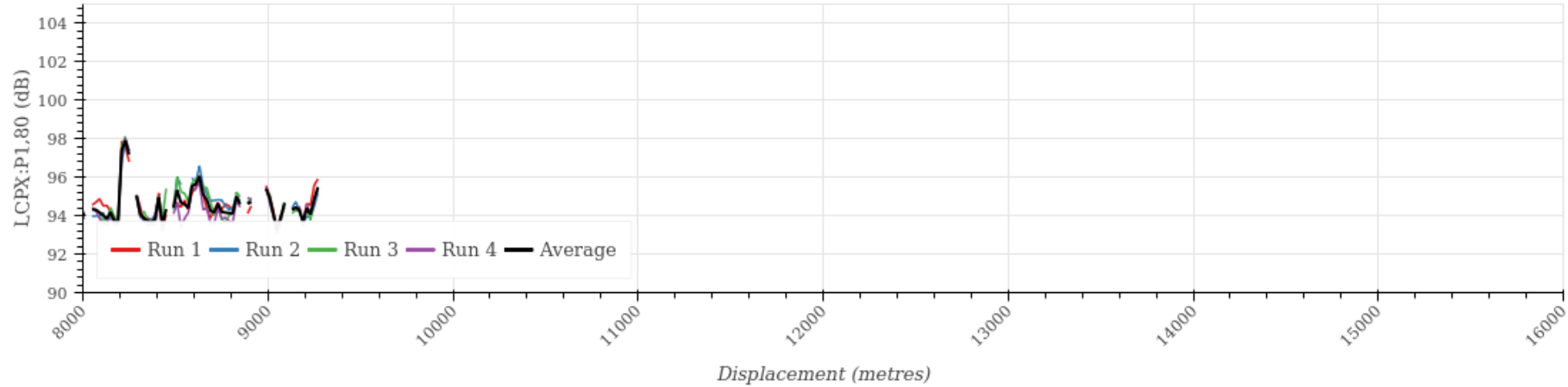
ID: 1747, Name: 016-0007, Lane: EB3, Displacement: 0-8000m



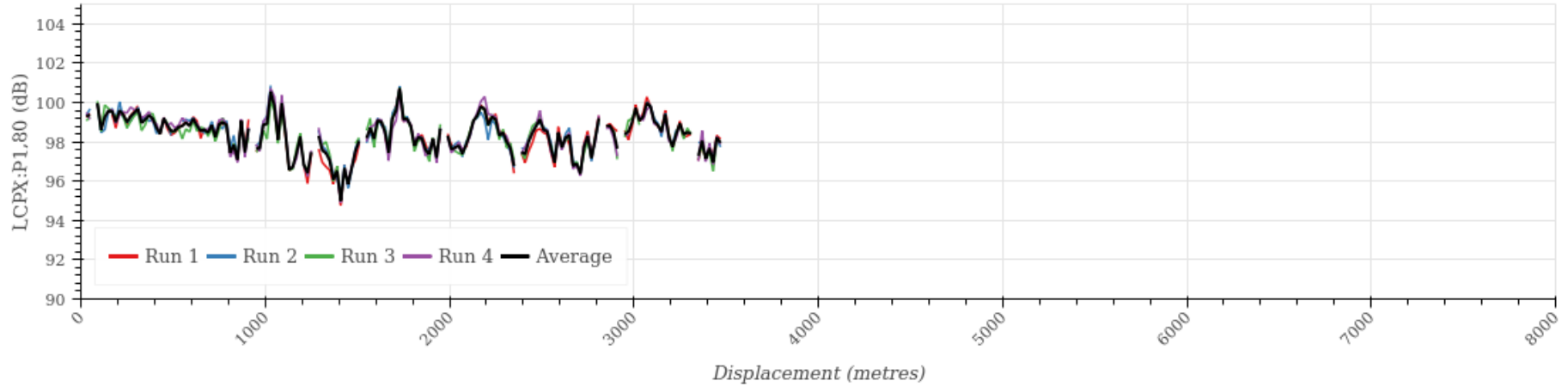
ID: 1934, Name: 016-0000, Lane: EB2, Displacement: 0-8000m



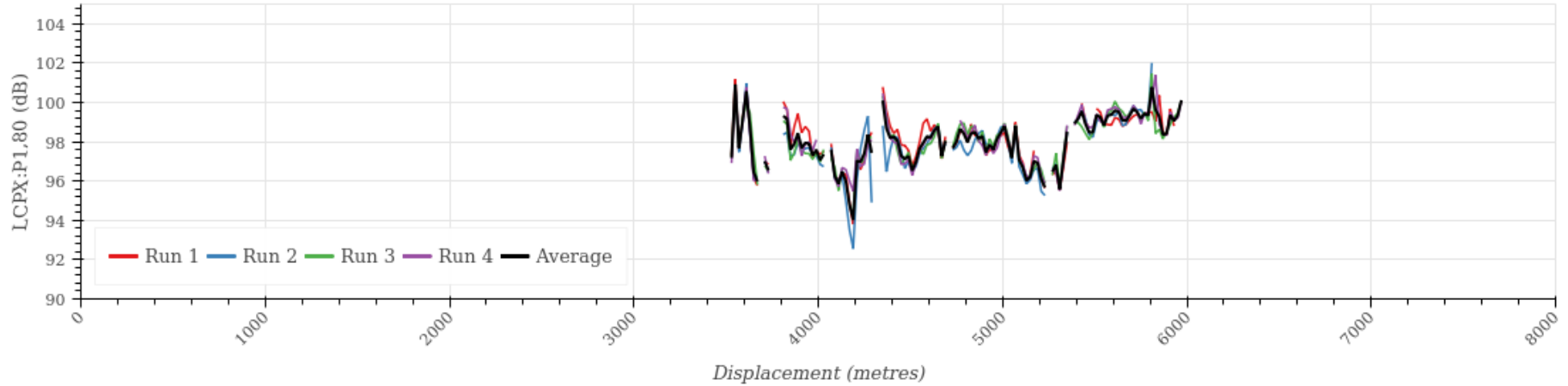
ID: 1934, Name: 016-0000, Lane: EB2, Displacement: 8000-16000m



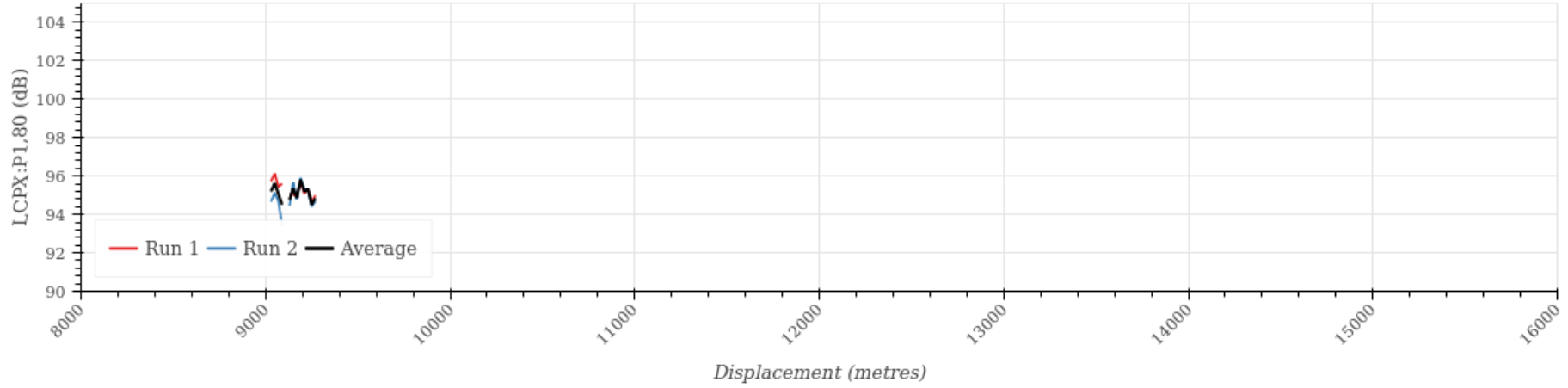
ID: 246, Name: 016-0007, Lane: EB2, Displacement: 0-8000m



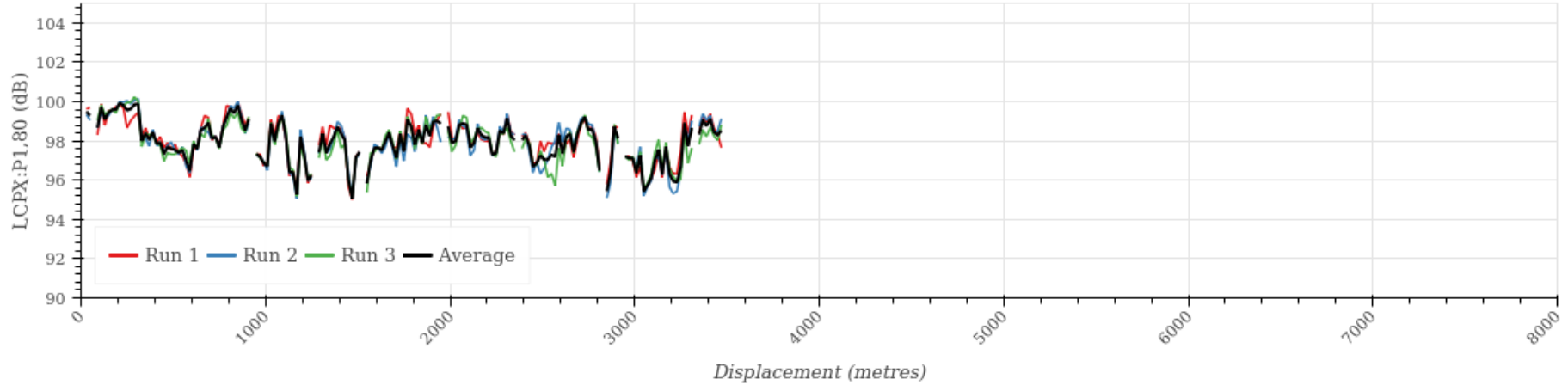
ID: 1747, Name: 016-0007, Lane: EB2, Displacement: 0-8000m

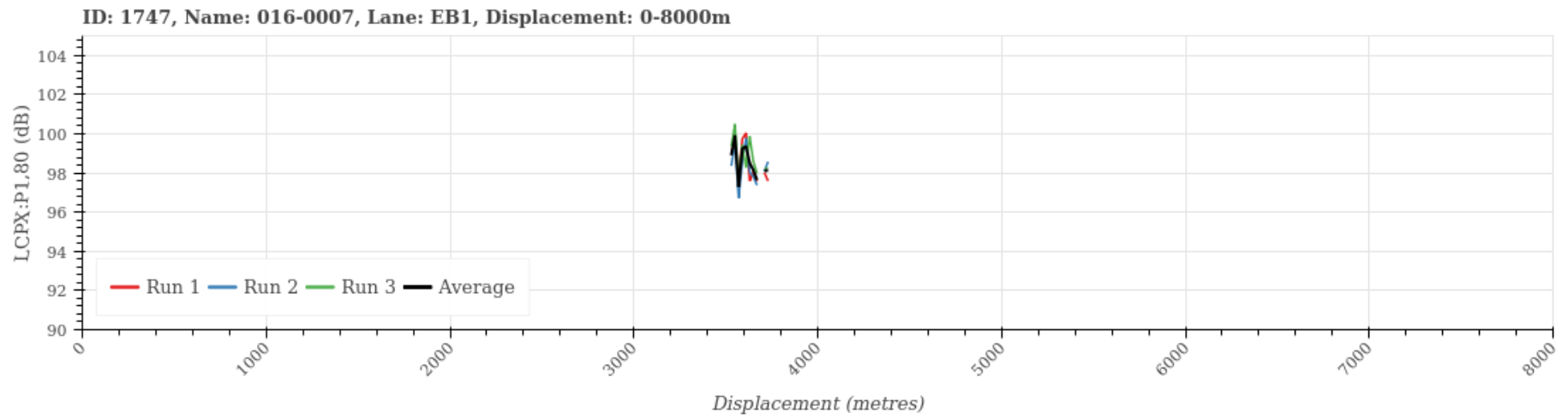


ID: 1934, Name: 016-0000, Lane: EB1, Displacement: 8000-16000m



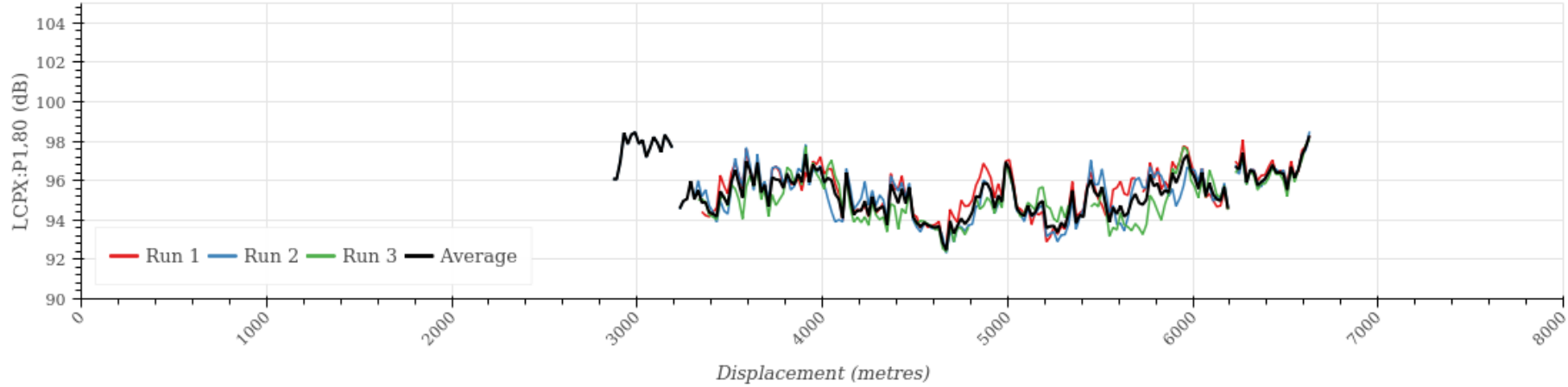
ID: 246, Name: 016-0007, Lane: EB1, Displacement: 0-8000m



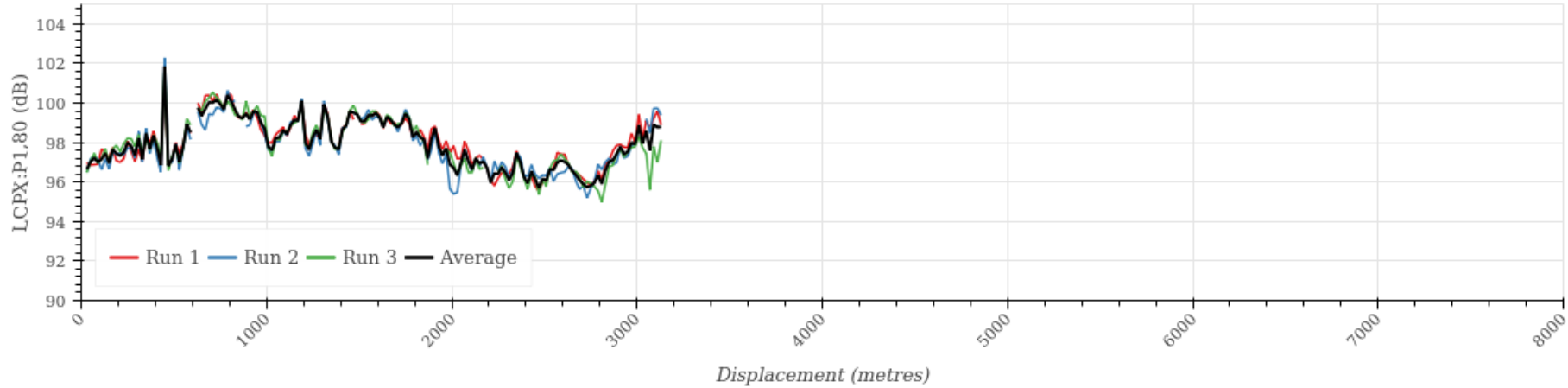


A.5 Upper Harbour Motorway – Hobsonville to Albany Highway – SH18 – NB

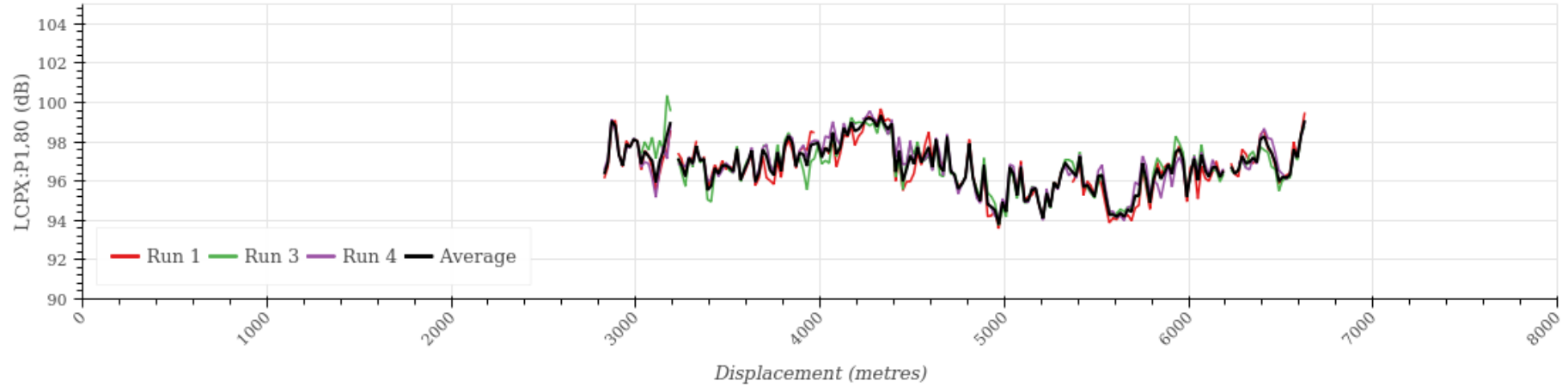
ID: 1985, Name: 018-0000-D, Lane: right, Displacement: 0-8000m



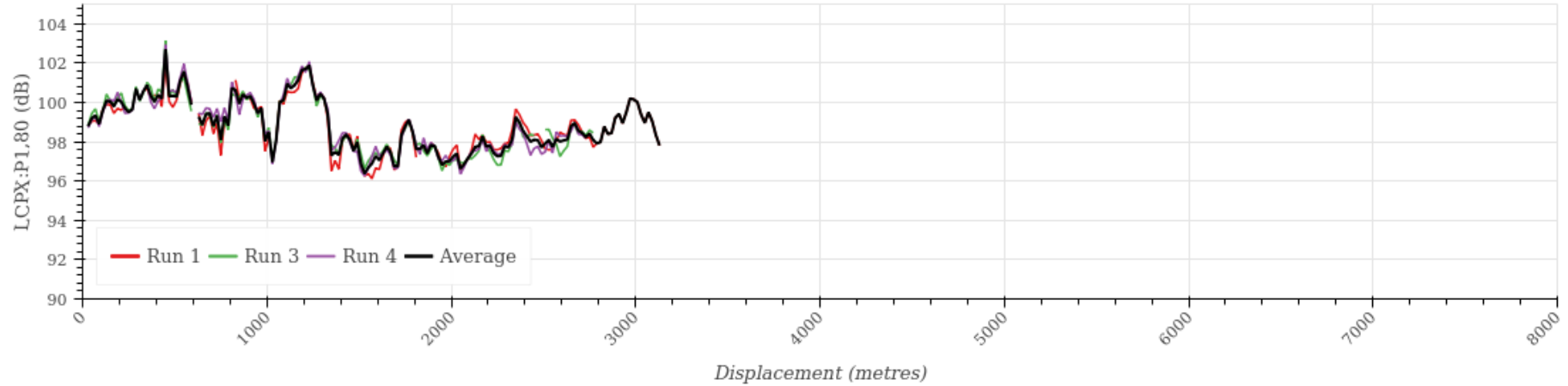
ID: 3197, Name: 018-0007-D, Lane: right, Displacement: 0-8000m



ID: 1985, Name: 018-0000-D, Lane: left, Displacement: 0-8000m

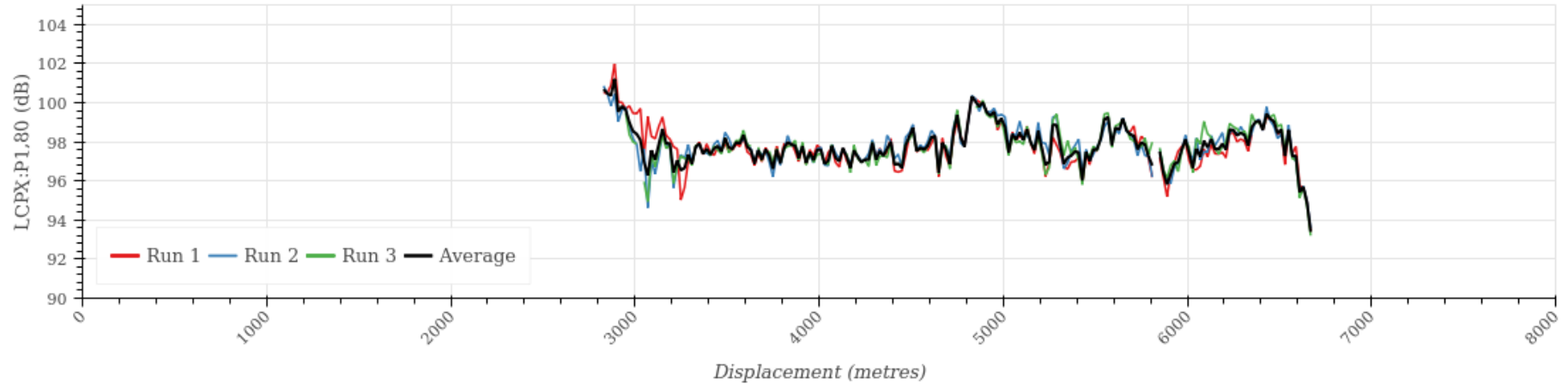


ID: 3197, Name: 018-0007-D, Lane: left, Displacement: 0-8000m

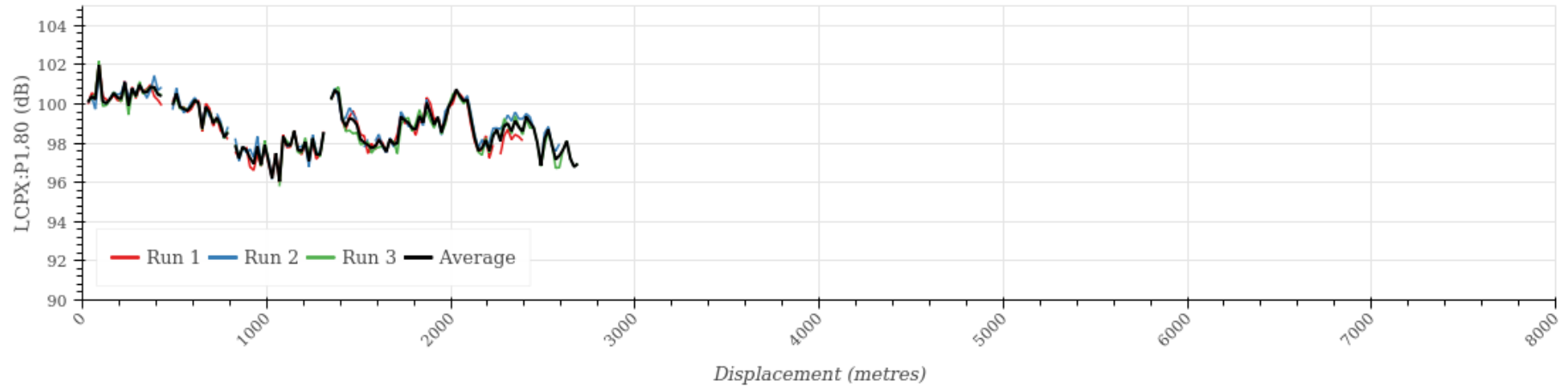


A.6 Upper Harbour Motorway – Hobsonville to Albany Highway – SH18 – SB

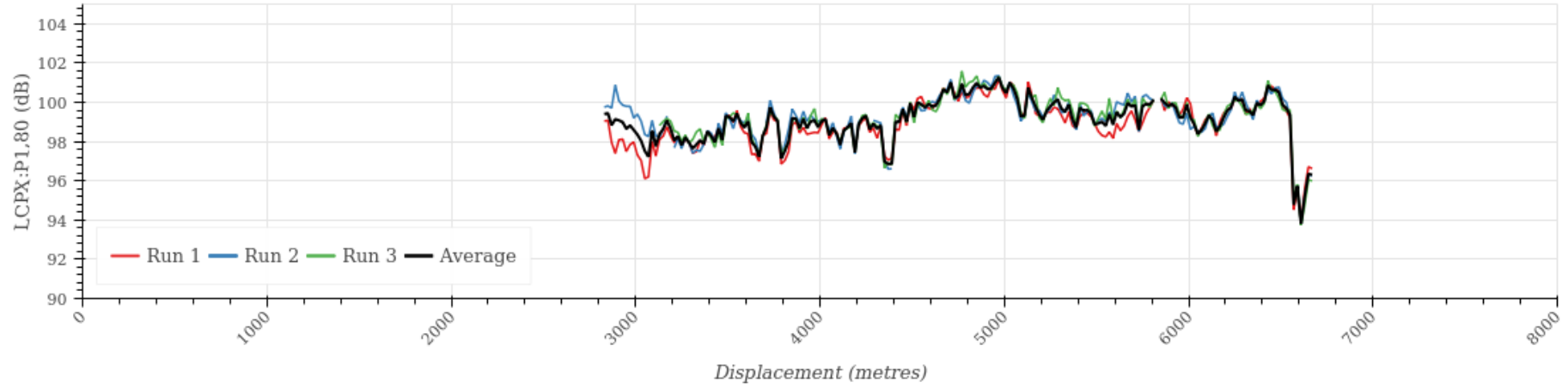
ID: 1986, Name: 018-0000-I, Lane: right, Displacement: 0-8000m



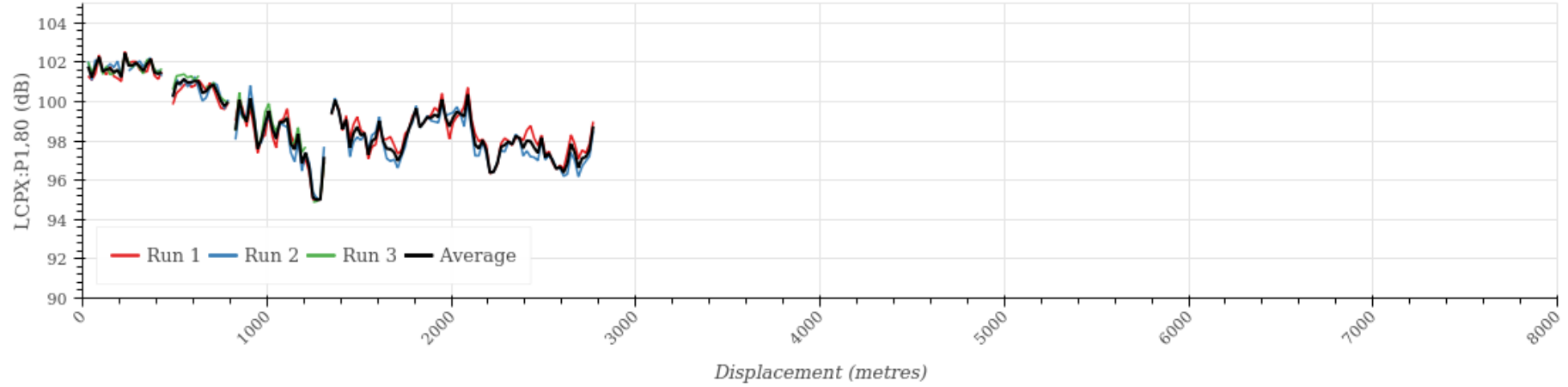
ID: 1927, Name: 018-0007-I, Lane: right, Displacement: 0-8000m



ID: 1986, Name: 018-0000-I, Lane: left, Displacement: 0-8000m

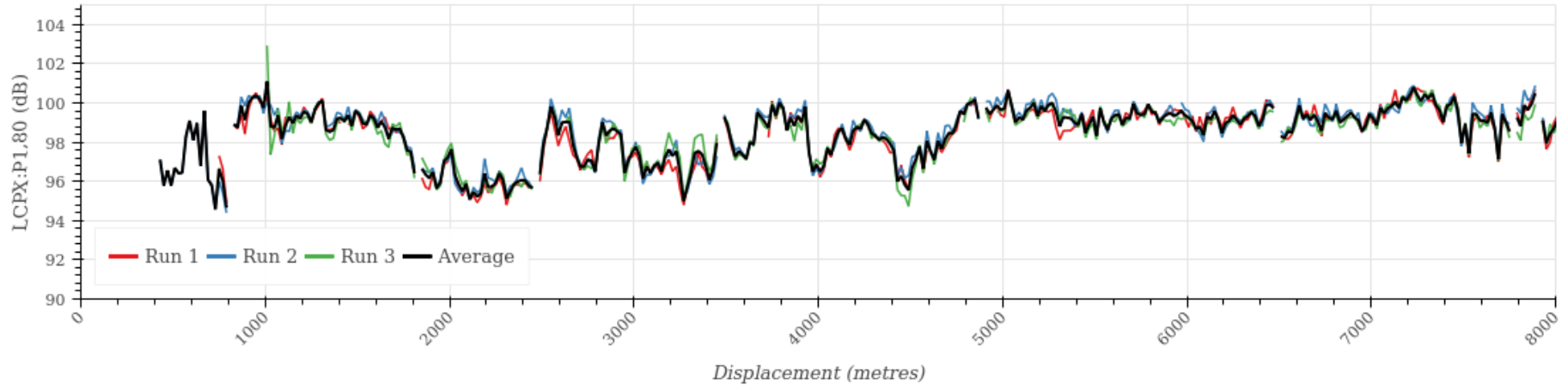


ID: 1927, Name: 018-0007-I, Lane: left, Displacement: 0-8000m



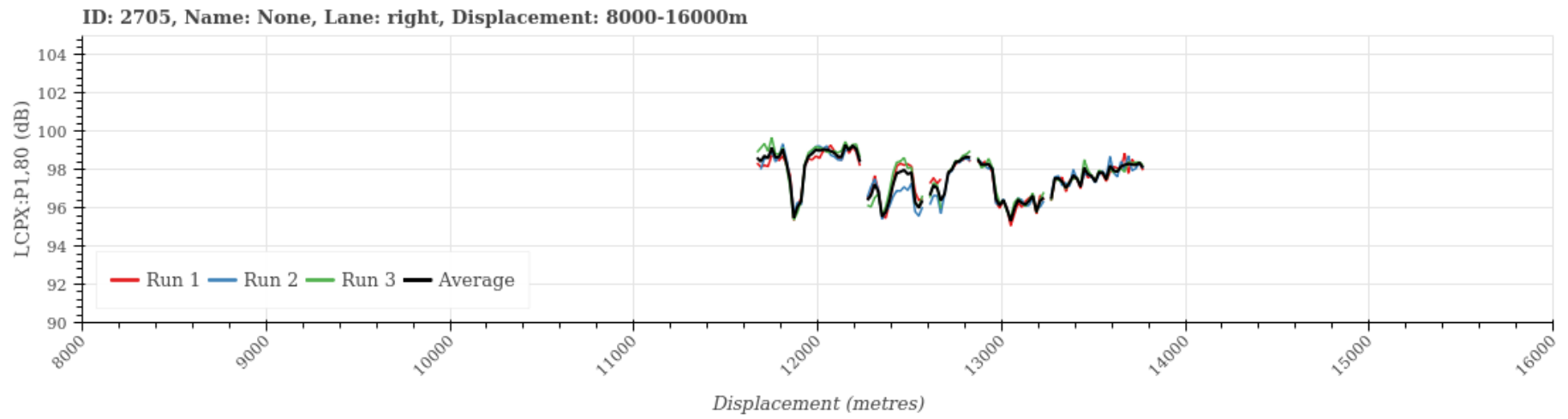
A.7 Northern Motorway – Wairau Valley to Silverdale – SH1 – NB

ID: 2614, Name: 01N-0398-D, Lane: right, Displacement: 0-8000m

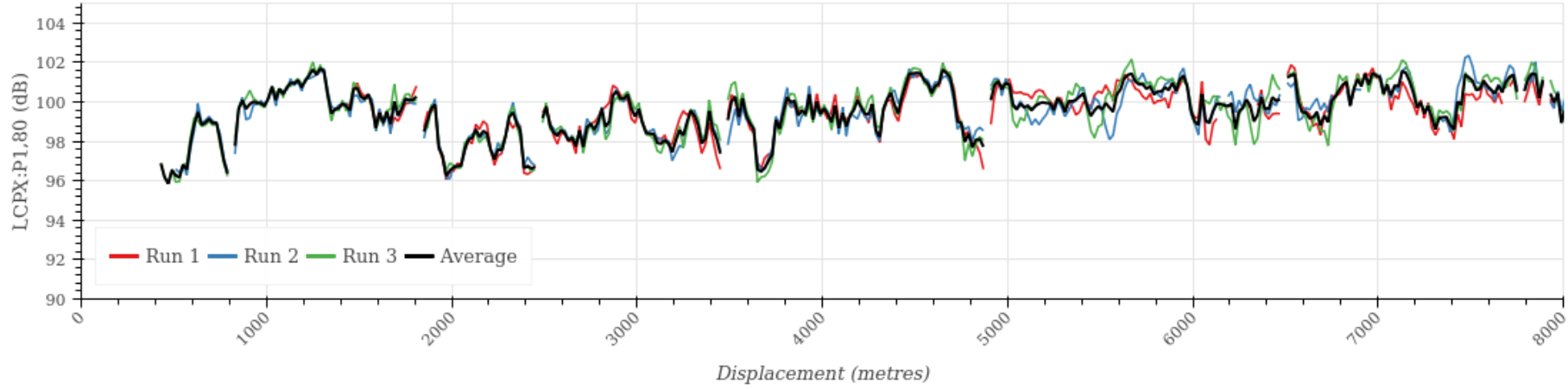


ID: 2614, Name: 01N-0398-D, Lane: right, Displacement: 8000-16000m

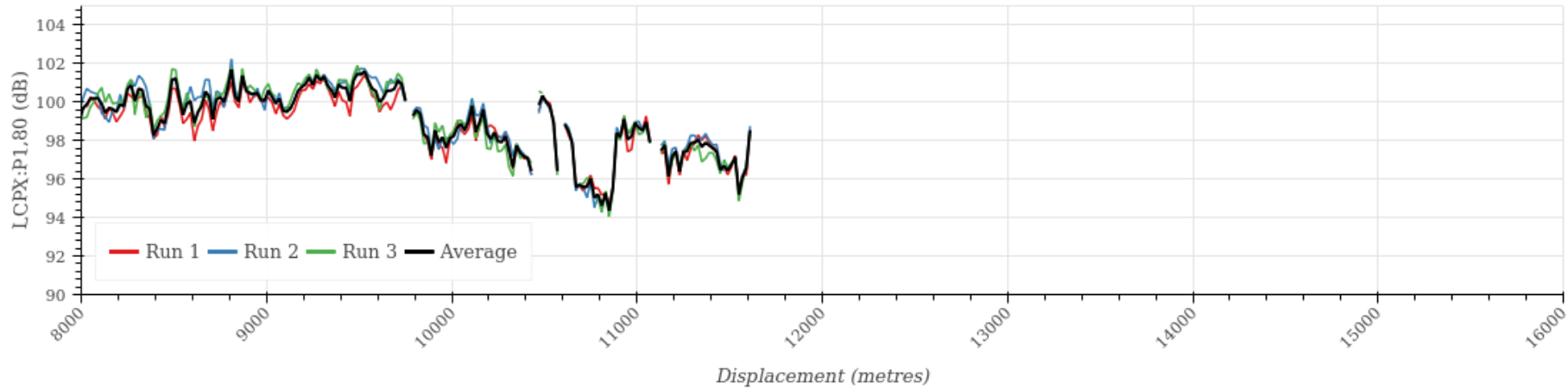


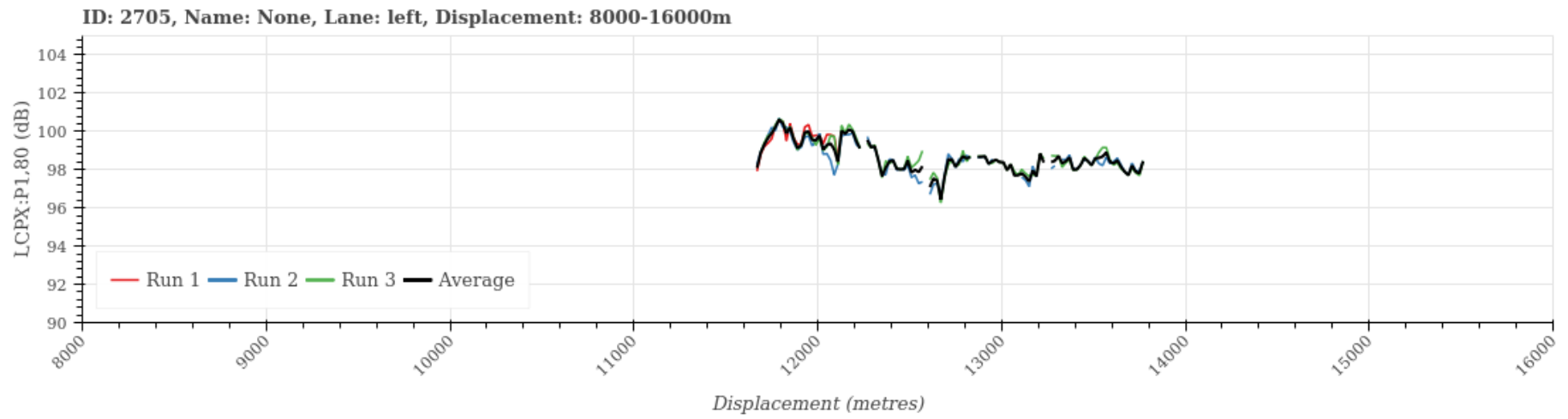


ID: 2614, Name: 01N-0398-D, Lane: left, Displacement: 0-8000m



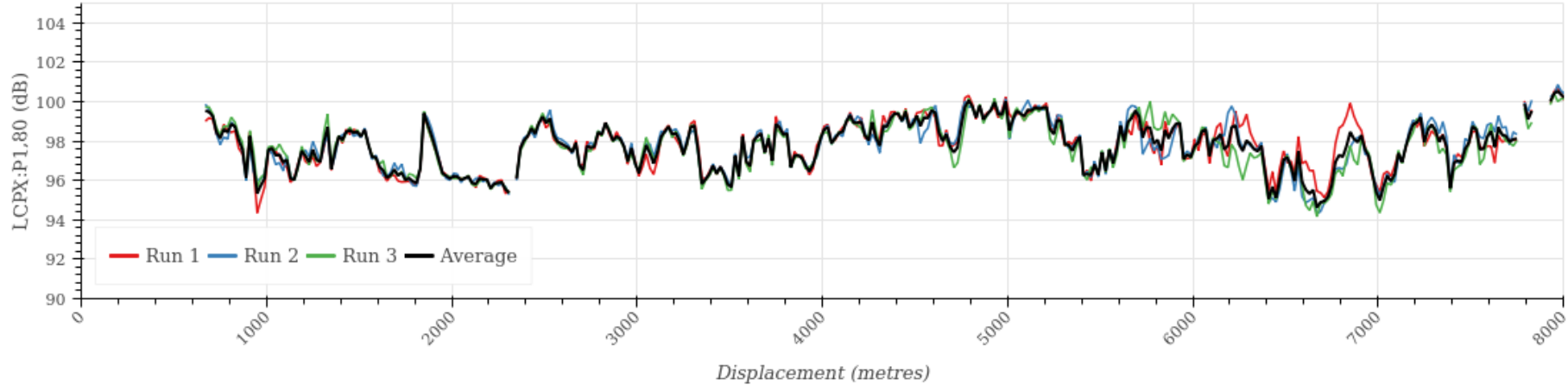
ID: 2614, Name: 01N-0398-D, Lane: left, Displacement: 8000-16000m





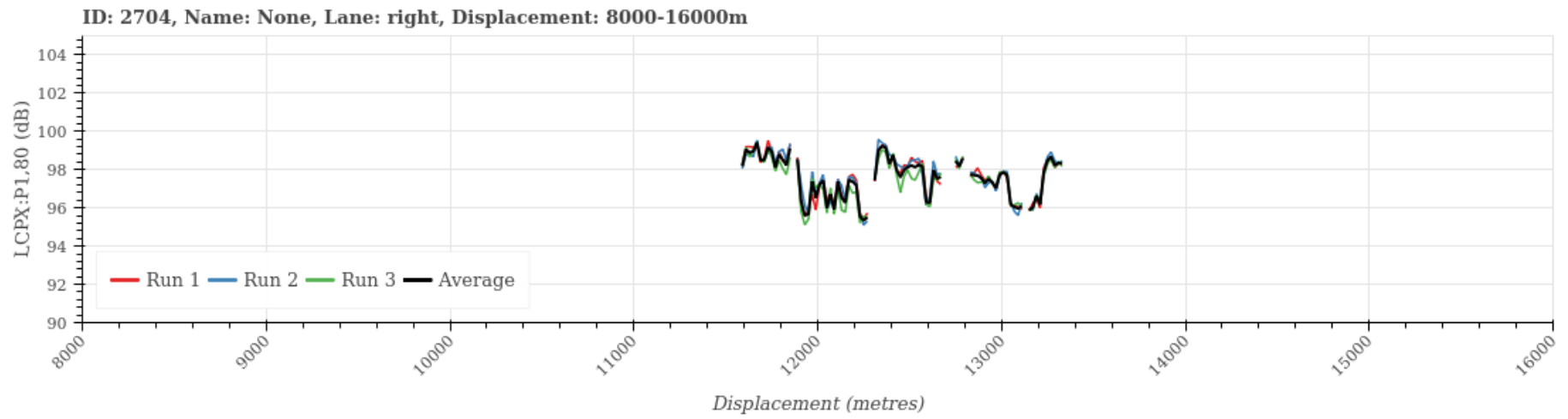
A.8 Northern Motorway – Wairau Valley to Silverdale – SH1 – SB

ID: 2613, Name: 01N-0398-I, Lane: right, Displacement: 0-8000m

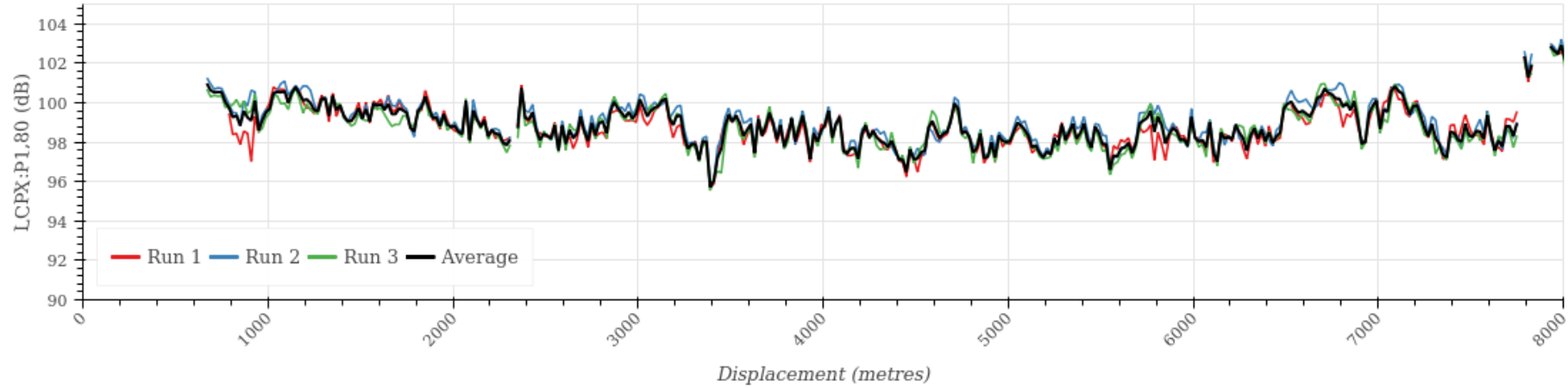


ID: 2613, Name: 01N-0398-I, Lane: right, Displacement: 8000-16000m

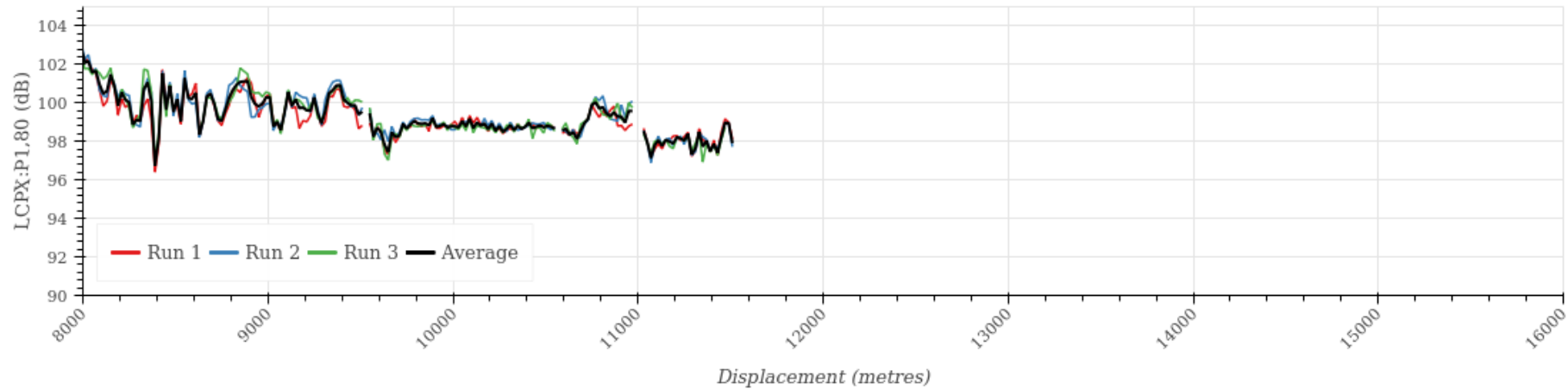


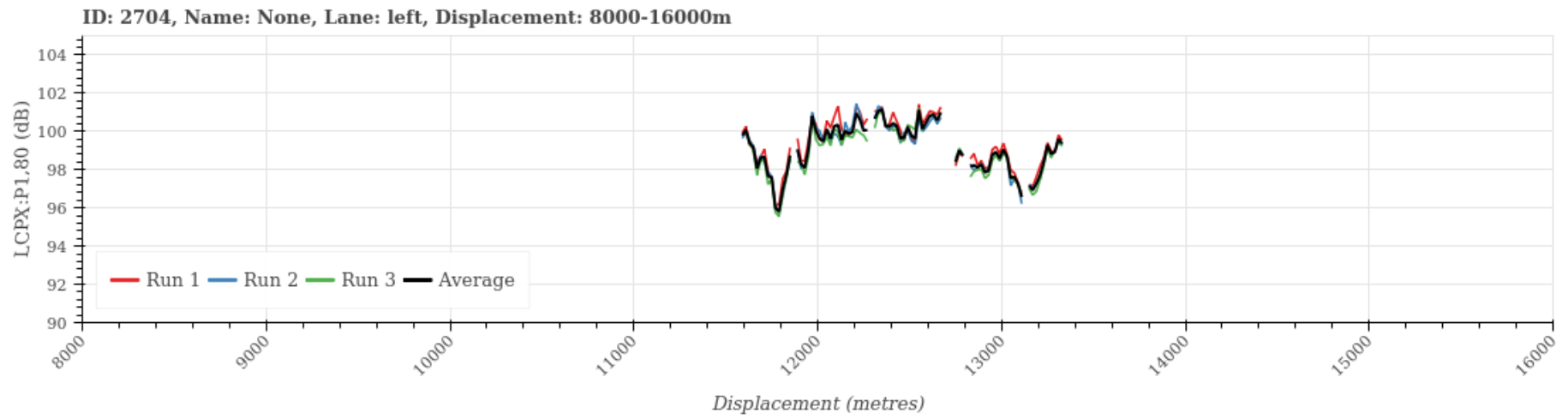


ID: 2613, Name: 01N-0398-I, Lane: left, Displacement: 0-8000m



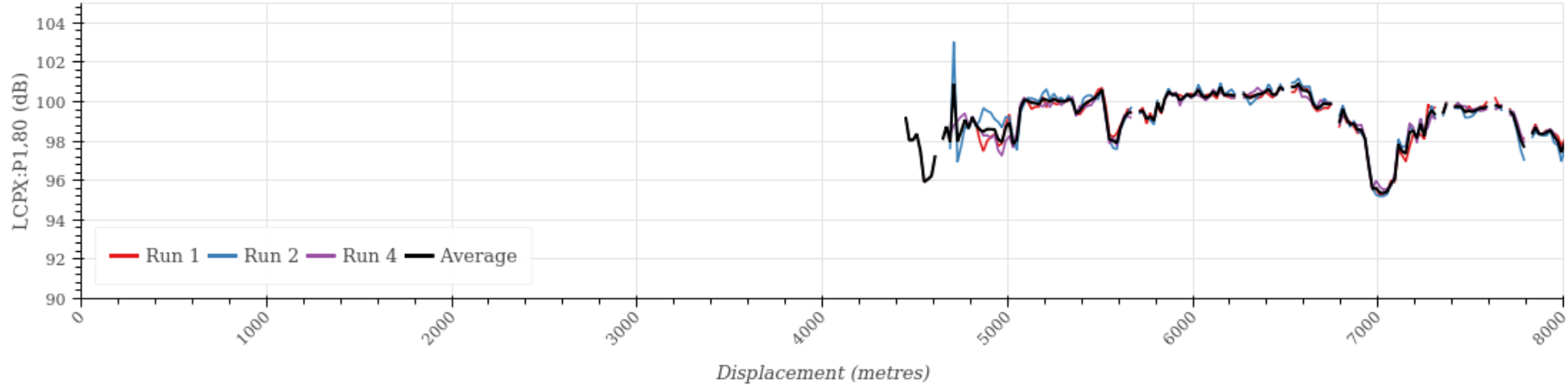
ID: 2613, Name: 01N-0398-I, Lane: left, Displacement: 8000-16000m



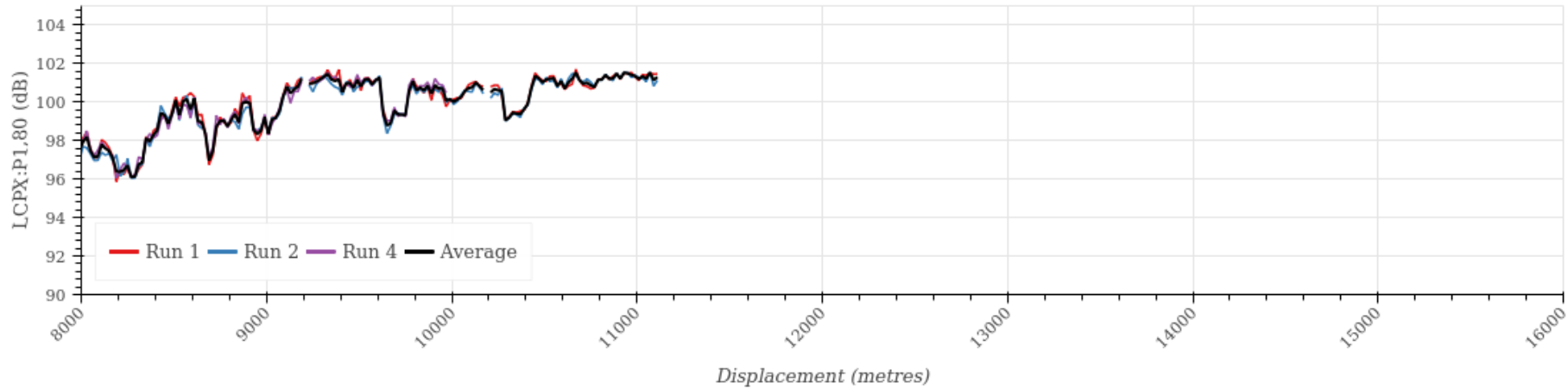


A.9 Southern Motorway – Greenlane to Otara – SH1 – SB

ID: 157, Name: 01N-0431-I, Lane: right, Displacement: 0-8000m

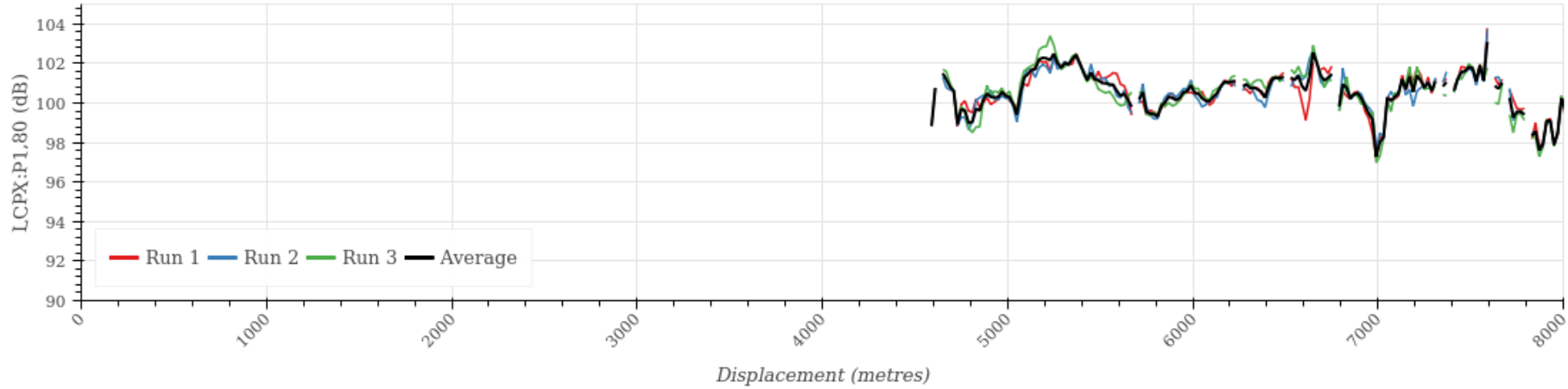


ID: 157, Name: 01N-0431-I, Lane: right, Displacement: 8000-16000m

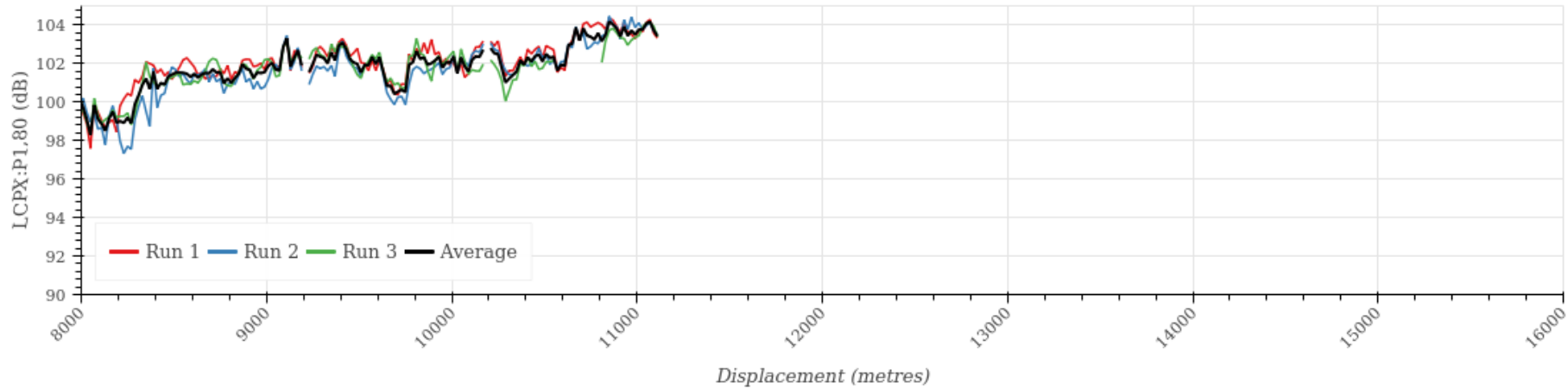




ID: 157, Name: 01N-0431-I, Lane: left, Displacement: 0-8000m

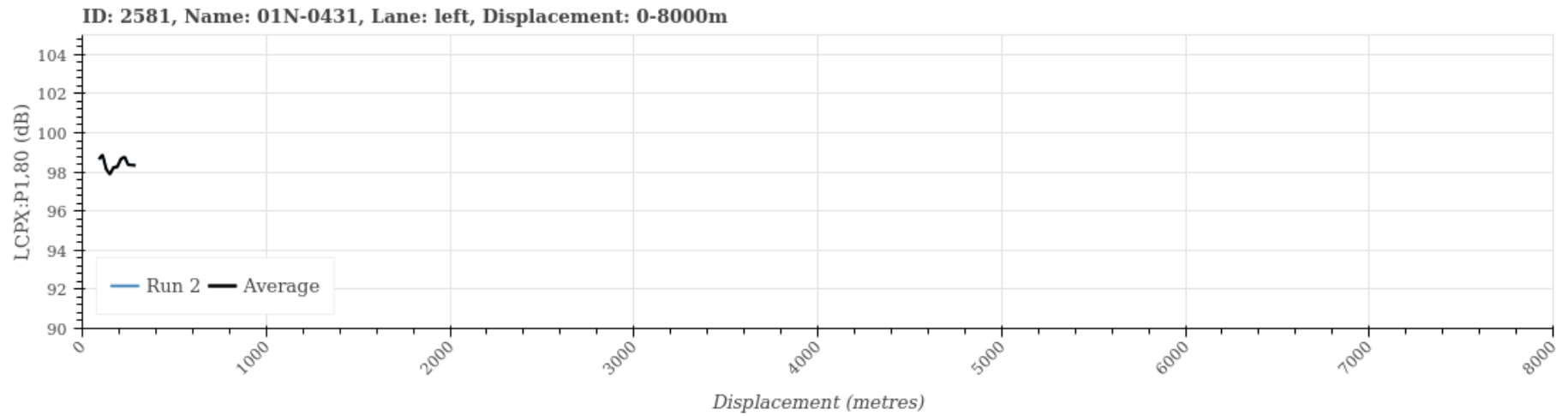


ID: 157, Name: 01N-0431-I, Lane: left, Displacement: 8000-16000m



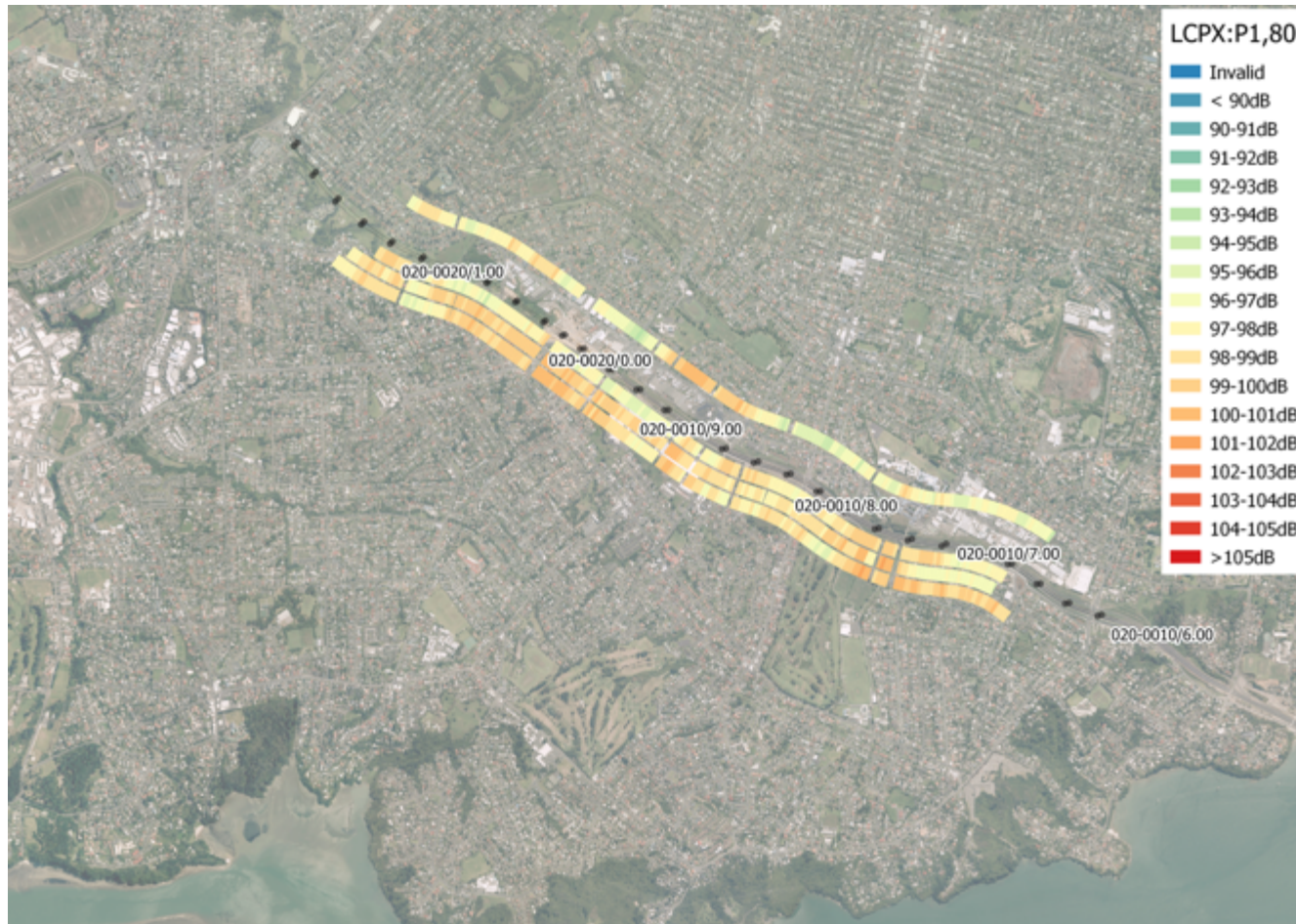


A.10 Southeastern Highway to SH1 – Northbound Ramp



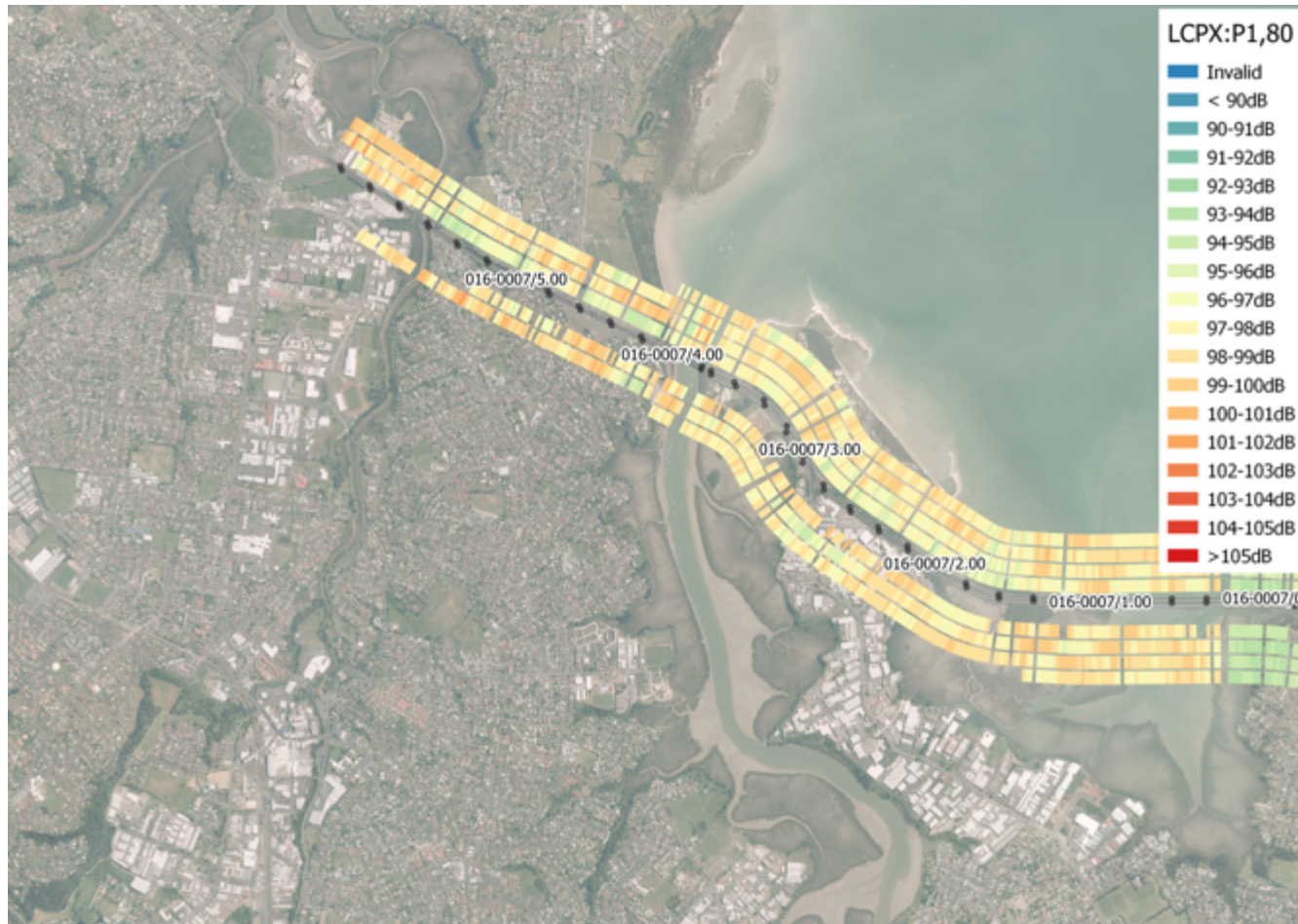
Appendix B Maps

B.1 Southwestern Motorway – Waterview tunnel approach – SH20

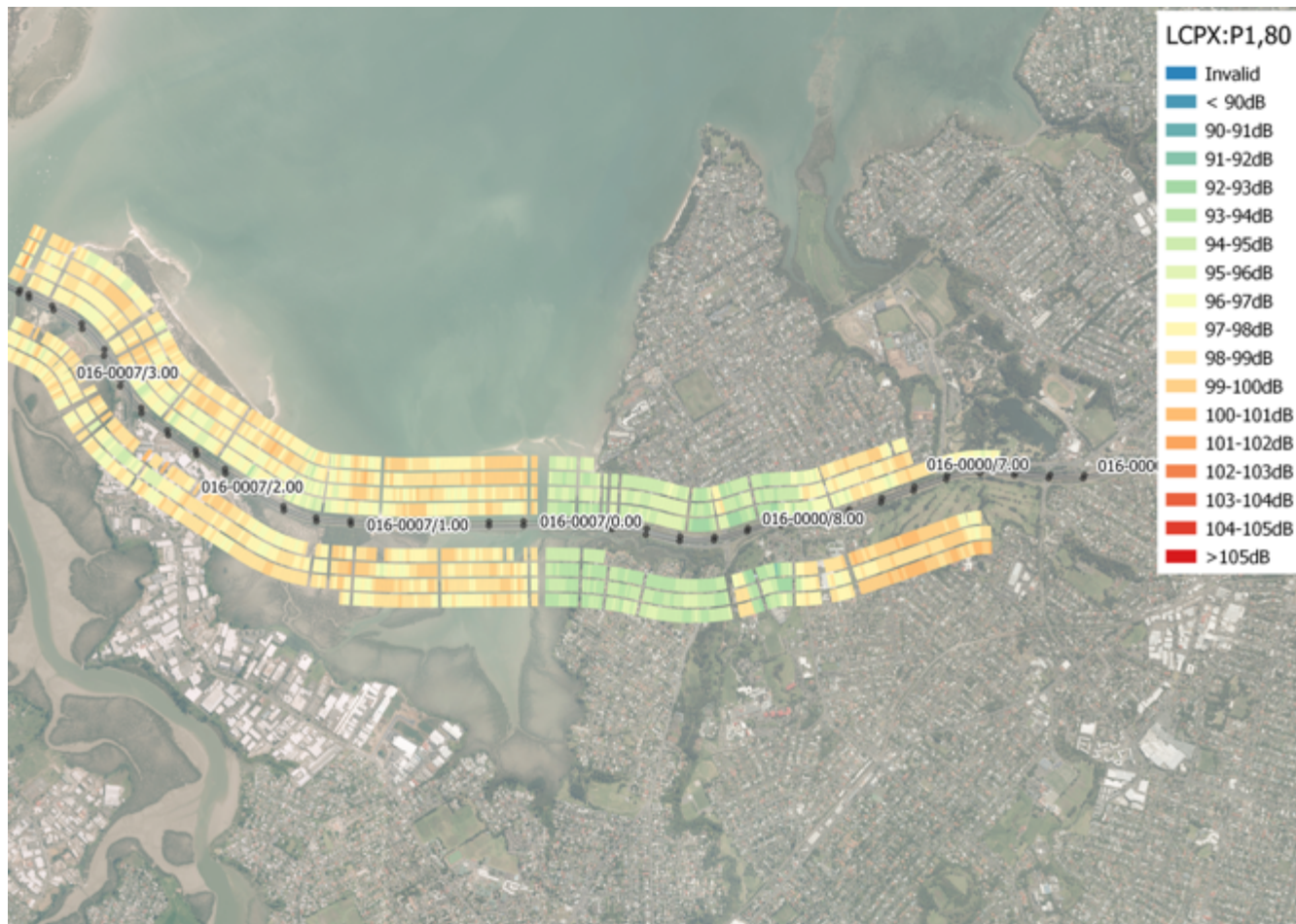


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B.2 Northwestern Motorway – Waterview to Lincoln Road – SH16



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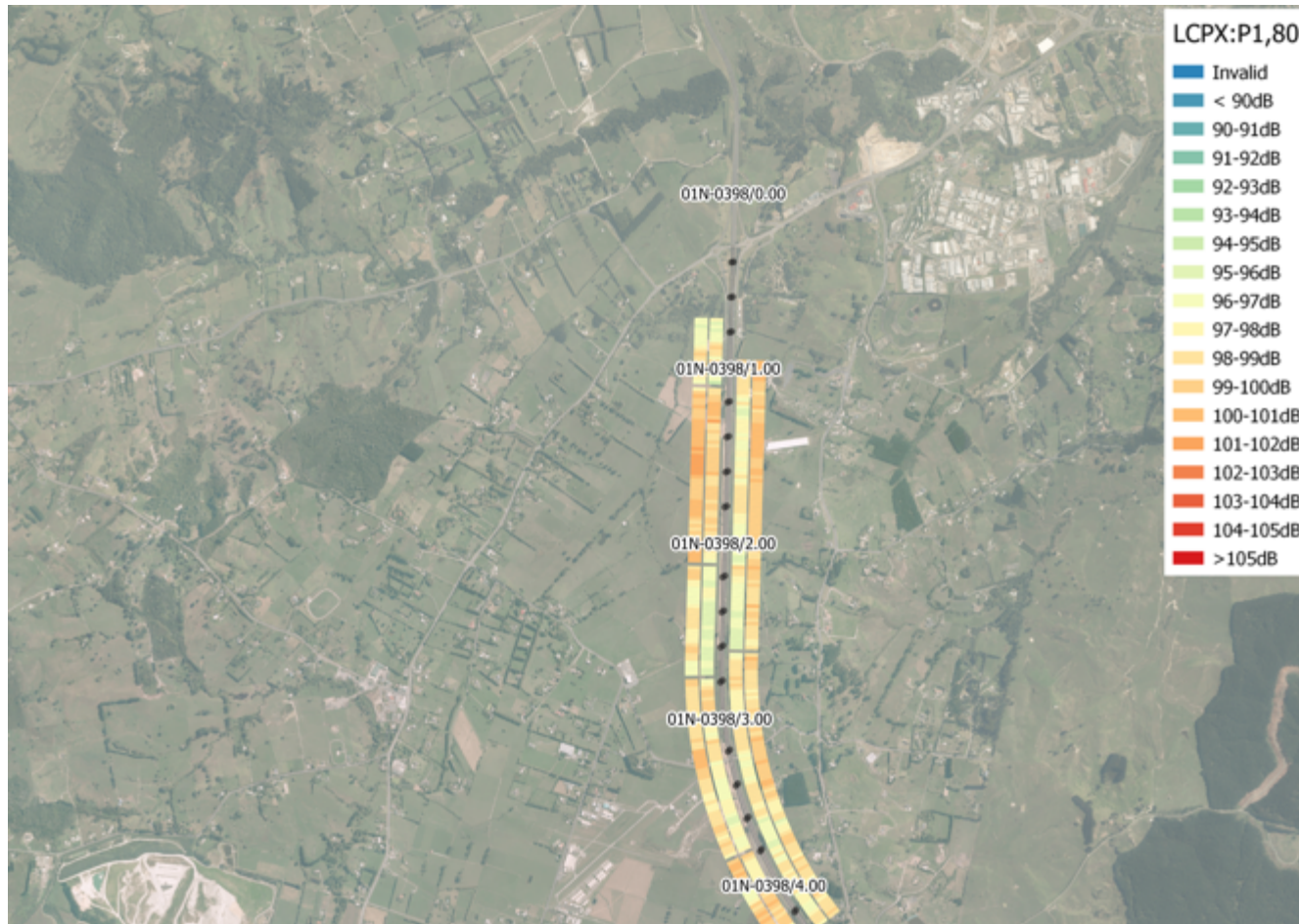
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B.3 Upper Harbour Motorway – Hobsonville to Albany Highway – SH18



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B.4 Northern Motorway – Wairau Valley to Silverdale – SH1



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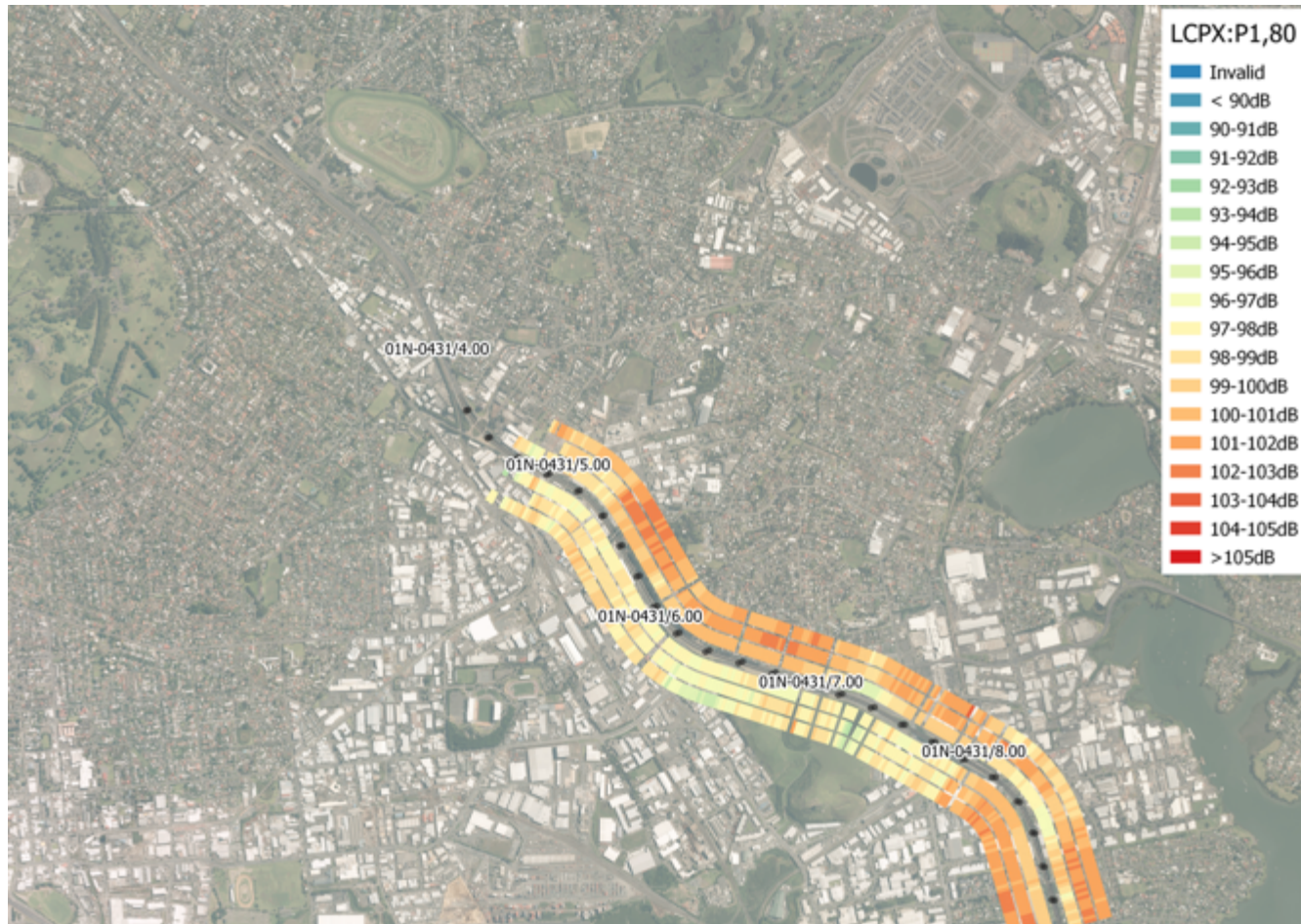


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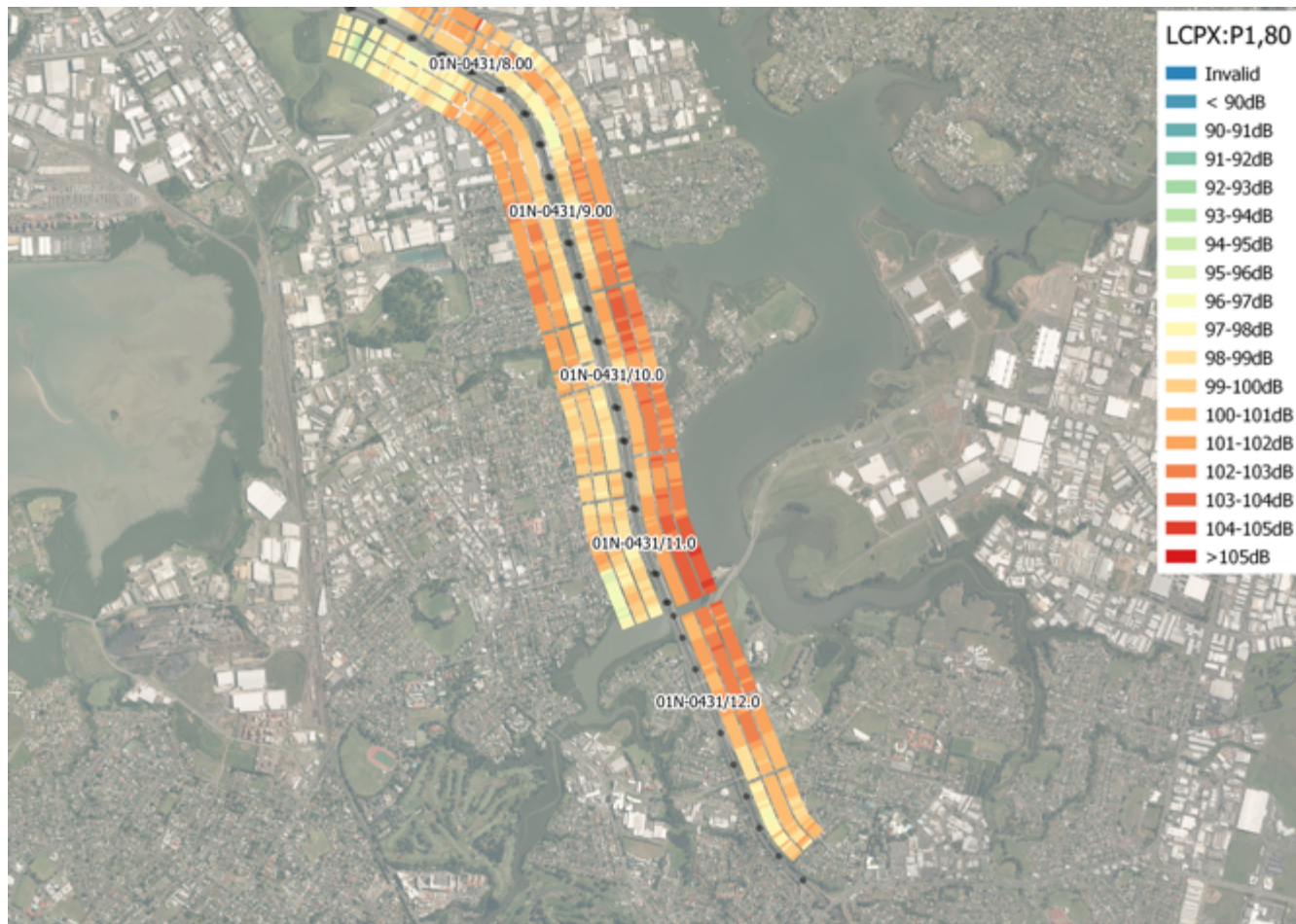


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B.5 Southern Motorway – Greenlane to Otara – SH1

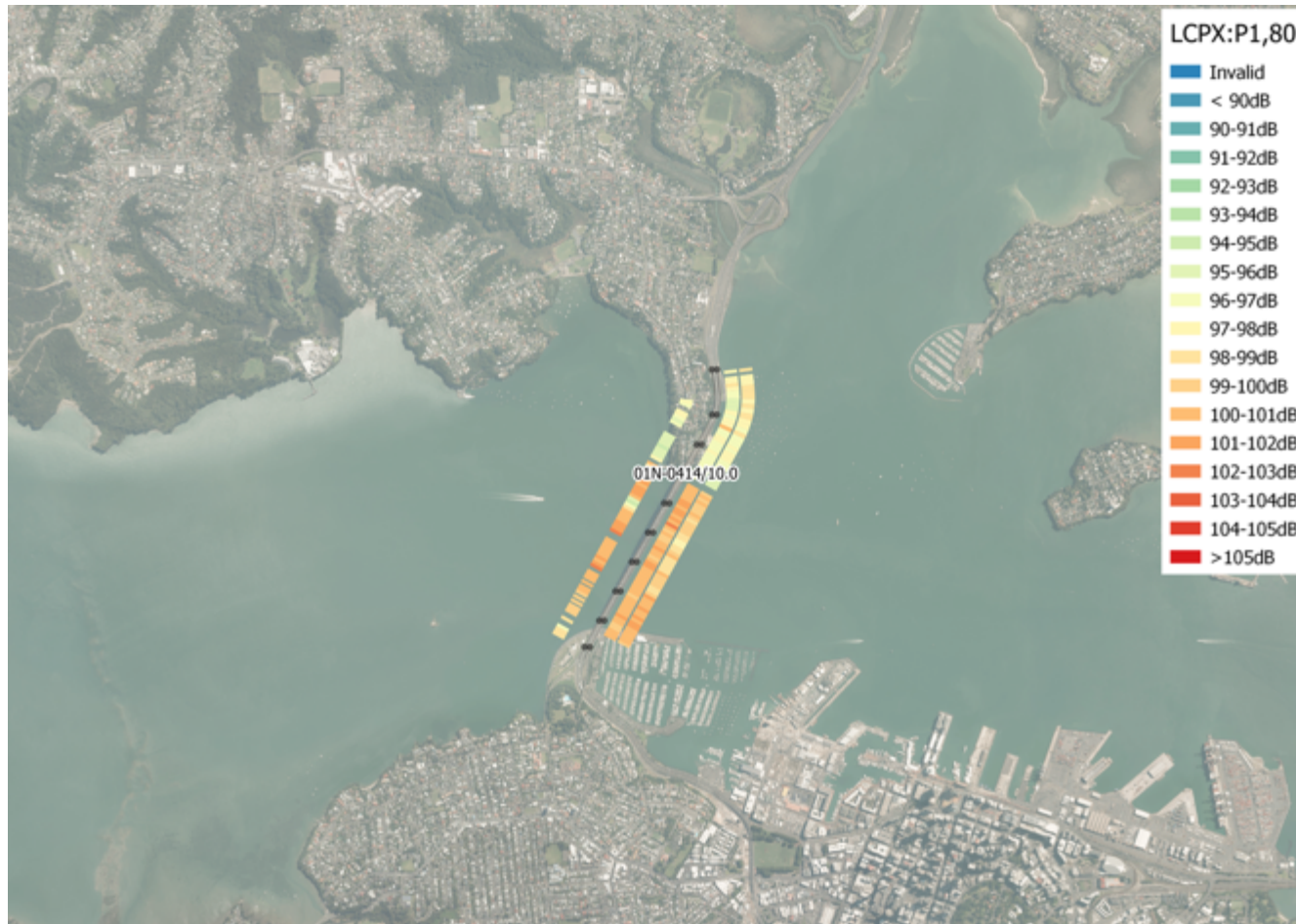


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B.6 Harbour Bridge – Clip on lanes – SH1



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Appendix C Measurement Details

C.1 Southwestern Motorway – Waterview tunnel approach – SH20

Table 11 Southwestern Motorway – Waterview tunnel approach – measurement details

<i>Date</i>	18/06/2019	
<i>Road Rs/Rp</i>	NB: 020-0020-I, 020-0010-I	
	SB: 020-0020-D, 020-0010-D	
<i>Location and number of measurement runs</i>	<ul style="list-style-type: none"> • 3 lanes in south bound direction, repeated 3 times for each lane • 3 lanes in north bound direction, repeated 3 times for each lane 	
<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	71.9
<i>Equipment</i>	Transport Agency CPX trailer	
<i>Tow vehicle make/model</i>	Ford Ranger	
<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 STMS L2/3	
<i>Weather conditions during testing</i>	Wind	< 13 km/h
	Temperature	8° – 13° C
	Precipitation	None
<i>Last precipitation</i>	0.3mm on 17th June 2019 (approx. 24hrs before test)	

Throughout the testing the traffic conditions were light with a limited number of vehicle pass-by events. All testing was undertaken at night between 19:00 and 05:00.

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 obvious areas of damage.

An overview of the measurement site is presented in Figure 42 below.



Figure 42 Southwestern Motorway – Waterview tunnel approach.

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C.2 Northwestern Motorway – Waterview to Te Atatu – SH16

Table 12 Northwestern Motorway – Waterview to Te Atatu – measurement details

<i>Date</i>	18/06/2019	
<i>Road Rs/Rp</i>	WB: 016-0007-I	
	EB: 016-0007-D	
<i>Location and number of measurement runs</i>	<ul style="list-style-type: none"> • 5 lanes in west bound direction. 3 measurements in each lane • 4 lanes in east bound direction. 3 measurements in each lane 	
<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	71.9
<i>Equipment</i>	Transport Agency CPX trailer	
<i>Tow vehicle make/model</i>	Ford Ranger	
<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 STMS L2/3	
<i>Weather conditions during testing</i>	Wind	< 13 km/h
	Temperature	8° – 13° C
	Precipitation	None
<i>Last precipitation</i>	0.3mm on 17 th June 2019 (approx. 24hrs before test)	

Throughout the testing the traffic conditions were light with a limited number of vehicle pass-by events. All testing was undertaken at night between 19:00 and 05:00.

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 obvious areas of damage.

An overview of the measurement site is presented in Figure 43 below.

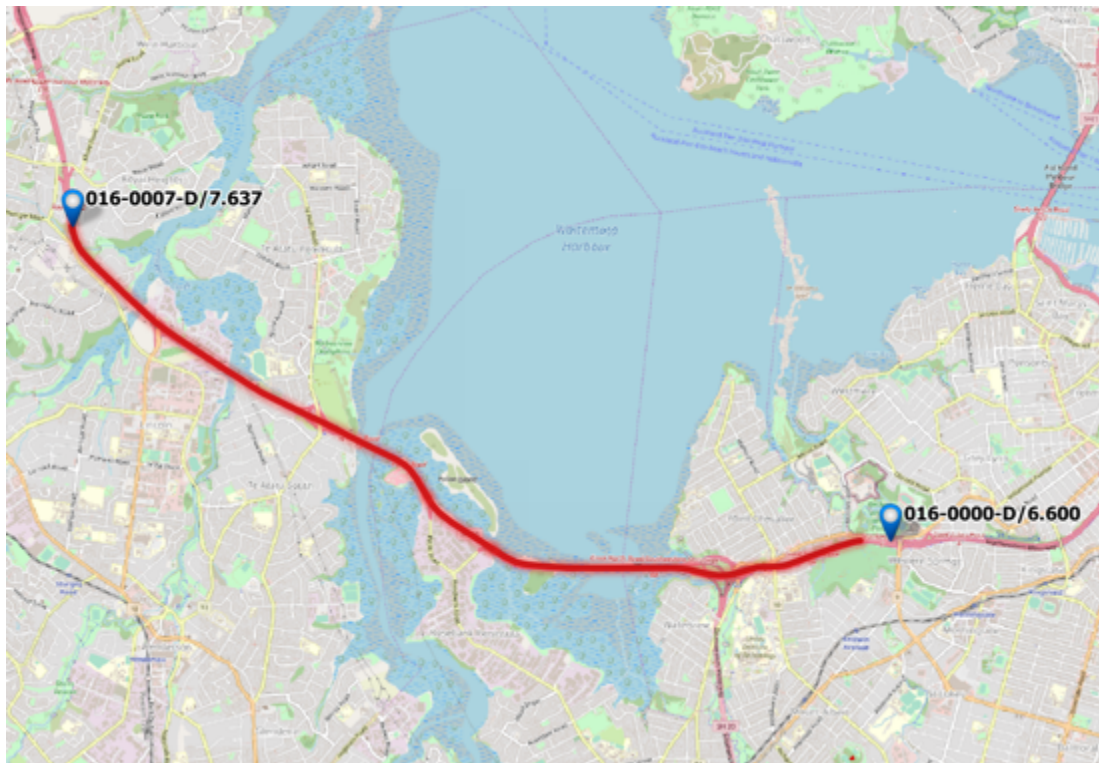


Figure 43 Northwestern Motorway – Waterview to Te Atatu.

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C.3 Upper Harbor Motorway – Hobsonville to Albany Highway – SH18

Table 13 Upper Harbor Motorway – Hobsonville to Albany Highway

<i>Date</i>	10/06/2019	
<i>Road Rs/Rp</i>	NB: 018-0007-D, 018-0000-D	
	SB: 018-0007-I, 018-0000-I	
<i>Location and number of measurement runs</i>	<ul style="list-style-type: none"> • Two north bound lanes. Repeated 3 times. • Two south bound lanes. Repeated 3 times. 	
<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	71.9
<i>Equipment</i>	Transport Agency CPX trailer	
<i>Tow vehicle make/model</i>	Ford Ranger	
<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	<13 km/h
	Temperature	12° – 14° C
	Precipitation	None
<i>Last precipitation</i>	0.1mm on 10 th June 2019 (<24hrs before test)	
	1.4mm on 8 th June 2019 (>24hrs before test)	

Throughout the testing the traffic conditions were light with a limited number of vehicle pass-events. All testing was undertaken at night between 19:00 and 05:00.

The weather was fine and there had been no significant rain in the previous 24 hours. A very light shower was noted at approximately 06:00 on the 10th of June, this was approximately 13 hours before starting measurements. The road surface was dry throughout the testing. In general, the road surface was in good condition with no obvious areas of damage.

An overview of the measurement site is presented in Figure 44 below.



Figure 44 Upper Harbor Motorway – Hobsonville to Albany Highway.

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C.4 Northern Motorway – Wairau Valley to Silverdale – SH1

Table 14 Northern Motorway – Wairau Valley to Silverdale

<i>Date</i>	10/06/2019	
<i>Road Rs/Rp</i>	NB: 01N-0398-D	
	SB: 01N-0398-I	
<i>Location and number of measurement runs</i>	<ul style="list-style-type: none"> • Two north bound lanes. Repeated 3 times. • Two south bound lanes. Repeated 3 times. 	
<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	71.9
<i>Equipment</i>	Transport Agency CPX trailer	
<i>Tow vehicle make/model</i>	Ford Ranger	
<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	<13 km/h
	Temperature	12° – 14° C
	Precipitation	None
<i>Last precipitation</i>	0.1mm on 10 th June 2019 (<24hrs before test)	
	1.4mm on 8 th June 2019 (>24hrs before test)	

Throughout the testing the traffic conditions were light with a limited number of vehicle pass-events. All testing was undertaken at night between 19:00 and 05:00.

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 obvious areas of damage.

An overview of the measurement site is presented in Figure 45 below.



Figure 45 Northern Motorway – Wairau Valley to Silverdale.

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C.5 Southern Motorway – Greenlane to Otara – SH1

Table 15 Southern Motorway – Greenlane to Otara

<i>Date</i>	11/06/2019	
<i>Road Rs/Rp</i>	NB: 01N-0431-D	
	SB: 01N-0431-I	
<i>Location and number of measurement runs</i>	<ul style="list-style-type: none"> • Three north bound lanes. Repeated 3 times. • Three south bound lanes. Repeated 3 times. 	
<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	71.9
<i>Equipment</i>	Transport Agency CPX trailer	
<i>Tow vehicle make/model</i>	Ford Ranger	
<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>	0.1mm on 10 th June 2019 (>24hrs before test)	

Throughout the testing the traffic conditions were light with a limited number of vehicle pass-by events. All testing was undertaken at night between 19:00 and 05:00.

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 obvious areas of damage.

An overview of the measurement site is presented in Figure 46 below.



Figure 46 Southern Motorway – Greenlane to Otara.

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C.6 Harbor Bridge – Clip on lanes – SH1

Table 16 Harbor Bridge – Clip on lanes

<i>Date</i>	10/06/2019 and 18/06/2019	
<i>Road Rs/Rp</i>	NB: 01N-0414-D	
	NB: 01N-0414-I	
<i>Location and number of measurement runs</i>	<ul style="list-style-type: none"> • Two south bound lanes. Repeated 3 times. • Two north bound lanes. Repeated 3 times. 	
<i>Lateral road position</i>	Left wheel path	
<i>Measurement resolution</i>	20 metre segments	
<i>Surface types</i>	BOLID	
<i>Reference speed</i>	80 km/h	
<i>Correction factors</i>	Speed coefficient, B	25
	Temperature correction coefficient, γ_t	-0.048
	Tyre hardness	71.9
<i>Equipment</i>	Transport Agency CPX trailer	
<i>Tow vehicle make/model</i>	Ford Ranger	
<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>	0.6mm on 8 th June 2019 (>24hrs before test) 2.2mm on 7 th June 2019 (approx. 24hrs before test)	

Throughout the testing the traffic conditions were light with a limited number of vehicle pass-events. All testing was undertaken at night between 19:00 and 05:00.

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 obvious areas of damage.

An overview of the measurement site is presented in Figure 47 below.



Figure 47 Harbor Bridge – Clip on lanes

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C.7 Curran Street – Northbound onramp

Table 17 Curran Street – Northbound onramp

<i>Date</i>	18/06/2019	
<i>Road Rs/Rp</i>	01N-0437-R3	
<i>Location and number of measurement runs</i>	<ul style="list-style-type: none"> One lane in north bound direction. Repeated 3 times. 	
<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	71.9
<i>Equipment</i>	Transport Agency CPX trailer	
<i>Tow vehicle make/model</i>	Ford Ranger	
<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	< 13 km/h
	Temperature	8° – 13° C
	Precipitation	None
<i>Last precipitation</i>	2.2mm on 7 th June 2019 (approx. 24hrs before test)	

Throughout the testing the traffic conditions were light with a limited number of vehicle pass-by events. All testing was undertaken at night between 19:00 and 05:00.

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 obvious areas of damage.

An overview of the measurement site is presented in Figure 48 below.

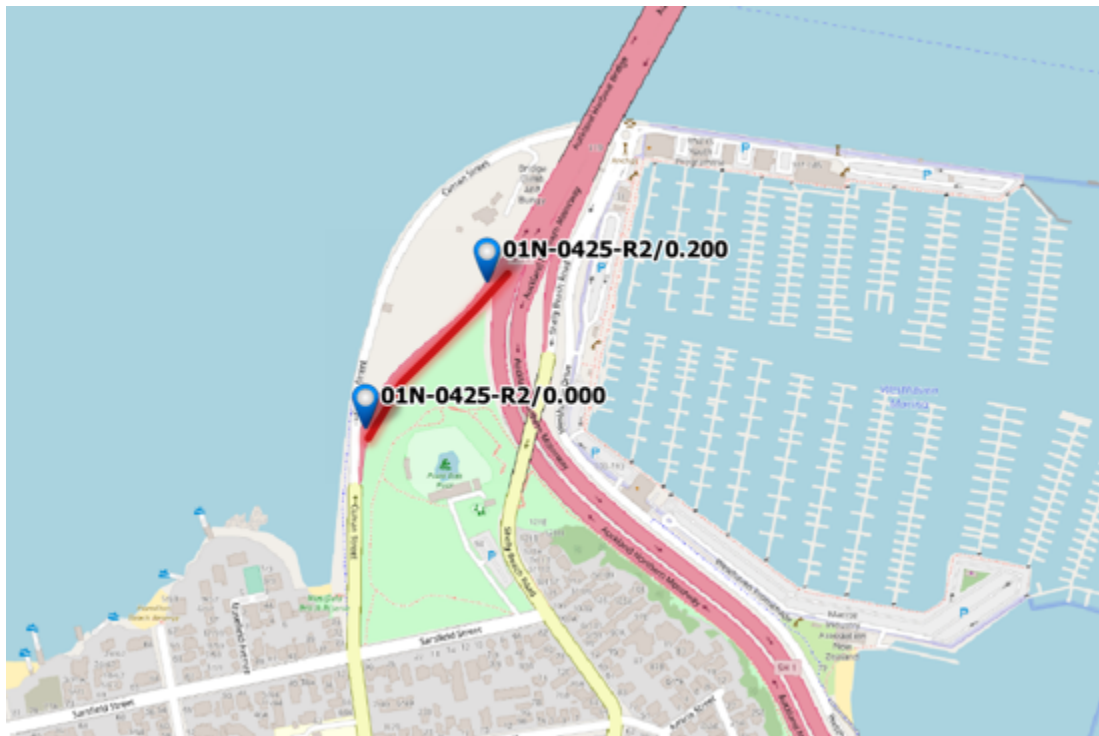


Figure 48 Curran Street – Northbound onramp

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C.8 Waterview tunnel – Northern Ramps – SH1

Table 18 Waterview tunnel – Northern Ramps

<i>Date</i>	18/06/2019	
<i>Road ID</i>	N/A	
<i>Location and number of measurement runs</i>	<ul style="list-style-type: none"> • One north bound lanes onto SH16 east bound. Repeated 2 times. • Two east bound lanes from SH16 onto SH20 south bound. Repeated 3 times. • 2 north bound lanes onto SH16 west bound. Repeated 3 times. • Two east bound lanes from SH16 onto SH20 south bound. Repeated 3 times. 	
<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	71.9
<i>Equipment</i>	Transport Agency CPX trailer	
<i>Tow vehicle make/model</i>	Ford Ranger	
<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	< 13 km/h
	Temperature	8° – 13° C
	Precipitation	None
<i>Last precipitation</i>	2.2mm on 7 th June 2019 (approx. 24hrs before test)	

Throughout the testing the traffic conditions were light with a limited number of vehicle pass-by events. All testing was undertaken at night between 19:00 and 05:00.

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 obvious areas of damage.

The ramps were tested as part of the testing of the Waterview approach and SH16. As such some sections were not fully tested.

C.9 Southeastern Highway to SH1 – Northbound Ramp

Table 19 Southeastern Highway to SH1 – Northbound Ramp

<i>Date</i>	11/06/2019	
<i>Road ID</i>	2581	
<i>Location and number of measurement runs</i>	One lane in northbound direction. Repeated 3 times.	
<i>Lateral road position</i>	Left wheel path	
<i>Measurement resolution</i>	20 meter 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	71.9
<i>Equipment</i>	Transport Agency CPX trailer	
<i>Tow vehicle make/model</i>	Ford Ranger	
<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	< 13 km/h
	Temperature	8° – 13° C
	Precipitation	None
<i>Last precipitation</i>	2.2mm on 7 th June 2019 (approx. 24hrs before test)	

Throughout the testing the traffic conditions were light with a limited number of vehicle pass-by events. All testing was undertaken at night between 19:00 and 05:00.

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 obvious areas of damage.

An overview of the measurement site is presented in Figure 49 below.



Figure 49 Southeastern Highway to SH1 – Northbound Ramp

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