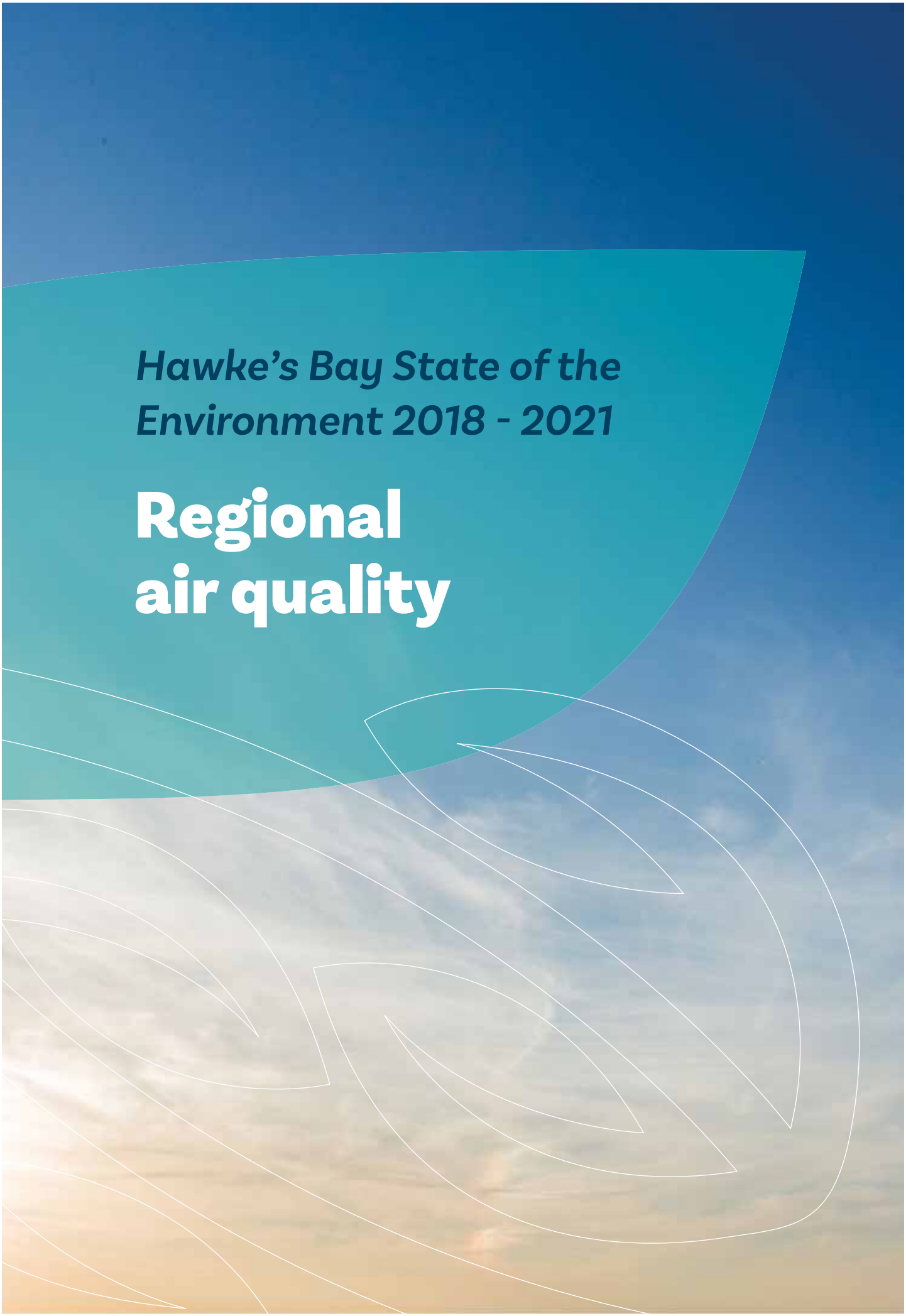
Hawke's Bay State of the Environment 2018 - 2021

Regional air quality



3. Regional Air quality

While we are out and about and enjoying our Hawke's Bay environment, we tend not to be thinking about what is in the air we breathe. However, air pollution in our public spaces can occasionally exceed health guidelines, or locally generated air pollution may cause our wellbeing to suffer.

The main pollutant of concern in Hawke's Bay is fine particles, which are invisible without a microscope. We are most interested in particulates called PM_{10}, which are a mix of solid particles and tiny droplets less than 10 micrometres in diameter. Ten micrometres is just one fifth of the thickness of a human hair.

Particulates less than 2.5 micrometres diameter, or $PM_{2.5}$, are especially concerning because they are inhaled deep into the lungs and may enter the bloodstream. Breathing elevated levels of PM_{10}, and $PM_{2.5}$, particularly long-term, can adversely affect respiratory and cardiovascular systems.

Hawke's Bay has three airsheds (Napier, Hastings, and Awatoto) where HBRC has been monitoring PM_{10} levels for several years (Figure 3-1). Our air quality sites are Marewa Park in Napier (established in 2005), St John's College in Hastings (2006), and Waitangi Road in Awatoto (2012).

We compare our measurements to the National Environmental Standards for Air Quality (NES-AQ) for PM_{10}, which is a daily average of 50 micrograms per cubic metre of air ($\mu g/m^3$). The World Health Organisation (WHO) guideline matched the NES-AQ until September 2021, when the WHO guideline was revised down to 45$\mu g/m^3$.

The number of occasions the region's air quality measurements have exceeded the NES-AQ for PM_{10} has decreased since we began monitoring (Figure 3-2). Prior to 2014, Marewa Park typically recorded between three and five exceedances each year, while Hastings had ten or more. The numbers have dropped to one at most at Marewa Park, and less than five at St John's College in the last five years.

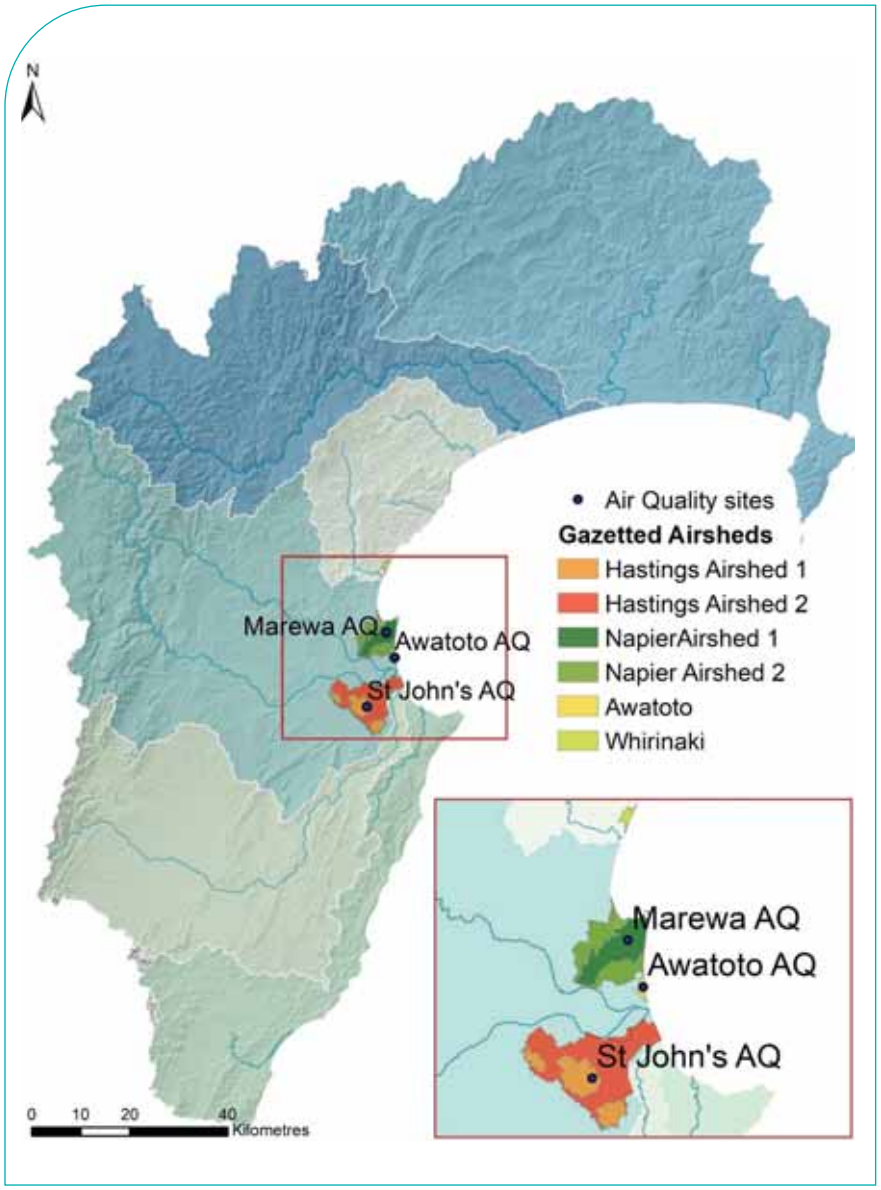


Figure 3-1. Hawke's Bay's gazetted airsheds and the sites where particulate concentrations are measured and compared to the National Environmental Standard for PM_{10}.

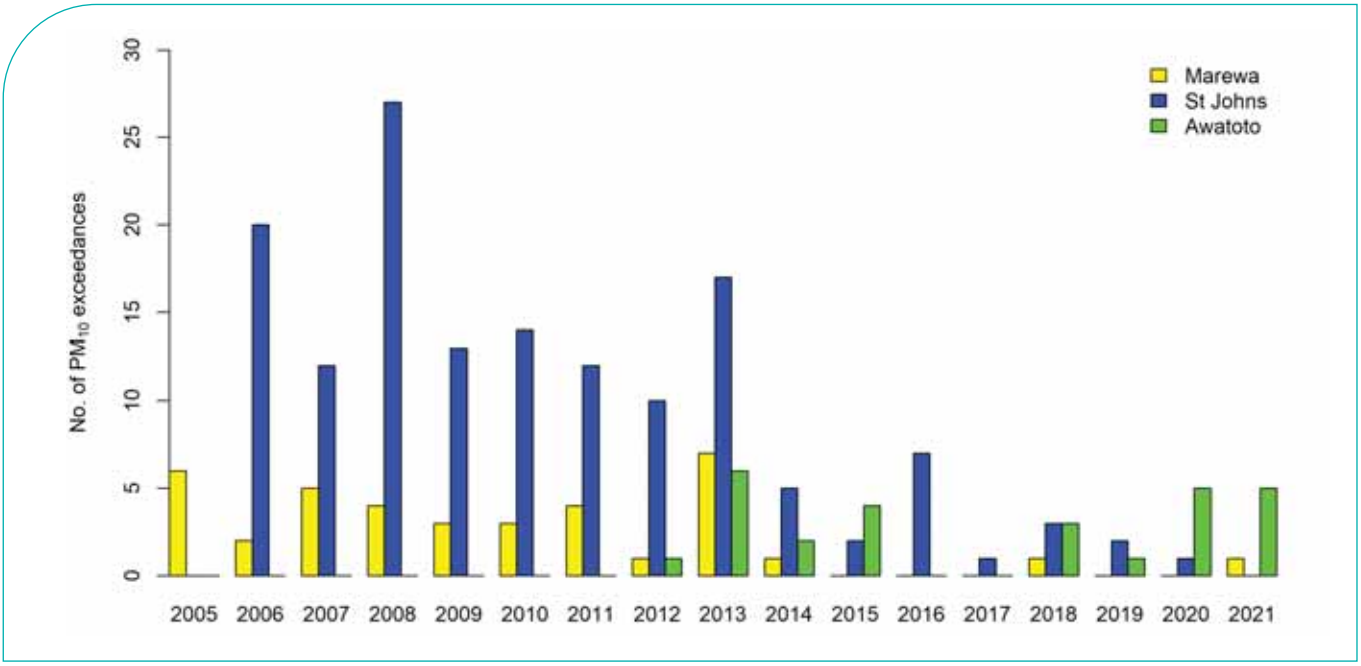


Figure 3-2. Exceedances of the NES-AQ for PM_{10} at Marewa Park (since 2005), St John's College (since 2006) and Awatoto (since 2012). Where no result is showing for a site after its establishment date, no exceedances were recorded that year.

An airshed is considered polluted if the average number of PM_{10} exceedances over the last five years is more than one per year. On that basis, the Napier airshed is not considered polluted. At this time unfortunately, the Hastings airshed is considered polluted, however if exceedances reduce to no more than one exceedance per year in 2022 and 2023, this will bring this airshed into the 'unpolluted' category.

Exceedances in the Awatoto airshed have typically ranged between zero and five. The monitor here is near the coast where much of the PM_{10} comes from natural sources, such as sea salt and wind-blown dust or soil. Wind direction, temperature, wave height, and swell direction are key influencers on particulate levels here. Their various influence can be determined by relating PM_{10} concentrations with properties of the sea and local weather using a machine learning technique.

PM_{10} data were revisited to evaluate whether exceedances change drastically when PM_{10} concentrations are compared against the new WHO guideline of 45µg/m^3. The number of exceedances does not change for Marewa Park for the last three years. St John's College still has no exceedances in 2021 but they increase in 2020 and 2019 to three and six respectively. Awatoto exceedances change the most, doubling in 2021 and increasing to nine and two in 2020 and 2019, respectively.

We have also monitored $PM_{2.5}$ at St John's College and Awatoto since 2016 and at Marewa Park since 2019. The WHO guideline for daily average $PM_{2.5}$ was 25µg/m^3 prior to September 2021, when it was lowered to 15µg/m^3. The WHO guideline allows for three exceedances of the limit per year.

Vandalism and theft at both Marewa Park and St John's College in 2020 and 2021 resulted in lost data, so it's possible that some recent exceedances may have been missed. To account for this, $PM_{2.5}$ concentrations have been calculated from PM_{10} and weather conditions based on the relationships among these factors in previous years at those sites. These relationships enable us to estimate $PM_{2.5}$ concentrations where data gaps exist as well as for years before we started $PM_{2.5}$ monitoring (Figure 3-3).

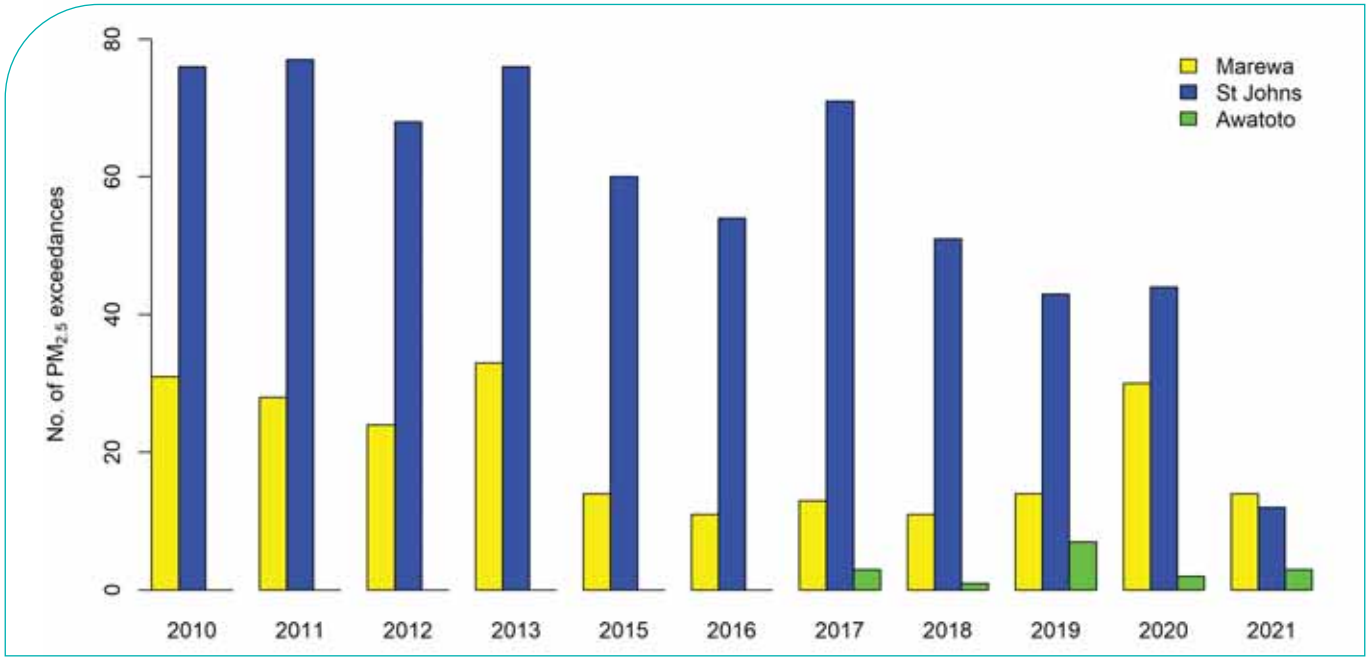


Figure 3-3. Exceedances of the new WHO guideline for daily average $PM_{2.5}$ at Marewa Park (since 2019), St John's College (since 2016) and Awatoto (since 2016). Models were used to estimate exceedances at Marewa Park and St John's College in 2020 and 2021 (vandalism affected data collection) and from 2010-2015 (before $PM_{2.5}$ monitoring began).

Awatoto would have achieved the new lower daily WHO $PM_{2.5}$ guideline for the last five years, except in 2019. Figure 3-3 shows that the new guideline poses a much greater challenge for the Napier and Hastings airsheds.

The WHO guidelines for *annual* (as opposed to daily) average PM_{10} and $PM_{2.5}$ are 15µg/m^3 and 5µg/m^3, respectively. We have not achieved the $PM_{2.5}$ annual guideline at the three sites in all the years of monitoring. We have achieved the PM_{10} guideline at Marewa Park and St John's College over the past five years but failed to meet it at Awatoto in 2020 and 2021.

In addition to measuring particulates in air, we also undertake emission inventories every five years in Napier, Hastings, and Havelock North. The inventories are estimates of the particulate levels emitted from various activities (for example from industry, transport, and wood burners used for home heating). The inventories do not account for natural sources of particulates. We focus primarily on winter emissions, when we observe the highest concentrations, so that we can see if there are any changes in emissions that help explain trends we observe.

The most recent inventory was conducted in 2020. Emissions in winter in Napier and Hastings dropped approximately 67% between the first inventory in 2005 and 2020 (Figure 3-4), although the largest declines occurred between 2005 and 2015. The reduction has been achieved mostly through changes in home heating methods. The Council required residents to phase out old wood burners by 1st January 2020 and provided financial support through its Heatsmart and Sustainable Homes schemes. The subsequent drop in emissions matches the decline in peak concentrations, which in Hastings went from 113µg/m^3 in 2006 to below 40µg/m^3 in winter 2021 (Figure 3-5).

The decline in peak concentrations over time at Marewa Park is closer to 50%. The site is nearer to the sea and has a higher proportion of natural or "uncontrollable" contributions to particulate concentrations than St John's College. The decline in particulates is therefore not as great as the reduction in emissions from human activities.

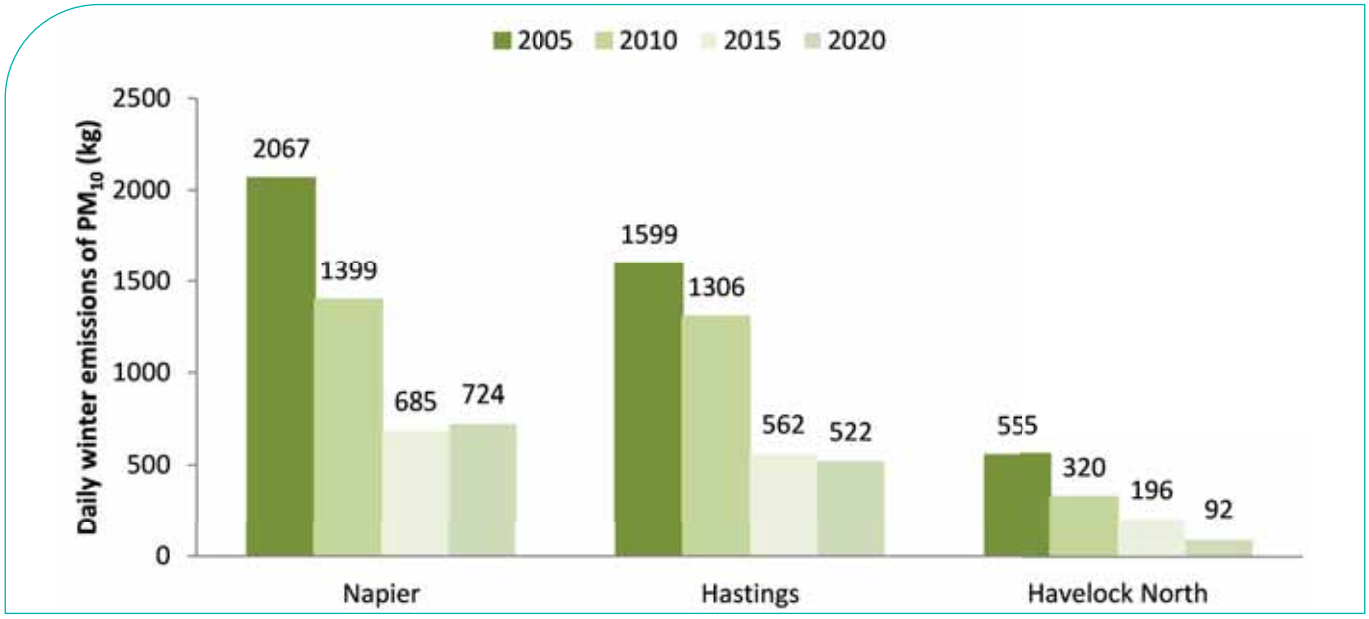


Figure 3-4. Emissions of PM_{10} on an average winter's night in Napier, Hastings, and Havelock North in 2005, 2010, 2015, and 2020.

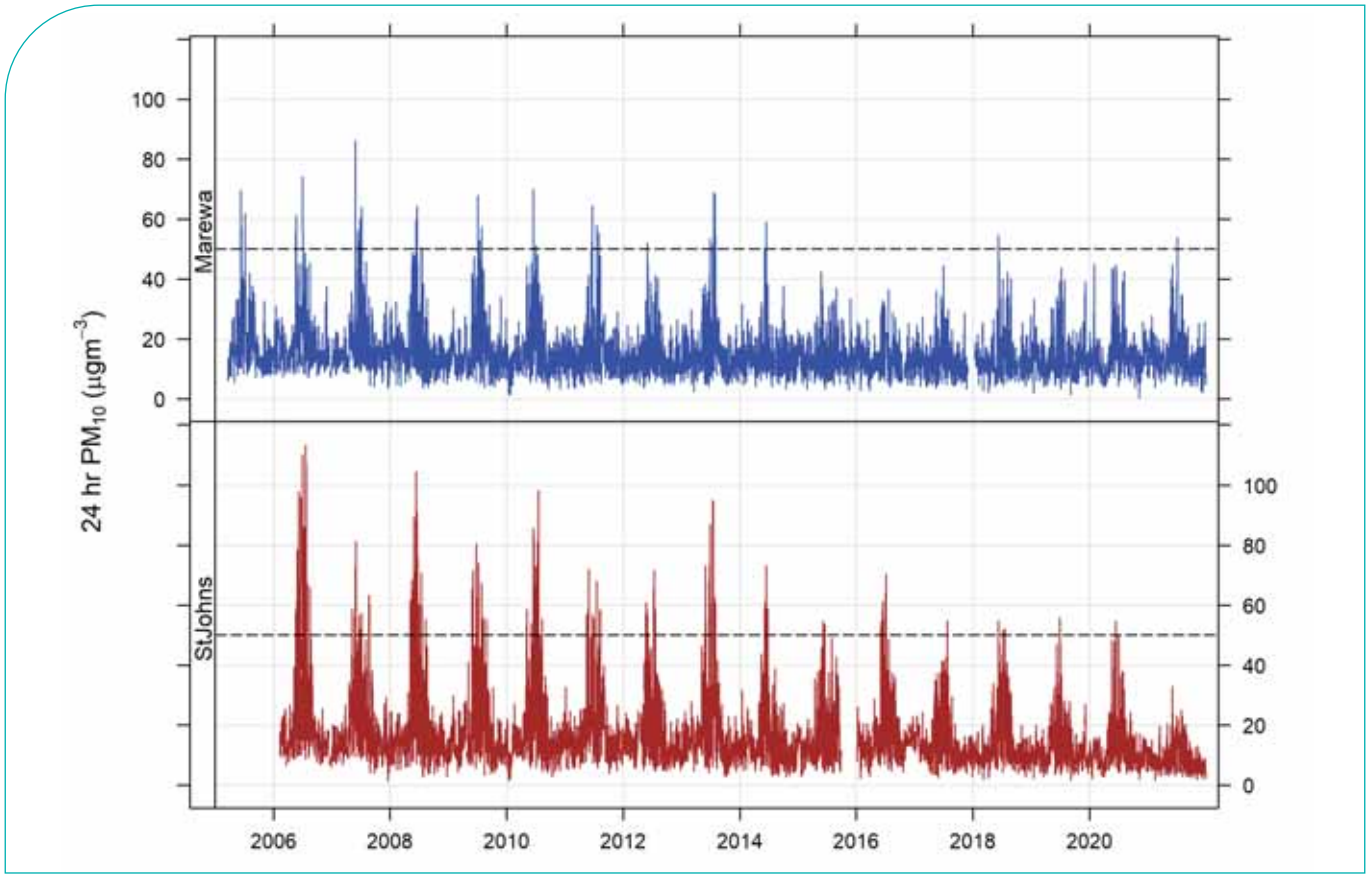


Figure 3-5. A time series of daily average PM_{10} concentrations at Marewa Park and St John's College. The dashed black line is the NES-AQ limit of 50µg/m^3.

HBRC's monitoring resources are limited given the size of the region. Therefore, we rely on Hawke's Bay residents to let us know when they encounter air pollution.

Weather plays a significant role in the levels of particulates and other pollutants. Rain, wind, and unstable air can remove pollutants or disperse them over a broad area. There are exceptions, such as when wind raises dust from the ground or carries pollen, sea salt, or volcanic gases into an area. However, concentrations are typically higher in calm and frosty conditions, when temperatures are colder at ground level than they are higher up (known as a temperature inversion). In this situation, there is limited mixing of air, and pollutants can accumulate if emissions continue.

We monitor temperature, humidity, wind speed, and wind direction at our air quality sites. Temperatures have increased over time, including during winter, while wind speed has dropped. These two forces may counteract each other to a certain degree. Reduced wind strength decreases dispersion, which can lead to increased pollutant concentrations. On the other hand, warmer temperatures are likely to decrease air pollution by reducing both the need to heat homes and the occurrence of temperature inversions.

Trends in humidity are mixed, with no trend detected at St John's College and an increase in humidity at the two coastal sites, Marewa Park and Awatoto.

The frequency of northeasterlies at St John's College and Awatoto has increased, and similarly, easterlies have become more frequent at Marewa Park, where Napier Hill influences wind flow. The frequency of northwest winds has decreased at St John's College and Awatoto, while at Marewa Park south to southwest winds have decreased.

This pattern is likely to increase sea salt contributions, particularly at Awatoto and Marewa Park due to their proximity to the coast, which in turn may counteract the reduced contribution to pollutants from human activities. This might explain why trends in particulates at St John's College have been more dramatic than at the other sites. It is also consistent with the trends in humidity observed at the two coastal sites.

Particulates are not our only measure of air quality. The NES-AQ also has limits for nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO) and ozone (O_3). These pollutant gases are typically associated with traffic or industrial processes. We monitor them at busy roadside locations in Napier and Hastings in winter, every four to five years.

We have most consistently monitored CO and NO_2 (Figure 3-6). The last occasion was in 2021 at Heretaunga Street West in Hastings and at the corner of Hyderabad and Taradale Roads in Napier. No exceedances of any of the NES-AQ gases were recorded since the monitoring began. Additionally, the results in 2021 all fell within the "Excellent", "Good" or "Acceptable" categories (or Performance Indicators) that the Ministry for the Environment recommends are used for reporting pollutant concentrations relative to the standards.

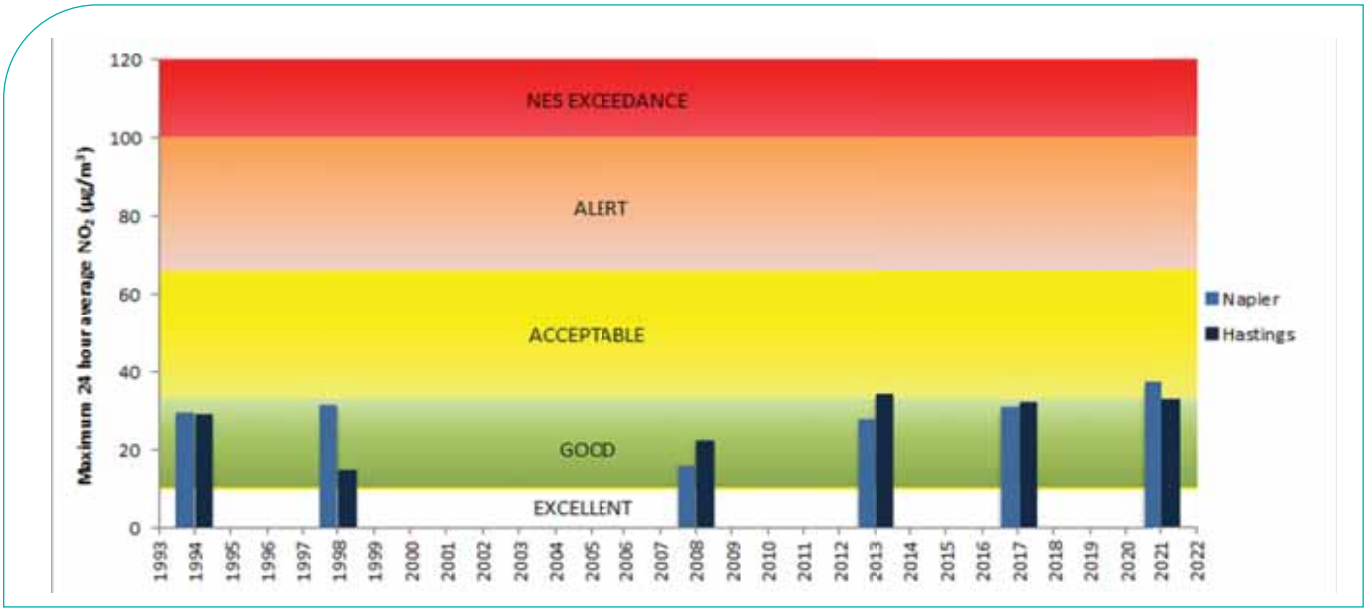


Figure 3-6. The maximum NO_2 24-hour average measured in Napier and Hastings, over a two-month period in winter in 1994, 1998, 2008, 2013, 2017, and 2021. The concentrations are compared to the Ministry for the Environment's Environmental Performance Indicators, which range from "Excellent" to "NES-AQ Exceedance".

While the results compare well to the NES-AQ and are also within the previous WHO guidelines (pre-September 2021), they do not meet the newly revised WHO guidelines. The most notable change in the WHO guidelines is the new NO_2 daily and annual average guidelines for our urban centres of 25µg/m^3 and 10µg/m^3, respectively. We exceeded the daily guideline more than twenty times in Napier and four times in Hastings during the two months of monitoring in 2021. The average daily NO_2 concentration of 21µg/m^3 and 16µg/m^3 in Napier and Hastings, respectively, raises concern that we might exceed the annual guideline if we monitored year-round.

HBRC's monitoring resources are limited given the size of the region. Therefore, we rely on Hawke's Bay residents to let us know when they encounter air pollution. Figure 3-7 shows the type and geographical spread of incidents reported to the Council over the last few years. The number of complaints increased between 2015 and 2020 due to a rise in reports of an objectionable odour from a single source (Figure 3-8). This shows the impact that local activity can have on the wellbeing of the surrounding neighbourhood.

Our targets for air pollution can change in response to new research on the health effects of air pollution. The NES-AQ for air quality is currently under review and decisions about new standards will be made with the new WHO guidelines in mind.

We have made good advances in reducing the levels of fine particulates in our urban centres and have otherwise met the health criteria for NES-AQ gases. However, the new WHO guidelines shift the goalposts significantly. The levels of natural particulate sources in the region may make the annual $PM_{2.5}$ guideline especially difficult to achieve.

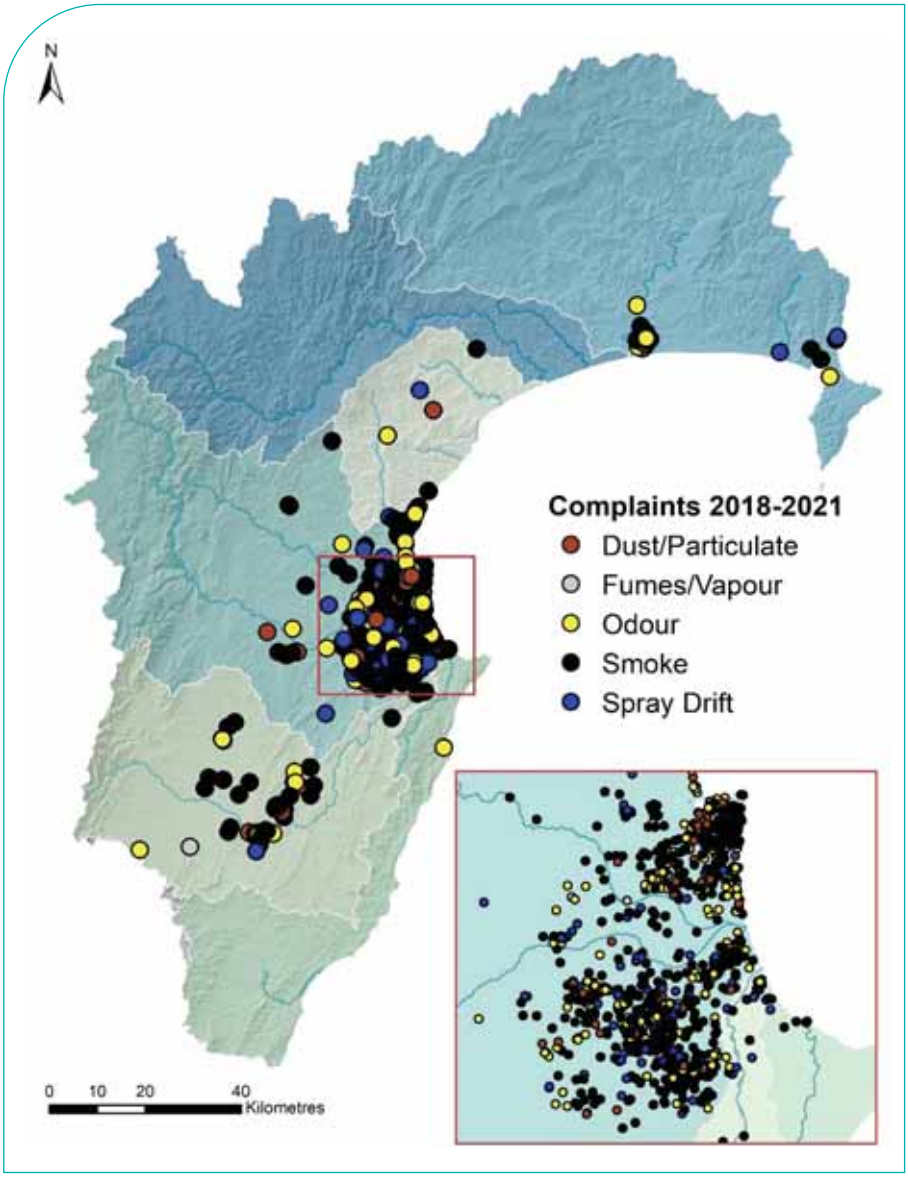


Figure 3-7. Air pollution complaints to the Council between 2018 and 2021, categorised by the subject of the complaint.

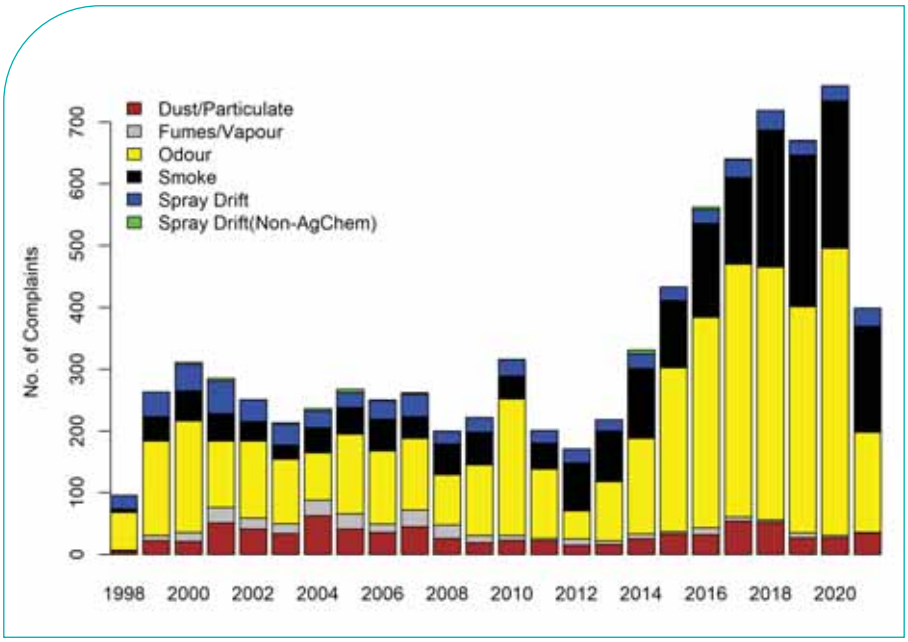


Figure 3-8. The annual number of complaints about air pollution to the Council, categorised by the subject of the complaint.