Yanchep Rail Extension Part 2

Public Transport Authority

Qualitative Air Quality Assessment

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Contents

Executive Summary

The Public Transport Authority (PTA) proposes to extend a future connection of the Northern Suburbs Railway by 7.2 kilometers, from north of the future Eglinton Station to the suburb of Yanchep in the City of Wanneroo. The extension of railway to Yanchep is referred to as the Yanchep Rail Extension (YRE), with the portion from Eglinton Station to Yanchep described as YRE Part 2.

This report provides a qualitative assessment of the net benefits associated with air quality expected due to the construction of YRE Part 2. The assessment involved reviewing local meteorological and air quality conditions near the region serviced by the YRE Part 2, in combination with road traffic data, to identify potential air quality impacts. The qualitative assessment did not include air dispersion modelling.

Large increases in rail commuter demand are predicted due to the urban growth anticipated in the Yanchep area. Without the construction of YRE Part 2, commuters travelling from or to Yanchep will need private motor vehicles or bus transport to connect to the northernmost rail station at Eglinton. Therefore, it is reasonable to assume that without the extension of the rail line to Yanchep, the main road routes between Yanchep and the new Eglinton station would see significantly increased traffic volumes and increased congestion.

The main air quality impact of the increased demand for traffic volumes and consequential congestion would likely be seen along the main corridor of Marmion Ave between Yanchep and Eglington. Sensitive locations such as residences close to the main road may experience increased concentrations of vehicle-derived pollutants, especially those to the north and west of the route. However, these increased concentrations are unlikely to be significant in the context of the national ambient air quality standards for carbon monoxide (CO) and nitrogen dioxide (NO_2).

Concentrations of particles less than 10 microns in diameter (PM_{10}) and particles less than 2.5 microns in diameter ($PM_{2.5}$) would be expected to increase. The more congested the traffic, the less efficiently vehicle engines operate and the greater the emissions of pollutants per kilometer travelled. Particles assessed or measured as $PM_{2.5}$ and PM_{10} are higher risk pollutants, primarily due to the high background levels that occur occasionally, especially during smoky conditions when affected by fires outside the area surrounding the YRE Part 2 development envelope (Area of Focus). Also, emissions of key hydrocarbon air pollutants such as formaldehyde and benzene may increase during congested conditions.

In conclusion, the effect of the proposed YRE Part 2 for the Area of Focus is expected to be both reduced traffic congestion and reduction in number of vehicle trips between Yanchep and Eglinton. This will be better than the comparative air quality situation with the scenario where only Part 1 of the YRE is constructed, for these reasons:

- Fewer motor vehicles will use the main corridor routes between Yanchep and Eglinton.
- Air pollutant emissions will be reduced from more efficiently operating motor vehicle engines, both on the main corridor routes and on feeder roads and at intersections with the main corridor routes.
- Faster moving traffic will reduce the time that vehicles spend in the Area of Focus, reducing the air pollutant load.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs Group (Australia) Pty Ltd (“JACOBS”) is to provide a qualitative air quality impact assessment for the project “Part 2 of the Yanchep Rail Extension” in accordance with the scope of services set out in the contract between JACOBS and the Public Transport Authority (Contract PTA180505). That scope of services, as described in this report, was developed with the Public Transport Authority.

In preparing this report, JACOBS has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Public Transport Authority and/or from other sources. Except as otherwise stated in the report, JACOBS has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

JACOBS derived the data in this report from information sourced from the Public Transport Authority (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. JACOBS has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by JACOBS for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of the Public Transport Authority, and is subject to, and issued in accordance with, the provisions of the agreement between JACOBS and the Public Transport Authority. JACOBS accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

1.1 Project Background

The Public Transport Authority (PTA) proposes to extend a future connection of the Northern Suburbs Railway by 7.2 kilometers, from north of the future Eglinton Station to the suburb of Yanchep in the City of Wanneroo. The proposal is to construct and operate the rail extension and one new intermodal – rail, bus, 'park and ride', 'kiss and ride, walk and cycle – transit station at Yanchep.

The extension of the Northern Suburbs Railway to Yanchep is referred to as the Yanchep Rail Extension (YRE), with the portion from Eglinton Station to Yanchep described as YRE Part 2. The proposed route for YRE Part 2 is shown in Figure 1.

The PTA has requested a qualitative assessment of air quality net benefits expected from YRE Part 2, due to reduced road vehicle travel based on modelling and the increased use of public transport; i.e., mode shift from road to train. For the purpose of this assessment the area surrounding the YRE Part 2 development envelope is identified as the Area of Focus, as shown in Figure 1.

1.2 Scope of Works

This report provides a qualitative air quality impact assessment of the air quality net benefits expected due to the construction of the YRE Part 2. The assessment involved reviewing local meteorological and air quality conditions near the Area of Focus, in combination with road traffic data, to identify potential air quality impacts. No air dispersion modelling was undertaken.

The assessment considered some meteorological and ambient air quality data near but not inside the Area of Focus, because meteorological and ambient air quality conditions inside and just outside the Area of Focus are expected to be similar.

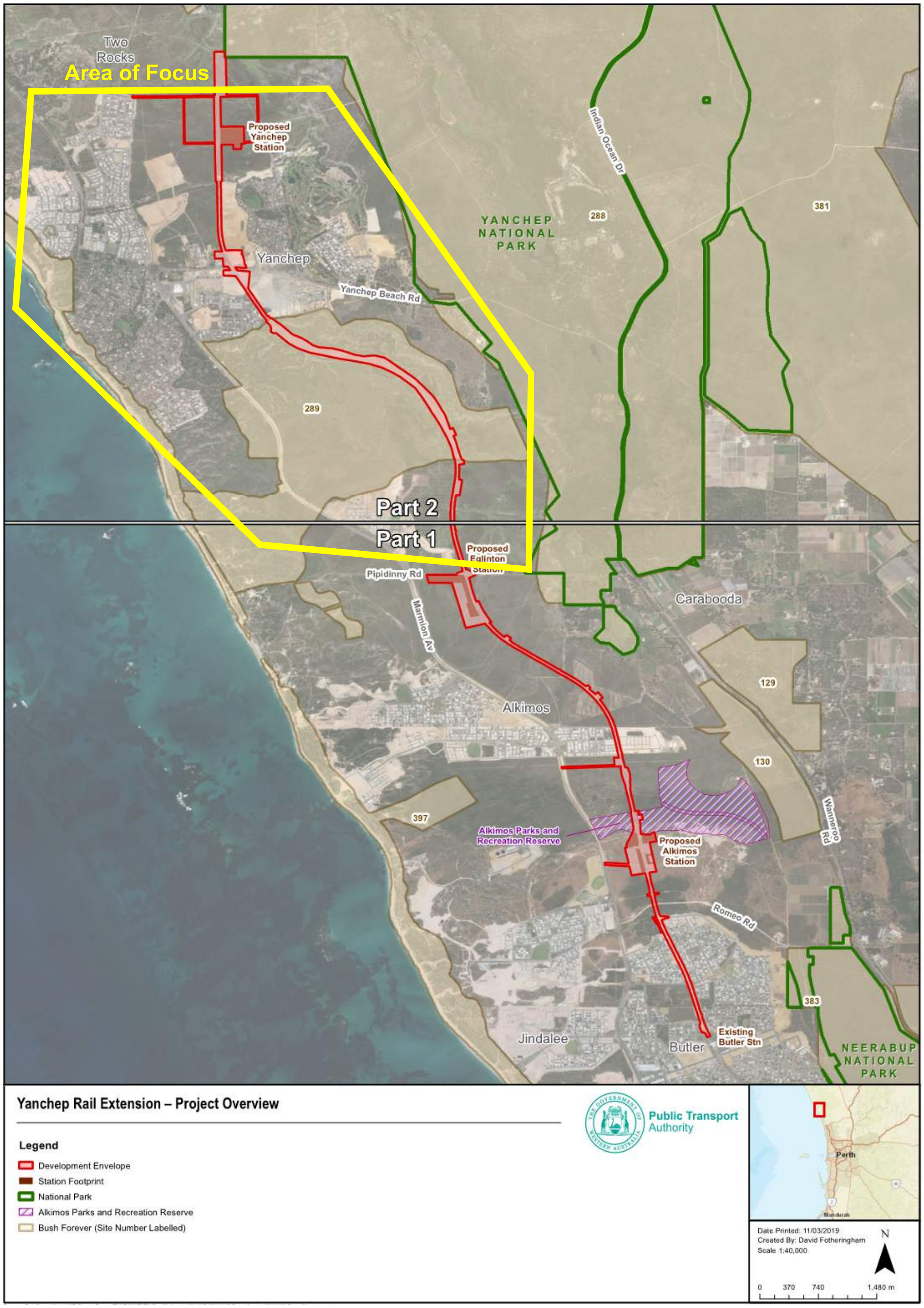

Figure 1: Area of Focus – YRE Part 2 (PTA, 2019) – Area of Focus highlighted by yellow polygon.

2. Air Quality Pollutants and Criteria

2.1 Air Pollutants from Vehicles

'Criteria' air pollutants are used in Australia and around the world as key indicators of ambient air quality. Air quality standards set for these pollutants are based on criteria that relate to the preservation of human health and other environmental effects. Australia's national standards for six criteria air pollutants in outdoor (ambient) air, are: carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ozone, particles less than 10 microns in diameter (PM_{10}), particles less than 2.5 microns in diameter ($PM_{2.5}$), and sulfur dioxide (SO_2) (Australian Government, 2017a).

Motor vehicles are major sources of carbon monoxide (CO) and oxides of nitrogen (NO_x) in urban airsheds in Australia. Nitrogen dioxide (NO_2) is a component of NO_x that is harmful to human health. Also, motor vehicles are significant emitters of Volatile Organic Compounds (VOCs) or hydrocarbons, and PM_{10} and $PM_{2.5}$.

Therefore, criteria pollutants typically relevant for emissions from motor vehicles are CO, NO_2, PM_{10} and $PM_{2.5}$. Lead in petrol is no longer an environmental issue in Australia. Sulfur levels in diesel are now low, therefore SO_2 is a low risk air pollutant with respect to emissions from motor vehicles.

Photochemical smog, as indicated by higher ozone (O_3) concentrations, is formed by NO_x, VOCs and other pollutants in the presence of sunlight. Emissions of PM_{10}, and similarly $PM_{2.5}$, contribute to the formation of smog in the cooler months.

2.2 Relevant Air Quality Criteria

The National Environment Protection (Ambient Air Quality) Measure (Air NEPM) provides criteria for pollutants. Table 1 details the air quality pollutants and the maximum concentration standards, which are used to assess ambient air quality to protect human health and wellbeing.

In addition to the list in Table 1, the Air NEPM includes a goal to move to $PM_{2.5}$ standards of 20 micrograms per cubic meter ($\mu g/m^3$) (1 day average) and 7 $\mu g/m^3$ (1 year average) by 2025.

Air NEPM standards are intended to be applied at performance monitoring locations that represent air quality for a region or sub-region of 25,000 people or more. Importantly, the standards are not relevant to air emissions from individual sources, specific industries or roadside locations. The Department of Water and Environmental Regulation of Western Australia (DWER) conducts ambient monitoring in accordance with Air NEPM requirements. These monitoring sites and relevant data for this air quality assessment are discussed in Section 3.1.

Table 1: Air NEPM Standards for Pollutants

Pollutant	Averaging period	Maximum concentration (parts per million or micrograms per cubic metre)
Carbon monoxide	8 hours	9.0 ppm
Nitrogen dioxide	1 hour 1 year	0.12 ppm 0.03 ppm
Photochemical oxidants (as ozone)	1 hour 4 hours	0.10 ppm 0.08 ppm
Sulfur dioxide	1 hour 1 day 1 year	0.20 ppm 0.08 ppm 0.02 ppm
Lead	1 year	0.50 µg/m^3
Particles as PM_{10}	1 day 1 year	50 µg/m^3 25 µg/m^3
Particles as $PM_{2.5}$	1 day 1 year	25 µg/m^3 8 µg/m^3

3. Local Environment

3.1 Topography and Meteorology

The city of Perth lies on a coastal plain which has gently undulating terrain rising to about 40 meters (m) above sea level. The coastal plain is about 25 kilometers (km) wide and is bounded on its eastern side by the north-south oriented Darling Escarpment, which rises to about 300m above mean sea level (DER, 2001). This regional topography is illustrated in Figure 2, which also shows the location of the YRE Part 2 route, and four meteorological monitoring stations operated by Bureau of Meteorology (BOM) near the Area of Focus.

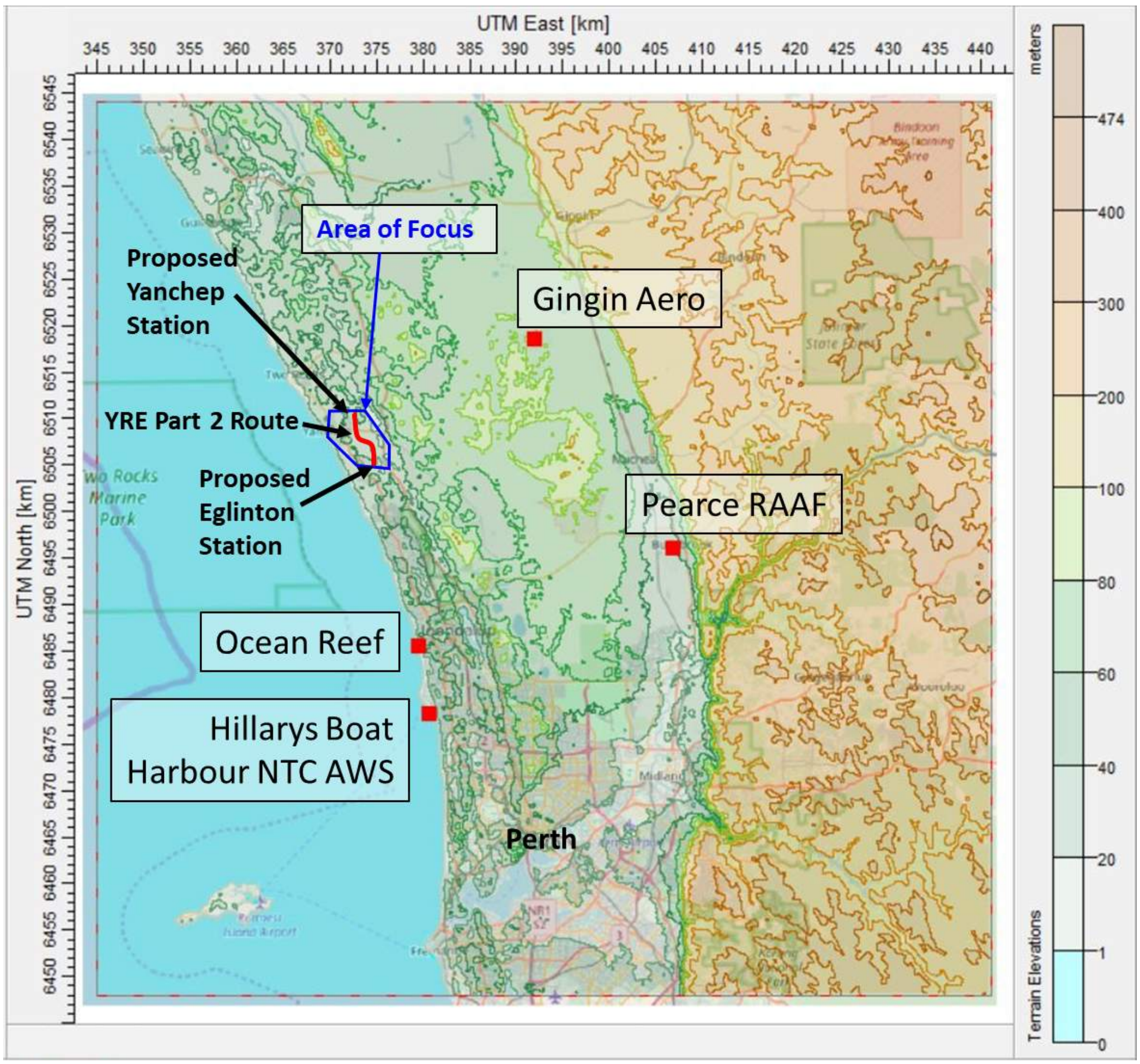

Figure 2: Regional Topography and Meteorological Monitoring Stations (red squares) around the Area of Focus. Map source: CALPUFF View (Lakes Environmental).

Local winds are important for the dispersion of air pollutants. In general, the prevailing winds at a particular location are usually related to larger scale weather systems. These can cause local air quality impacts by transporting air pollution from sources outside the locality, such as bushfires. Sea breezes can be important for affecting air pollutant concentrations in coastal areas, and land breezes created by significant terrain elevations can also be important. Calm periods or light winds, for example occurring at night and in the early morning and evening, can influence air quality impacts due to local sources; e.g., road traffic, by not properly dispersing the emissions.

Hourly records of wind speed and direction for the four meteorological monitoring stations shown in Figure 1 were purchased from the BOM. Wind-roses summarizing hourly average wind speed and direction for the period January 2013 to December 2018 are shown on Figure 3. The Ocean Reef station displays higher wind speeds than the other stations, likely influenced by local coastal exposure and not representative of the broader Area of Focus. Of these four stations, the Gingin Aero station is likely to most closely represent typical wind conditions around the urban areas between Eglinton and Yanchep in the Area of Focus.

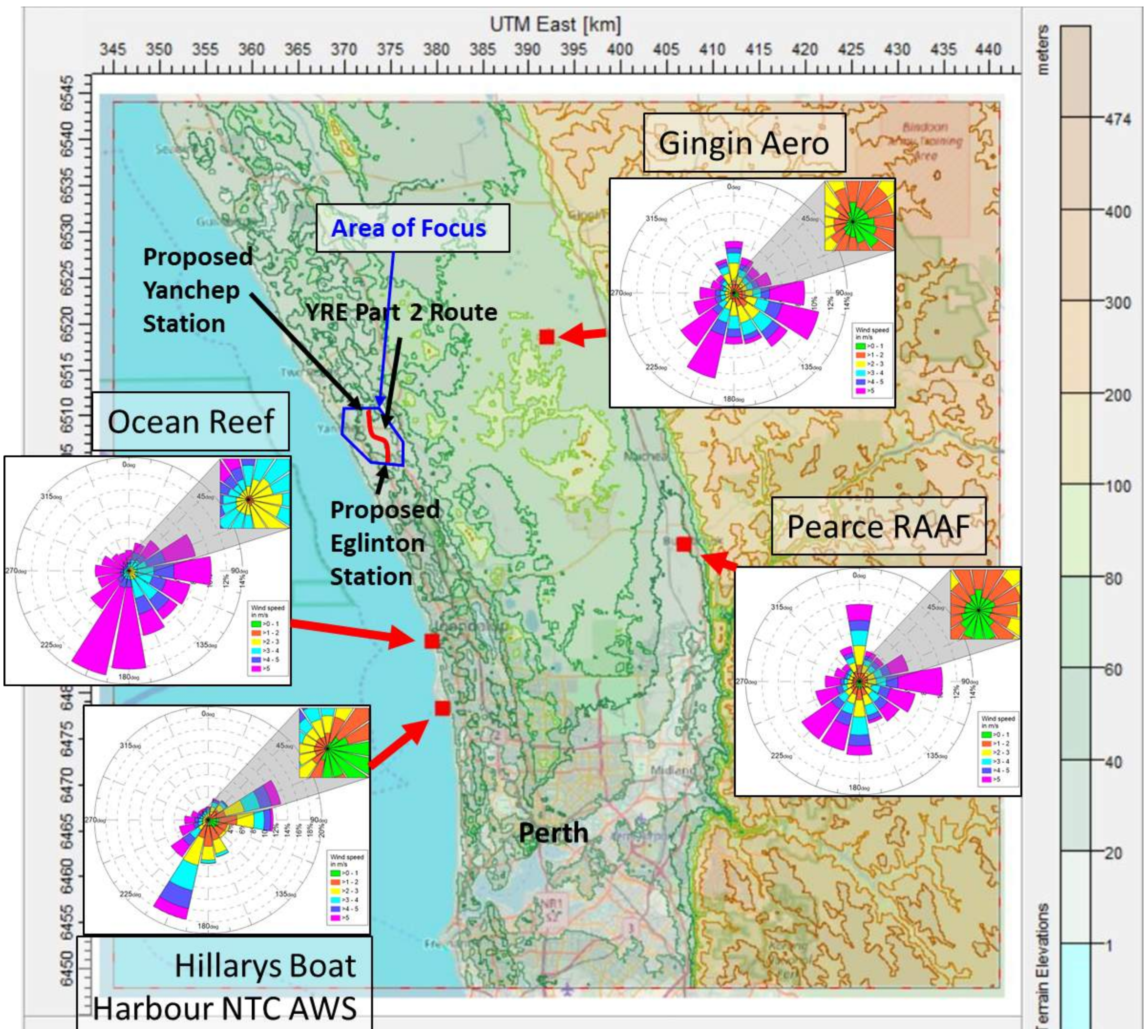

Figure 3: Wind speed and direction distributions at BOM monitoring stations near Area of Focus. For wind speed legend, refer Figure 4.

The Gingin Aero station wind-rose is shown in larger view in Figure 4. Light winds, less than approximately 2 m/s, occur predominantly from the sectors comprising winds from the north around to the south-southeast, which would cause emissions from vehicle traffic to be carried south through to north-northwest. Sensitive receptors on the eastern side of a heavily trafficked road are less likely to be downwind of the vehicle emission sources in these cases.

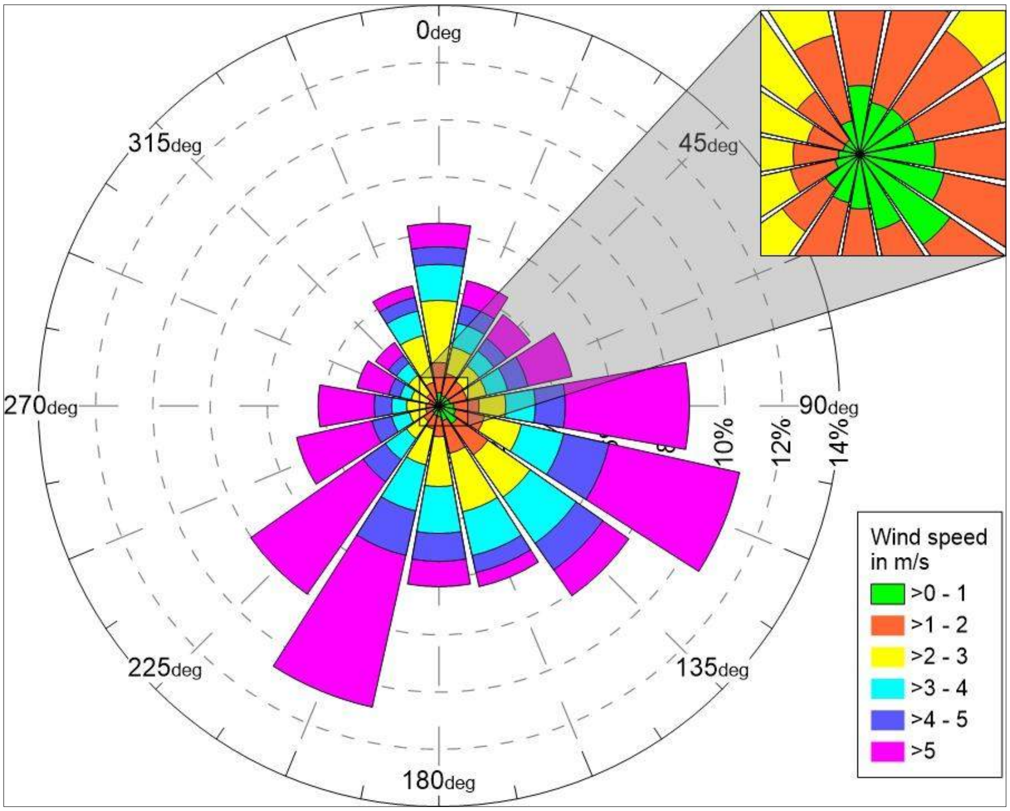

Figure 4: Wind-rose for Gingin Aero, showing distribution of hourly average wind speed and direction records for January 2013 to December 2018.

3.2 Background Air Quality

DWER operates 13 ambient air quality monitoring stations in Western Australia, eight of these in the Perth region, for the purpose of monitoring air quality under the Air NEPM requirements. The eight stations within the Perth region are sited in a range of locations with varying local air emission sources and receiving environments, shown in Figure 5.

The Duncraig site is described by DWER as representative of air quality in a receiving environment near a major road with moderate to high traffic flows. The Duncraig site is located in a north metropolitan suburb 16km north-northwest of the Perth CBD with moderate/high density housing and moderate to high traffic flow. The site is located 200m west of the Mitchell freeway, which is described in DWER (2018) as *"a main north-south arterial road carrying approximately 98000 vehicles daily".* Of the eight air quality monitoring sites in the Perth region, this site was considered by Jacobs to most closely represent potential future ambient air quality close to major routes in the Area of Focus, due to the proximity to a major traffic route and the absence of nearby major industrial emissions.

Figure 5: DWER-operated ambient air quality monitoring stations in the Perth region. Source: DERM website https://www.der.wa.gov.au/your-environment/air/air-quality-data

The Duncraig site measures the pollutants CO, NO_2, PM_{10} and $PM_{2.5}$. Ambient air quality monitoring data statistics for the Duncraig site, as reported in DERM (2018), are provided in Appendix 1. Over the last 10 years, concentrations of CO and NO_2 measured at the Duncraig site have declined, however the same trend is not seen in the PM_{10} and $PM_{2.5}$ data which has remained relatively consistent.

Maximum measured CO and NO_2 concentrations at the Duncraig site are well below the Air NEPM standards.

However, peak PM_{10} and $PM_{2.5}$ concentrations measured at Duncraig each year exceed the Air NEPM standards. Exceedances are investigated by DERM and often are attributed to bush fires or burn offs (DER (2016), DERM (2017) and DERM (2018)). However, particulate emissions from motor vehicles can contribute to the magnitude of exceedences, if meteorological conditions are unfavourable for dispersion (especially in light or calm winds).

4. Traffic Emission Assessment

4.1 Existing Primary Transport Routes

The north-west sub-region (NWSR) of the Perth Metropolitan area is one of the fastest growing regions in Australia. Transportation within the northern section of the NWSR corridor is characterized by high levels of car use relative to public transport for both travel within the corridor and for travel to other areas. The primary routes are Marmion Avenue and Wanneroo Road, and further to the south the Mitchell Freeway. Marmion Avenue and Wanneroo Road are shown on Figure 1. This northern section of the NWSR corridor includes the areas shown in Figure 1 for both YRE Part 1 and YRE Part 2.

These routes are already highly congested in the morning and afternoon peaks. Congestion is expected to increase with Yanchep's increasing population even with a proposed northern extension of the Mitchell Freeway (not shown on Figure 1); the road network connecting the northern suburbs to central Perth will be less able to accommodate increasing demand for car trips originating from the Yanchep Two Rocks area (METRONET, 2018).

4.2 Vehicle Travel Avoided Due to Project

Transport modelling estimates provided by the Project Team do not differentiate between the influence of YRE Part 1 and YRE Part 2. The estimated savings in vehicle journeys forecast for the year 2030/31, expressed in terms of kilometers travelled per year by vehicle class (Vehicle Kilometers Travelled, or 'VKT'), are summarized in Table 2. The negative value shown for Buses in Table 2 indicates an increase in VKT for buses due to introduction of new public transport routes and/or more frequent buses on existing routes.

Table 2: Forecast of vehicle trips avoided due to implementation of both YRE Part 1 and YRE Part 2, 2030/31 (source: METRONET, 2018)

Transport mode	VKT avoided (millions), 2030/31
Car	111.1
Light commercial vehicle (LCV)	5.5
Heavy commercial vehicle (HCV)	0.8
Bus	-2.6

The scope of this air quality assessment is limited to YRE Part 2, however the VKT avoided due to this portion of the YRE alone are not available.

5. Qualitative Air Quality Assessment

Large increases in rail commuter demand are predicted due to the growth anticipated in the Yanchep area. Without the construction of YRE Part 2, commuters travelling from or to Yanchep will need private motor vehicles or bus transport to connect to the northernmost rail station at Eglinton. Therefore, it is reasonable to assume that without the extension of the rail line to Yanchep, the main routes between Yanchep and the new Eglinton station would see significantly increased road traffic volumes and increased congestion.

5.1 Scenario without the implementation of YRE Part 2

The main air quality impact of the increased demand for traffic volumes and consequential congestion would likely be seen along the main corridor of Marmion Ave between Yanchep and Eglington.

Sensitive locations such as residences close to the main road would likely experience increased concentrations of vehicle-derived pollutants, although based on the ambient air quality monitoring data presented earlier for Duncraig these increased concentrations are unlikely to be significant in the context of the Air NEPM criteria for CO and NO_2.

For this scenario concentrations of PM_{10} and $PM_{2.5}$ in the Area of Focus would be expected to increase, with the magnitude of the increase depending on the severity of congestion. The more congested the traffic, the less efficiently vehicle engines operate and the greater the emissions of pollutants per kilometer travelled.

Particles as $PM_{2.5}$ and PM_{10} are therefore assessed as ‘higher risk’ pollutants, primarily due to the high background levels that occur occasionally, especially during smoky conditions when affected by fires outside the Area of Focus.

There is less information about hydrocarbon levels, however it is reasonable to assume concentrations of higher risk hydrocarbons such as formaldehyde and benzene would increase with increases in road traffic and congestion.

5.2 YRE Part 2 Conclusion

YRE Part 2 is expected to reduce both traffic congestion and the number of vehicle trips between Yanchep and Eglinton. This will improve the air quality situation for the Area of Focus in comparison with the scenario where only YRE Part 1 is constructed, for these reasons:

- Fewer motor vehicle trips on the main corridor routes between Yanchep and Eglinton.
- Air pollutant emissions will be reduced from more efficiently operating motor vehicle engines, both on the main corridor routes and on feeder roads and at intersections with the main corridor routes.
- Faster moving traffic will reduce the time that vehicles spend in the Area of Focus, reducing the air pollutant load.

6. References

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Department of Water and Environmental Regulation (DWER) (2017): *2016 Western Australia air monitoring report"*, July 2017.

Department of Water and Environmental Regulation (DWER) (2018): *2017 Western Australia air monitoring report"*, July 2018.

METRONET (2018): *Yanchep Rail Extension Infrastructure Australia Final Submissio*n, Government of Western Australia.

Public Transport Authority (2019), Figure - Yanchep Rail Extension Project Overview.

Appendix A. Ambient Air Quality Monitoring Data for Duncraig DERM Monitoring Site

Tables and Graphs showing trend data for Duncraig – source: DERM (2018).

Table D10: Daily peak eight-hour carbon monoxide at Duncraig (2008–2017)
Trend station/region: Duncraig

AAQ NEPM standard
9.0 ppm (eight-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2008	99.0	0	3.1	1.9	1.7	1.4	1.0
2009	98.2	0	2.6	1.7	1.4	1.0	0.7
2010	87.5	0	2.3	2.0	1.8	1.5	1.1
2011	99.3	0	1.9	1.3	1.2	1.0	0.7
2012	99.5	0	2.4	1.9	1.5	1.1	0.9
2013	99.5	0	2.1	1.8	1.6	1.2	0.8
2014	99.7	0	1.9	1.4	1.0	0.8	0.7
2015	99.5	0	1.7	1.4	1.3	1.0	0.7
2016	99.8	0	1.4	1.2	1.1	0.8	0.7
2017	96.9	0	1.4	1.1	0.9	0.8	0.6

Table D13: Daily peak one-hour nitrogen dioxide at Duncraig (2008–2017)
Trend station/region: Duncraig

AAQ NEPM standard
0.12 ppm (one -hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (ppm)	99th percentile (ppm)	98th percentile (ppm)	95th percentile (ppm)	90th percentile (ppm)
2008	97.7	0	0.038	0.034	0.030	0.029	0.027
2009	98.5	0	0.042	0.037	0.034	0.030	0.027
2010	87.5	0	0.038	0.035	0.033	0.030	0.028
2011	99.3	0	0.035	0.032	0.030	0.028	0.027
2012	96.8	0	0.047	0.037	0.033	0.030	0.027
2013	97.9	0	0.040	0.031	0.030	0.028	0.026
2014	99.3	0	0.048	0.029	0.028	0.026	0.024
2015	98.2	0	0.036	0.034	0.032	0.028	0.026
2016	99.8	0	0.033	0.029	0.028	0.026	0.024
2017	98.2	0	0.032	0.031	0.030	0.027	0.026

Table D38: Daily peak 24-hour particles as PM_{10} at Duncraig (2008–2017)
Trend station/region: Duncraig

AAQ NEPM standard
50 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (µg/m³)	99th percentile (µg/m³)	98th percentile (µg/m³)	95th percentile (µg/m³)	90th percentile (µg/m³)
2008	99.2	0	46.9	34.4	31.1	25.8	21.9
2009	99.2	0	45.5	36.2	30.4	24.5	22.6
2010	99.4	0	47.9	33.1	30.8	25.1	22.7
2011	99.3	1	**65.9**	30.1	29.5	25.7	23.2
2012	99.4	2	**89.5**	35.5	28.3	26.1	23.0
2013	99.3	0	37.6	32.1	28.1	25.6	22.8
2014	99.4	1	**53.0**	31.2	28.1	25.1	22.4
2015	99.4	1	**82.7**	40.1	36.7	28.0	25.2
2016	99.6	0	40.0	34.2	29.7	25.8	21.8
2017	98.4	1	**51.4**	33.4	30.1	26.4	22.5

Bold numerals indicate where a relevant standard has been exceeded

Table D45: Daily peak 24-hour particles as $PM_{2.5}$ at Duncraig (2008–2017)
Trend station/region: Duncraig

AAQ NEPM standard
25 µg/m³ (24-hour average)

Year	Data recovery (%)	No. of exceedences (days)	Max conc. (µg/m³)	99th percentile (µg/m³)	98th percentile (µg/m³)	95th percentile (µg/m³)	90th percentile (µg/m³)
2008	99.3	1	**38.3**	18.0	15.9	12.6	11.1
2009	99.4	3	**32.7**	22.1	17.5	13.2	11.5
2010	99.3	3	**36.4**	20.1	15.9	13.7	12.0
2011	99.4	1	**52.1**	14.7	13.4	11.5	10.4
2012	97.5	3	**77.3**	22.0	14.4	12.7	11.0
2013	98.5	0	18.7	15.6	14.4	12.7	11.4
2014	99.7	1	**47.6**	16.8	15.3	13.0	11.0
2015	99.6	3	**35.8**	22.9	18.3	15.2	12.9
2016	99.4	1	**27.0**	15.9	15.4	12.0	10.9
2017	98.5	3	**40.5**	22.9	19.0	14.2	11.5

Bold numerals indicate where a relevant standard has been exceeded

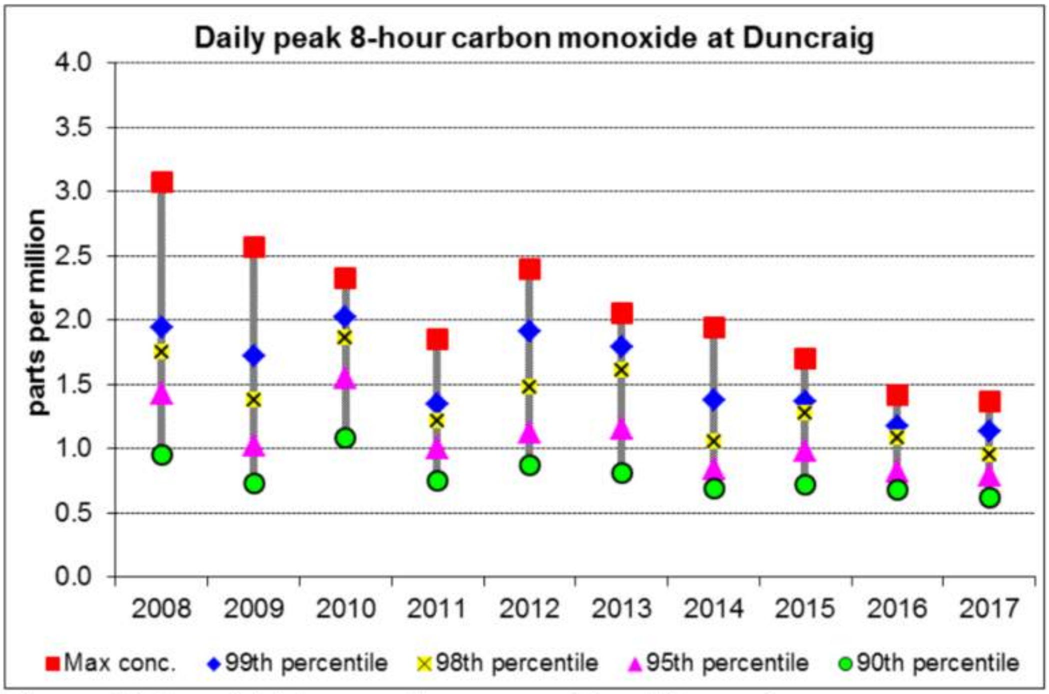

Figure E1-2 – eight-hour carbon monoxide at Duncraig

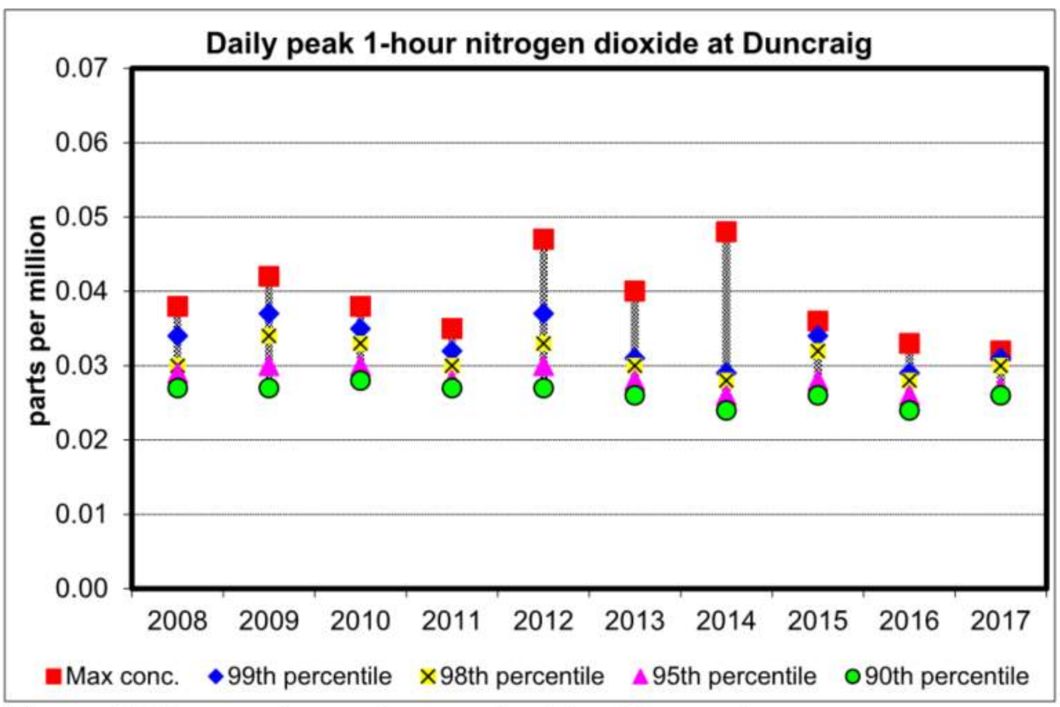

Figure E2-2 – one-hour nitrogen dioxide at Duncraig

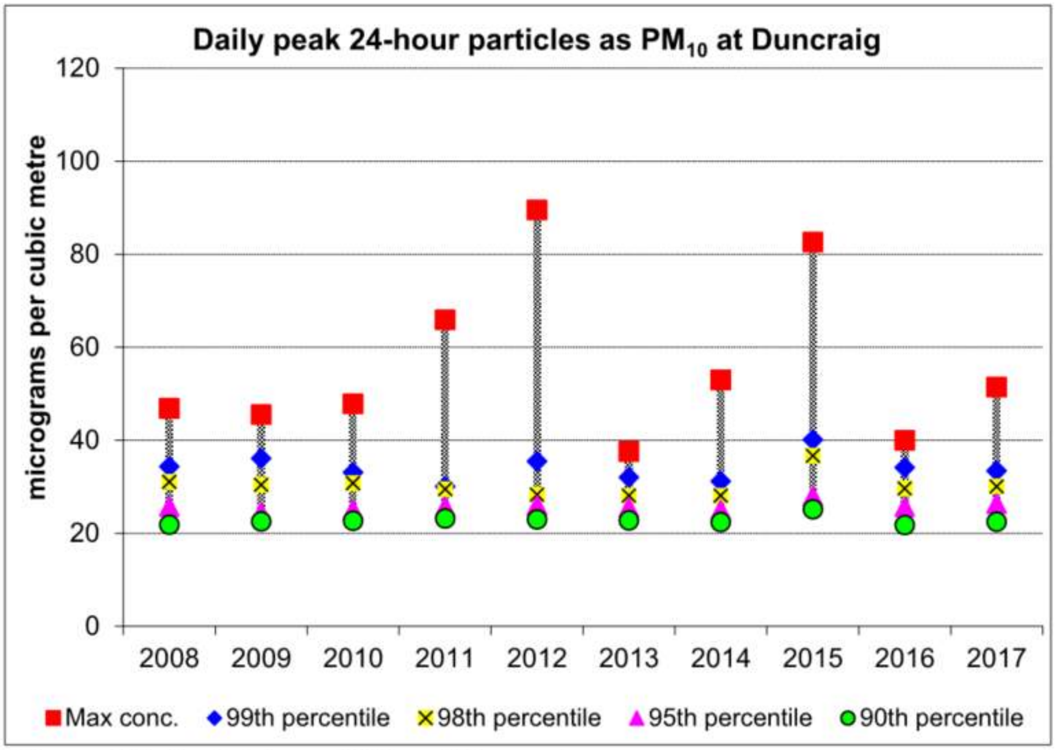

Figure E5-5 – 24-hour PM_{10} at Duncraig

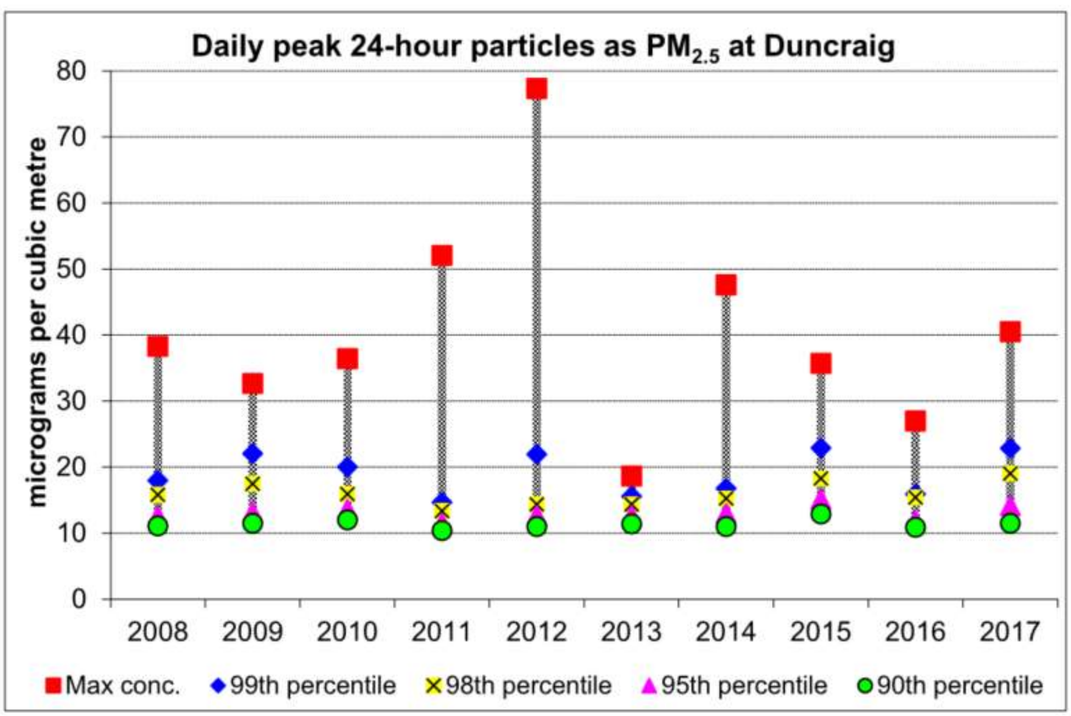

Figure E6-4 – 24-hour $PM_{2.5}$ at Duncraig