2023 Air quality monitoring

Greater Wellington
Te Pane Matua Taiao

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Overview

Greater Wellington (GW) measures key air pollutants at core monitoring sites to track air quality trends and to check that air quality meets national standards and guidelines which aim to provide a minimum level of health protection for our communities. We also operate a traffic-related air pollution monitoring network using passive diffusion tubes to track trends in harmful emissions across the region. This report contains summaries of annual results for the calendar year from both these networks as well as long term trends from the core sites.

Monitoring networks

The maps below show locations of air quality core monitoring sites and passive tube sites. Airsheds, shown by purple polygons, are geographic areas defined for managing air pollution emissions and for carrying out air quality monitoring for compliance with national standards and guidelines. Monitoring is mandatory in airsheds where national air quality standards are likely to be breached. Air quality standards and guidelines still apply to areas that are outside airsheds.

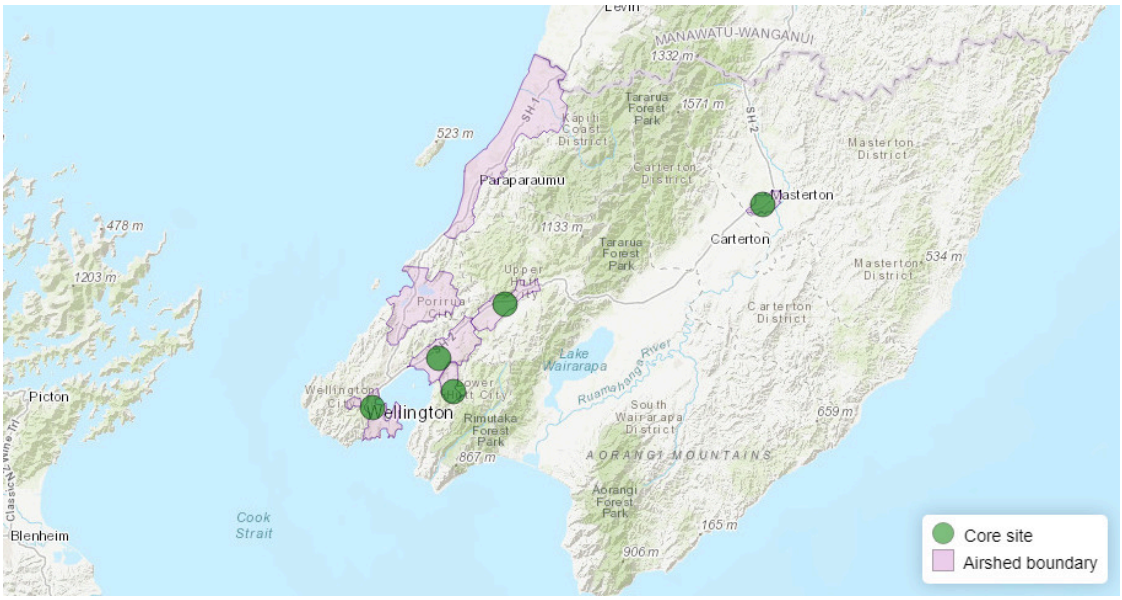

Figure 1: Core air quality monitoring sites.

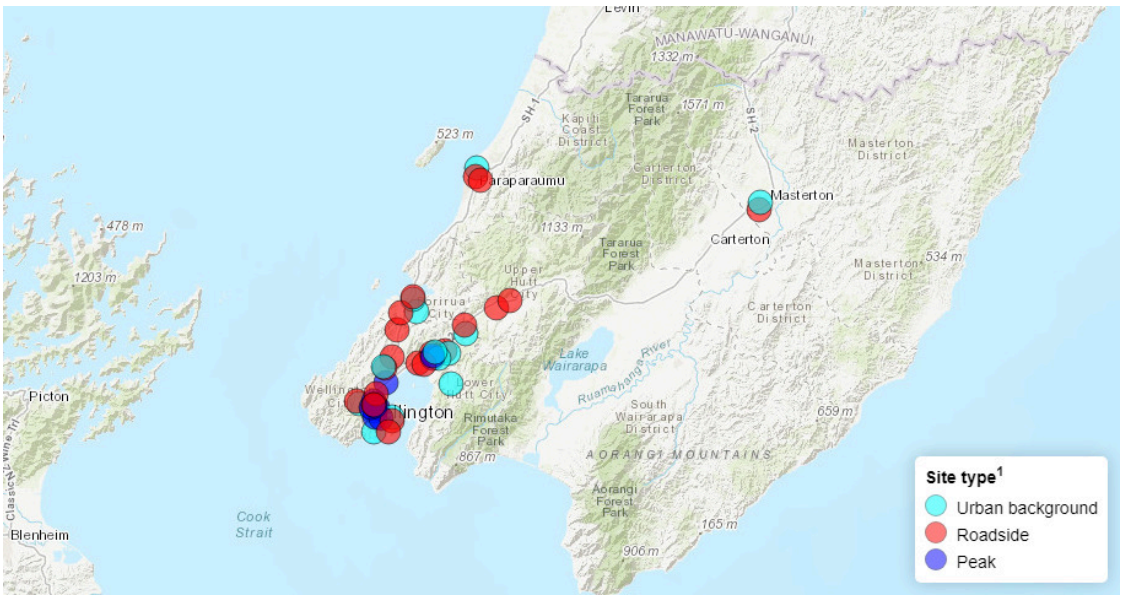

Figure 2: Passive tube air quality monitoring sites. See the methods section for descriptions of each passive tube site type.

Monitoring objectives

1. Assess airshed compliance with national standards and guidelines designed to protect human health and the environment;
2. Track trends in air quality and urban emissions between different areas and over time;
3. Contribute to our understanding of air quality processes and impacts in the Wellington region; and
4. Provide information required to determine the effectiveness of regional plans and policies.

Information on key pollutants monitored

- Particulate matter (PM_{10} & $PM_{2.5}$): Particle air pollution known as particulate matter (PM) is the mixture of microscopic solid particles and liquid droplets suspended in air. Breathing in these particles can lead to respiratory (lung) and cardiovascular (heart) problems. The largest source of $PM_{2.5}$ measured in our region is wood smoke from winter home fires. [Read more]
- Nitrogen dioxide (NO_2): Nitrogen dioxide (NO_2) is formed from the exhaust emissions of cars, trucks, ships, aviation and industrial activities that involve burning of fossil fuels. Traffic is the largest source of nitrogen dioxide in the region. [Read more]

Methods

Air quality is measured continuously in real-time using standard monitoring methods at core monitoring sites with these data displayed on GW's live data viewer (graphs.gw.govt.nz) or LAWA (lawa.org.nz/explore-data/wellington-region/air-quality). Measurements from core sites are used for checking compliance with national environmental standards and guidelines and for tracking long term trends. Day-to-day levels of air pollution are strongly influenced by the weather, so variables such as wind speed and direction are measured at core monitoring sites to help interpret air quality measurements.

Table 1: Monitoring methods for each pollutant.

	Monitoring Instrument	Sites (2023)	Method	Units
PM_{10}	Thermo Andersen series FH62 C14 beta attenuation monitor	Lower Hutt, Upper Hutt, Wainuiomata	Automated method equivalent to the United States Code of Federal Regulations (CFR)[1]	$\mu g/m^3$
	Thermo Scientific 5014i beta attenuation monitor	Masterton West, Wellington Central	EQPM-1102-150 Method 9.11: Determination of suspended particulate matter – PM10 beta attenuation monitors in accordance with AS/NZS 3580.9.11:2008	$\mu g/m^3$
$PM_{2.5}$	Thermo Andersen series FH62 C14 beta attenuation monitor + Very Sharp Cut Cyclone particle size separator.	Wainuiomata, Lower Hutt, Upper Hutt	Does not have USEPA equivalency	$\mu g/m^3$
	Thermo Andersen 5014i + Very Sharp Cut Cyclone particle size separator.	Masterton West, Wellington Central	EQPM-0609-183 Method 9.12: Determination of suspended particulate matter – PM2.5 beta attenuation monitors in accordance with AS/NZS 3580.9.12:2013	$\mu g/m^3$
NO_2	API T series analyser	Masterton West, Wellington Central, Upper Hutt	Chemiluminescence in accordance with AS 3580.5.1:2011 Method 5.1: Determination of oxides of nitrogen – Direct-reading instrumental method	Parts per billion (ppb) converted to $\mu g/m^3$ by multiplying by 2.05 (0°C)
	Passive diffusion tube	Various	NZ Transport Agency (2017) Ambient air quality (nitrogen dioxide) monitoring network. Operating Manual 2017/18	$\mu g/m^3$

	Monitoring Instrument	Sites (2023)	Method	Units
CO	API 300 series analyser	Wellington Central	Gas Filter Correlation Infrared in accordance with AS 3580.7.1:2011 Method 7.1: Determination of carbon monoxide – Direct-reading instrumental method	Parts per million (ppm) converted to mg/m^3 by multiplying by 1.25 (0°C)

[1] Title 40 – Protection of the Environment, Volume 2, Part 50, Appendix J: Reference Method for the Determination of Particulate Matter as PM_{10} in the Atmosphere.

Air quality standards and guidelines

Standards and guidelines set limits on the amount of a pollutant in air to provide a minimum level of health protection across the population. The limits can be stated as a short term average (1-hour) to protect against acute effects from exposure to high levels of an air pollutant or as a long term average (annual) to protect against chronic effects from life time exposures, such as decreased life expectancy.

Regional target: Proposed National Resources Plan – Schedule L1: Regional ambient air quality targets

National standard: National Environmental Standards for Air Quality (2004) – Schedule 1

National guideline: Ambient air quality guidelines (2002). Ministry for the Environment.

World Health Organization guideline: WHO global air quality guidelines. Particulate matter ($PM_{2.5}$ and PM_{10}), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. (2021).

Table 2: PM_{10} standards and guidelines.

Limit	Averaging period	Permissible exceedances per year	Assessment criteria
33 µg/m^3	24-hour	0	Regional target
50 µg/m^3	24-hour	1	National standard
13 µg/m^3	Annual	NA	Regional target
15 µg/m^3	Annual	NA	WHO guideline

Table 3: $PM_{2.5}$ standards and guidelines.

Limit	Averaging period	Permissible exceedances per year	Assessment criteria
17 µg/m^3	24-hour	0	Regional target
15 µg/m^3	24-hour	3	WHO guideline
7 µg/m^3	Annual	NA	Regional target
5 µg/m^3	Annual	NA	WHO guideline

Table 4: Nitrogen dioxide (NO_2) standards and guidelines.

Limit	Averaging period	Permissible exceedances per year	Assessment criteria
132 µg/m^3	1-hour	0	Regional target
200 µg/m^3	1-hour	9	National standard
25 µg/m^3	24-hour	3	WHO guideline
66 µg/m^3	24-hour	0	Regional target
10 µg/m^3	Annual	NA	WHO guideline

NO_2 passive tube site types

Site type	Description (NIWA)
Urban background	A site located within an urban area that is more than 400 m from any road with Annual Average Daily Traffic (AADT) > 10,000
Roadside	A site located within 200 m of the centreline of any road with AADT > 10,000
Peak	A site with one or more of the following: • Located within 200 m of the centreline of more than one road with AADT > 10,000 is classed as ‘multiple roadside’ • Located within 100 m of the centre of any roundabout or signalised intersection is classed as ‘intersection’ • Located in a street with AADT > 5,000 and building heights > 8 m on both sides is classed as ‘street canyon’ • Suspected to be influenced by atypically high volumes of diesel exhausts (from buses, trucks, rail, aviation, maritime or industrial sources) is classed as ‘high diesel’.

Particulate matter results

Particles are classified by their size with PM_{10} referring to inhalable particles smaller than 10 microns (µm) in diameter. Of the inhalable particles, those smaller than 2.5 microns ($PM_{2.5}$) can penetrate more deeply into the respiratory system and therefore pose the greatest risk to health (see Appendix 2: Particulate matter particle sizes for a diagram). Air quality standards and guidelines has more information on the thresholds used for the following summaries.

PM_{10}

Annual summary

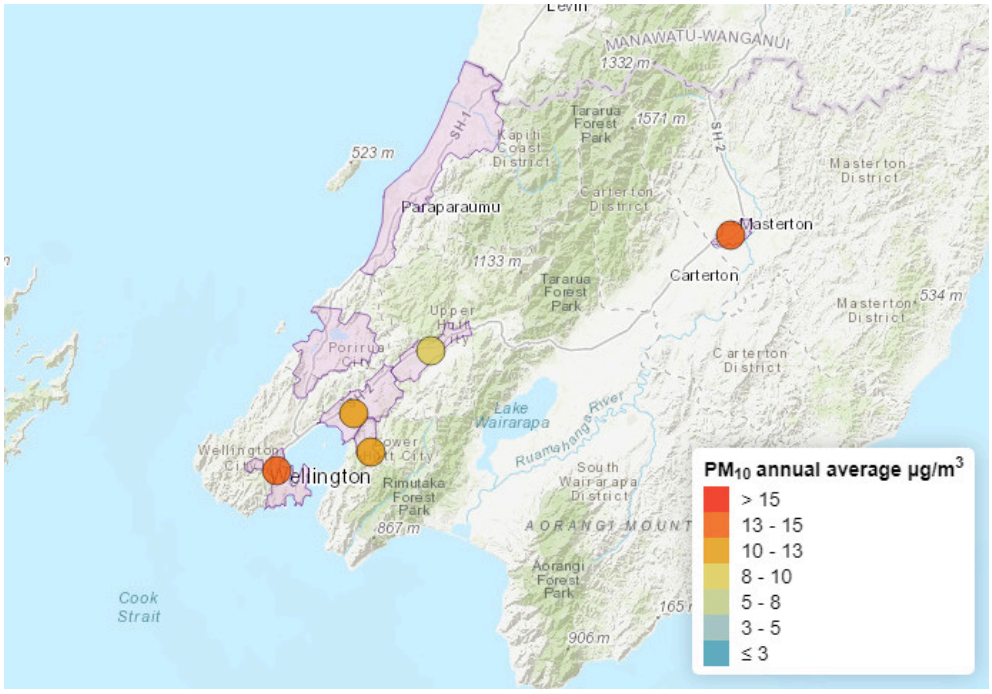

Figure 3: Annual PM_{10} summary results are shown in the map and table. Annual averages are only reported for sites with more than 75% data capture.

Table 5: Annual summary for PM_{10}. All values in µg/m^3. Data capture (%) refers to the proportion of total days per year with at least 18 hours data present.

Site	Average (annual)	Maximum (24-hr)	2nd highest (24-hr)	No. days > 50 µg/m^3 (24-hr)	Data capture (%)
Masterton West	13.1	53	41	1	92.3
Wellington Central	12.9	38	32	0	97.0
Lower Hutt	10.4	33	27	0	100.0
Upper Hutt	9.6	28	27	0	98.6
Wainuiomata	10.1	30	24	0	99.5

24-hour averages

Graphs of daily average PM_{10} are shown with colour bands representing a percentage of the national standard of 50 µg/m^3. High pollution days (exceedances above 50 µg/m^3) are shown in the red colour band and days that met the regional target (33 µg/m^3) are shown in the light blue colour band. Hover over the graphed days to see specific values. Note the high value for Lower Hutt in January 2023 was due to nearby demolition works.

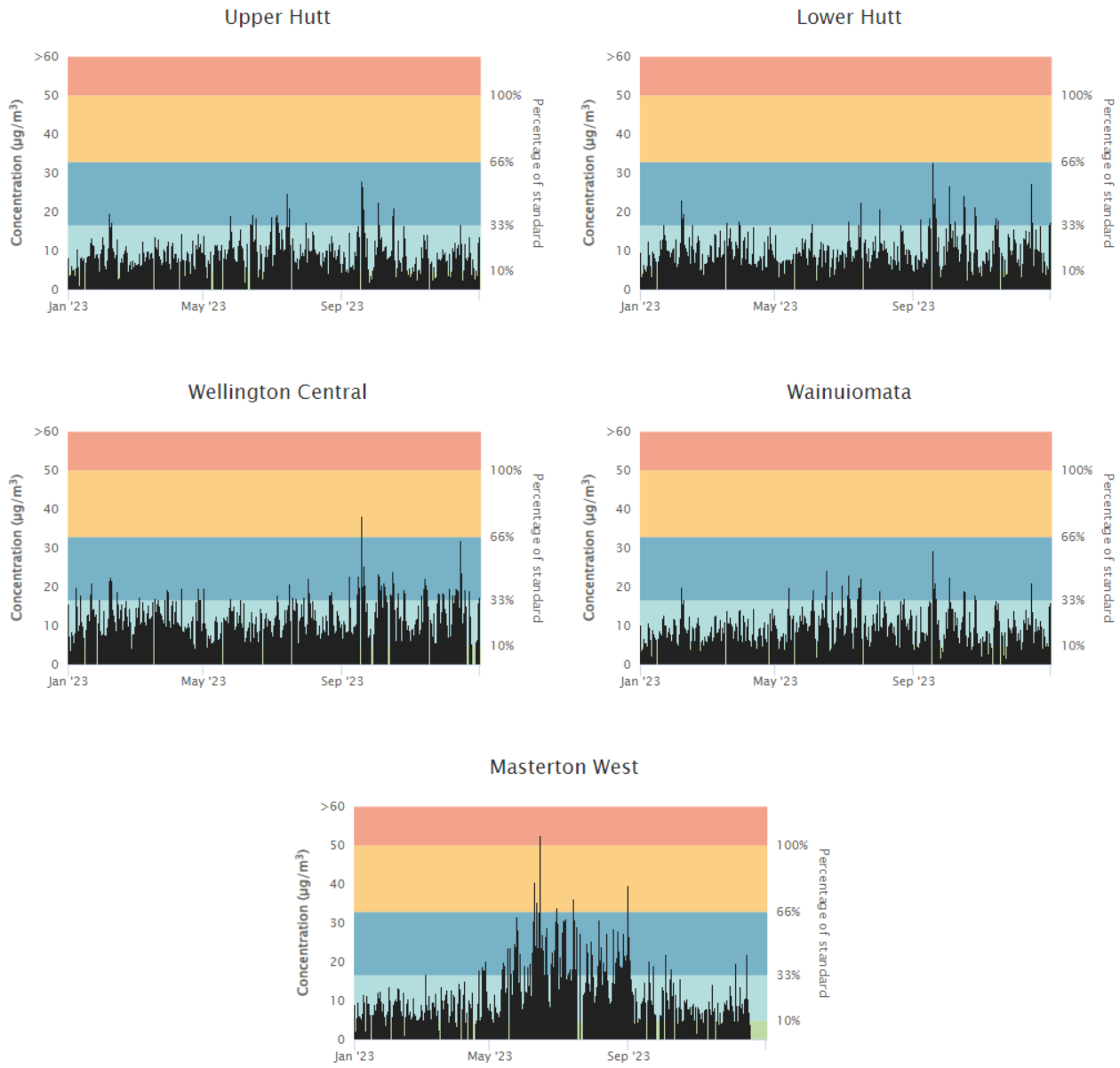

Figure 4: 24-hour average PM_{10} levels from core monitoring sites.

Trends annual average

Graphs of annual average PM_{10} show years above the World Health Organization guideline (15 µg/m^3) in the red colour band and years that met the regional target (13 µg/m^3) in the light blue colour band.

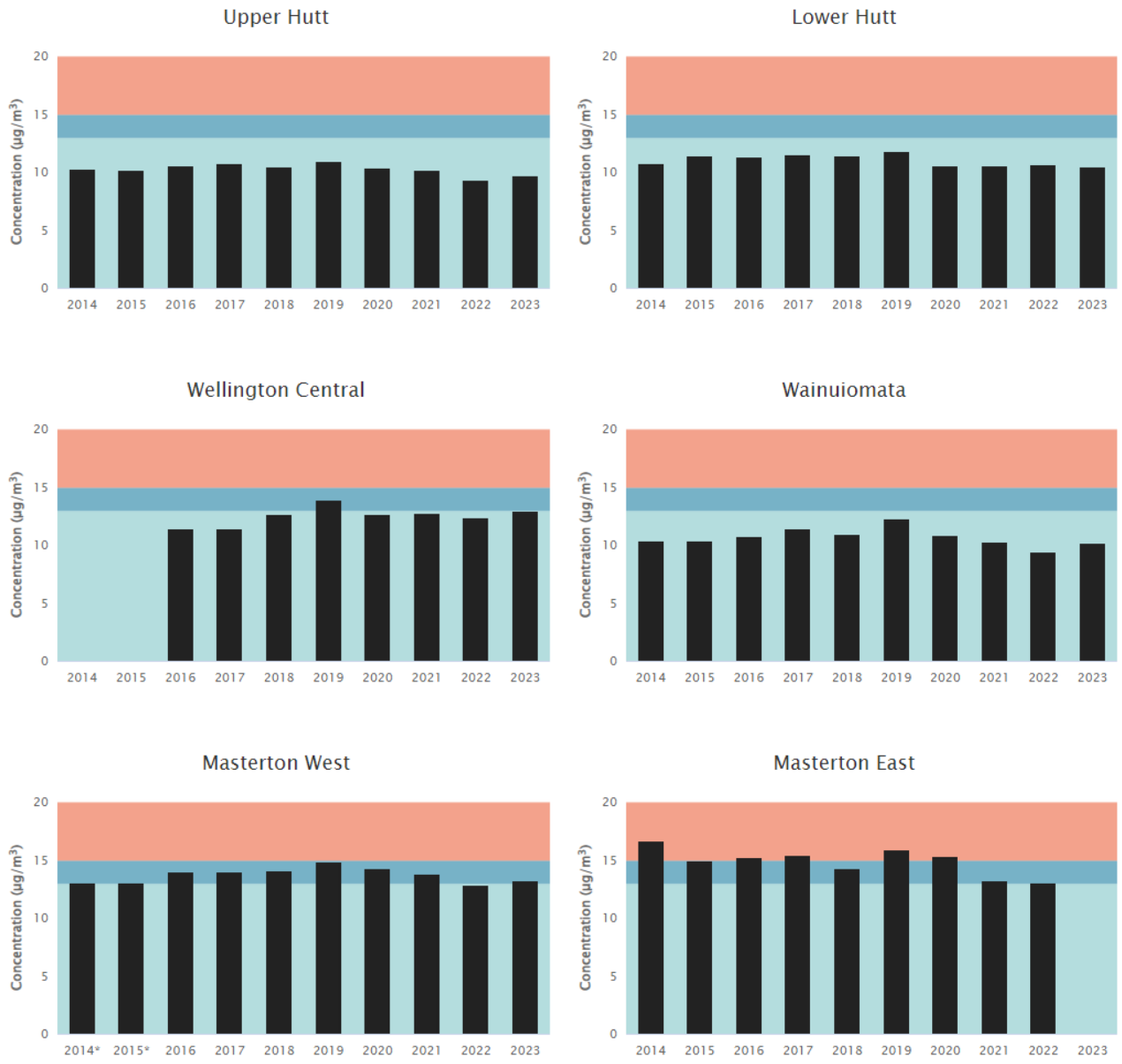

Figure 5: Annual average PM_{10} levels from core monitoring sites. Note: only previous years with at least 75% data capture (ie, 274 days with data present) are shown. Results for years marked with * have been adjusted to account for a change in monitoring instrument.

Trends high pollution days

Table 6: This table shows the number of PM_{10} high pollution days per year (exceedances) above the national standard limit of 50 µg/m^3. The standard allows one day per year to be above this limit. Blank lines are shown where there was no monitoring data.

Year	Lower Hutt	Masterton West	Masterton East
2023	0	1	
2022	1	1	
2021	0	1	4
2020	0	0	3
2019	0	4	8
2018	0	3	6
2017	0	3	5
2016	0	1	10
2015	0	1	4
2014	0	0	13
2013	0	1	14
2012	0	5	
2011	0	1	

$PM_{2.5}$

Annual summary

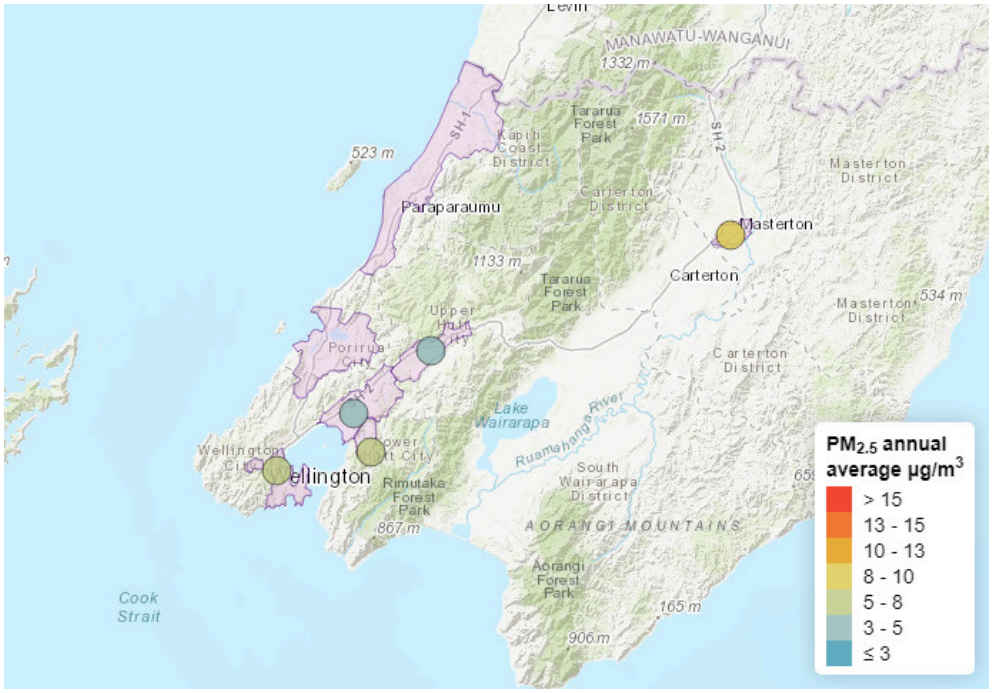

Figure 6: Annual $PM_{2.5}$ summary results are shown in the map and table. Annual averages are only reported for sites with more than 75% data capture.

Table 7: Annual summary for $PM_{2.5}$. All values in µg/m^3. Data capture (%) refers to the proportion of total days per year with at least 18 hours data present.

Site	Average (annual)	Maximum (24-hr)	4th highest (24-hr)	No. days > 15 µg/m^3 (24-hr)	Data capture (%)
Masterton West	8.9	48	32	58	93.2
Wainuiomata	5.3	23	18	8	99.7
Upper Hutt	4.9	23	16	4	98.6
Lower Hutt	4.5	15	11	0	99.7
Wellington Central	5.2	15	10	0	98.6

24-hour averages

Graphs of daily average $PM_{2.5}$ show days above the regional target of 17 µg/m^3 in the dark blue and red colour bands and days that met the World Health organization guideline of 15 µg/m^3 in the light blue colour band.

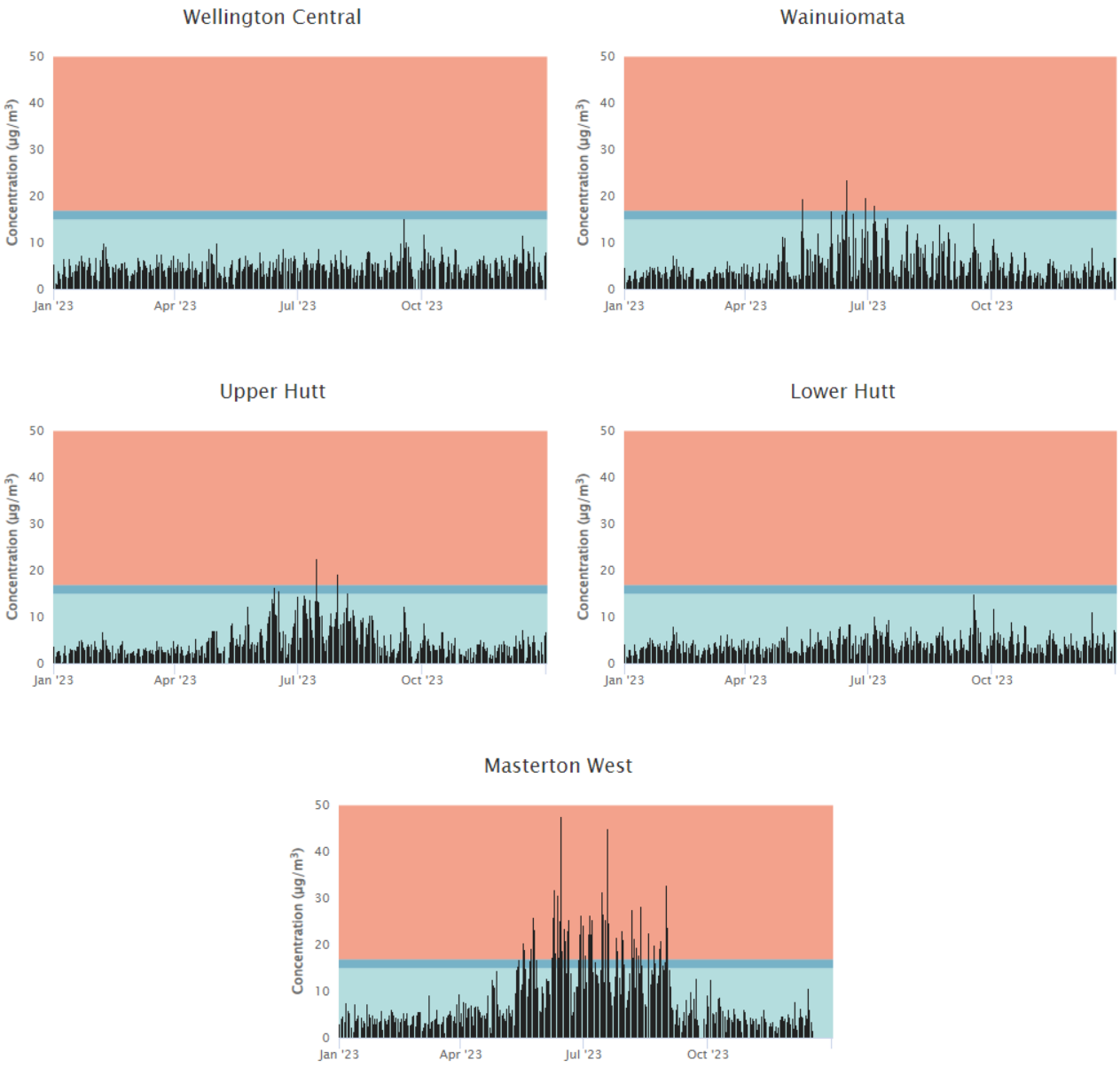

Figure 7: 24-hour average $PM_{2.5}$ levels from core monitoring sites.

Trends annual average

Graphs of annual average $PM_{2.5}$ show years above the regional target of 7 µg/m^3 in the light blue and red colour bands and days that met the World Health Organization guideline of 5 µg/m^3 in the light blue colour band.

Figure 8: Annual average $PM_{2.5}$ levels from core monitoring sites. Note: only years with at least 75% data capture are shown.

Trends high pollution days

Table 8: The number of high $PM_{2.5}$ pollution days per year, where daily averages were above the World Health Organization guideline of 15 µg/m^3. The guideline allows three day per year to be above this limit. Blank lines are shown where there was no monitoring data.

Year	Masterton West	Upper Hutt	Wainuiomata	Masterton East
2023	58	4	8	
2022	44		5	
2021	76		15	52
2020	80		24	88
2019	73		11	83
2018	66		14	76
2017	70		26	83
2016	58		17	70
2015	63		16	75
2014	73		25	74
2013	69		15	
2012	86		26	
2011	78			

Nitrogen dioxide results

Traffic-related air pollution is measured at three core sites and is supplemented by a regional network of low cost nitrogen dioxide (NO_2) passive diffusion tubes. (A picture of NO_2 tube site can be seen in Appendix 3: Passive tube monitoring sites). Air pollution levels from traffic vary considerably across the region and so a larger monitoring network is needed to capture representative regional and local trends. Some sites are also part of the Waka Kotahi national monitoring network. The passive tubes are a manual monitoring method and data is only available as monthly averages after the tube has been analysed in a laboratory.

Core sites

Air quality standards and guidelines has more information on the thresholds used for the following summaries.

Annual summary

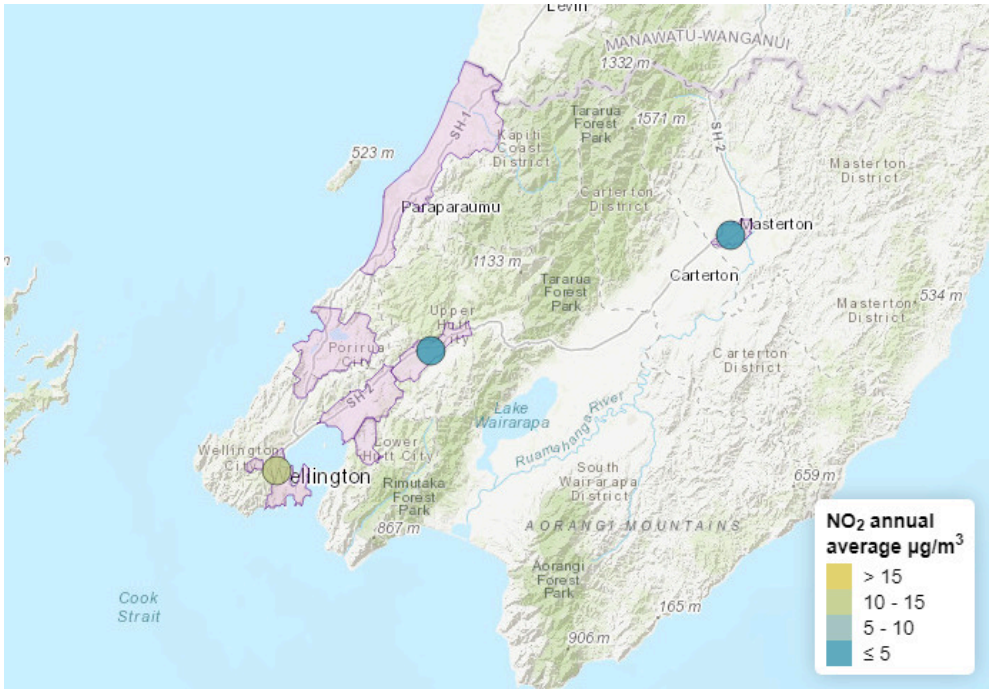

Figure 9: Annual average NO_2 (µg/m^3) from core monitoring sites across the region. Annual averages are only reported for sites with more than 75% data capture.

Table 9: Annual summary for NO_2. All values in µg/m^3. Data capture (%) refers to the proportion of total hours with at least 45 minutes of data present and the proportion of total days with at least 18 hours of data present.

Site	Average (annual)	Max (1-hr avg)	10th highest (1-hr)	No. hours > 200 µg/m^3	Max (24-hr)	No. days > 25 µg/m^3	Data capture (%)
Masterton West	4.2	41	36	0	17	0	87.1
Upper Hutt	4.8	40	35	0	19	0	85.5

24-hour averages

Graphs of daily average NO_2 show days above the World Organization guideline of 25 µg/m^3 in the dark blue colour band. There were no days above the regional target of 66 µg/m^3 in the red colour band.

Figure 10: 24-hour average nitrogen dioxide levels from core monitoring sites.

Trends annual average

Graphs of annual average NO_2 show years that met the World Health Organization guideline of 10 µg/m^3 in the light blue colour band.

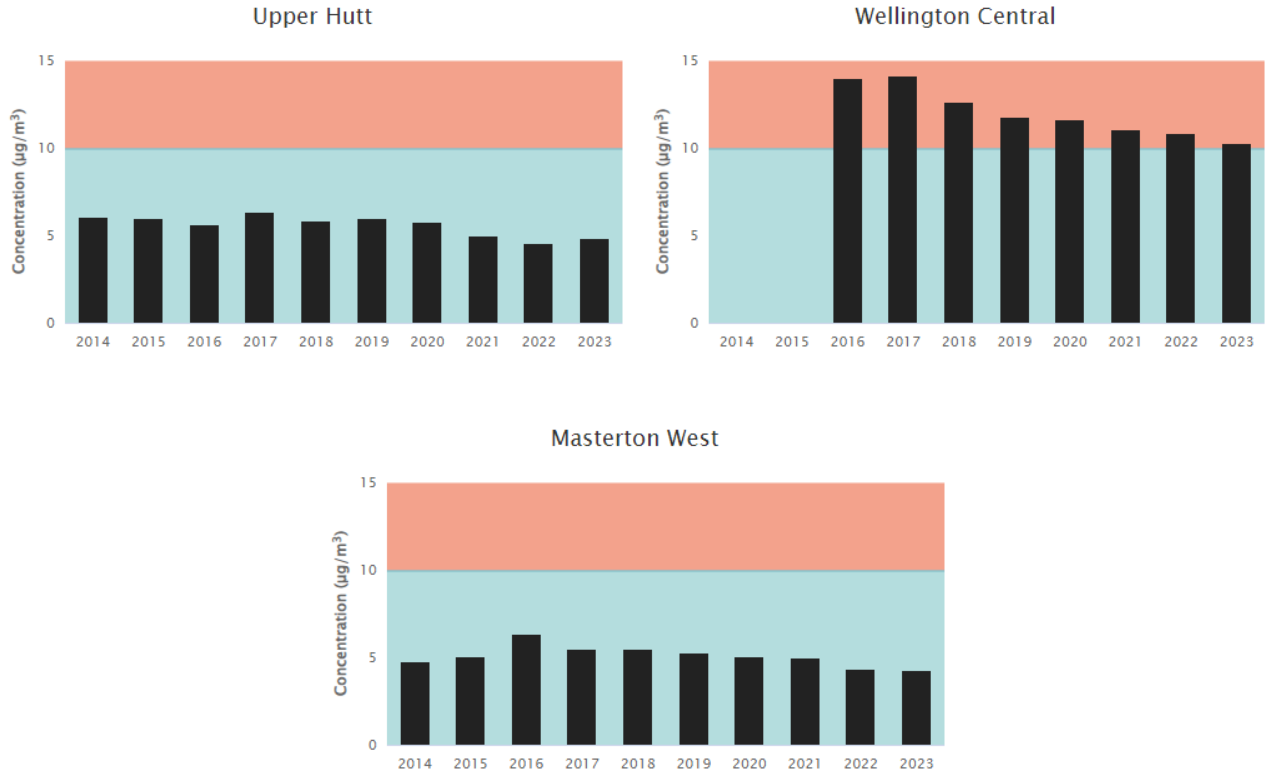

Figure 11: Annual average nitrogen dioxide levels from core monitoring sites. Note only previous years with at least 75% data capture (ie, 274 days with data present) are shown.

Passive tube sites

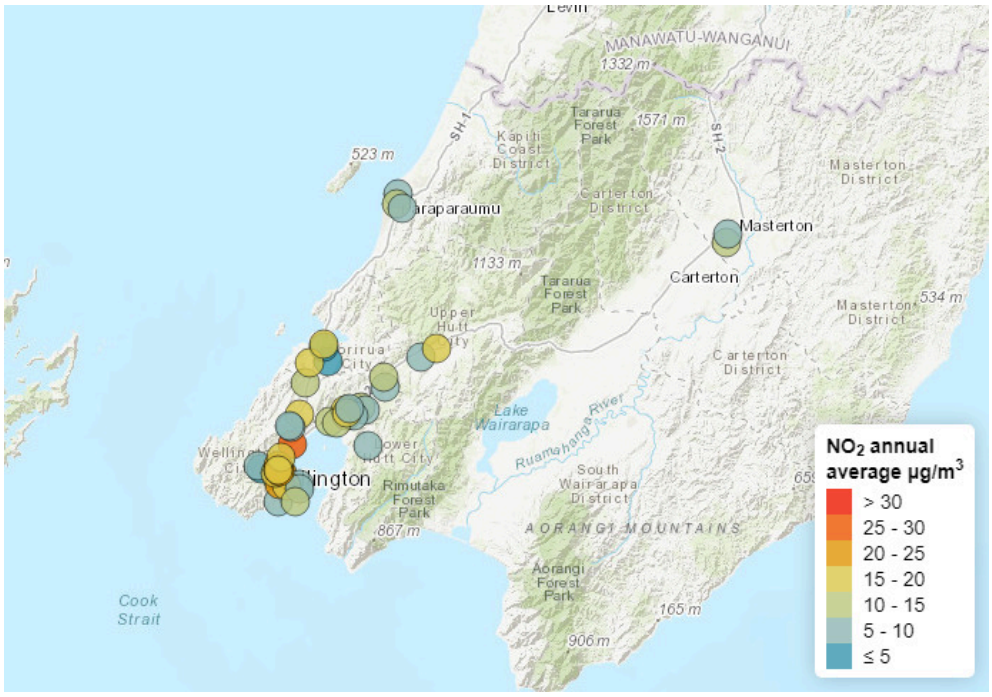

Figure 12: Annual average NO_2 (µg/m^3) from the passive tube monitoring sites across the region used to track long term trends in traffic-related air pollution.

Table 10: Seasonal averages based on NZTA reporting criteria for summer (January to March) and winter (July to September). NO_2 levels are generally higher in winter than in summer most as the colder temperatures and lower wind speeds during winter are less favourable for dispersing vehicle emissions.

NZTA ID	Site type	Average (annual)	Average (winter)	Average (summer)	Data capture (%)
GW002	Peak	27.5	30.2	23.7	100.0
GW003	Peak	21.9	24.4	18.3	91.7
GW004	Urban background	7.0	8.0	5.7	100.0
GW005	Urban background	5.0	6.2	3.4	100.0
GW006	Urban background	12.1	13.6	8.9	100.0
GW007	Roadside	15.1	18.0	12.2	100.0
GW009	Urban background	5.7	6.7	4.0	100.0
GW010	Roadside	11.4	13.6	8.3	100.0
GW011	Roadside	9.0	11.1	6.3	100.0
GW012	Urban background	4.6	5.8	3.5	100.0
GW013	Roadside	13.4	15.4	10.4	100.0
GW015	Urban background	5.6	6.6	4.0	100.0
GW016	Roadside	12.9	15.2	9.6	100.0
GW017	Roadside	22.0	25.2	16.6	100.0
GW018	Urban background	5.3	6.2	3.8	100.0
GW019	Urban background	6.5	7.5	4.4	100.0
WEL003	Roadside	13.9	15.7	8.0	83.3
WEL008	Peak	27.3	30.0	21.1	100.0

NZTA ID	Site type	Average (annual)	Average (winter)	Average (summer)	Data capture (%)
WEL047	Roadside	7.9	9.2	5.4	100.0
WEL048	Urban background	6.4	7.1	4.1	91.7
WEL049	Peak	24.5	27.7	19.3	100.0
WEL050	Peak	18.6	21.1	13.7	100.0
WEL051	Roadside	9.3	10.2	7.2	100.0
WEL052	Roadside	18.2	22.4	12.7	83.3
WEL053	Peak	16.4	18.5	11.5	100.0
WEL054	Urban background	9.9	9.1	5.3	100.0
WEL057	Roadside	16.7	19.7	12.7	100.0
WEL063	Roadside	5.4	5.6	4.2	100.0
WEL072	Urban background	4.9	5.8	3.8	83.3
WEL073	Peak	16.4	18.5	11.5	100.0
WEL078	Roadside	10.7	12.1	7.0	100.0
WEL079	Roadside	13.5	15.1	10.3	100.0
WEL080	Roadside	16.4	18.7	12.1	100.0
WEL081	Peak	24.9	30.2	19.4	100.0
WEL082	Peak	24.2	28.7	17.8	100.0
WEL083	Peak	23.2	26.5	19.0	100.0
WEL084	Roadside	19.0	21.2	15.1	100.0
WEL085	Roadside	9.6	9.9	9.7	100.0
WEL086	Roadside	18.6	22.0	13.0	100.0
WEL088	Roadside	15.8	16.5	13.9	83.3
WEL089	Roadside	12.7	14.4	9.1	83.3
WEL090	Peak	17.7	20.6	13.3	100.0
WEL091	Urban background	8.3	9.4	5.9	100.0
WEL094	Urban background	5.4	5.1	4.6	91.7
WEL096	Urban background	6.6	7.6	5.1	100.0
WEL098	Roadside	12.5	13.4	9.8	91.7

Table 11: Seasonal averages summarised by site type. All values in µg/m^3. Data capture (%) refers to the proportion of total months with data present per year. See the methods section for more information on each site type.

Site type	No. sites	Average (annual)	Average (winter)	Average (summer)	Data capture (%)
Peak	11	22.1	25.1	17.1	99.2
Roadside	21	13.5	15.5	10.1	96.4
Urban background	14	6.7	7.5	4.8	97.6

Wind speed & direction results

Wind speed and direction are measured at 10m above ground level at core monitoring sites. Wind and other meteorological data influence dispersion and dilution of air pollutants and are used to help interpret air quality trends.

The wind roses show the proportion of time that the wind is blowing from a particular direction in a specific wind speed band. The wedge points towards the direction from which the wind arises.

Annual

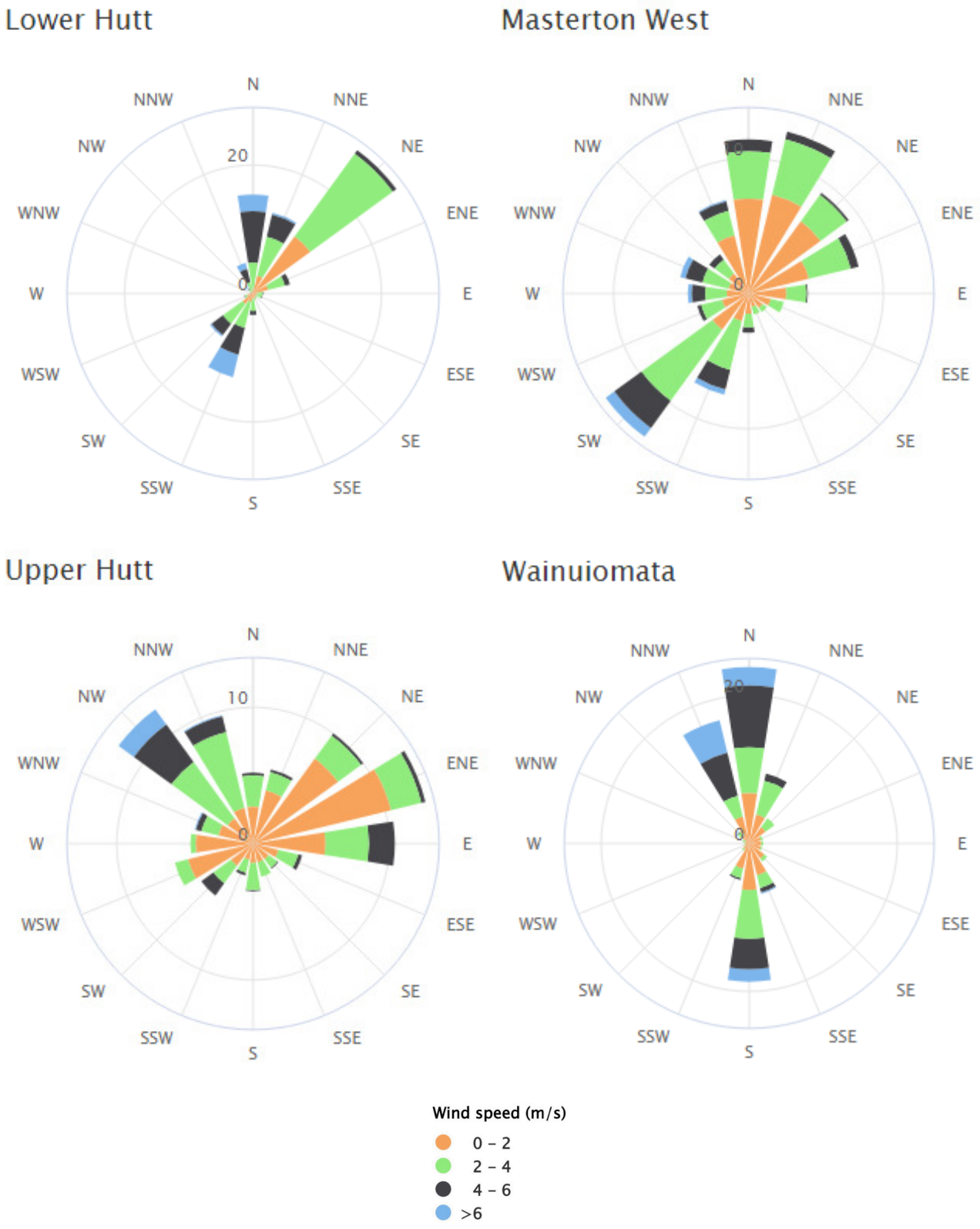

Figure 13: Annual wind speed and direction in core monitoring areas.

Summer

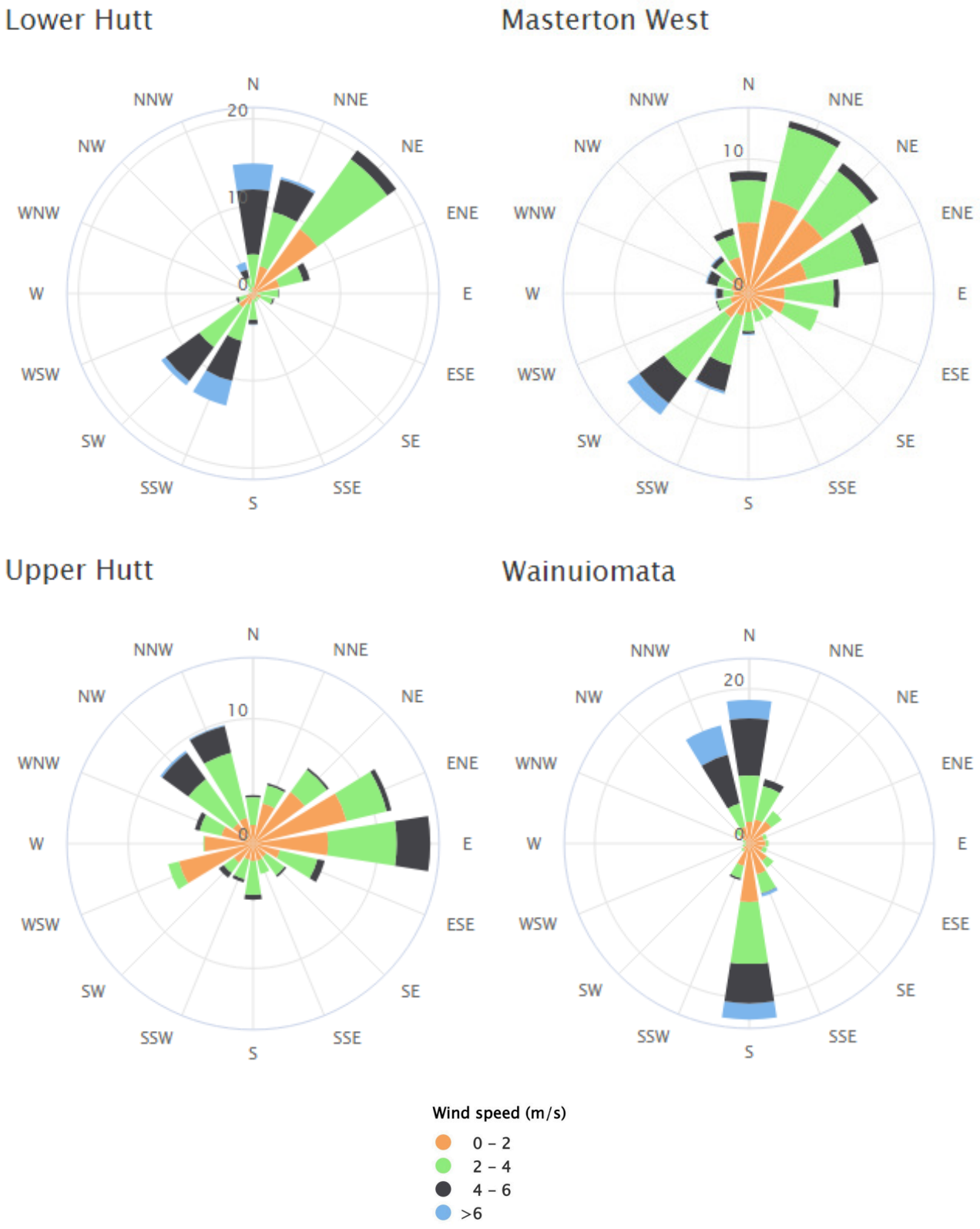

Figure 14: Summer (Dec-Feb) wind speed and direction in core monitoring areas.

Autumn

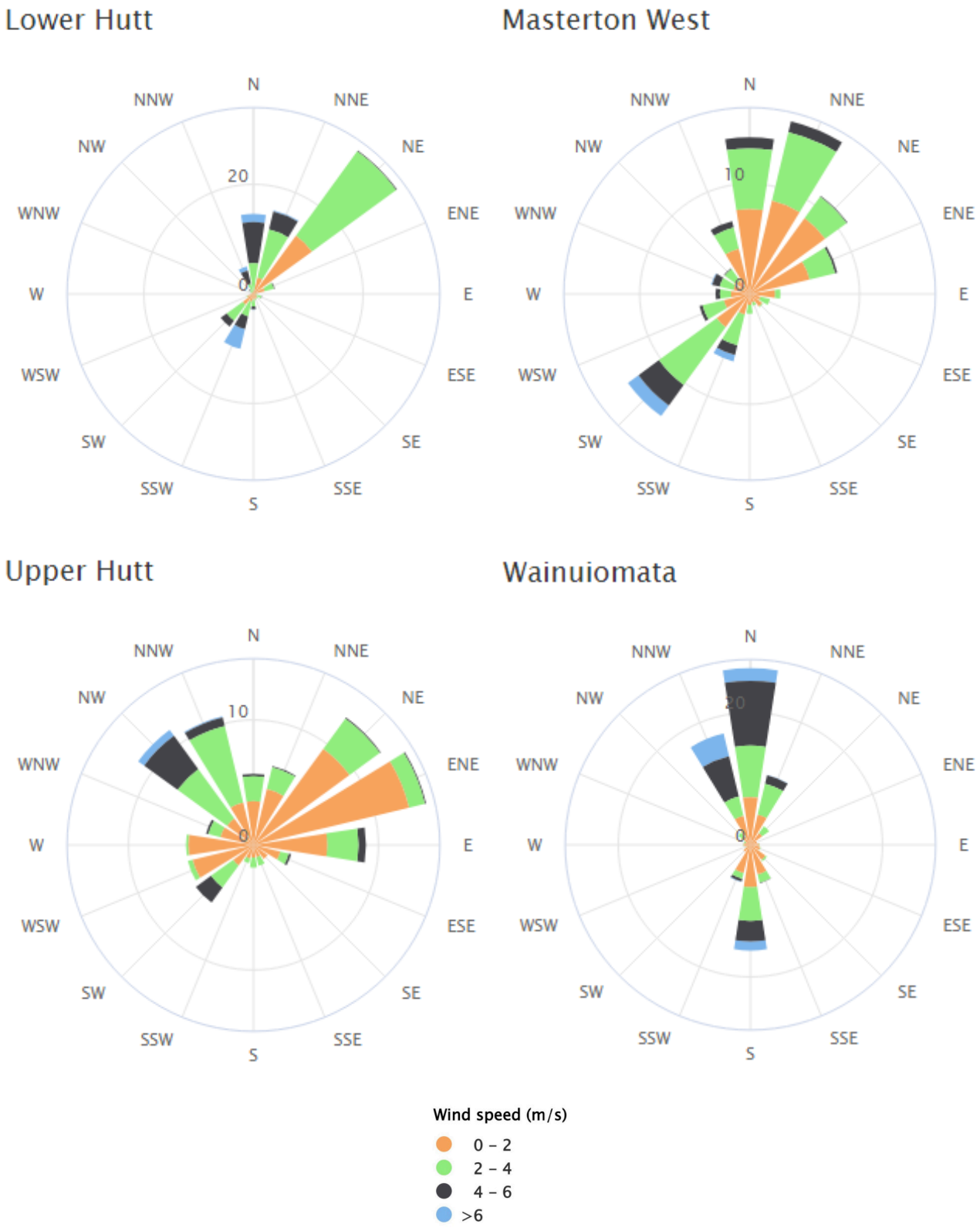

Figure 15: Autumn (Mar-May) wind speed and direction in core monitoring areas.

Winter

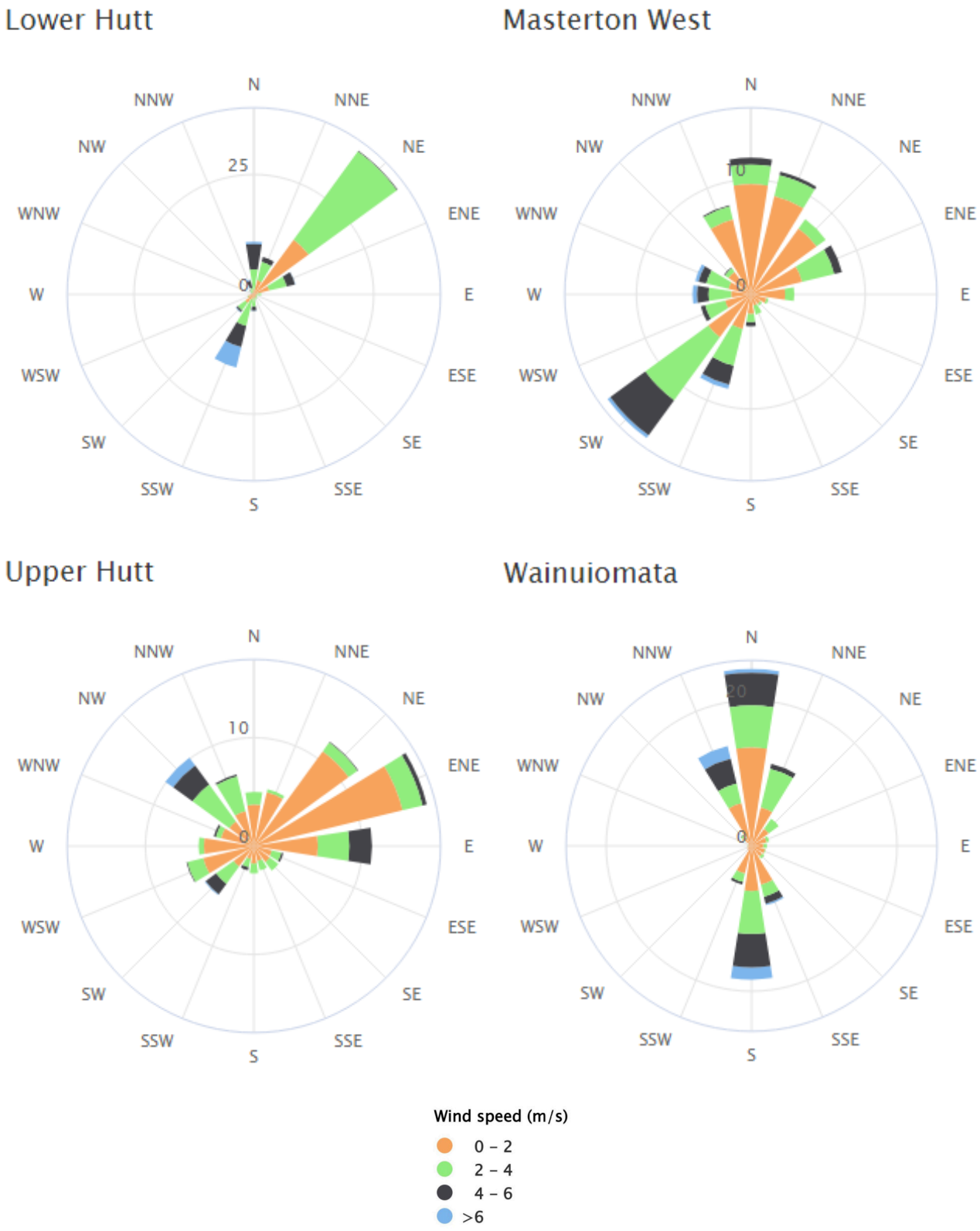

Figure 16: Winter (Jun-Aug) wind speed and direction in core monitoring areas.

Spring

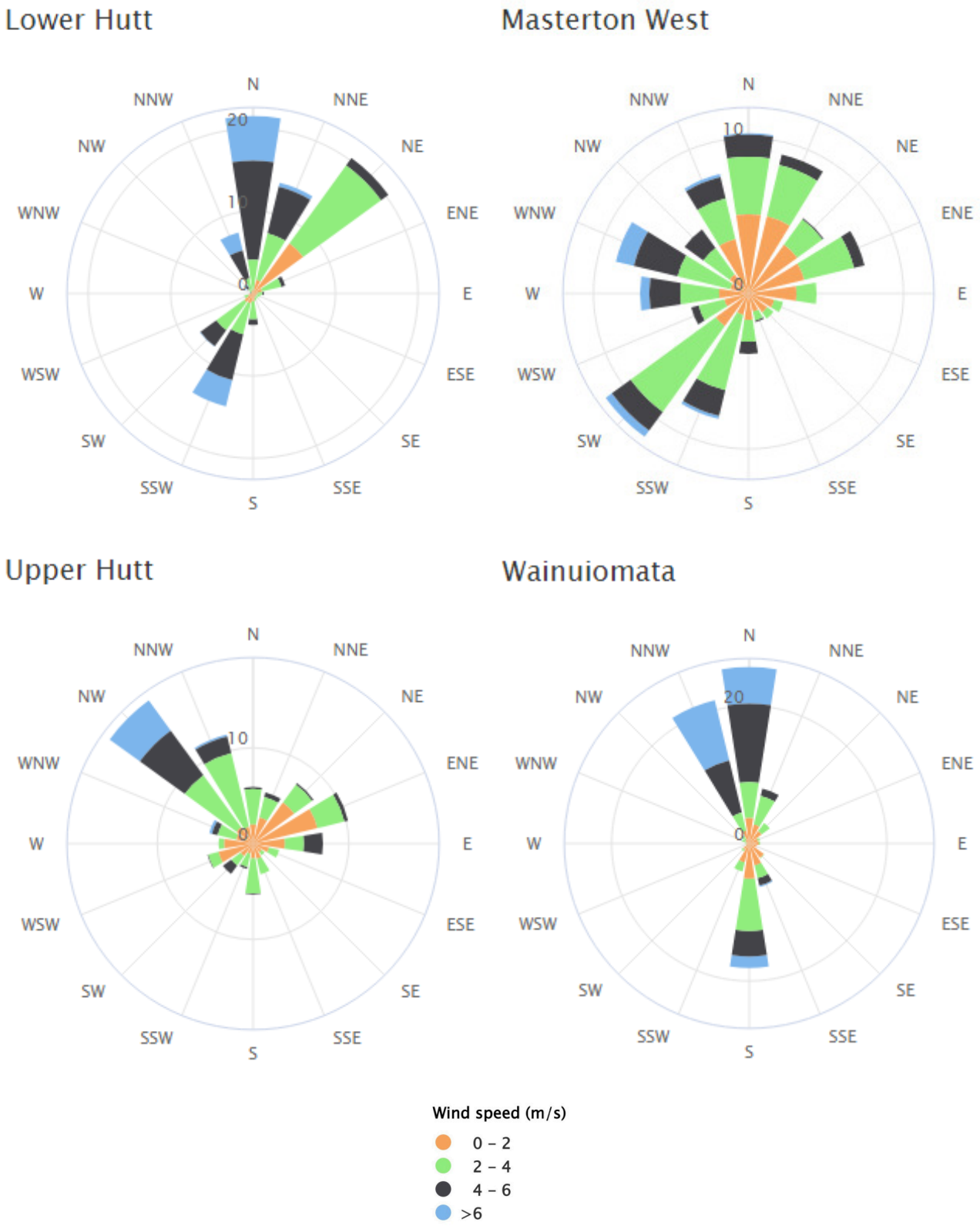

Figure 17: Spring (Sep-Nov) wind speed and direction in core monitoring areas.

Appendix 1: Air quality monitoring sites

Table A1.1: Lower Hutt monitoring site details.

Site Name	Lower Hutt		
Station	Birch Lane		
Hilltop site ID	108		
Location			
Address	Philip Evans Reserve, 15 Birch St, Waterloo, Lower Hutt		
Map reference	Easting	Northing	
NZTM	1761032	5435863	
NZMG	2671054	5997577	
WGS84	Lat: -41.212603	Long: 174.920871	
Site details			
Site type	Residential / Commerical		
Airshed	Lower Hutt Valley		
Altitude	0 m		
Nearest Road	100 m		
Nearest Tree	10 m		
Site Classification (MfE, 2009)	Residential		
(AS/NZ 3580.1.1:2007)	Neighbourhood		
NEMs (2022)	Neighbourhood		
Parameters measured			
	Instrument	Start date	End date
PM_{10} (µg/m^3)	FH62	14/12/2010	
PM_{10} (µg/m^3)	TEOM	5/04/2001	13/12/2011
PM2.5 (µg/m^3)	FH62	7/01/2021	
Carbon monoxide (ppm)	M300E	25/10/2001	11/01/2012
Nitrogen oxides (NO, NO_2, NOx) (ppb)	M200E	13/08/2001	11/01/2012
Meteorological	RH, Temp, WS, WD, global solar radiation, rain, Barometric Pressure	25/10/2001	
Mast height	10m		
Internal temperature	25°C		
Data acquisition			
Sampling rate	AQ - 10 seconds, Met - 3 seconds		
Logger average	5-minute		
Monitoring notes			
Passive NO_2 tube NZTA		Start date	End date
Triplicate		1/03/2010	31/12/2013

Table A1.2: Upper Hutt monitoring site details.

Site Name	**Upper Hutt**		
Station	Savage Park		
Hilltop site ID	2468		
Location			
Address	15 Savage Cres, Upper Hutt		
Map reference	Easting	Northing	
NZTM	1773804	5445684	
NZMG	2683825	6007400	
WGS84	Lat: -41.121549	Long: 175.070348	
Site details			
Site type	Type: Residential	Scale: Neighbourhood	
Airshed	Upper Hutt Valley		
Altitude	43 m		
Nearest Road	69 m		
Nearest Tree	11 m		
Site Classification (MfE, 2009)	Residential		
Parameters measured			
	Instrument	Start date	End date
PM_{10} (µg/m^3)	FH62	8/11/2005	
PM2.5 (µg/m^3)	FH62	5/08/2020	10/3/204
Black carbon (ng/m^3)	AE33	6/07/2022	
Carbon monoxide (ppm)	M300E	30/09/2005	22/02/2024
Nitrogen oxides (NO, NO_2, NOx) (ppb)	M200E	19/09/2005	
Meteorological	RH, Air Temp, Soil Temp, WS, WD, solar radiation, rain, Barometric Pressure	14/09/2005	
Mast height	10m		
Internal temperature	25°C		
Data acquisition			
Sampling rate	AQ - 10 seconds, Met - 5 seconds		
Logger average	5-minute		
Monitoring notes			
Passive NO_2 tube NZTA		Start date	End date
Triplicate		1/03/2010	1/11/2012

Table A1.3: Masterton East monitoring site details.

Site Name	Masterton East	Closed	
Station	Chanel College		
Hilltop site ID	3579		
Location			
Address	30 Herbert Street	Masterton	
Map reference	Easting	Northing	
NZTM	1823279.81	5462375.21	
NZMG	2733294.01	6024095.93	
WGS84	Lat: -40.959262	Long: 175.653116	
Site details			
Site type	Type: Residential	Scale: Neighbourhood	
Airshed	Masterton Urban		
Altitude	105m		
Nearest Road	75m		
Nearest Tree	15m		
Site Classification (MfE, 2009)	Residential (peak)		
Parameters measured			
	Instrument	Start date	End date
PM_{10} (µg/m^3)	5014i	17/05/2012	11/01/2023
$PM_{2.5}$ (µg/m^3)	5014i + VSCC	2/12/2013	12/12/2022
Meteorological	RH, Temp, BP, WS, WD	11/05/2012	11/01/2023
Mast height	6m		
Internal temperature	25°C		
Data acquisition			
Sampling rate	AQ - 10 seconds, Met - 5 seconds		
Logger average	5-minute		
Monitoring notes			
		Start date	End date
Fine and coarse PM measured by GNS Science	GENT	1/07/2010	1/09/2010

Table A1.4: Masterton West monitoring site details.

Site Name	**Masterton West**		
Station	Wairarapa College		
Hilltop site ID	2637		
Location			
Address	83 Pownall Street	Masterton	
Map reference	Easting	Northing	
NZTM	1822756	5463164	
NZMG	2732764	5463158	
WGS84	Lat: -40.952364	Long: 175.646546	
Site details			
Site type	Type: Residential	Scale: Neighbourhood	
Airshed	Masterton Urban		
Altitude	161m		
Nearest Road	124m		
Nearest Tree	5m		
Site Classification (MfE, 2009)	Residential		
(AS/NZ 3580.1.1:2007)	Neighbourhood		
Parameters measured			
	Instrument	Start date	End date
PM_{10} (µg/m^3)	5014i	17/12/2015	
	FH62 (inlet 40°C)	18/06/2007	16/12/2015
	5014i	25/05/2012	2/12/2013
	TEOM	9/10/2002	1/01/2011
	High Volume Sampler	17/04/2003	30/03/2005
$PM_{2.5}$ (µg/m^3)	5014i	11/12/2015	
	SHARP 5030	28/01/2011	10/12/2015
Black carbon (ng/m^3)	AE33	8/03/2023	
Carbon monoxide (ppm)	M300E	9/10/2002	1/02/2024
Nitrogen oxides (NO, NO_2, NOx) (ppb)	M200E	1/01/2003	
Meteorological	Temp, WS, WD, RH, BP, soil moisture, soil temperature, rainfall, net solar radiation	4/06/2002	
Mast height	15m		
Mast height	10m - replacement	2020	
Internal temperature	25°C		
Data acquisition			
Sampling rate	AQ -10 seconds, Met-5 seconds		
Logger average	5-minute		

Table A1.5: Wainuiomata monitoring site details.

Site Name	**Wainuiomata**	
Station	Wainuiomata Bowling Club	
Hilltop site ID	2579	
Location		
Address	1B Moohan Street	Wainuiomata
Map reference	Easting	Northing
NZTM	1763651	5429685
NZMG	2673674	5991399
WGS84	Lat: -41.267695	Long: 174.953745
Site details		
Site type	Type: Residential	Scale: Neighbourhood
Airshed	Wainuiomata	
Altitude	80m	
Nearest Road	20m	
Nearest Tree	10m	
Site Classification (MfE, 2009)	Residential	

Parameters measured			
	Instrument	Start date	End date
PM_{10} (µg/m^3)	FH62	30/06/2006	
$PM_{2.5}$ (µg/m^3)	FH62 + VSCC	1/05/2012	
PM_{10} (µg/m^3)	High Volume Sampler	20/09/2000	6/10/2007
Meteorological	RH, Air Temp, Soil Temp, WS, WD, BP, solar radiation, soil moisture	1/01/2005	
Mast height	10m		
Internal temperature	25°C		

Data acquisition	
Sampling rate	AQ - 10 seconds, Met - 3 seconds
Logger average	5-minute

Monitoring notes			
		Start date	End date
PM measured by GNS Science	Streaker	29/09/2014	
PM measured by GNS Science	GENT	1/09/2006	25/09/2008
Inorganic arsenic	High Volume sampler PM_{10}	25/10/2011	31/10/2013

Table A1.6: Wellington Central monitoring site details.

Site Name	**Wellington central**		
Station	Willis Street AQ		
Hilltop site ID	4795		
Location			
Address	222 Willis Street, Te Aro, Wellington		
	Intersection Wellington urban motorway and Willis Street		
Map reference	Easting	Northing	
NZTM	1748360	5427132	
NZMG	2658382	5988844	
WGS84	Lat: -41.293625	Long: 174.771919	
Site details			
Site type	Peak transport		
Airshed	Wellington City		
Altitude	24m		
Nearest Road	8m		
Nearest Tree	30m		
Site classification (MfE, 2009)	Traffic		
(AS/NZ 3580.1.1:2007)	Peak transport		

Mobile station

Fixed station

Parameters measured			
Mobile station	Instrument	Start date	End date
PM_{10} (µg/m^3)	FH62	20/01/2015	14/09/2015
Carbon monoxide (ppm)	M300E	20/01/2015	14/09/2015
Nitrogen oxides (NO, NO_2, NOx) (ppb)	M200E	20/01/2015	14/09/2015
Fixed station			
PM_{10} (µg/m^3)	SHARP 5030	8/01/2016	18/05/2018
	5014i	18/05/2018	
$PM_{2.5}$ (µg/m^3)	SHARP 5030	8/01/2016	16/01/2018
	5014i	16/01/2018	
Carbon monoxide (ppm)	M300E	17/12/2015	
Nitrogen oxides (NO, NO_2, NOx) (ppb)	M200E	16/12/2015	
Black carbon (µg/m^3)	AE33	5/10/2016	
Ozone (ppm)	M400E	23/11/2017	
Meteorological			
	RH (%), Temperature (°C), Wind speed (m/s), Wind direction (degrees), Barometric Pressure	5/01/2016	
Mast height	6m		
Internal temperature	25°C		
Data acquisition			
Sampling rate	AQ -10 seconds, Met - 3 seconds		
Logger average	5-minute		
Monitoring notes			
NO_2	Passive tube (triplicate) by NZTA	1/01/2015	
Black carbon measured by NIWA	AE22 (not telemetered, downloaded data)	10/03/2016	27/09/2017

Appendix 2: Particulate matter particle sizes

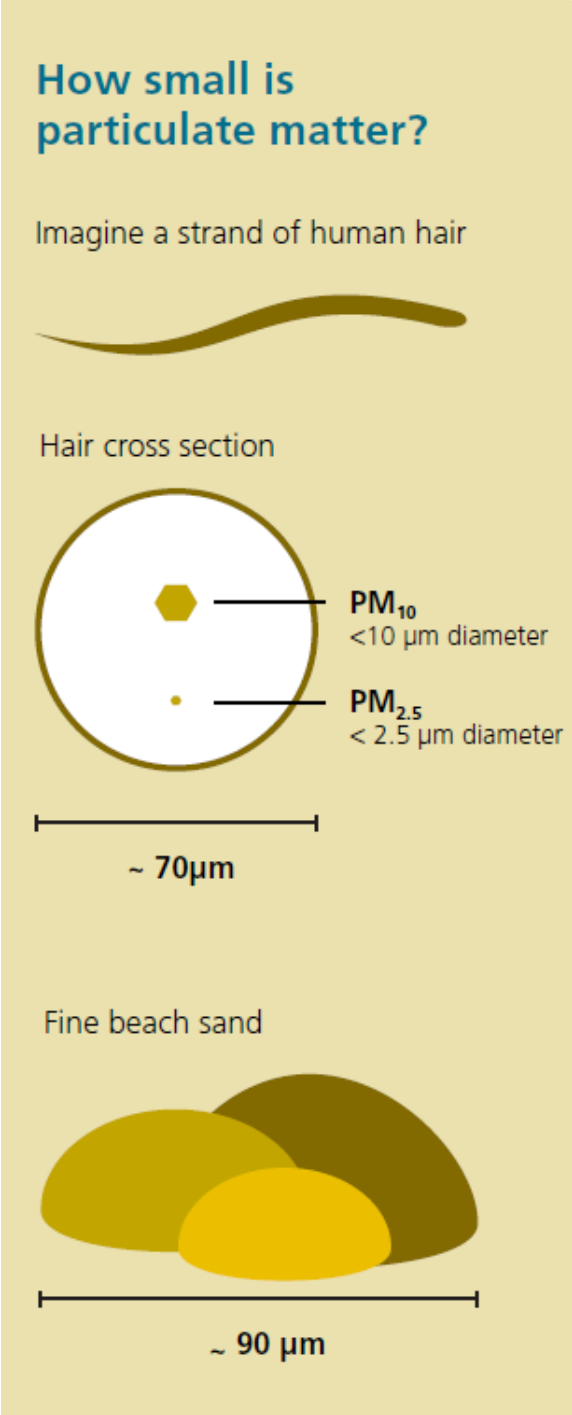

Figure 18: Diagram of particulate matter particle sizes.

Appendix 3: Passive tube monitoring sites

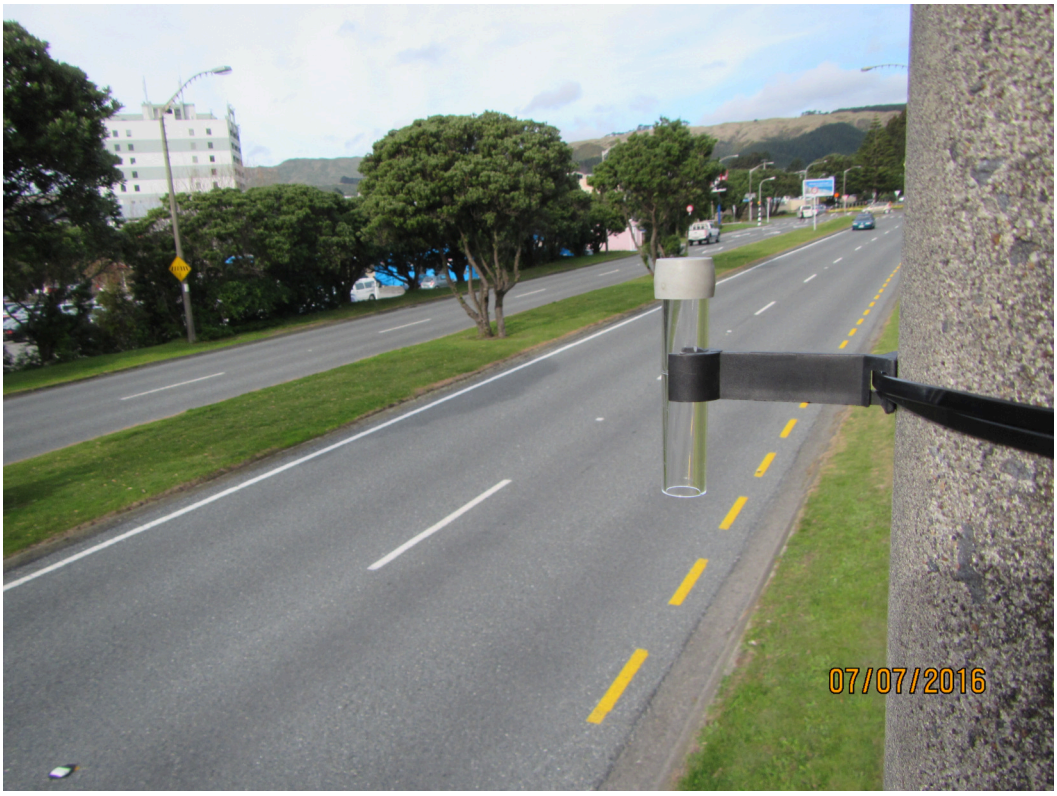

Figure 19: Example of a passive NO_2 monitoring tube.

Table A3.1: Passive NO_2 tube monitoring sites.

NZTA ID	Area	GWRC classification	Lat	Lng
GW002	Wellington North	Peak	-41.253	174.805
GW003	Welington	Peak	-41.295	174.783
GW004	Wellington	Urban background	-41.311	174.817
GW005	Wellington	Urban background	-41.287	174.742
GW006	Wellington	Urban background	-41.300	174.773
GW007	Wellington North	Roadside	-41.210	174.816
GW009	Lower Hutt	Urban background	-41.171	174.982
GW010	Lower Hutt	Roadside	-41.199	174.934
GW011	Upper Hutt	Roadside	-41.128	175.050
GW012	Porirua	Urban background	-41.133	174.873
GW013	Porirua	Roadside	-41.165	174.827
GW015	Kapiti	Urban background	-40.891	175.008
GW016	Kapiti	Roadside	-40.905	175.004
GW017	Wellington	Roadside	-41.288	174.778
GW018	Lower Hutt	Urban background	-41.255	174.949
GW019	Lower Hutt	Urban background	-41.204	174.944
WEL003	Lower Hutt	Roadside	-41.220	174.875
WEL008	Wellington	Peak	-41.301	174.779
WEL047	Wellington	Roadside	-41.284	174.739
WEL048	Wellington	Urban background	-41.335	174.775
WEL049	Wellington	Peak	-41.311	174.779

NZTA ID	Area	GWRC classification	Lat	Lng
WEL050	Wellington	Peak	-41.312	174.793
WEL051	Wellington	Roadside	-41.317	174.817
WEL052	Lower Hutt	Roadside	-41.204	174.904
WEL053	Lower Hutt	Peak	-41.211	174.908
WEL054	Lower Hutt	Urban background	-41.213	174.921
WEL057	Upper Hutt	Roadside	-41.115	175.081
WEL063	Kapiti	Roadside	-40.912	175.014
WEL072	Porirua	Urban background	-41.113	174.865
WEL073	Wellington	Peak	-41.294	174.772
WEL078	Lower Hutt	Roadside	-41.156	174.979
WEL079	Lower Hutt	Roadside	-41.221	174.888
WEL080	Porirua	Roadside	-41.135	174.838
WEL081	Wellington	Peak	-41.283	174.775
WEL082	Wellington	Peak	-41.291	174.777
WEL083	Wellington	Peak	-41.293	174.779
WEL084	Wellington	Roadside	-41.272	174.782
WEL085	Wellington	Roadside	-41.228	174.802
WEL086	Wellington	Roadside	-41.290	174.777
WEL088	Porirua	Roadside	-41.108	174.865
WEL089	Masterton	Roadside	-40.960	175.639
WEL090	Lower Hutt	Peak	-41.207	174.907
WEL091	Lower Hutt	Urban background	-41.202	174.914
WEL094	Wellington	Urban background	-41.226	174.798
WEL096	Masterton	Urban background	-40.950	175.640
WEL098	Wellington	Roadside	-41.336	174.808