



Ambient PM₁₀ monitoring adjacent to unsealed roads in Northland 2013 - 2020

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Executive summary

Unsealed roads generate dust. There are number of adverse effects from dust to humans and the environment such as dust nuisance, health effects and effects on ecosystem. The majority (61%) of Northland's roading network comprises unsealed roads. Movement of vehicles, especially heavy vehicles, generates dust during dry months, affecting residents living near unsealed roads. As a result, Northland Regional Council (council) receives several dust nuisance complaints on its Environmental Hotline from vehicle traffic travelling on unsealed roads every summer months. Historically, council investigated complaints by deploying deposition gauge dust monitors to monitor dust at affected sites. In 2013, council decided to monitor PM₁₀ every summer, instead of deploying deposition gauges due to the limitations associated with the information obtained from these monitors. The primary purpose of unsealed road PM₁₀ monitoring is to;

- Investigate dust nuisance incidents reported to the council's environmental hotline;
- Identify roads which experience high level of dust;
- Share monitoring results with interested parties including Northland's three district councils (Whangārei District Council, Kaipara District Council and Far North District Council).

Monitoring is conducted using an E-BAM and monitoring sites are selected based on either recommendation from Northland's three district councils or dust nuisance incidents reported to council's environmental hotline. The monitoring period varies between several days to several weeks, depending on weather conditions, site availability and the initial dust assessment made by council officers.

Between 2013 and 2020, council has deployed its PM₁₀ monitor to 40 different sites in Northland. Monitoring results indicate that potential adverse human health impact may occur in some areas due to dust discharged from unsealed roads. The concentration of PM₁₀ was found to be impacted by weather conditions, rainfall and wind direction during the monitoring period, as well as the number and size of vehicles travelling on the road. Monitoring results showed that more than twenty percent of the time, PM₁₀ concentration was greater than the National Environmental Standard (NES) for air quality. Settlement Road in the Kaipara District, Gelenmohr Road in the Whangārei District and Ngapipito Road in the Far North District, were found to be hotspots where elevated PM₁₀ levels were recorded.

Introduction

Northland Regional Council (council) monitor particulate matter concentrations less than 10 micrometres (PM₁₀) adjacent to unsealed roads. Monitoring is undertaken annually during the summer months. Results are reported to district councils, the Northland District Health Board (NDHB) and interested parties.

This report is a summary of unsealed road PM₁₀ monitoring results obtained between 2013 and 2020. Annual technical reports are available on [council's website](#). This report provides the following information:

- Background
- Dust
- Environmental effects of dust
- PM₁₀
- Monitoring method
- Site locations
- Results and discussion

Background

Northland has over six thousand kilometres of unsealed roads which accounts for around 61 percent of total road length in the region, excluding state highways (NZTA, 2017). Vehicle traffic (particularly heavy vehicles) on unsealed roads contributes to dust emissions during dry weather conditions. Council typically receives several dust nuisance complaints through the environmental hotline relating to vehicle traffic on unsealed roads during the summer months.

Prior to 2013, council visited sites to investigate unsealed road dust and deployed deposition gauge dust monitors to measure dust levels. Deposition gauges collect dust particles greater than 10-20 micrometres (MfE, 2016). Deposition gauge monitoring is cost effective but needs to be deployed for a period of at least 30 days, is not suitable for short-term monitoring and only provides limited information.

Council commenced monitoring of smaller dust particles (less than 10 micrometres in aerodynamic diameter – “PM₁₀”) in 2013 using a hired Met One Environmental Beta Attenuation Monitor (E-BAM). This monitoring was undertaken at the request of the Medical Officer of Health for Northland (NDHB) to further investigate and address concerns raised by residents affected by unsealed road dust. Dust particles smaller than 10 µm in diameter are of concern as they are commonly known for adversely affecting human and environmental health (MfE & Stats NZ, 2018). PM₁₀ was monitored at four unsealed roads (Wright, Opouteke, Ngapipito and Pipiwai) in 2013. These roads were selected based on high deposition gauge monitoring results conducted in previous months. Elevated daily PM₁₀ concentrations were recorded at all four monitoring sites.

Following the concerns raised by communities approaching District Councils, Regional Council and Northland District Health Board with a request to minimise dust emission from unsealed roads, the development of a non-statutory measure: “*Regional Dust from Unsealed Roads Mitigation Framework*” (the framework) 2014 was initiated. The framework was a combined effort of the following organisations:

Far North District Council,
Whangārei District Council,
Kaipara District Council,
Waka Kotahi NZ Transport Agency,
Northland District Health Board, and
Northland Regional Council.

The framework aimed to assist the District Councils in mitigating dust emissions from unsealed roads at targeted sites and was adopted by the Regional Transport Committee in 2014. The framework identified PM₁₀ and PM_{2.5} monitoring results as one of the criteria to prioritise roads to apply dust mitigation measures. Following the 2013 monitoring and development of the framework, council purchased an E-BAM in 2014 and initiated a monitoring programme to measure PM₁₀ concentrations at sites adjacent to unsealed roads every summer.

Objective

The main objective of this monitoring is to;

- Investigate dust nuisance incidents reported to council's environmental hotline, and
- Identify sites adjacent to unsealed roads experiencing high levels of dust as a result of traffic and to assist under the framework of district councils in prioritising mitigation measures.

PM₁₀

Particulate matter is a collective term used to describe very small solid or liquid particles such as dust, fumes, smoke and mist or fog. Particulate material, which has an aerodynamic diameter of less than 10 micrometres, is referred to as PM₁₀. PM₁₀ in the atmosphere originates from both natural and anthropogenic activities. It is estimated that unsealed road dust contributes 12 percent of PM₁₀ and 2 percent of PM_{2.5} in New Zealand (MfE & Stats NZ, 2018).

PM₁₀ is small enough to be inhaled. Research has shown that fine particles are more responsible for specific health effects (PCE, 2015). The National Environmental Standard (NES) for air quality set by the Ministry for the Environment (MfE) for PM₁₀ in order to protect human health is 50 µg/m³ averaged over a 24-hour period (MfE 2004).

Monitoring methodology

A Met One Environmental Beta Attenuation Monitor (E-BAM) with a PM₁₀ inlet is used for PM₁₀ monitoring. This instrument draws 16.7 litres ambient air per minute and measures the mass concentration of PM₁₀ by use of beta attenuation. This instrument is designed to draw PM₁₀ via a vacuum pump on to a filter tape. The filter tape is located between a C14 (an isotope of carbon used as a source of beta rays) source and a detector. As the mass of PM₁₀ increases on the filter tape, the beta count is reduced. The relationship between the decrease in beta count and particulate mass is computed and, a continuous "real time" concentration (in µg/m³) of particulate is measured. This result is then used to calculate the 24-hour averages, in accordance with the Ministry for the Environment's (MfE) National Environmental Standard for Air Quality.

Monitoring site locations

Monitoring sites are selected by using one of the following criteria;

- Roads referenced in the “Regional Dust from Unsealed Roads Mitigation Framework” 2014.
- Road names recommended by district councils prior to each monitoring season.
- Investigation of dust nuisance complaints reported to council’s environmental hotline.

All unsealed road PM₁₀ monitoring sites between 2013 and 2020 are presented in Figure 1.



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Results and Discussions

Northland Regional Council has monitored PM₁₀ adjacent to unsealed roads since summer 2013. Monitoring results are provided to all interested parties at the end of each monitoring season. Unsealed road PM₁₀ monitoring is not a part of the council's state of the environment monitoring for air and the monitor used for this program is not listed as a compliant monitor for PM₁₀ under the NES air quality. Even though this monitoring is not compliant with NES air quality and the intention of monitoring was not to check NES compliance, results are compared with the NES for PM₁₀, which is 50 µg/m³ averaged over a 24-hour period (MfE, 2004).

This report provides an overall summary of all PM₁₀ monitoring results. Table 1 displays the highest and second highest daily PM₁₀ concentrations recorded for the monitoring period and the total rainfall during each monitoring period collected from the nearest rainfall station. The graphs in Appendix 1 present daily average PM₁₀ concentrations and rainfall for each monitoring site.

Results presented in Table 1 are 24-hour averages of PM₁₀ obtained from the data collected at 10-minute intervals by the EBAM. Data analysis is based on the "Good Practice Guide for Air Quality Monitoring and Data Management 2009" (MfE, 2009). The good practice guide recommends having at least 75% of valid data (i.e. percentage of a set of data continuously measured at 10-minute intervals over a calendar day from midnight to midnight) for compliance monitoring. Daily PM₁₀ concentrations presented in the appendix may not have more than 75% valid data on days when the monitor was installed and removed from the site. For example, if data measurement commenced part way through a calendar day, then a full set of data was not measured for that day.

Table 1: Summary of PM₁₀ monitoring results

Monitoring site location	Monitoring period	PM ₁₀ concentration (µg/m ³)		Total rainfall at nearby rainfall station (mm)
		Highest	Second highest	
2013				
Wright Road	14 to 18 March	39	33	8
Opouteke Road	18 to 22 March	321	83	4.5
Ngapipito Road	22 March to 2 April	147	112	30
Pipiwai Road	2 to 10 April	100	44	11
2015				
Matawaia-Maromaku Road	11 to 20 February	91	56	8
Pungaere Road	23 February to 6 March	52	50	29.5
Opouteke Road	19 March to 7 April	42	42	39
2015/2016				
Rawhati Road	3 to 11 December	30	29	12
Takou Bay Road	11 to 22 December	12	11	5.5
Snooks Road	7 to 12 January	17	11	17

Monitoring site location	Monitoring period	PM ₁₀ concentration (µg/m ³)		Total rainfall at nearby rainfall station (mm)
		Highest	Second highest	
Te Maire Road	21 January to 3 February	12	9	52.5
Jubilee Road	3 to 11 February	12	11	49
Kohumaru Road	11 to 19 February	54	49	140
Omahuta Road	19 February to 3 March	70	48	141
Petley Road	11 to 21 March	16	12	13
Pouto Road	7 to 15 April	13	10	15.5
2016/2017				
Golden Stairs Road	5 to 17 November	42	36	101
Paparoa Station Road	26 November to 7 December	34	32	1.5
Moore Road	8 to 19 December	24	18	14
Millbrook Road	24 January to 3 February	97	83	0
Brooks Road	3 to 21 February	45	42	68
Waihue Road	14 February to 1 March	82	50	86
Pouto Road	1 to 24 March	86	74	108
Knudson Road	7 to 23 March	36	30	207
Paparore Road	27 March to 11 April	13	11	73
Ruaroa Road	27 March to 11 April	60	55	45
2017/2018				
Ross Road	10 to 22 November	34	33	40
Durham Road	24 to 30 November	62	45	0
Pigs Head Road	21 December to 3 January	94	75	16
Pebblebrooke Road	6 to 22 January	95	84	60
2018/2019				
Ninihi Road	6 to 18 December	90	88	53.5
Glenmohr Road	12 to 22 January	90	76	10
McBeth Road	8 to 18 February	54	42	14
Parapara Road	19 February to 7 March	109	102	37.5
Ruaroa Road	7 to 28 March	87	79	34.5
2019/2020				
Valley Road	22 January to 5 February	37	36	0
Settlement Road	5 to 18 February	170	166	0
Lawrence Road	18 to 26 February	54	46	0
Prescott Road	28 February to 6 March	36	24	21
Rawhiti Road	9 to 23 March	20	18	43

Summer 2013

Council hired an EBAM to monitor PM₁₀ at Wright Road and Opouteke Road in Whāngarei District Council (WDC) area and Ngapipito Road and Pipiwai Road in Far North District Council (FNDC) area. The only site that did not exceed PM₁₀ concentration greater than 50 µg/m³ was Wright Road. It is important to note that dust suppressant was applied on this road a couple of days after the monitor was installed.

Opouteke Road recorded highest PM₁₀ concentration during 2013 monitoring. The property where the monitor was located was less than 20 meters from the road. This road was also treated with dust suppressant three months prior to monitoring, though the effect of dust suppressant was not evident in PM₁₀ concentrations.

PM₁₀ concentration at Ngapipito Road exceeded the daily average NES for air quality on several occasions. Nine out of 11 days of PM₁₀ concentration recorded at Ngapipito Road were greater than 50 µg/m³. This site also showed the highest deposition gauge dust results out of the four sites monitored prior to PM₁₀ monitoring.

Pipiwai Road PM₁₀ concentration was found to be less than expected as a result of frequent showers during the monitoring period, and also watering on road to suppress the dust started during the monitoring period.

Summer 2014

Council did not undertake PM₁₀ monitoring in 2014. However, purchased an EBAM in late 2014 to monitor PM₁₀ during summer.

Summer 2015

PM₁₀ monitoring commenced in February 2015. Monitoring was conducted at or near residential dwellings adjacent to unsealed roads. PM₁₀ was monitored at the following three sites: Matawaia-Maromaku Road and Pungaere Road within FNDC boundaries and Opouteke Road in the Kaipara District Council (KDC) area. The daily PM₁₀ concentration recorded at Matawaia-Maromaku Road exceeded 50 µg/m³ on one occasion. All sites monitored during this summer did not seem impacted by major dust problem. Frequent showers during monitoring may have contributed to low PM₁₀ concentration this year.

Summer 2015/16

Nine sites (four from FNDC, three from KDC and two from WDC areas) were monitored in summer 2015/16. Sites located at Kohumaru Road and Omahuta Road recorded the highest PM₁₀ concentrations out of the nine sites monitored, with some concentrations greater than 50 µg/m³ over a 24-hour averaging period. Elevated concentrations were recorded despite the highest rainfall totals being recorded at both sites during the monitoring periods. Summer 2015/2016 was wetter than previous summers, as indicated by the rainfall data in Table 1, which partly explains lower concentration of PM₁₀ than previous summer results. A total of 89 days data was obtained during this summer monitoring but PM₁₀ concentration was higher than average of 50 µg/m³ over a 24-hour period on only two occasions.

Summer 2016/17

Ten sites (four from KDC and three each from WDC and FNDC areas) were monitored in summer 2016/17. Millbrook Road in Whangarei District, Pouto and Waihue Road in Kaipara District and Ruaroa Road in Far North District recorded elevated PM₁₀ concentrations over a 24-hour averaging period. Out of the ten sites monitored, Millbrook Road recorded highest PM₁₀ concentration. Seven out of 11 days of PM₁₀ concentration recorded at this site were

greater than $50 \mu\text{g}/\text{m}^3$. Elevated concentration recorded at this site was likely related to no rain recorded during the monitoring period and also the location of the monitor which was close to the road. Pouto Road exceeded $50 \mu\text{g}/\text{m}^3$ on six occasions out of 24 days of monitoring. Despite high rainfall and location of the monitor about 40 meters away from the road, Pouto Road recorded elevated PM_{10} concentrations. A total of 155 days of data was collected from ten sites using two monitors this summer. Out of 155 days PM_{10} concentration was greater than $50 \mu\text{g}/\text{m}^3$ on 17 occasions with exceedances occurring at four out of the ten monitoring sites. Lowest concentration of PM_{10} was recorded at Knudson Road, which was affected by the highest rainfall (207 mm) during the monitoring period.

Summer 2017/18

Four sites (three from WDC and one from KDC areas) were monitored in summer 2017/18. The site located at Pigs Head Road and Pebblebrooke Road recorded the highest PM_{10} concentrations out of the four sites monitored, with several occasions where concentrations recorded were above $50 \mu\text{g}/\text{m}^3$ over a 24-hour averaging period. The monitor was located close to the road and there was little rain recorded during the monitoring period at Pigs Head Road. However, at Pebblebrooke Road, 60 mm of rain was recorded during the monitoring period.

Summer 2018/19

Five sites (three from FNDC and two from WDC areas) were monitored in summer 2018/19. All sites recorded elevated PM_{10} concentrations, with several exceedances over $50 \mu\text{g}/\text{m}^3$ over a 24-hour averaging period. Out of two sites monitored in WDC, the site at Glenmohr Road exceeded PM_{10} concentration above $50 \mu\text{g}/\text{m}^3$ on several occasions. All three sites located in Far North district recorded elevated PM_{10} concentrations despite all sites recording rain during monitoring period as shown in Table 1.

Summer 2019/20

Five sites (three from KDC and one each from WDC and FNDC areas) were monitored in 2020. The site located at Settlement Road recorded the highest PM_{10} concentrations out of the five sites with several exceedances recorded above NES ($50 \mu\text{g}/\text{m}^3$) over a 24-hour period. The PM_{10} concentration at this road fell below the NES as a result of change in wind direction from south westerly to easterly to north-easterly. Wind direction data was obtained from council's Ruakaka air monitoring station. Easterly to north easterly wind made the location of the monitor upwind from Settlement Road. There was no rain recorded during the monitoring period. Other sites monitored during this summer did not record elevated PM_{10} concentrations.

PM_{10} concentration over $50 \mu\text{g}/\text{m}^3$

Figure 2 displays the percentage of daily PM_{10} concentrations which exceeded the NES ($50 \mu\text{g}/\text{m}^3$ averaged over a 24-hour period) out of total number of days monitored at each site. The larger the red dot corresponds to greater frequency of daily PM_{10} concentration exceedance of the NES during the monitoring period. The monitoring programme spanned between 2013 and 2020 with varying monitoring periods from site to site. PM_{10} concentration is influenced by several factors such as the monitoring period, rainfall, wind direction and speed, traffic, etc. The dataset obtained to date is too small for undertaking further analysis. Therefore, the results shown in Figure 2 are indicative only.

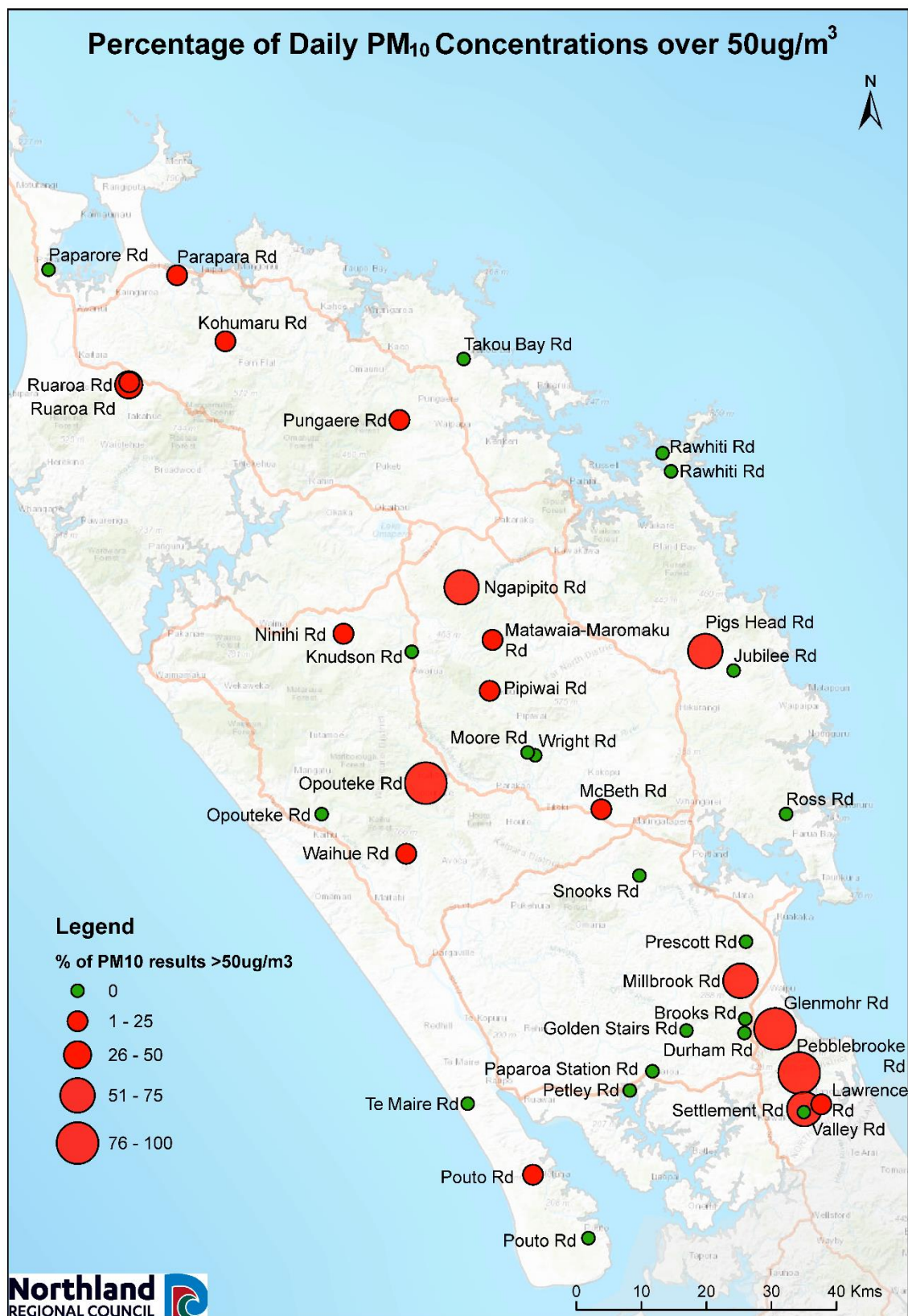


Figure 2: Percentage of daily PM₁₀ concentration recorded over 50 $\mu\text{g}/\text{m}^3$ for the entire monitoring period (summer 2013-summer 2020)

Limitation of PM₁₀ monitoring along unsealed road

- The PM₁₀ EBAM monitor used for this monitoring is not a Ministry for the Environment NES for Air Quality approved instrument.
- While it is likely that the majority of results recorded by the EBAM originated from unsealed roads, it is important to note that PM₁₀ can also originate from other sources such as fires, sea spray, pollen and vehicle exhausts.
- Most of the time the PM₁₀ monitor was located near the road and monitoring conditions for each site were similar. This therefore means that results obtained represent PM₁₀ levels occurring at the monitoring location and may not be representative of actual ambient PM₁₀ levels in the area.
- PM₁₀ concentration may vary depending on weather conditions such as rainfall, wind speed and direction.

Conclusion

- The primary purpose of this monitoring was to identify unsealed roads which experience elevated level of dust (measured as PM₁₀) as a result of traffic and assist road controlling authorities in prioritising mitigation measures. To meet the purpose of this monitoring, Northland Regional Council has conducted unsealed road PM₁₀ monitoring at 40 different sites in Northland between 2013 and 2020.
- During this monitoring, a total of 498 days of data was collected. Out of 498 days PM₁₀ concentration was greater than 50 µg/m³ on 105 days. Daily PM₁₀ concentration was over 100 µg/m³ on 12 days, out of which five days were recorded at Settlement Road in Kaipara District.
- Monitoring periods varied between four days and 24 days from site to site.
- Daily PM₁₀ concentration at Opouteke Road in 2013 and Glenmohr Road in 2019 exceeded NES every day during the respective monitoring periods. High percentage of NES exceedance was also recorded at Settlement Road in 2020, Pebblebrooke Road in 2019 and Ngapipito Road in 2013.
- Rainfall during monitoring period affected on PM₁₀ concentration. The highest rainfall (207 mm) during a two-week monitoring period was recorded at Knudson Road in 2017. As a result, daily PM₁₀ concentration recorded at this site was below the 50 µg/m³.
- Elevated daily PM₁₀ concentrations were recorded at Kohumaru Road and Omahuta Road in 2016 despite elevated rainfall recorded during monitoring (141 and 140 mm respectively).

References

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Glossary

EBAM – Environmental Beta Attenuation Monitor

FNDC – Far North District Council

KDC – Kaipara District Council

MfE – Ministry for the Environment

µg – microgram

µg/m³ – microgram per cubic metre

NES - National Environmental Standard

NRC – Northland Regional Council

NZTA – New Zealand Transport Agency

PM – particulate matter

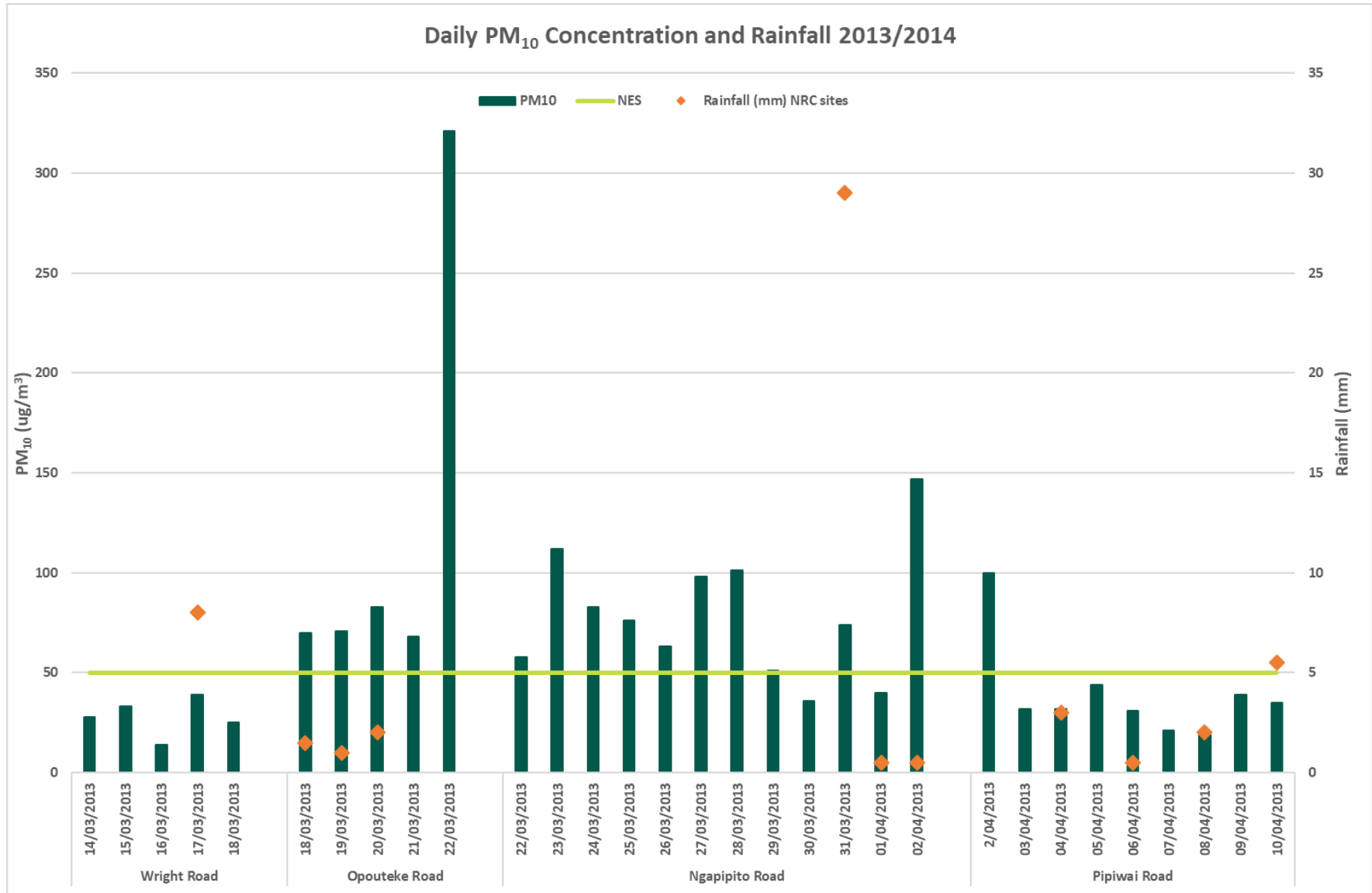
PM₁₀ – particulate matter less than 10 microns in aerodynamic diameter

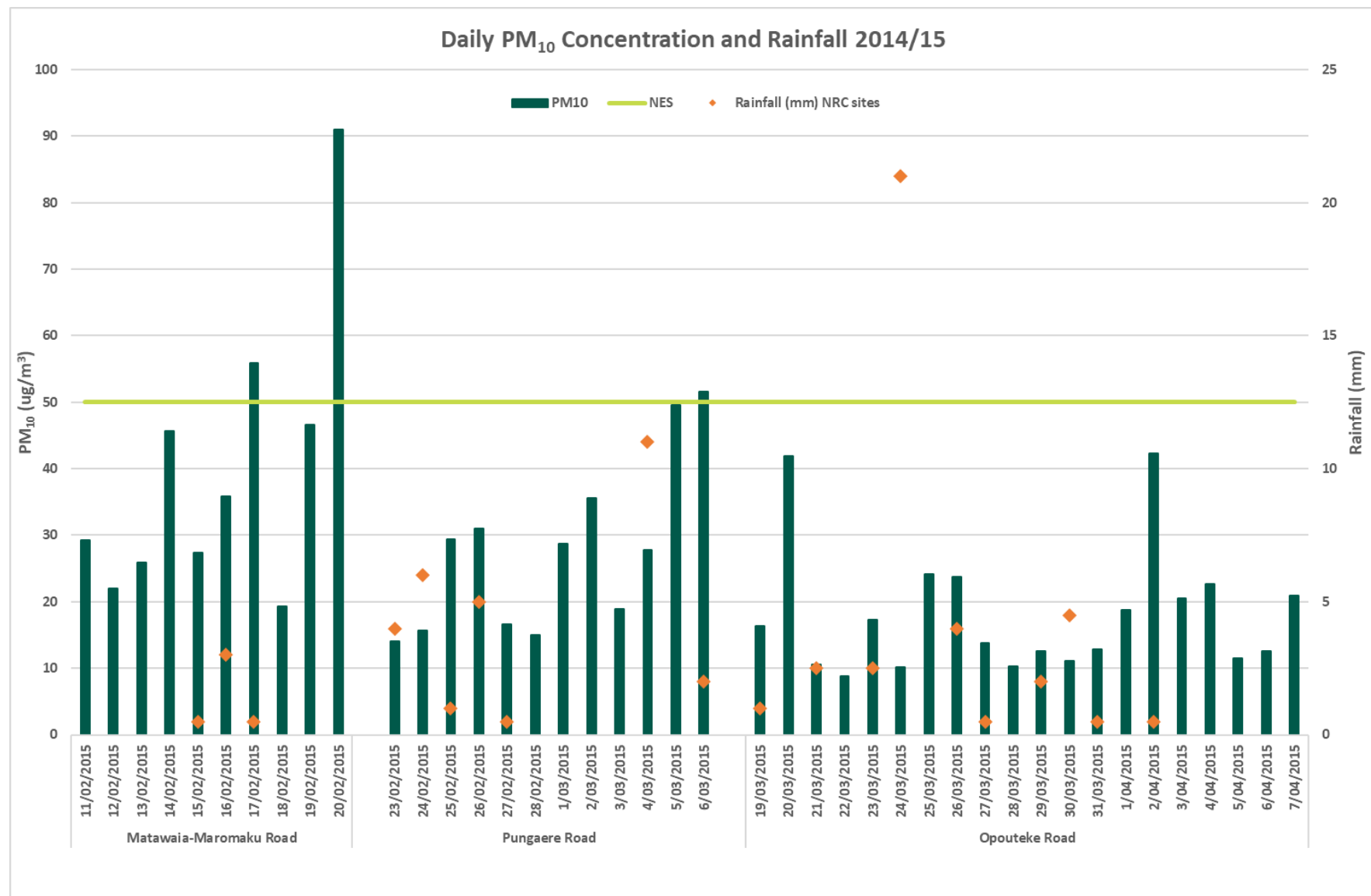
PM_{2.5} – particulate matter less than 2.5 microns in aerodynamic diameter

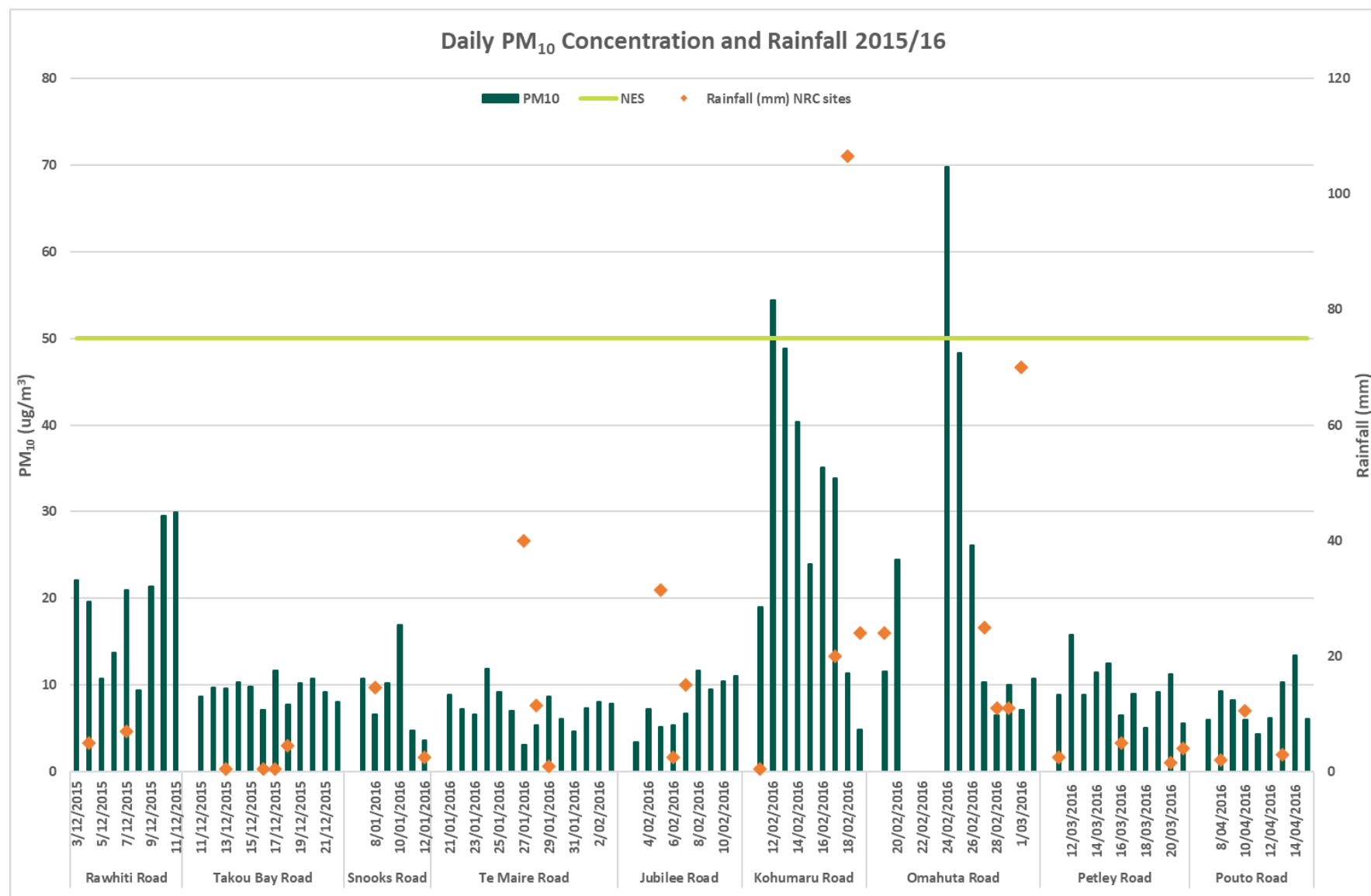
RCA – Road controlling authority

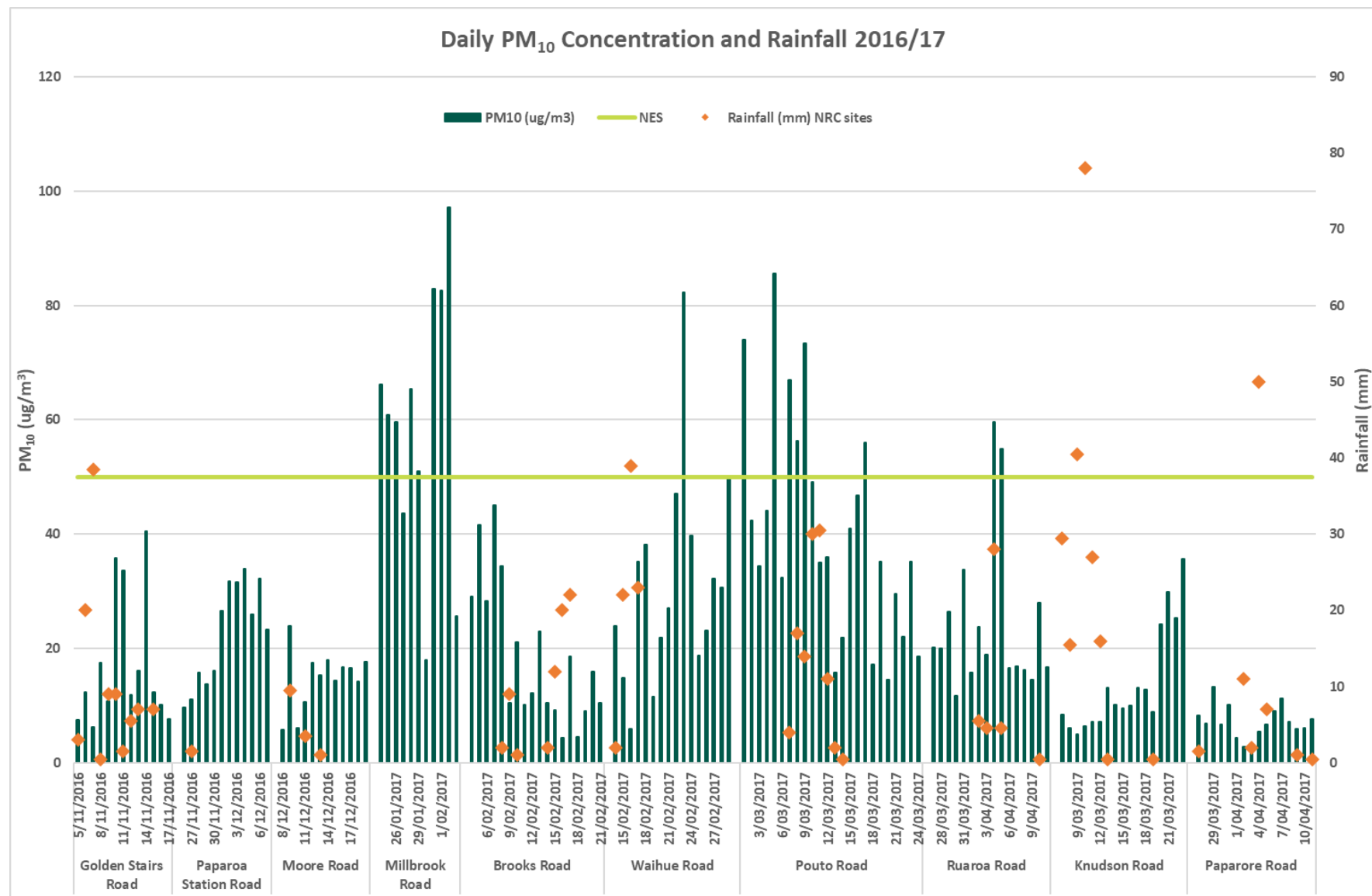
WDC – Whangārei District Council

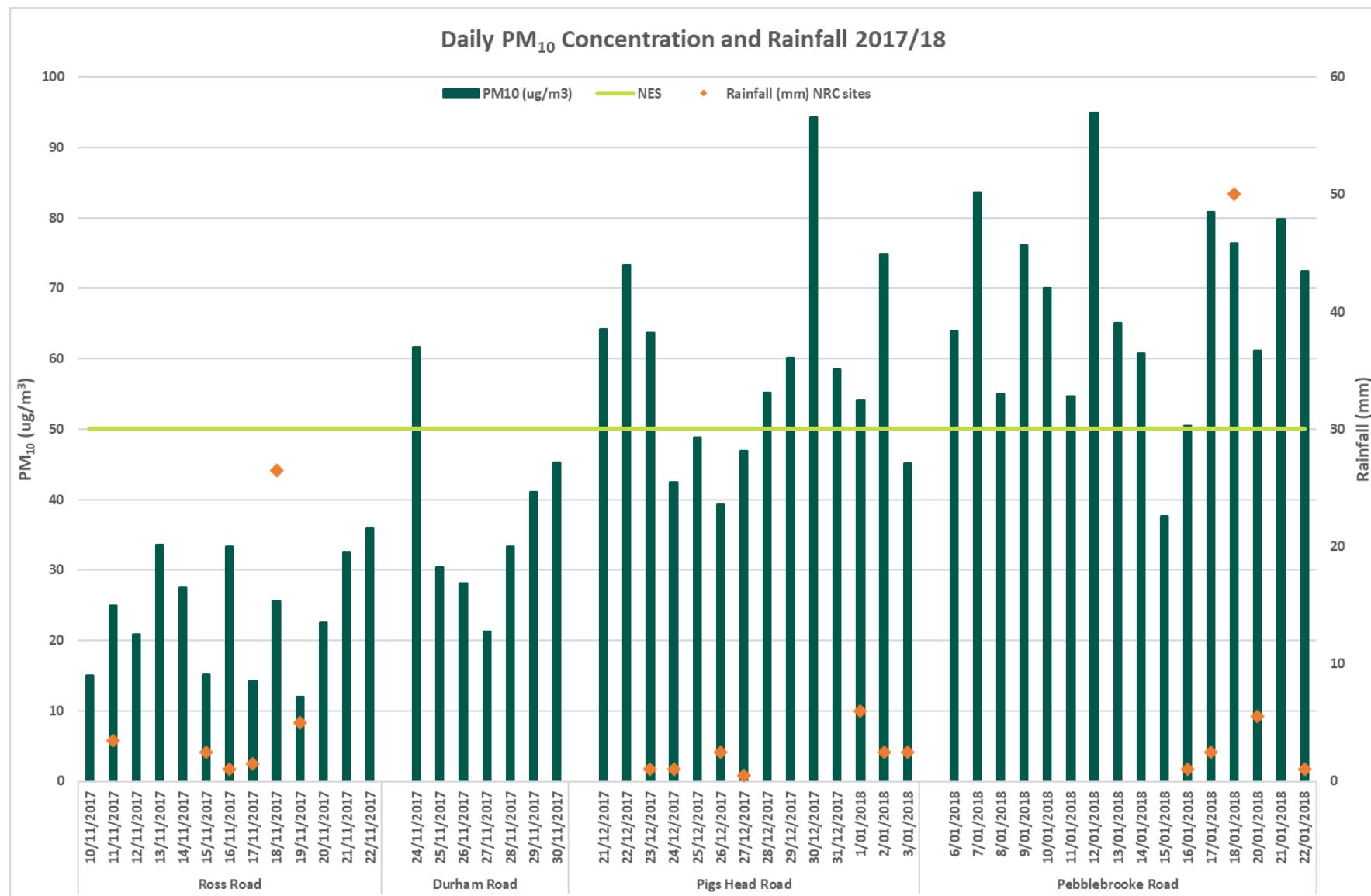
Appendix 1 – Daily average PM₁₀ concentration 2013 – 2020

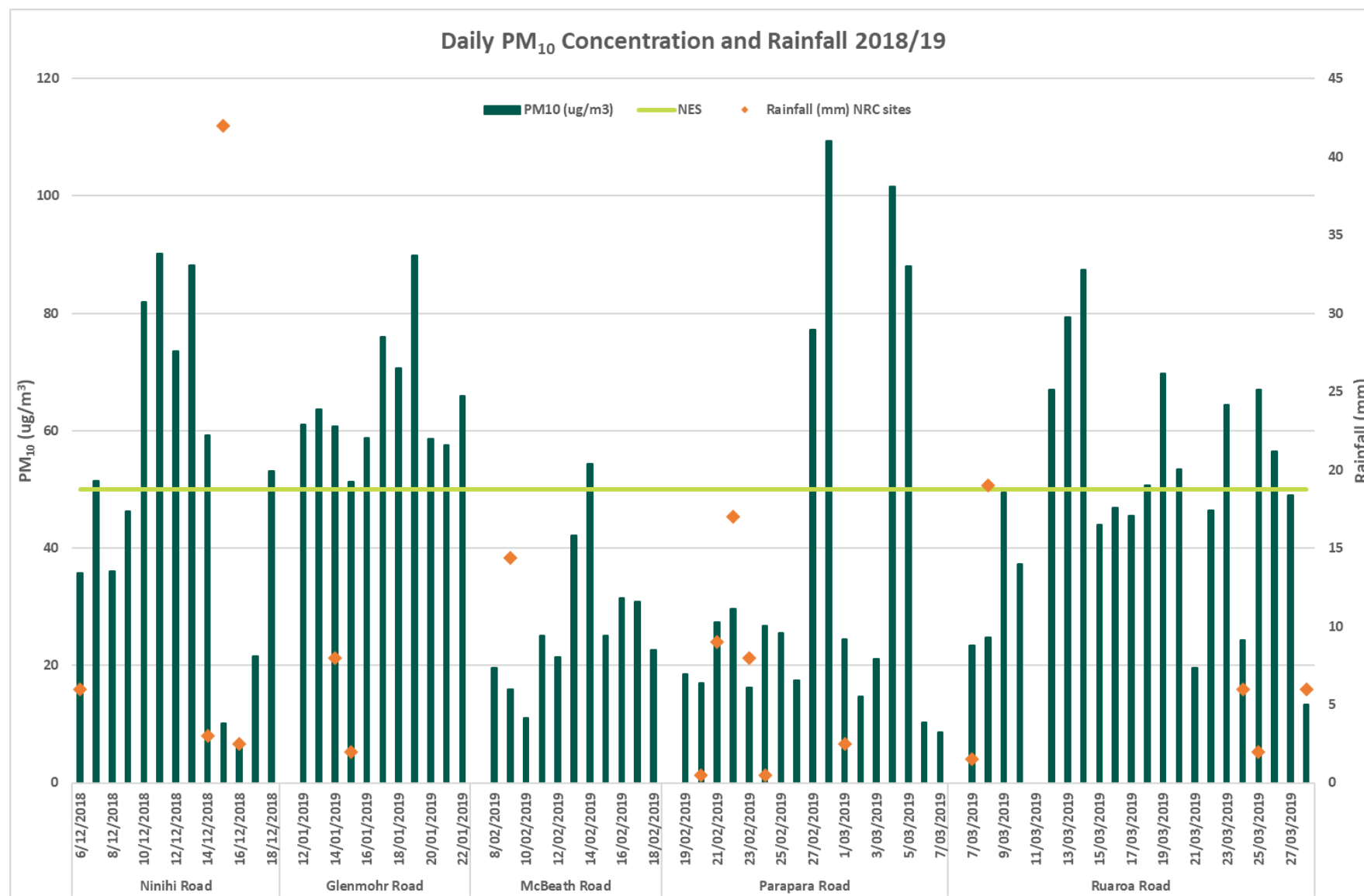


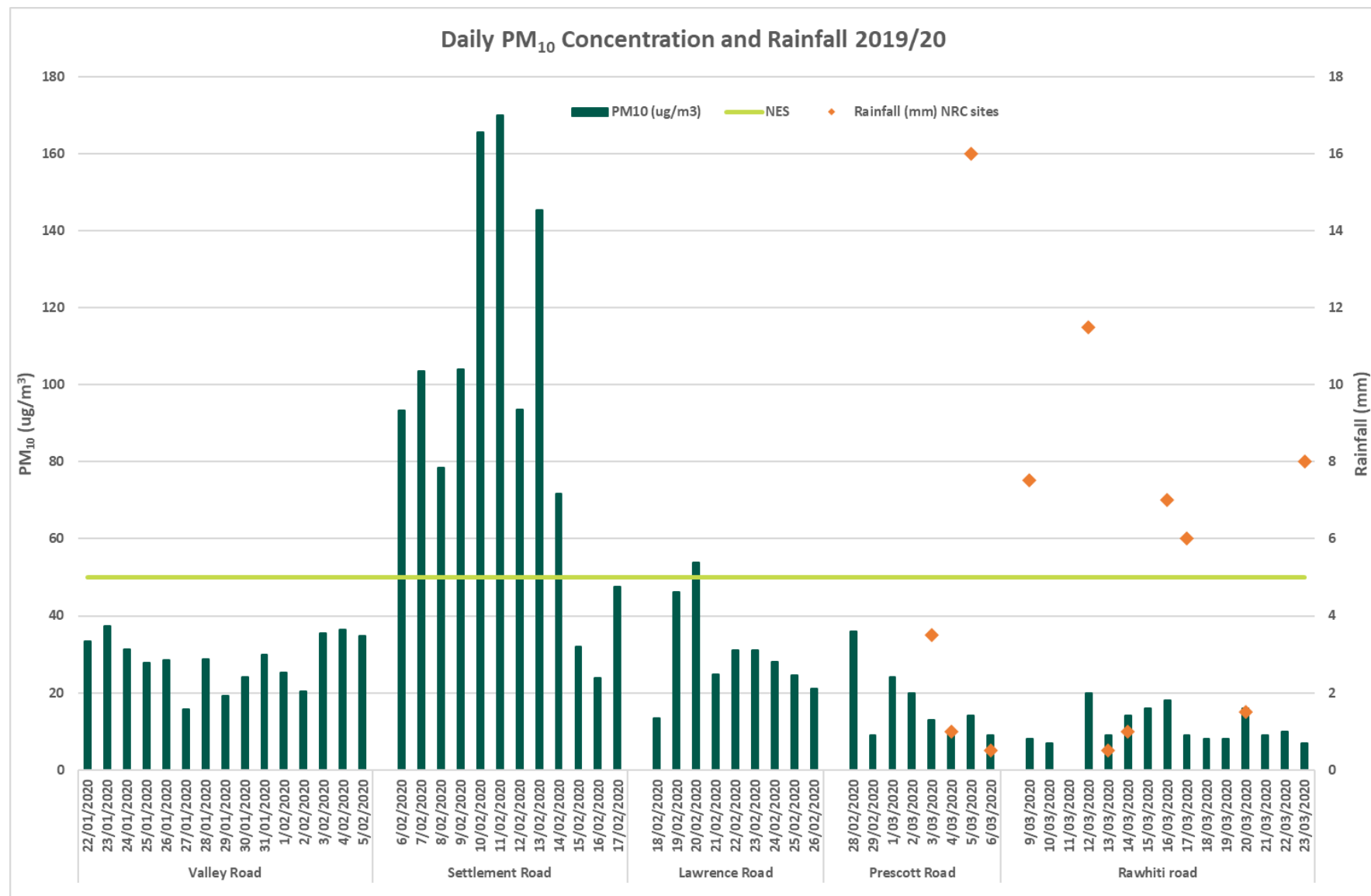












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