Supplementary information

Provided in conjunction with the
advice of the Environmental Protection Authority
to the Minister for Environment
under Section 16(e) of the
Environmental Protection Act 1986

on

Consideration of potential health and amenity impacts of dust in determining the size of a buffer for urban development in the Mandogalup area

June 2017

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1 Introduction

In June 2016, the Environmental Protection Authority (EPA) was requested to provide independent environmental advice concerning:

> *the size of the buffer relating to health and amenity impacts of dust now and into the future in respect to potential urban development in the Mandogalup area.*

Consistent with its functions under the *Environmental Protection Act 1986* (the EP Act), the EPA has capacity to provide advice to the Minister for Environment on environmental matters generally, and on any matter which the Minister may refer to it for advice. The former Minister for Environment asked the EPA to provide advice under section 16(e) of the EP Act.

This report provides the supplementary information and analysis which formed the basis of the EPA's advice to the Minister for Environment under section 16(e) (EPA 2017).

1.1 Background

In October 2015, the draft Planning and Development Legislation Amendment (Western Trade Coast Protection Area) Bill 2015 was tabled in Parliament. The Western Trade Coast Protection Area encompasses the industrial area known as the Western Trade Coast (WTC), which includes the Kwinana Industrial Area, Rockingham Industry Zone, Latitude 32 Industry Area and the Australian Marine Complex, as well as a buffer of surrounding land which separates industry from residential areas. The purpose of the Bill was to prohibit new sensitive land uses within the Protection Area. The EPA understands that to date the buffer has been enforced through land use planning policy, which does not provide a high level of long-term land use certainty for industry or residents, and that the draft Bill was to provide that certainty.

The boundary of the Protection Area follows the Kwinana Industrial (including Air Quality) Buffer ('Kwinana Buffer') which was endorsed by the Western Australian Planning Commission in September 2010.

The stated purpose of the Kwinana Buffer is to address land use constraints arising from the Kwinana industrial area and associated industry such as sulfur dioxide, risk, dust, noise, light and odour[1].

The Kwinana Buffer, endorsed by the WAPC, included:

- a revised buffer line of 1 km north, north-east and east from the boundary of the Alcoa Residue Disposal Area land holding; and
- an additional 0.5 km extension of the 1 km buffer as a non-residential and sensitive uses 'transition zone'.

The WAPC resolved in 2011 that the extent and location of the buffer around the Alcoa RDA should be reviewed in five years (i.e. 2016).

1.2 Development of the EPA's s16e advice

In developing its advice in accordance with the Minister's request, the EPA principally had regard for the technical aspects of the generation of dust in the Mandogalup area and its potential for health and amenity impacts.

[1] WAPC Review of the Kwinana Air Quality Buffer - Position Paper 2008

Further, while the EPA's s16e advice may inform future land use planning decisions regarding the Kwinana Buffer, it is not the purpose of the advice to make specific planning recommendations for the Mandogalup area.

In preparing its advice, the EPA conducted both a desktop review of material and undertook consultation with stakeholders through meetings and a public submission process. This supplementary report provides detail on the technical material and analysis the EPA took into consideration in forming its advice.

The following material informed the development of this report and the s16e advice:

- Compliance reports by Alcoa to the Department of Environment (DER) in relation to Alcoa of Australia Limited (Alcoa) EP Act Licence for the Kwinana residue disposal area (RDA) - which provided air quality monitoring data for stations;
- Air quality monitoring data for surrounding areas;
- Alcoa's Long Term Residue Management Strategies (2012 and 2013) for the Kwinana RDA;
- Technical reports, including air quality modelling and air quality assessments;
- Wind direction and speed data for a Bureau of Meteorology research station approximately 4kms from Mandogalup;
- Dust complaint information provided by Alcoa and DER in the Mandogalup and surrounding areas;
- Meetings with key stakeholders, including relevant State Government Departments, Alcoa, Kwinana Industries Council, Residents of Mandogalup, Qube Property Group, Satterley Property Group and the City of Kwinana; and
- Public submissions received by the EPA on potential dust impacts in the Mandogalup area.

Detailed information about the data and material collected and used by the EPA for this report is provided in Appendix 2.

This supplementary report has been structured around the key elements of the Minister's request:

1. Dust in the Mandogalup area;
2. Potential for health impacts from dust in Mandogalup; and
3. Potential for amenity impacts from dust in Mandogalup.

From its analysis, the EPA formed its advice on the size of Kwinana Buffer in relation to future urban development for the area which is provided in EPA 2017.

2 Dust in the Mandogalup area

Figure 1 shows the Mandogalup area to which the Minister's request relates. While the EPA's advice relates specifically to this area, the EPA had regard to information on dust more generally in the locality, where it considered this relevant.

Alcoa's Kwinana residue disposal area (RDA), located immediately to the west of the Mandogalup area, is the largest individual potential source of dust impacting the area. The RDA currently operates some 160 hectares (ha) of residue drying beds. The existing Kwinana Buffer in Mandogalup is based on distances from the RDA boundary.

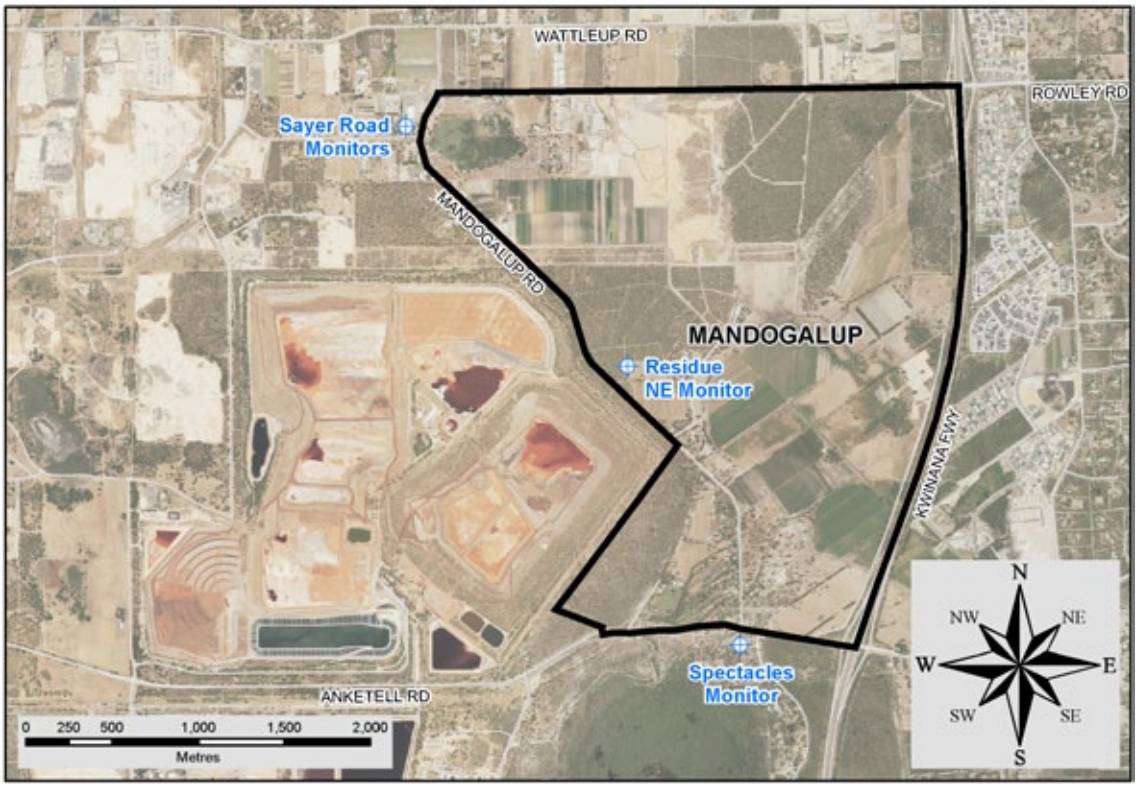

Figure 1: Spatial view of the Mandogalup area, including three air quality monitoring sites

Residue deposited at the RDA consists of two components, a coarse sand fraction (often termed 'red sand') and a fine silt fraction (often termed 'red mud'). The coarse sand fraction is used for construction purposes on the RDA. The fine red mud is deposited to drying beds to be dried through solar evaporation.

Alcoa's Long Term Residue Management Strategies (2012 and 2013) set out Alcoa's short, medium and long term plans for operation and management of the RDA, including dust management.

Alcoa has implemented a number of significant improvements to its dust management practices since 2005, including an advanced sprinkler system which is operated in response to daily weather forecasts and residue area conditions and continuous dust monitors around the residue area. The completion of the upgrade of the dust sprinkler system in 2009 appears to have led to an improvement in dust performance[2].

There have been a number of studies of the potential for dust to be blown from Alcoa's Kwinana RDA. The studies have shown that with wind speeds in excess of about 23 km/h (6.5 m/sec) fine residue can be picked up and blown from the RDA surfaces if they become dry.

Alcoa's Long Term Residue Management Strategy 2012 indicates that the months from October to April are the time of the year when the risk of dust generation is potentially greatest. In summer, the predominant winds are moderate to strong east-south-easterly and south-westerly winds. Strong and gusty south-westerly winds develop around midday with the onset of the sea breeze which eases in the late evening. The speed of these winds together with the higher ambient temperatures over summer, and therefore faster mud drying rates, results in the highest potential for dust to be blown off site.

[2] 2012 Alcoa *Kwinana refinery long term residue management strategy*

The amount of dust, and distance it is blown from the RDA, depends on a variety of factors including wind speed and duration. The concentration of dust in the air reduces with distance from the RDA as it disperses in the air. The dust concentration may also reduce if there is significant deposition of dust particles. The Kwinana RDA dust studies have shown that the primary source of dust from the RDA is wind erosion entrainment and that due to the fine nature of the residue mud particles, there is unlikely to be significant deposition of the dust particles over the first few kilometres (GHD Pty Ltd, 2009).

Alcoa has developed a calibrated air quality model to estimate the amount of dust emissions from the RDA and dust concentrations in the air in the surrounding area, including background dust levels.

A report on this modelling by GHD Pty Ltd in 2009 (GHD Pty Ltd, 2009) indicated that for the current RDA operation, potentially significant levels of atmospheric dust originating from the RDA extended up to three kilometres (km) to the north and north-east of the facility, based on two years of meteorological data. This is consistent with the predominant south-westerly winds in the locality.

The GHD report indicated that while significant dust levels were not predicted in other directions from the RDA in the two years modelled, potential for significant, but less frequent dust impacts could occur in other directions.

Alcoa is currently implementing a new technology for depositing residue at the RDA, called residue filtration. The filtration process produces a dry residue cake by filtering the mud slurry through a membrane. Alcoa's LTRMS 2013 indicates that the new technology will reduce the amount of land required for residue disposal and the potential for dust from the residue drying beds.

The filtrate facility has recently been commissioned and is ramping up to full capacity. Once the reliability of the filtrate facility has been established, Alcoa will also be able to completely close drying bed F. However, no firm timeframe for this has been set.

Alcoa's Long Term Residue Management Strategy 2012 indicates that the strategy will be reviewed and updated on a five yearly basis. As such, a review is due to be undertaken in 2017. The review should indicate the extent to which implementation of the filtration system, and any other dust management practices, can reduce the level of dust emissions from the RDA in the future.

There are a number of other potential sources of dust affecting the Mandogalup area, both within and outside the area, including sand and limestone quarries, construction earthworks, market gardening and fire break maintenance. Such potential dust sources occur throughout the metropolitan area to greater or lesser degrees.

In particular there are large areas of sand and limestone quarrying in the Latitude 32 Industry area which abuts Mandogalup's north-west boundary and on the north-western side Alcoa's RDA land (Appendix 1). Due to the predominant wind directions, this quarrying activity has significant potential to affect dust levels in the northern Mandogalup area (Figure 1).

EPA advice - dust in the Mandogalup area

- The potential for dust from Alcoa's RDA is a primary determinant for the size of a buffer required in the Mandogalup area.
- Existing dust control measures limit the frequency and amount of dust currently blown from the RDA.
- Due to the wind pattern in the locality, dust which is blown from the RDA is predominantly blown to the north and north-east of the RDA.
- There is limited potential for dust to be blown to the east of the RDA.
- New technology being installed at the RDA facilities has potential to reduce the amount of dust blown from the RDA site in the future.
- Sand and limestone quarrying in the Latitude 32 Industry area and north-western part of Alcoa's RDA property also have significant potential to affect dust levels in the northern Mandogalup area.

3 Potential for health impacts

3.1 Health risk studies of Alcoa's Refineries including RDAs

In 2014 Alcoa undertook a review of health risk assessments (HRA) relating to acute, chronic and incremental carcinogenic health effects of five Alumina refineries in Australia, including dust from residue disposal areas. The review, setting out the approach used in the HRAs and general findings, is presented in a paper by Donoghue, et al (2014).

Emissions from alumina refineries including RDAs can pose health risks in three ways:

1. Risks of acute health effects;
2. Risks of chronic health effects; and
3. Incremental carcinogenic risks.

The review concluded that the risks of acute health effects from emissions are adequately controlled, and the risks of chronic health effects and incremental carcinogenic risks are negligible.

The review indicated that the primary potential for health effects from RDA dust emissions was associated with PM_{10} levels (particles less than 10 microns in size) in the air. The review also noted, however, that a study had found that based on its size distribution and composition, red mud dust appears to be no more hazardous to human health than more general urban particulate matter.

Alcoa's 2012 *Kwinana Long Term Residue Management Strategy* (LTRMS) indicates that "*Residue dust is slightly alkaline and could be an irritant if high enough concentrations occurred – however extensive monitoring data shows this is very unlikely as the level of dust emitted from the residue area is well below the levels likely to cause any health impacts.*" As part of developing this section 16(e) advice, Alcoa provided further information supporting this position.

Alcoa's LTRMS 2012 and 2013 also include guiding principles for development and operation of the RDA, established through a Stakeholder Reference Group which includes community and government representatives. The 2012 LTRMS indicates that "*In response to the information provided, the Kwinana LTRMS Stakeholder Reference Group determined that a guiding principle around health impacts of residue dust was not required.*"

3.2 Potential health impacts from dust

As indicated above, Alcoa's health risk assessments showed that the primary *potential* for health effects to occur from dust from RDAs is associated with dust increasing PM_{10} levels in air.

In recent years, evidence has accumulated indicating that airborne dust particles have a range of adverse effects on health[3]. The primary concern with dust is particles small enough to be inhaled by humans. Particles larger than PM_{10} are usually caught in the nose and throat and expelled while PM_{10} and smaller particles may lodge throughout the lungs. The finer the particles, the deeper into the lungs they are inhaled and the greater the risk of an adverse reaction[4]. The other consideration is the duration of exposure – whether it is short term, i.e. months, or long term (possibly years).

3.3 Air quality standards related to potential health effects from dust particulates

National Environment Protection (Ambient Air Quality) Measure (NEPM)

Western Australia has a goal of achieving the National Environment Protection Standards for particulate matter in ambient air, in line with the NEPM.

Up until February 2016, the NEPM PM_{10} *daily* standard was set at 50 µg/m^3, with allowance for up to five exceedances per year under specific circumstances. However, recent epidemiological research suggests that there is no threshold below which health effects do not occur. The NEPM PM_{10} daily standard was varied in February 2016 to remove the maximum five allowable exceedances and rename the allowable exceedances to 'exceptional events', and to clarify that these 'exceptional events' were to apply only to bushfires, dust storms and fuel reduction burning for fire management purposes.

A single exceedance of the NEPM PM_{10} standard does not mean there will be health effects. However, a significant exceedance, or regular exceedances over a considerable period of time, could lead to acute or chronic health effects.

The NEPM also sets a PM_{10} *annual average* standard of 25 µg/m^3.

The NEPM sets a *daily* standard for $PM_{2.5}$ (particles less than 2.5 microns) of 25 µg/m^3 and *annual average* of 8 µg/m^3. These particles are sometimes referred to as 'fine' or 'respirable,' and can penetrate deeper into the lungs than the larger particles in the PM_{10} size fraction.[5] The daily standard, like PM_{10}, only provides for exceedances in exceptional events.

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[3] These reactions and impacts on human health effects vary in scope, severity and duration and in an Impact Statement prepared for National Environment Protection Council (July 2014) were listed as including:

- premature mortality
- aggravation of cardiovascular disease such as atherosclerosis
- aggravation of respiratory disease such as asthma
- changes to lung tissue, structure and function
- cancer (particles may contain carcinogenic substances such as heavy metal)
- reproductive and developmental effects
- changes in the function of the nervous system.

[4] [2011] WASAT 160 - Wattleup Road Development clause 51 – evidence by Ms Goetzmann

[5] Draft Variation to the National Environment protection (Ambient Air Quality) Measure; Impact Statement Prepared for: National Environment Protection Council (July 2014)

Residue dust studies have shown that there is a very low $PM_{2.5}$ fraction in residue dust, indicating that any $PM_{2.5}$ particles from the RDA are unlikely to contribute to health impacts in the area.

Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999

The *Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999* (Kwinana EPP) and associated regulations contain an ambient air quality standard and ambient air quality limits for Total Suspended Particles (TSP) (particles less than 50 microns (PM_{50})) which apply in the Kwinana area, including the Mandogalup area.

The standard is the concentration of TSP which it is 'desirable not to exceed' and the limits are the concentration which 'should not be exceeded'[6]. In respect of the Mandogalup area, the EPP sets a standard for TSP of 90 µg/m^3 averaged over 24 hours, and limits of 150 µg/m^3 averaged over 24 hours and 1000 µg/m^3 averaged over 15 minutes.

It is sometimes assumed that the Kwinana EPP TSP standard and limits are solely intended as amenity criteria for the area. However, the Kwinana EPP sets out that the standard and limits are to protect 'the health, welfare, convenience, comfort and amenity' of people within the area. Consistent with this, the standard and limits were established with consideration of guidelines from the World Health Organisation, the National Health and Medical Research Council, the EPA of Victoria and the United States Environmental Protection Agency (EPA 1999). There is no indication that the Kwinana EPP TSP standard and limits were intended as only amenity criteria [7].

The Kwinana EPP TSP standard and limits were developed before Australia had established PM_{10} and $PM_{2.5}$ criteria as set out in the NEPM. An air quality TSP standard of 90 µg/m^3 is equivalent to a PM_{10} standard of 50 µg/m^3 where the ratio of PM_{10} particles to TSP particles is 55 per cent. Some analysis of the ratio of PM_{10} to TSP particles of dust samples in the northern Mandogalup area indicated an average of 53 per cent, providing some comparability of the NEPM PM_{10} standard and the Kwinana EPP TSP standard.

3.4 Air quality monitoring

PM_{10} monitoring results

Alcoa undertakes air quality monitoring at four locations in the vicinity of the RDA as a requirement of its license conditions under Part V of the EP Act (refer to Appendix 2).

Table 1 below summarises the number of exceedances of the NEPM PM_{10} daily standard of 50 µg/m^3 at the Sayer Road monitoring site over the last six years. The Sayer Road monitoring site is located about 700 metres north of the RDA (Figure 1). Results from two other air quality monitoring stations in Perth have been provided for comparative purposes.

Table 1: PM_{10} dust levels exceedances above NEPM daily standard of 50 µg/m^3

YEAR	SAYER ROAD	SOUTH LAKE	DUNCRAIG
2016	9	0	0
2015	5	2	1
2014	4	0	1
2013	2	0	0
2012	8	2	2
2011	5	1	1

[6] *Environmental Protection (Kwinana) (Atmospheric Wastes) Policy 1999*

[7] DER, Technical Expert Report, Dust in the Mandogalup Area – review of the air quality modelling and monitoring for the OEPA, 2016.

The data indicates that PM_{10} levels regularly exceeded 50 ug/m^3 during this period at the Sayer Road site, noting that the NEPM PM_{10} daily standard allowed for five exceedances per year, under specific circumstances, up until February 2016. The South Lake site is located in an area with moderate/high density housing and moderate to high traffic flow, and is also potentially influenced by emissions from the Kwinana Industrial Area from time to time. Comparatively, Duncraig is located 200m from the Mitchell Freeway with no industrial influences, moderate/high density housing and moderate to high traffic flow. The monitoring at Sayer Road includes dust from the RDA and all other sources and is consistently recording more annual exceedances than either of the two other monitoring sites.

With the revised NEPM PM_{10} daily standard of no exceedances of 50 ug/m^3 except in exceptional circumstances, air quality to the north of the RDA does not appear to meet the current NEPM goal and would not meet the NEPM standard into the future if exceedances continued on at the current level.

There are likely to be a number of sources of dust contributing to the exceedances of the NEPM daily standard of 50 ug/m^3 in the northern Mandogalup area. The air quality modelling, discussed further below, indicates dust from the RDA is a significant contributor to dust levels in the area. However, Alcoa is not required as part of its EP Act licence conditions to report, or provide information on, whether it considers dust from the RDA may have contributed significantly to dust levels when monitoring records an exceedance of the NEPM daily standard.

As outlined above, the large areas of sand and limestone quarrying in the Latitude 32 Industry area which abuts Mandogalup's north-west boundary, and on the north-western part of Alcoa's RDA land, also has significant potential to affect dust levels in the northern Mandogalup area.

Potential dust sources very local to the monitoring site, including market gardening and firebreak clearing, may also affect the monitoring results.

TSP monitoring results

Alcoa is required to monitor TSP levels at three locations around its RDA. In addition to the Sayer Road site, TSP is monitored at the Spectacles to the south-east of the RDA and Residue North East (NE) immediately to the north-east of the RDA Area F (Figure 1).

Table 2 below summarises the number of exceedances of the Kwinana EPP TSP daily standard of 90 µg/m^3 at these sites over the last six years. Results of PM_{10} monitoring from two other air quality monitoring stations in Perth have been provided for comparative purposes. The full plots of annual monitoring results are provided in Appendix 2.

Table 2: TSP exceedances above Kwinana EPP daily standard 90 µg/m^3

	TSP 90 µg/m^3 exceedances			PM_{10} 50 µg/m^3 exceedances	
YEAR	SAYER ROAD	RESIDUE NE[(i)]	SPECTACLES	SOUTH LAKE	DUNCRAIG
2016	4	n/a	0	0	0
2015	6	n/a	2[(ii)]	2	1
2014	6	n/a	0	0	1
2013	7	n/a	0	0	0
2012	8	5	2	2	2
2011	6	5	0	1	1

(i) Residue NE monitoring station was shut down May 2013

(ii) Excludes anomalous readings

The annual monitoring results indicate that air quality at the Sayer Road monitoring site north of the RDA does not currently meet the Kwinana EPP desired daily standard for TSP of 90 µg/m^3 on a considerable number of days each year. This is consistent with the PM_{10} monitoring exceeding the NEPM PM_{10} daily standard at this site.

The annual monitoring results for the Residue NE monitoring site indicate that air quality immediately to the north-east of the RDA is also unlikely currently to meet the Kwinana EPP desired daily standard of 90 µg/m^3 on a considerable number of days per year.

The annual monitoring results for the Spectacles site to the south-east of the RDA indicates that air quality generally meets the Kwinana EPP desirable daily standard for TSP and is comparable with air quality in other parts of the Perth area.

3.5 Air quality modelling

The calibrated air quality model that Alcoa developed is capable of predicting the dust emissions from the RDA, together with total dust in the locality which includes estimated background dust levels.

Current RDA operation

Figure 2 shows that the model predicts considerable contribution of RDA dust to total PM_{10} levels in the Mandogalup area to the north and north-east of the RDA, consistent with the predominant wind directions.

The modelling predicted five additional exceedances of the NEPM PM_{10} daily standard of 50 µg/m^3 to occur to the north of the RDA over the three year modelling period,[8] due in part to RDA dust contribution, consistent with the predominate wind directions (Location North). The model indicates the daily contribution from the RDA could be more than 20 ug/m^3. The modelling also indicates that RDA dust could increase the annual average PM_{10} level by more than 5 µg/m^3, which is significant in respect of the NEPM annual average standard of 25 µg/m^3.

The modelling also predicted one additional exceedance of the NEPM PM_{10} daily standard at Location RDA North-east due to dust from the RDA over the three year modelling period. However, no exceedances were shown at Location Boundary North-east further from the RDA.

No additional exceedances of the NEPM daily standard PM_{10} of 50 ug/m^3 were predicted in the eastern or south-eastern parts of the Mandogalup area as a result of dust from the RDA (Locations East and South-east). The figure also shows that the model predicts a negligible increase in annual average PM_{10} level in the Mandogalup area to the east and south-east of the RDA due to RDA dust.

Future RDA operation

The air quality model was also run with an assumed future operation in 2030 with RDA Area F closed but additional drying beds (Areas N, O and P) opened on the west side of the RDA (Figure 3).

The main area impacted by dust under the assumed 2030 operation was again the area to the north and north-east of the RDA. With the closure of RDA Area F in the 2030 scenario, dust impacts in the Mandogalup area immediately to the north-east of this were slightly reduced.

There was no increase in dust levels in the Mandogalup area to the east or south-east of the RDA under this assumed future operating scenario.

[8] The NEPM standard allowed for up to five exceedance per year, under specific circumstances, during the years covered by the model.

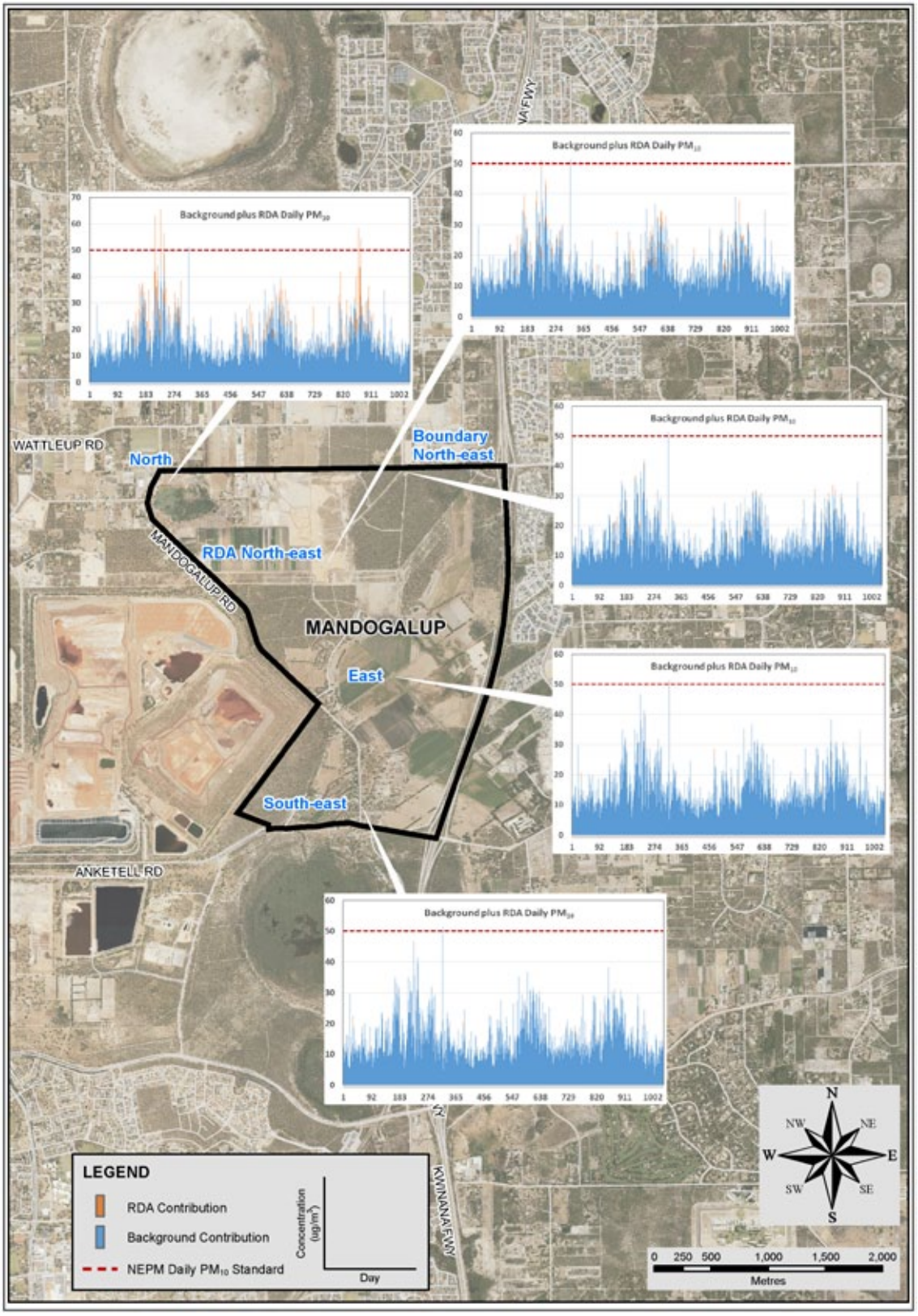


Figure 2: PM_{10} level at various locations in the Mandogalup area, including the contribution from RDA dust, as predicted by the model over a three year modelling period under current RDA operations

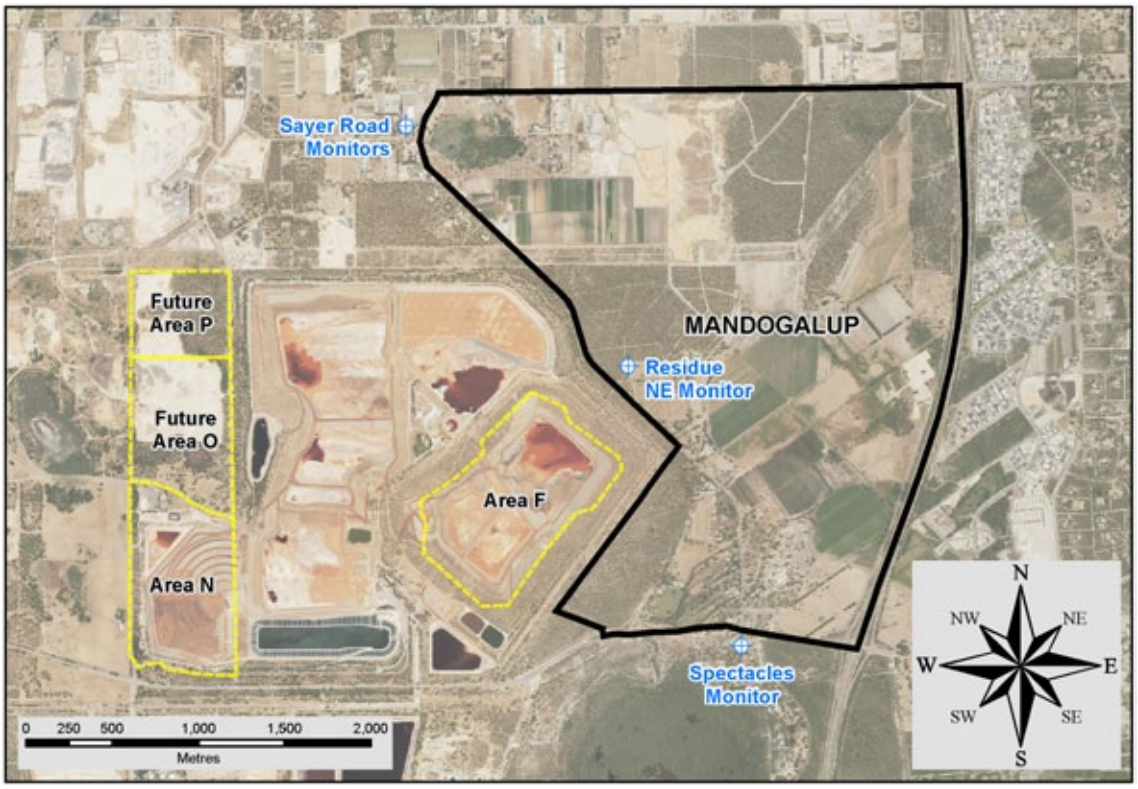


Figure 3: Spatial view of drying areas of Alcoa's residue disposal area

The potential 2030 operating scenario modelled did not include any allowance for a potential reduction in dust emissions which could be achieved in the future through the introduction of the new filtration technology, or any other potential management measures to reduce dust emissions. Given that the air quality to north and north-east of the RDA does not appear to meet the NEPM air quality goal under current RDA operations, investigation should be undertaken into whether further management measures can be implemented to reduce current dust emission levels from the RDA.

EPA advice - potential health impacts

- Based on health risk assessments of emissions from RDAs, and air quality monitoring and modelling information, there appears to be negligible risk of health impacts from dust in the eastern part of the Mandogalup area away from the RDA.
- However, air quality to the north and north-east of the RDA does not appear to meet the current NEPM goal for particulates smaller than 10 microns (PM_{10}) which was adopted in February 2016. There appears to be a number of sources of dust affecting this area, both within and outside the area, including dust from the RDA.
- While the current air quality to the north and north-east does not pose an immediate health risk, there is a need for investigations to determine the contribution of dust from the various sources resulting in the NEPM exceedances and for corrective measures to be undertaken, if practicable, to achieve the NEPM air quality goal in this area.

4 Amenity

4.1 Potential amenity impacts from dust

In its Environmental Factor Guideline: *Social Surroundings* (December 2016), the EPA defines amenity as a broad term that generally "means the qualities, attributes and characteristics of a place that make a positive contribution to quality of life" - i.e. 'how pleasant' it is to live there. Amenity values can be highly subjective. Dust has the potential to interfere with the convenience and comfort of people's lives, however people also have different levels of perception or tolerance for matters that impact amenity.

There are no air quality standards for the level of dust in air which is likely to cause unacceptable amenity impacts.

Dust may cause unreasonable amenity impacts if it results in excessive dust deposition settling on surfaces, often causing soiling and discolouration, for example on fabrics (such as washing) or on house roofs.

Dust deposition rates, that is the amount of dust depositing on a surface over a particular period of time, are dependent on a number a factors including the size of dust particles and wind speed.

4.2 Air quality standards related to potential amenity effects of dust

As indicated above, the Kwinana EPP was established to protect the 'the health, welfare, convenience, comfort and amenity' of people within the area.

As also indicated above, the Kwinana EPP and associated regulations set ambient air quality limits which 'should not be exceeded' in order the meet the EPP goal that the health, welfare, convenience, comfort and amenity of people in the area are protected. The air quality limits for TSP in the Mandogalup area are set at 150 µg/m^3 daily average and 1000 ug/m^3 averaged over 15 minutes.

While there is no quantifiable relationship between the Kwinana EPP TSP limits and amenity impacts, in the absence of alternative formal criteria, these limits provides a guide of potential excessive dust, and thus amenity impacts.

4.3 Air quality monitoring

As indicated above, as part of its licence under the *Environmental Protection Act 1986*, Alcoa is required to monitor TSP levels around its RDA at three sites: Sayer Road to the north; Residue NE immediately to the north-east of RDA Area F; and Spectacles to the south-east. Table 3 sets out the number of times air quality exceeded the Kwinana EPP TSP daily limit at these sites.The full plots of annual monitoring results are provided in Appendix 2.

The information indicates that there has been occasional events when the Kwinana EPP TSP daily limit has been exceeded to the north and north-east of the RDA. In particular, the monitoring results for the Sayer Road and Residue NE sites (Appendix 2) show a clear pattern of events of increased TSP levels in the summer months, consistent with the stronger south-west wind period. The Spectacles monitoring site to the south-east of the RDA does not show exceedances of the Kwinana EPP TSP daily limit, except for one 'exceptional' event.

Based on these results there appears some potential for amenity impacts to the north and north-east of the RDA, but limited potential to the south-east.

Table 3: Exceedances of TSP 150 µg/m³ daily limit at three dust monitoring locations over seven years.

	TSP 150 µg/m³ exceedances		
YEAR	SAYER ROAD	RESIDUE NE(i)	SPECTACLES
2016	0	n/a	0
2015	1	n/a	0
2014	0	n/a	0
2013	1	n/a	0
2012	0	1	0
2011	1	3	0
2010	2	1	0

(i) Residue NE monitoring station was shut down May 2013

4.4 Dust modelling

Unreasonable amenity impacts from dust may occur primarily through two means:

- regular dust events over several weeks which can lead to gradual build-up of dust on surfaces; and
- short-period dust events of very high concentrations which can cause rapid build-up of dust on surfaces, or soiling, if dust deposition rates are high.

Consideration of the frequency and size of dust events expected in an area can provide an indication of the potential for amenity impacts.

Dust events - current RDA operations

The potential for dust from the Kwinana RDA to cause amenity impacts in the surrounding areas due to regular dust events can be evaluated by considering the contribution of RDA dust to daily TSP levels in the area predicted by the dust modelling. The higher the daily TSP levels are, the higher the likelihood of gradual build-up of dust on surfaces.

Figure 4 illustrates that the model predicts regular RDA dust events to the north of the RDA (Location North) which elevate daily TSP levels during the summer months. This is consistent with the predominant wind direction. Contribution of RDA dust results in a predicted increase in the average daily TSP level to the north of around 8 ug/m³ (23%), with RDA dust more than twice the background dust on some days.

It was also predicted that the presence of RDA dust results in an increase in the average daily TSP level immediately to the north-east of the RDA of around 3.5 µg/m³ (10%) (Location RDA North-east), however, the magnitude of the RDA dust to background level was greater directly north of the RDA. The predicted impact of RDA dust to the north-east reduces with distance from the RDA, with limited impact on daily TSP level at Location Boundary North-east.

Modelling results in Figure 4 indicates a negligible contribution of RDA dust to the daily TSP levels in the Mandogalup area to the east and south-east of the RDA (Locations East and South-east).

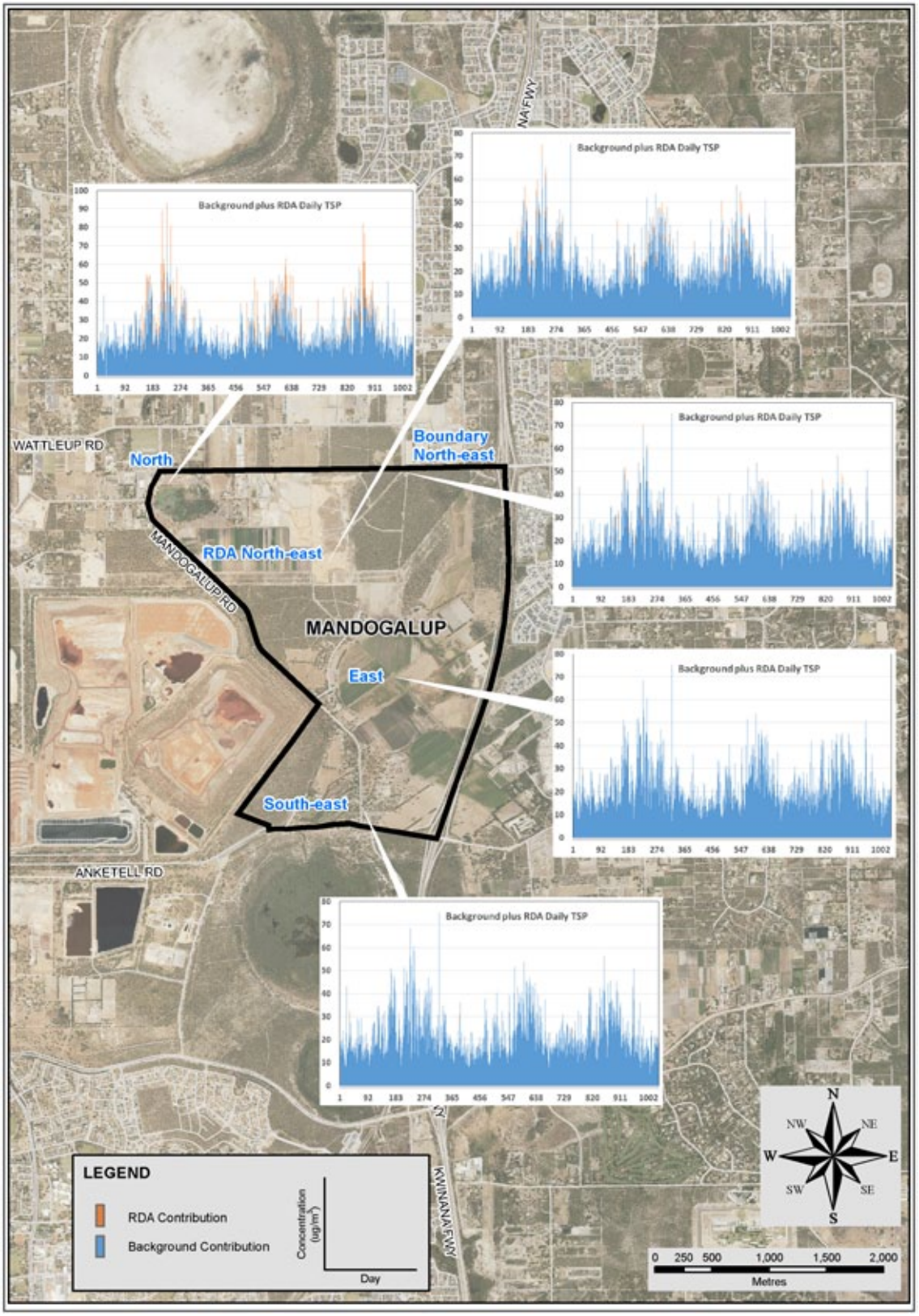


Figure 4: Daily TSP level at various locations in the Mandogalup area, including the contribution from RDA dust, as predicted by the model over a three year modelling period under current operations

The daily TSP air quality modelling results indicate that there is demonstrated to be some clear potential for amenity impacts to the north of the RDA and immediately to the north-east of the RDA under current operations. The modelling results indicate there is limited risk of amenity impacts to the east and south-east of the RDA based on expected daily TSP levels.

Daily dust events – future RDA operations

As indicated earlier, the air quality model was also run with an assumed future operation in 2030 with RDA Area F closed but additional drying beds (Areas N, O and P) opened on the west side of the RDA (Figure 3).

The main areas impacted by dust under the assumed 2030 operation were again the areas to the north and north-east of the RDA. With the closure of RDA Area F in the 2030 scenario, dust impacts in the Mandogalup area immediately to the north-east of this were slightly reduced.

There was no increase in dust levels in the Mandogalup area to the east or south-east of the RDA under this assumed future operating scenario.

The 2030 future operating scenario modelled did not include any allowance for a potential reduction in dust emissions which could be achieved in the future through the introduction of the new filtration technology, or any other potential management measures to further reduce dust emissions.

Peak dust events – current operations

The potential for dust from the Kwinana RDA to cause amenity impacts due to peak dust events can be evaluated by considering daily peak hourly TSP concentrations of dust emissions from the RDA predicted by the dust modelling. High peak hourly TSP concentration dust events could lead to rapid build-up of dust on surfaces if dust deposition rates were high.

Figure 5 illustrates that the model predicts significant contributions of RDA dust to daily peak hourly TSP concentrations to the north of the RDA. The RDA dust was predicted to lead to hourly dust concentrations above 200 µg/m^3 to the north of the RDA, with levels double background levels regularly over summer months. While such levels may not result in amenity impacts (cf the Kwinana EPP TSP standard of 90 µg/m^3 averaged over 24 hours, and a limit is 150 µg/m^3 averaged over 24 hours and 1000 µg/m^3 averaged over 15 minutes), the magnitude and frequency of predicted RDA dust events indicates considerable potential for amenity impacts in this area.

The model also predicts significant contributions of RDA dust to daily peak hourly TSP concentrations at Location RDA North-east. While not as great as to the north of the RDA, the magnitude and frequency of predicted RDA dust events again indicates some potential for amenity impacts in this area.

Figure 5 illustrates that the model predicts only minor contribution of RDA dust to daily peak hourly TSP levels at Location Boundary North-east, Location East and Location South-east in comparison to background dust levels, indicating low likelihood of dust from the RDA causing unreasonable amenity impacts in these areas.

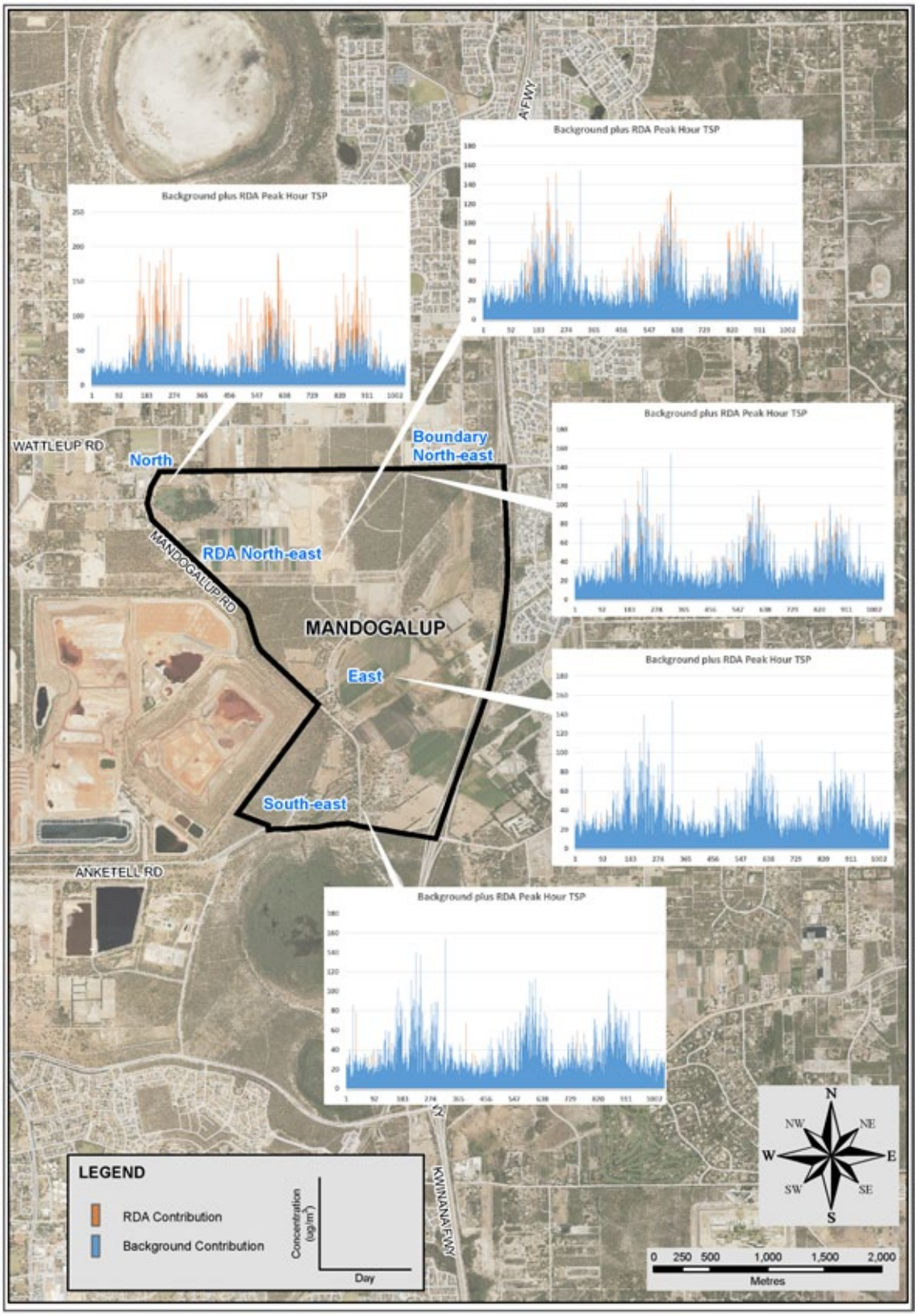


Figure 5: Daily peak hourly TSP level at various locations in the Mandogalup area, including the contribution from RDA dust, as predicted by the model over a three year modelling period under current operations

Peak dust events – future operations

As part of the process of information collection for the section 16(e) advice, Alcoa provided a submission containing further information on potential future peak hourly dust events from the RDA based on additional GHD air quality modelling (GHD Pty Ltd 2016).

The modelling indicated that for a 2030 operating scenario with a net additional 60 ha of drying beds established above the current area, one potentially significant one-hour dust event could occur, based on three years of meteorological data modelled.

The 2030 future operating scenario modelled did not include any allowance for a potential reduction in dust emissions which could be achieved in the future through the introduction of the new filtration technology, or any other potential management measures to reduce dust emissions.

4.5 Potential for dust deposition

Dust deposition is a primary mechanism of potential amenity impacts from dust.

Alcoa has not undertaken any dust deposition monitoring in the vicinity of the RDA to enable any empirical evaluation of the likely rate of deposition of RDA dust in the area, or relative contribution of RDA dust in comparison to background dust deposition.

As part of development of the Kwinana RDA air quality model, GHD Pty Ltd assessed likely dust deposition rates using a dust deposition algorithm in the dispersion model using an assumed particle size distribution. GHD Pty Ltd concluded that as the primary dust source from the RDA is wind entrained, dust from the RDA is unlikely to be rapidly deposited over the first few kilometres (GHD Pty Ltd 2008).

Investigations were undertaken of dust particle size ratios of dust in the air at two locations, 500 m and 2,000 m from Alcoa's Pinjarra RDA, as part of studies in 2008. Air Assessments (2008) concluded that "*with very similar ratios at the two sites [Kwinana and Pinjarra] no definite PM_{10}/TSP trend with distance is evident*".

Based on this finding, GHD Pty Ltd, as part of its upgrade of the Kwinana RDA air quality model in 2009, concluded that significant dust deposition (sufficient to affect modelling results) is unlikely to be occurring within the bounds of the model, which extended about 2,500 m from the RDA.

The findings that there is likely to be little deposition of dust from the RDA in the vicinity of the RDA is consistent with the fact that the residue dust mud is reasonably fine, the principle mechanism for dust to be blown from the site is by wind entrainment and that dust is only generated when wind strengths are relatively high, that is above 23 km/hr.

4.6 Dust complaints

Since the sprinkler upgrade on the RDA in 2009, and the consequent improvement in dust suppression, there have been nine complaints registered by Alcoa in the Mandogalup area north of the RDA, three in the townsite to the east of the RDA and two south of the area.

Since 2009 the DER has recorded one complaint about dust north of the RDA and three from within the Mandogalup townsite area to the south-east. These complaints were for "dust" generally and did not contain enough information to determine whether the RDA was the source.

In the public submission process run by the EPA, 54 of the 57 respondents said they had not noticed or experienced any dust issues on their Mandogalup property. When asked if there were sources of dust in the area, the majority did not respond or said they believed there were no dust sources.

The EPA acknowledges that that locating residential development in proximity to industrial activity can lead to increased complaints. The existing complaints data for the area does not provide a basis to make judgements, in this case, of the potential for increased complaints if residential development occurs in the eastern part of the Mandogalup area.

EPA advice - potential for amenity impacts

- Based on air quality monitoring, air quality modelling and licence compliance reporting there appears to be low likelihood of dust from the RDA causing unreasonable amenity impacts in the eastern part of the Mandogalup area away from the RDA.
- Based on air quality modelling information, the frequency and magnitude of dust events from the RDA to the north and north-east has potential to cause amenity impacts.

5 Reference list

Alcoa 2012, *Long Term Residue Management Strategy*, Kwinana 2012.

Alcoa 2013, *Long Term Residue Management Strategy – Interim Review*, Kwinana 2013.

Donoghue, et al 2014, *A. Michael Donoghue and Patrick S. Coffey, Journal of Occupational and Environmental Medicine, Vol 56, No. 5S*, May 2014.

EPA 1999, *Discussion Paper Options for the review of the Environmental Protection Kwinana) (Atmospheric Wastes) Policy 1999.*

EPA 2017, *Consideration of potential health and amenity impacts of dust in determining the size of a buffer for urban development in the Mandogalup area.* Advice of the Environmental Protection Authority to the Minister for Environment under Section 16(e) of the *Environmental Protection Act 1986*, May 2017.

GHD Pty Ltd 2008, *Report for Kwinana Residue Dust Emissions Study 2008 – Final Report*.

GHD Pty Ltd 2009, *Report for Kwinana Residue Dust Emissions Study 2009*.

GHD Pty Ltd 2016, *Mandogalup Buffer Review – submission support, Assessment of modelled impacts to Mandogalup*, August 2016.

WASAT 2014, *Wattleup Road Development Company Pty Ltd & Primewest (Wattleup) Pty Ltd v Western Australian Planning Commission.* Report to the Minister, (Matter No. DR 362 & 444 of 2013), November 2014.

APPENDIX 1

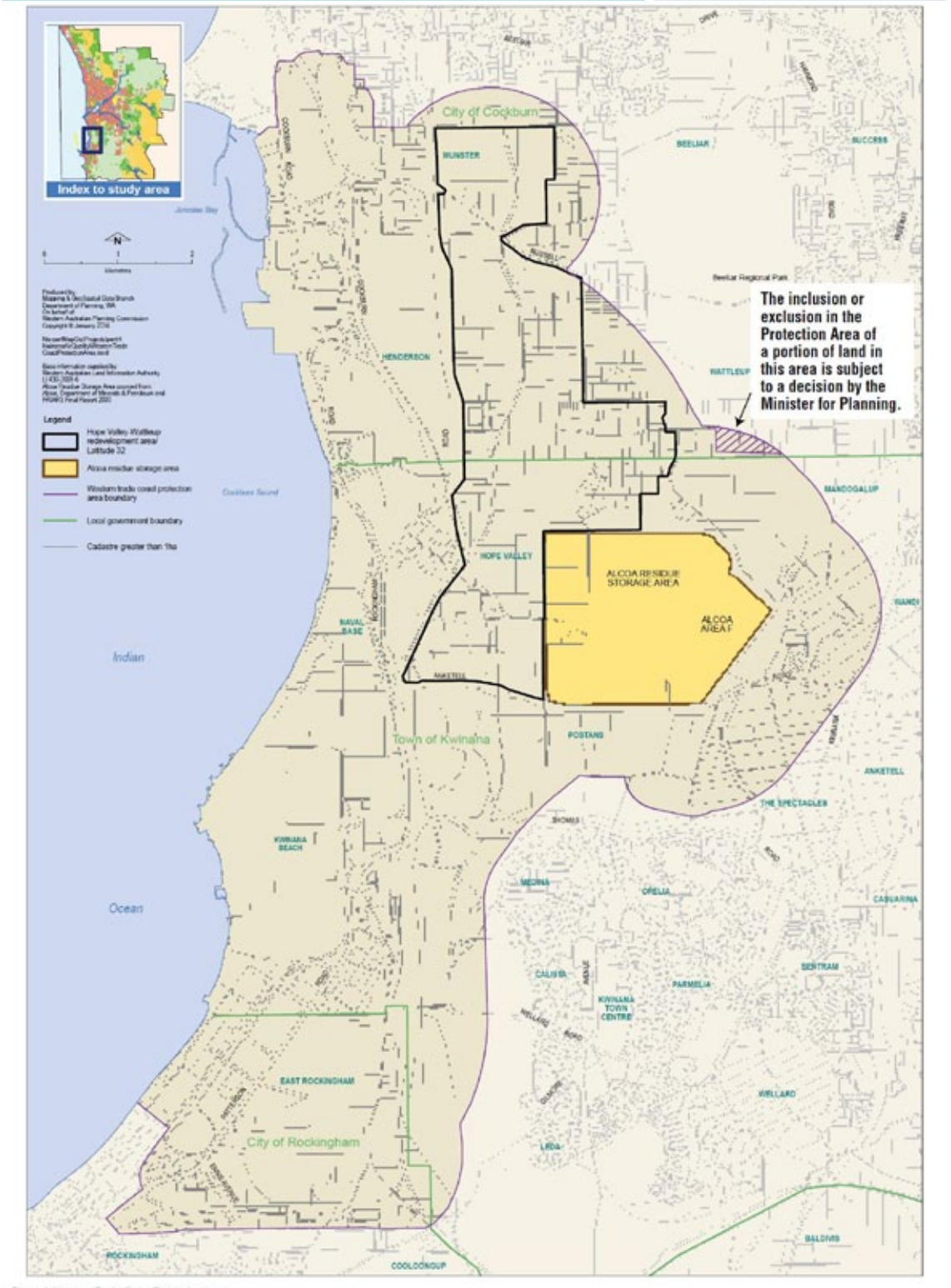


Figure 1. Western Trade Coast Protection Area

APPENDIX 2

Further information about the data and material considered by the EPA in preparing its s16e advice

A2.1 Air quality monitoring

Alcoa's licence under the *Environmental Protection Act 1986* for its Kwinana facilities requires that Alcoa '*implement and maintain dust control measures to minimise generation of airborne dust from…the RDAs*.' The licence requires Alcoa to conduct air quality monitoring in the vicinity of the RDA and to report if dust levels are recorded above 'Target levels' for TSP in the vicinity of the RDA and dust from the RDA was a contributor. For the Mandogalup area the target is TSP 90 µg/m^3 averaged over a 24 hour period.

Alcoa currently undertakes air quality monitoring at four locations in the vicinity of the RDA. TSP High Volume Sampling is undertaken on a daily basis at:

- Sayer Road to the north;
- Residue West to the west;
- Cooling Pond to the south; and
- Spectacles to the south east.

TSP monitoring was also being undertaken at a fifth site (Residue area NE), which was in the Mandogalup area (Figure A1 below), however monitoring was ceased at that site in 2013 and an alternative replacement site downwind of the RDA for south-westerly winds has not been established at this time.

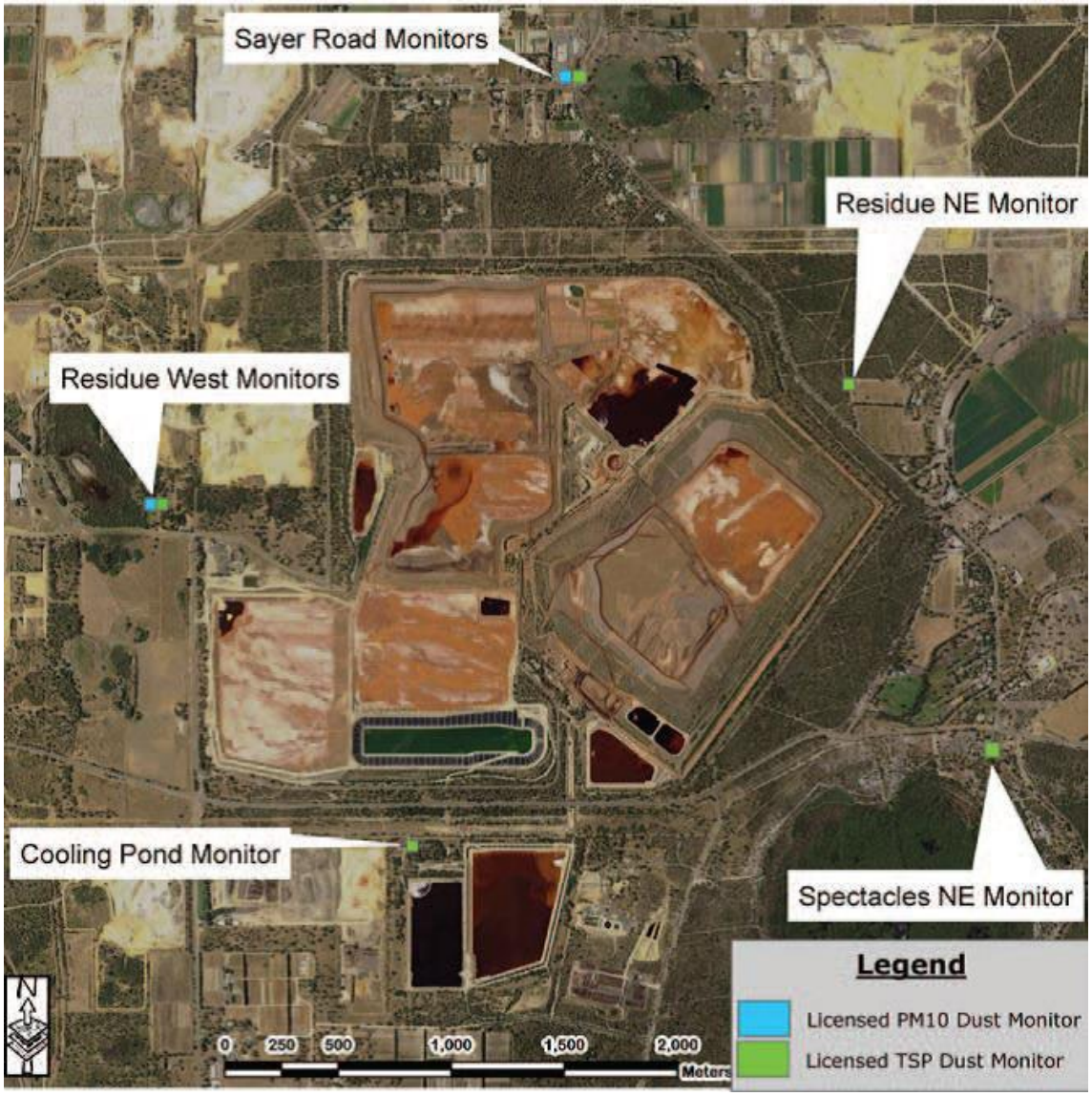
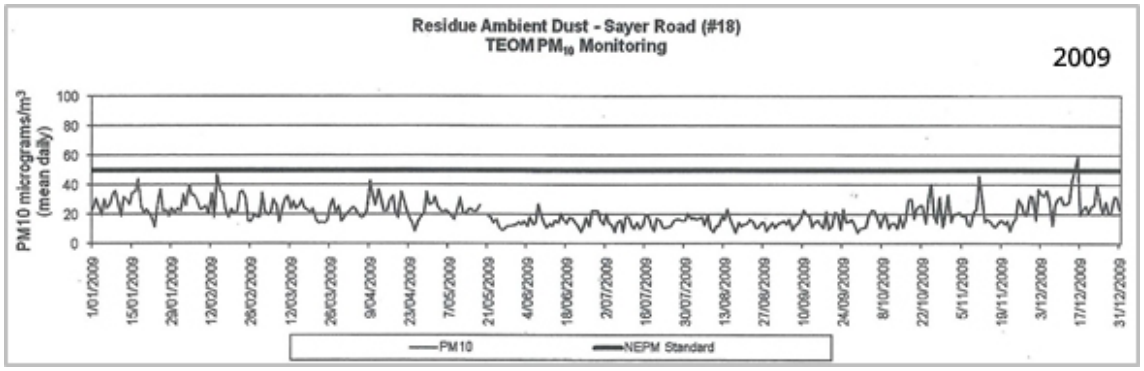
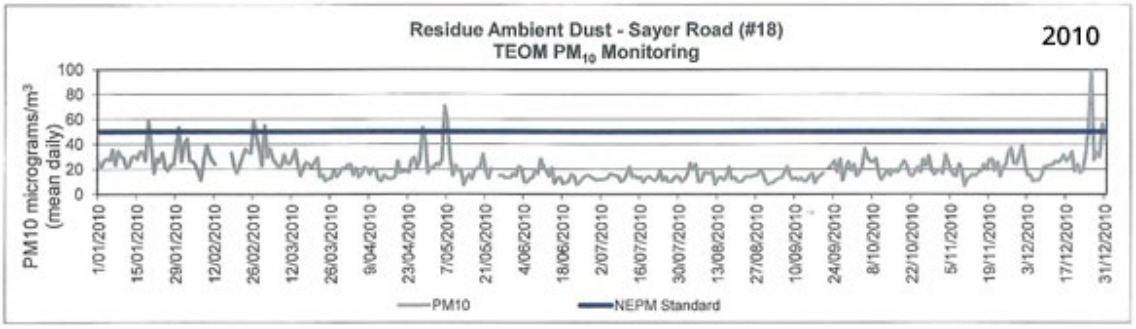
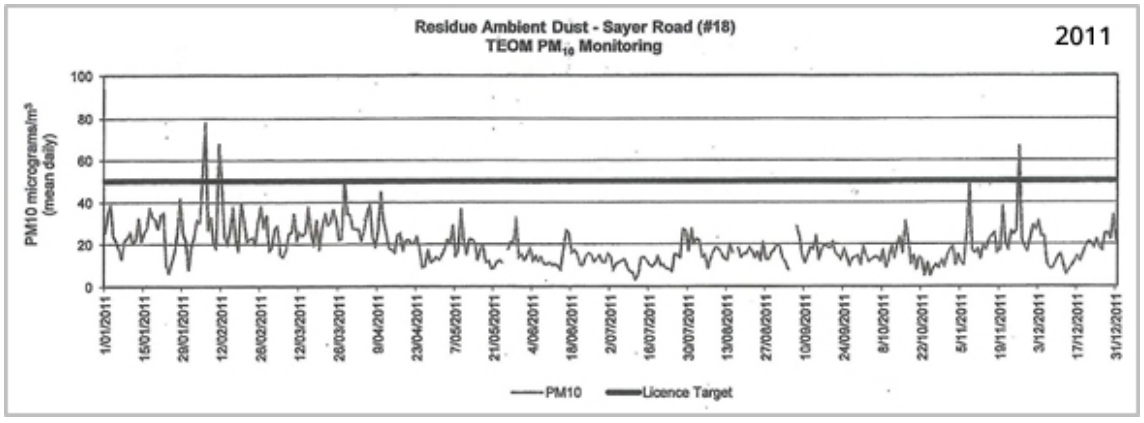


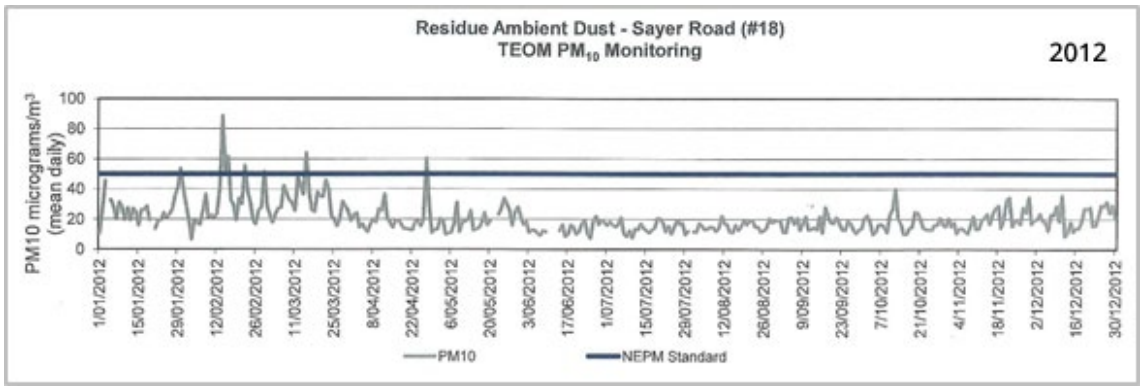
Figure A1: dust monitoring locations at the Alcoa Kwinana Alumina Refinery (Alcoa LTRMS 2012)

Under its licence conditions, Alcoa reports the results of its air quality monitoring through its annual environmental review. The EPA considered results from the monitoring stations relevant to their advice and the Sayer Road PM_{10} and TSP data, Spectacles TSP data and Residue area North East (iii) TSP data are provided below (Figures A2 to A5).


Residue Ambient Dust - Sayer Road (#18)
TEOM PM10 Monitoring
2009
PM10 micrograms/m3 (mean daily)
PM10
NEPM Standard


Residue Ambient Dust - Sayer Road (#18)
TEOM PM10 Monitoring
2010
PM10 micrograms/m3 (mean daily)
PM10
NEPM Standard


Residue Ambient Dust - Sayer Road (#18)
TEOM PM10 Monitoring
2011
PM10 micrograms/m3 (mean daily)
PM10
Licence Target


Residue Ambient Dust - Sayer Road (#18)
TEOM PM10 Monitoring
2012
PM10 micrograms/m3 (mean daily)
PM10
NEPM Standard

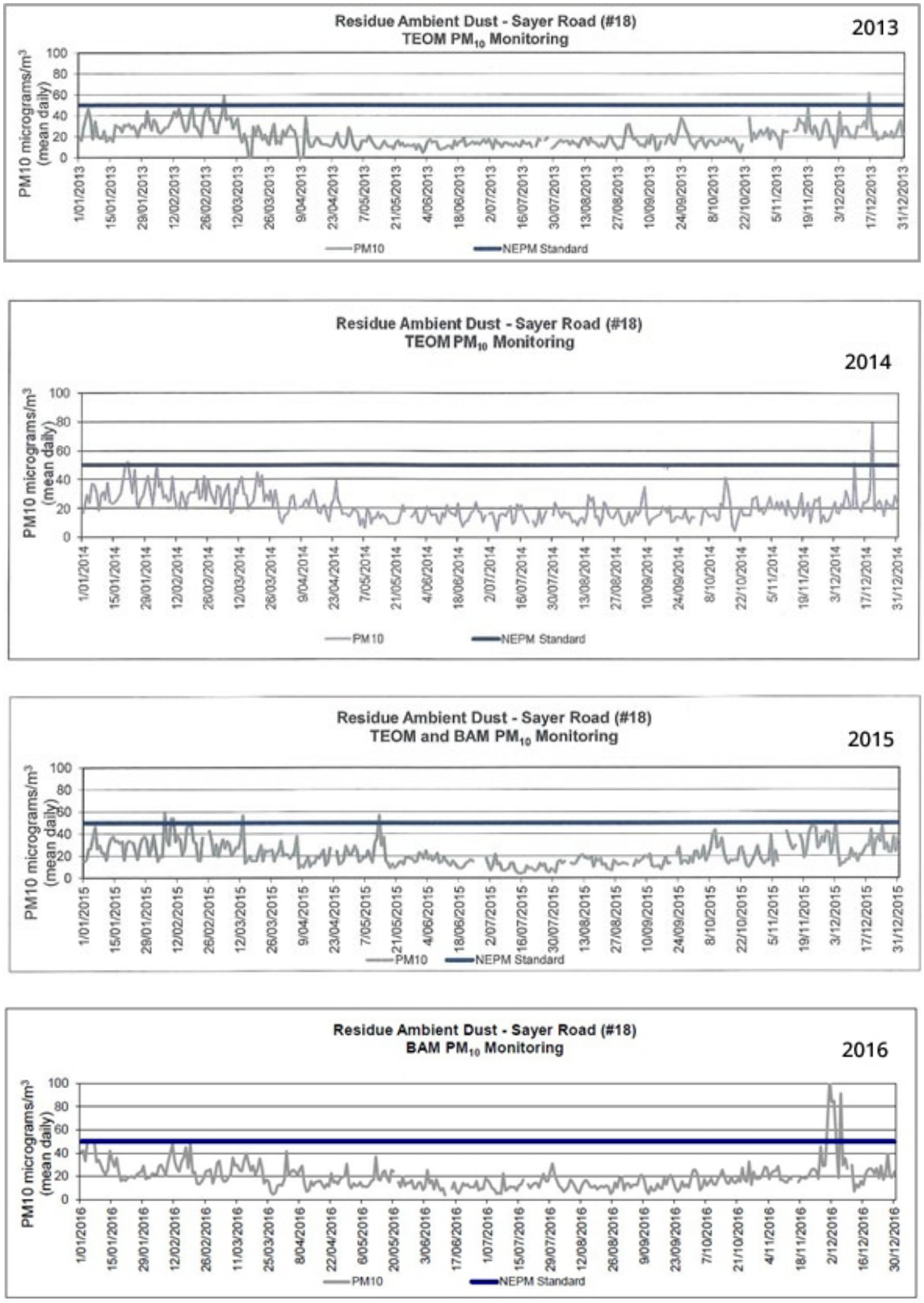
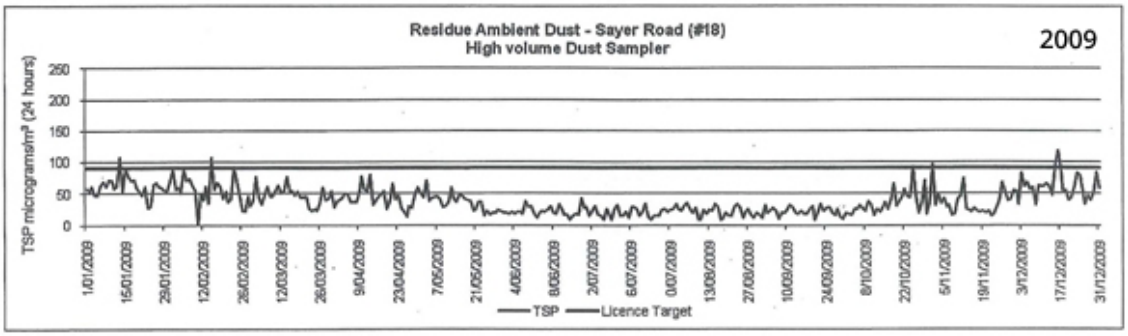
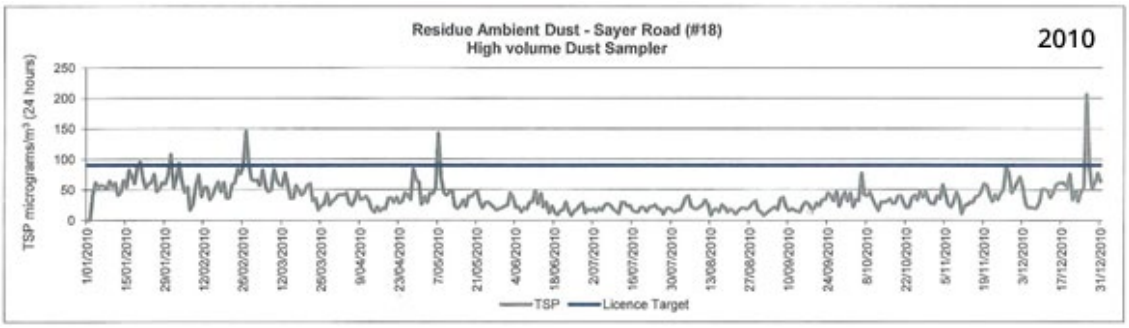
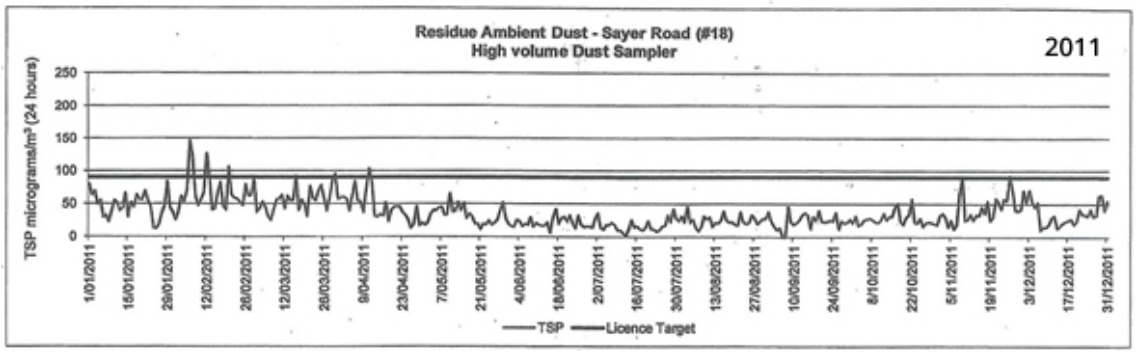
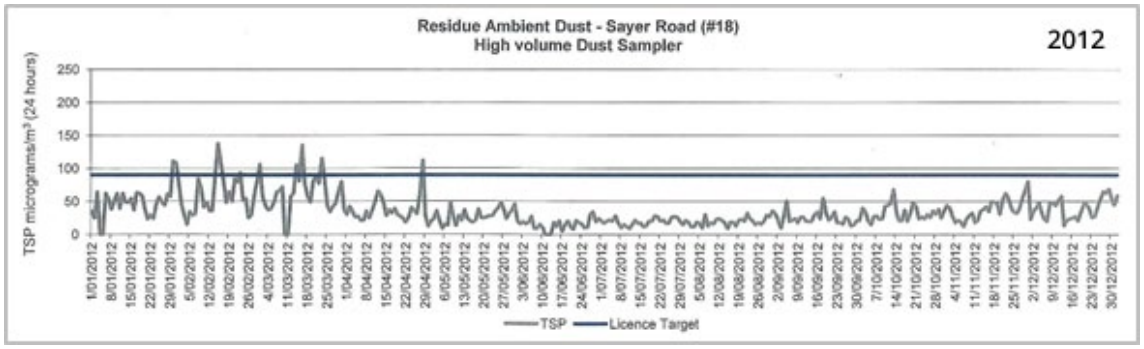


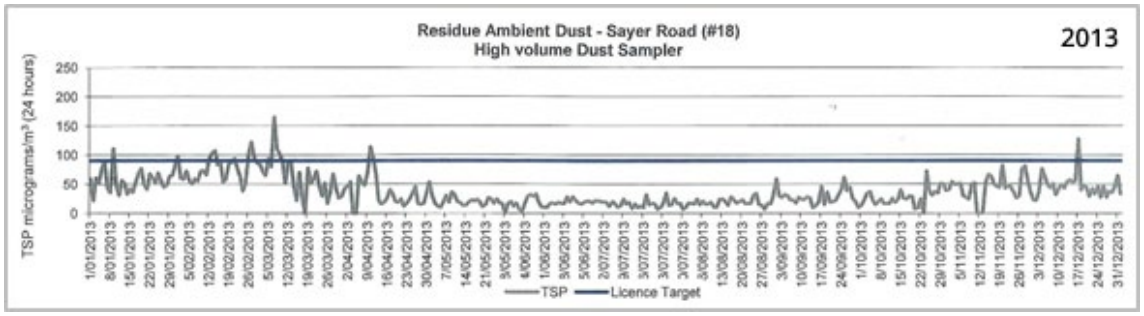
Figure A2: Residue Ambient Dust PM10 – Sayer Road (#18) – years 2009 – 2016. NEPM standard set at 50 micrograms/m³


Residue Ambient Dust - Sayer Road (#18)
High volume Dust Sampler
2009
TSP micrograms/m³ (24 hours)
TSP
Licence Target


Residue Ambient Dust - Sayer Road (#18)
High volume Dust Sampler
2010
TSP micrograms/m³ (24 hours)
TSP
Licence Target


Residue Ambient Dust - Sayer Road (#18)
High volume Dust Sampler
2011
TSP micrograms/m³ (24 hours)
TSP
Licence Target


Residue Ambient Dust - Sayer Road (#18)
High volume Dust Sampler
2012
TSP micrograms/m³ (24 hours)
TSP
Licence Target


Residue Ambient Dust - Sayer Road (#18)
High volume Dust Sampler
2013
TSP micrograms/m³ (24 hours)
TSP
Licence Target

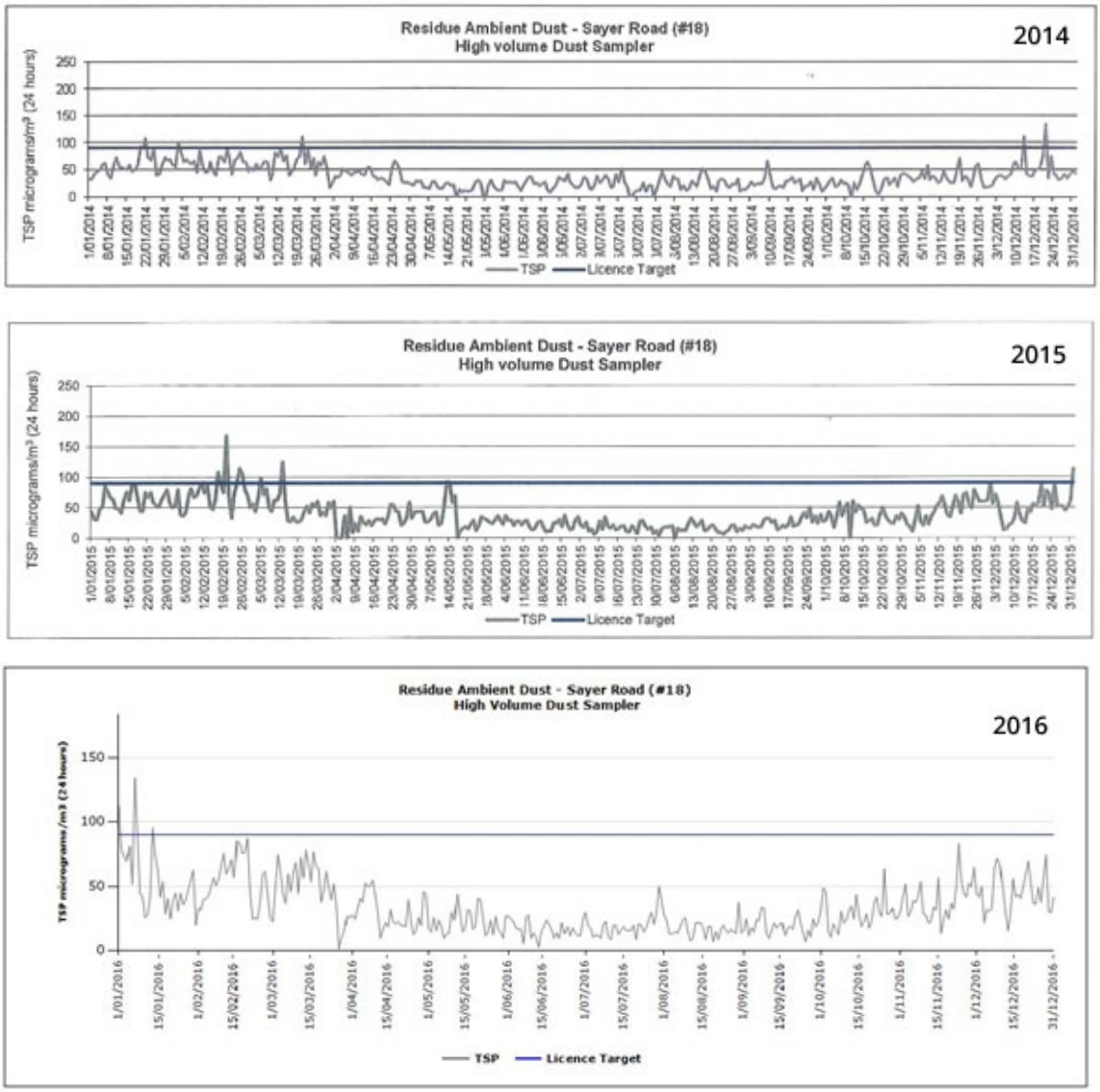
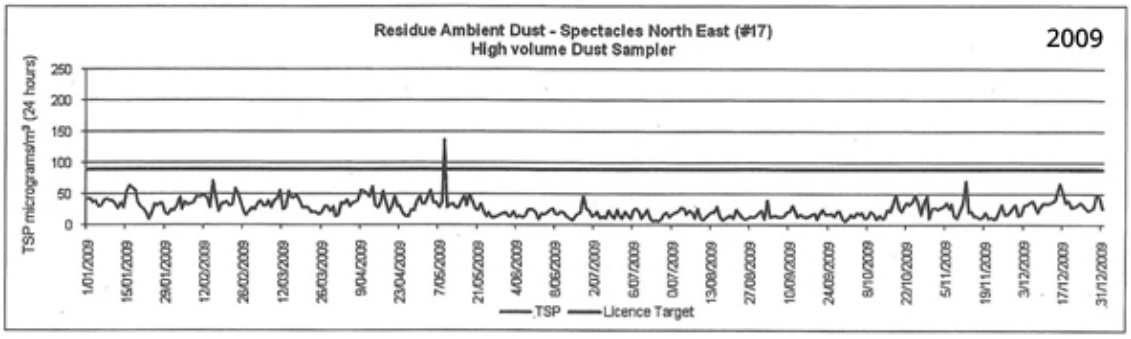
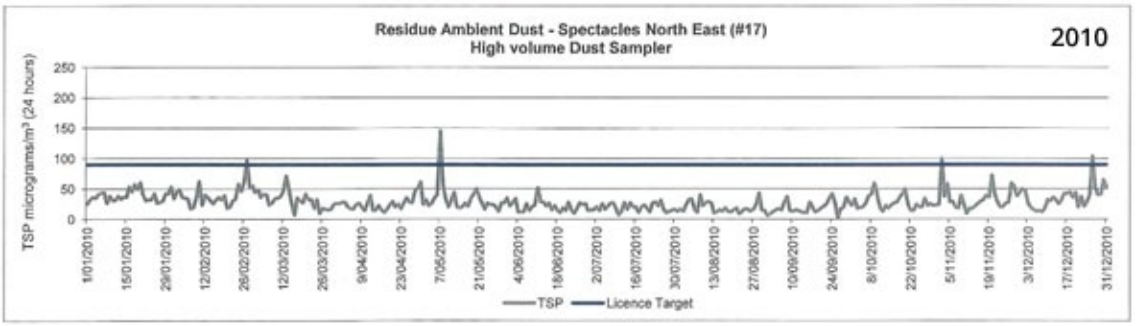
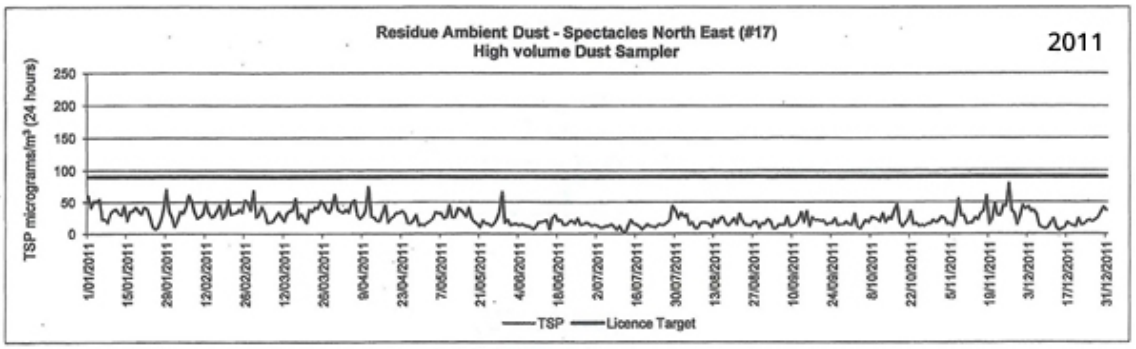
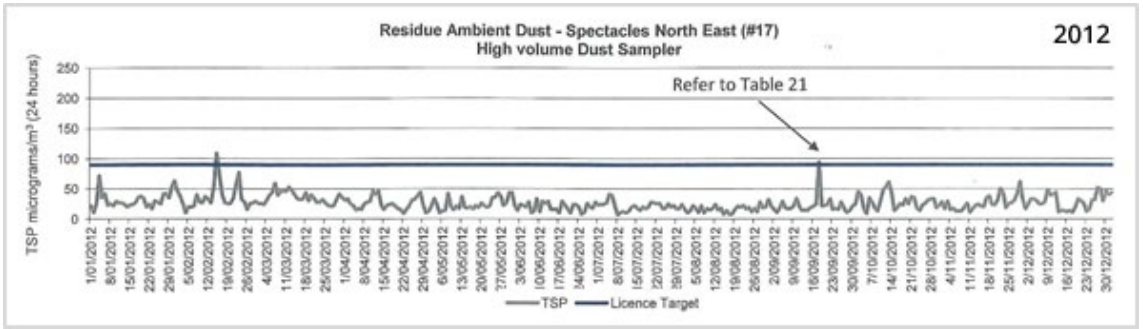


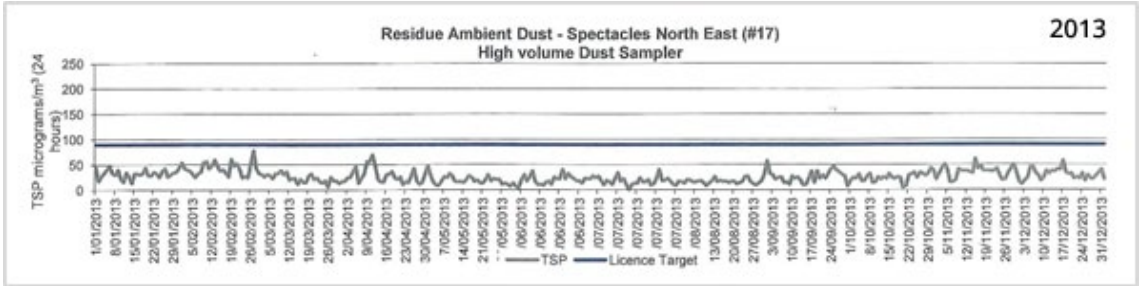
Figure A3: Residue Ambient Total Suspended Particulates (TSP) – Sayer Road (#18) – years 2009 – 2016. Licence target set at 90 micrograms/m³ (24 hours)


Residue Ambient Dust - Spectacles North East (#17)
High volume Dust Sampler
2009
TSP micrograms/m³ (24 hours)
TSP
Licence Target


Residue Ambient Dust - Spectacles North East (#17)
High volume Dust Sampler
2010
TSP micrograms/m³ (24 hours)
TSP
Licence Target


Residue Ambient Dust - Spectacles North East (#17)
High volume Dust Sampler
2011
TSP micrograms/m³ (24 hours)
TSP
Licence Target


Residue Ambient Dust - Spectacles North East (#17)
High volume Dust Sampler
2012
Refer to Table 21
TSP micrograms/m³ (24 hours)
TSP
Licence Target


Residue Ambient Dust - Spectacles North East (#17)
High volume Dust Sampler
2013
TSP micrograms/m³ (24 hours)
TSP
Licence Target

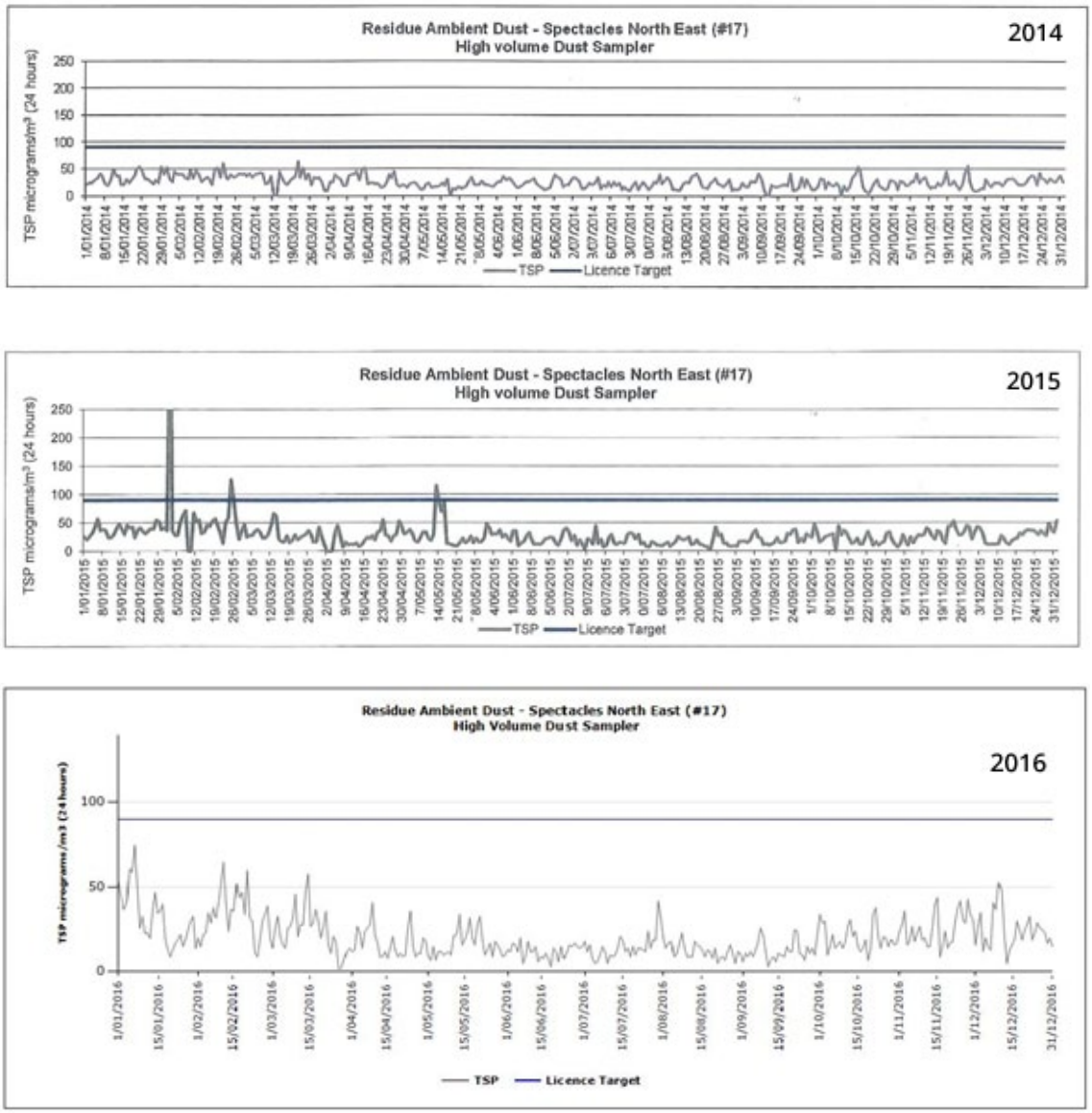


Figure A4: Residue Ambient Total Suspended Particulates (TSP) - Spectacles North East (#17) – years 2009 – 2015. Licence target set at 90 micrograms/m³ (24 hours)

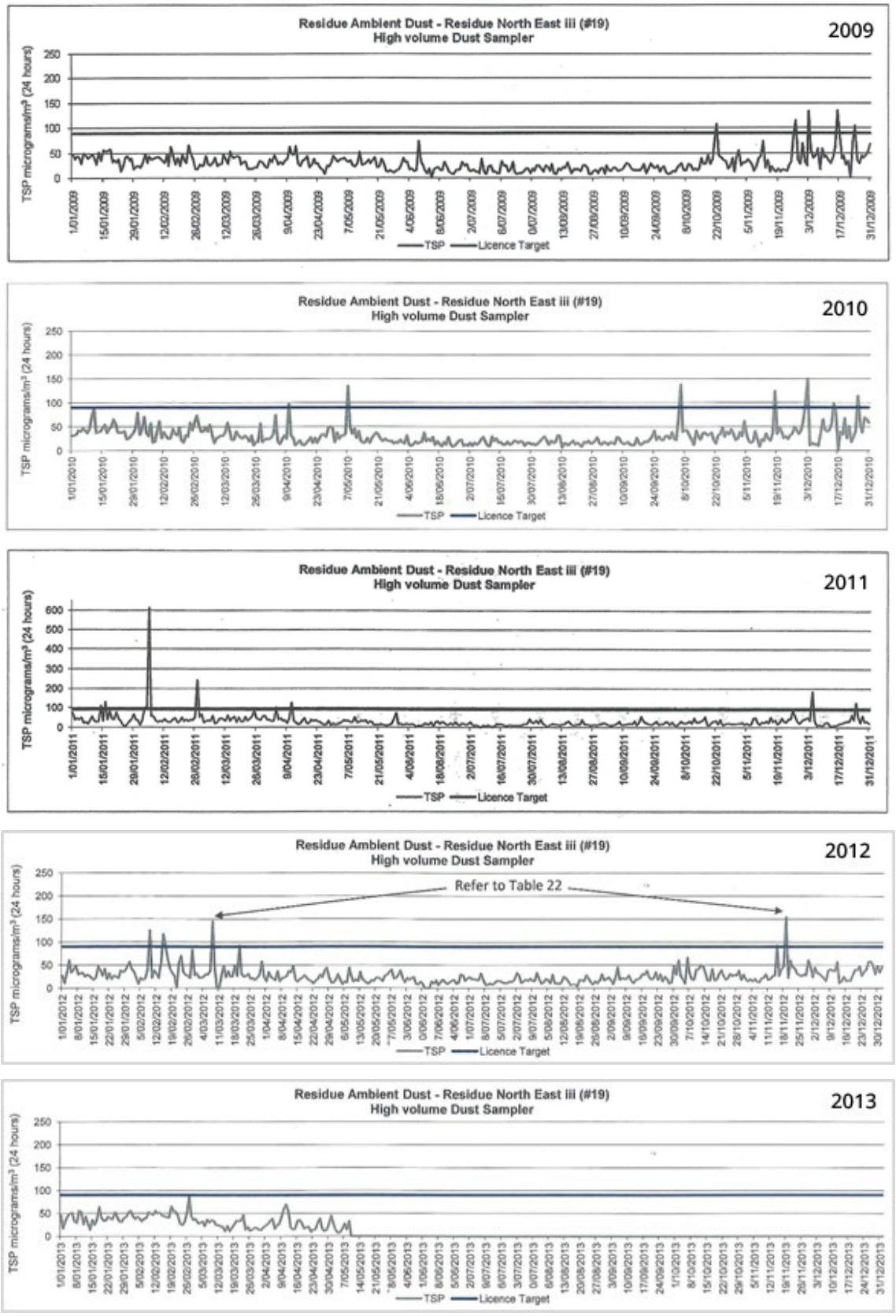


Figure A5: Residue Ambient Total Suspended Particulates (TSP) - Residue North East iii– years 2009 – 2013. Licence target set at 90 micrograms/m³ (24 hours). This monitoring station closed in May 2013.

PM_{10} is monitored continuously at two of the stations, Sayer Road to the north and Residue West. This is in line with the predominant winds from the south-west and east during the period when potential for dust generation is at its highest (October to April). There is currently no monitoring of dust levels for PM_{10} in the Mandogalup area to the north-east or of the RDA. While the frequency of westerly winds, particularly during the period of highest potential for dust generation is limited, it is unfortunate that PM_{10} levels in this direction cannot be confirmed with historical data.

A2.2 Wind data

The months from October to April are the time of the year when the risk of dust impacts in Mandogalup is potentially greatest. In summer, the predominant winds are moderate to strong east-south-easterly and south-westerly winds. Strong and gusty south-westerly winds develop around midday with the onset of the sea breeze which eases in the late evening. Figures A6 and A7 below illustrate the strong winds experienced in the summer months in the Kwinana area.

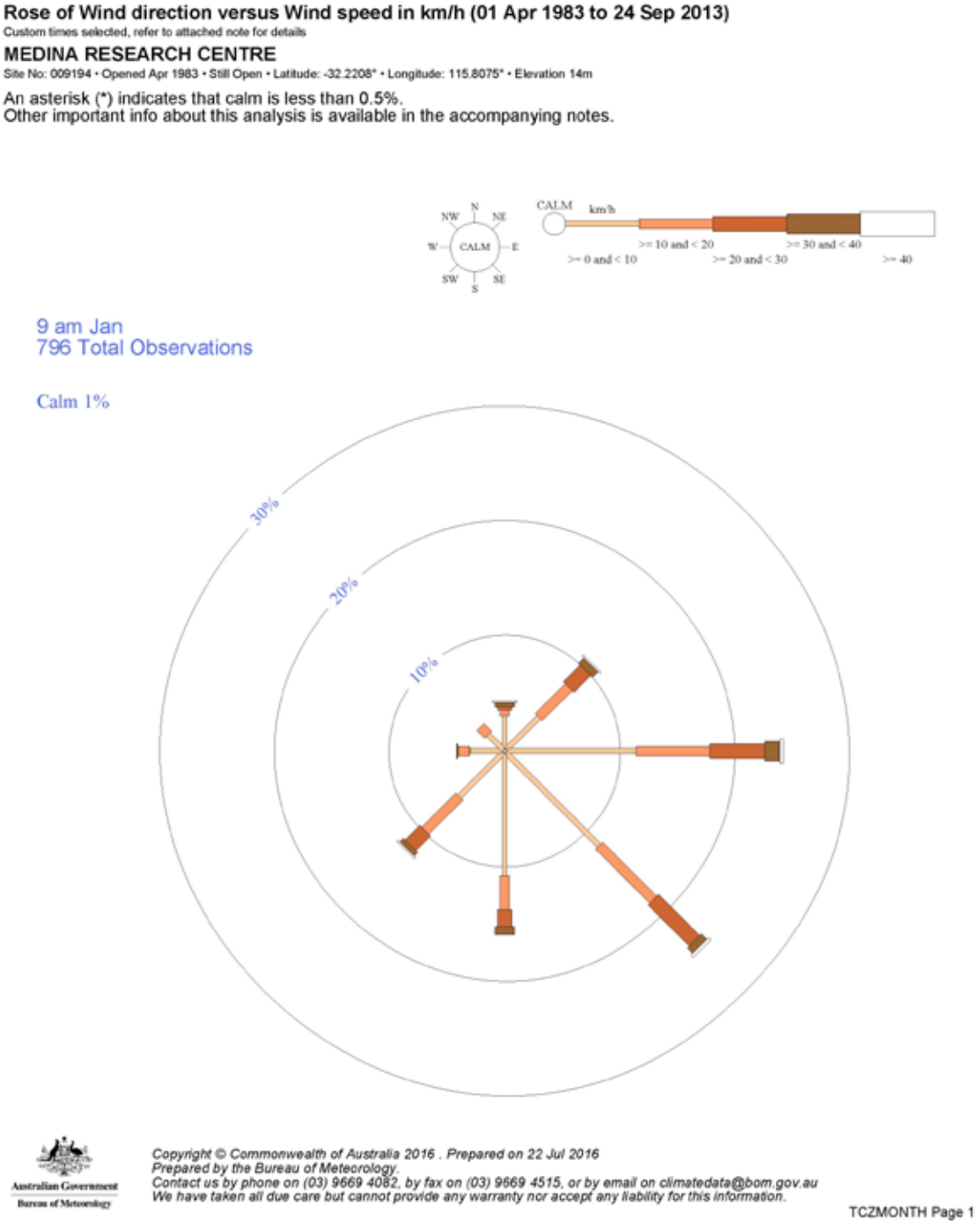


Figure A6 - 30 year average January 3pm wind rose data from the Bureau of Meteorology (BOM) Medina Research Centre (approximately 4 kilometres south-west of Mandogalup)

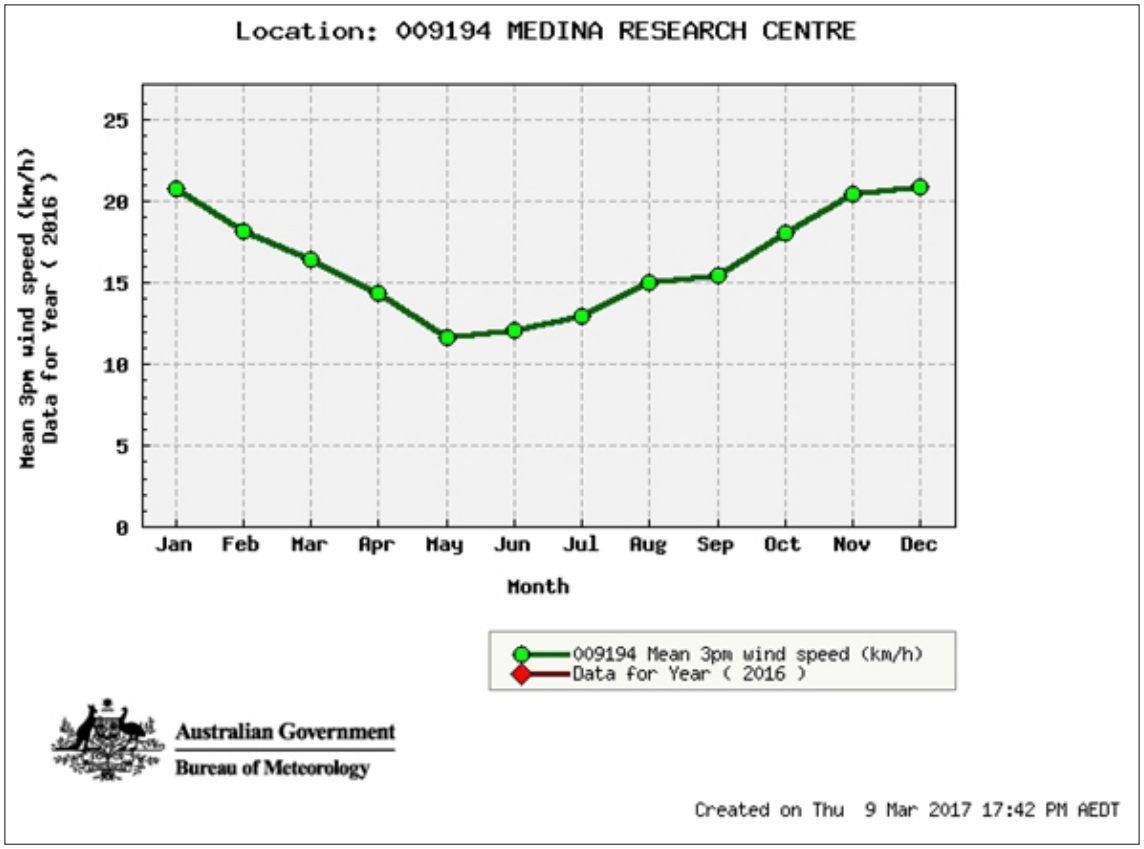


Figure A7: BOM average 3pm wind speed data for 2016 at the Medina Research Centre

A2.3 Air quality modelling

Alcoa developed a calibrated air quality model to estimate the amount of dust emissions from the RDA and dust concentrations in the air in the surrounding area, including background dust levels.

A report on this modelling by GHD Pty Ltd in 2009 (GHD Pty Ltd 2009) indicated that for the current RDA operation, potentially significant dust emissions (i.e. 20 percent above background levels) occurred from the RDA up to 3 kilometres (km) to the north-east of the facility based on analysis of two years of meteorological data (2007–08 and 2008–09). This is consistent with the predominant south-westerly winds in the locality. The model was also run with an assumed RDA operation in 2030. In this scenario, Area F was closed but additional drying beds (Areas O and P) were opened in the west of the RDA (Figure 1).

The assumed 2030 RDA operation did not include the introduction of the new filtrate process which could reduce the area of drying beds required to be open in the future.

RDA dust modelling results were also presented in an Expert Witness Assessment Reports for a State Administrative Tribunal matter (WASAT 2014) regarding a proposed subdivision in Wattleup in 2013. The modelling indicated similar predicted emissions to the north-east of the RDA for the current RDA operations and using meteorological data for 2012/13. This is consistent again with the predominant south-westerly winds in the locality.

There are differences of view as to how reliable the air quality model is in predicting dust concentrations in the surrounding air.

The issue of the reliability of the model was considered as part of the State Administrative Tribunal matters DR364 and DR44 but there was no agreement between experts who made submissions to the hearing. One expert submitted that the model over predicted the highest daily dust concentrations in the surrounding air. Alcoa submitted that over and under predictions of individual events were not a measure of the overall reliability of the model and the only way to assess the model was based on statistical measure. Alcoa considers that qualitative assessment of the model performance shows that the predictions are within normal and acceptable range when compared to the monitoring data and therefore the model results can be used for assessment of air quality in the surrounding area. No experts put a view that the model under predicts emissions.

GHD Pty Ltd, which developed the model, considers that the model's performance is very good for a model of this type for predicting dust levels from the RDA. GHD Pty Ltd did note that the area within 1 km of the RDA embankment is potentially affected by turbulence and wind shadowing caused by the RDA and therefore model predictions in this area are not reliable (GHD Pty Ltd 2009).

Based on the consideration of the reliability at the State Administrative Tribunal hearing and GHD Pty Ltd's assessment of the model's calibration, and the EPA's own independent evaluation, the EPA considers that the air quality model provides a useful tool for assessment potential impacts of dust beyond 1 km from the RDA. At worst, the model is likely to over-predict impacts.

A2.4 Complaints data

The Department of Environment Regulation provided the EPA data on complaints received about dust impacts in the vicinity of the Mandogalup area from 2004 onwards, as did Alcoa dating back to 2003.

A2.5 Public submissions

In developing its advice, the EPA conducted a public submission process in order to understand the views and experience of the Mandogalup community in relation to current land uses in the area and in particular the impacts from dust on these land uses.

57 submissions were received (once the data was corrected for multiple submissions from the same person or blank submissions).

Of the 57 respondents, 47% were current residents or had family residing in Mandogalup; 12% lease land, had friends in the area or were a previous resident, 33% did not provide an answer to their relationship to Mandogalup area and the remaining 7% were a variety of responses.

The submission period ran from 15 August to 12 September 2016. Respondents answered questions in an electronic survey on the EPA Consultation Hub (https://consultation.epa.wa.gov.au).

The Survey questions were:

1. Do you own land in the Mandogalup area? Y/N
2. If yes to the above:

   a) is your land located in the current Kwinana Industrial (including Air Quality) Buffer? Y/N

   b) what is the current zoning of your land?

3. If you do not own land in Mandogalup, please tell us about your relationship to the Mandogalup area.
4. Have you noticed or experienced any dust issues on your property? For example amenity issues such as dirty washing, loss of enjoyment and use. Please explain why / why not. Please include what you believe are sources of dust in the area.
5. What are your current land uses and what do you believe are appropriate land uses in the Mandogalup area? Why?