Review of Dust Management

Lucky Bay Operation

Technical Note for Client Information

Version A

Prepared for Australian Garnet Pty Ltd

September 2023

Project Number: 1388

Review of Dust Management

Technical Note for Client Information

[redacted]

Table of Contents

Tables

Figures

1 Introduction

1.1 Background

Australian Garnet Pty Ltd (Australian Garnet) own and operate the Balline Garnet Mine, an integrated mining, processing, packaging and distribution operation at Lucky Bay, Yallabatharra, approximately 110 kilometres (km) northwest of Geraldton in Western Australia.

Australian Garnet hold a Works Approval (W6214/2019/1) issued under the provisions of Part V of the Environmental Protection Act 1986 (expires 29 April 2024) which allows for time limited operation until the granting of a Licence. The Works Approval sets a number of requirements for dust controls to be commissioned and their environmental performance to be confirmed. A Dust Management Plan (Australian Garnet, 2022) is also in place to "*ensure the management of actual and potential dust emissions is conducted in a manner that:*

- *Fulfils Australian Garnet's relevant legal obligations;*
- *Meets or exceeds industry leading practice and satisfies relevant guidelines;*
- *Is responsive to changes in management and performance requirements.*

Australian Garnet has received community-based complaints regarding dust emissions associated with the operations and contracted Environmental Technologies & Analytics Pty Ltd (ETA) to undertake site investigations into the potential sources of emissions and provide recommendations for the management and monitoring of dust. This report documents the findings of a site review undertaken by ETA 28-30 August 2023.

1.2 Scope of work

The scope of work for this project includes the following components:

- Undertake a site visit with the following aims:
  - To observe and review operations and dust management and controls being implemented.
  - To observe premises boundary for dust leaving the premises, including visual evidence of dust deposition in close proximity to the premises boundary.
  - To review potential ambient dust monitoring locations suitable for:
    - boundary monitoring (if considered appropriate
    - sensitive receptor monitoring (if considered appropriate)
  - Undertake spot measurements for dust with client's equipment (if available). Noting that it was ETA's preference to undertake the site review initially and propose an appropriate measurement strategy to be implemented in due course.
- Prepare a Technical Note and provided key recommendations for Australian Garnet's consideration, noting that the technical note is intended for the information of Australian Garnet only for informing decision making. It is not intended for submission to DWER or other third parties. The Technical Note will address the following:
  - Operations and controls observed,
  - Improvements for consideration,
  - Monitoring requirements including onsite/boundary and, if deemed appropriate, community receptor monitoring.
  - Potential monitoring location options
  - Whether emissions estimation and / or dispersion modelling will be beneficial for informing Australian Garnet.

2 Background Information

The following section contains contextual background information including sensitive receptors and an analysis of the regional meteorological data, essential to understanding the potential for dust generation and impact.

2.1 Sensitive Receptors

Within the region immediately surrounding the operations there are three sensitive receptors. These receptors are presented in Figure 2-1 and are:

- Receptor 1: Residence on a rural property approximately 1,000 metres (m) from the operations boundary.
- Receptor 2: Lucky Bay Shacks and Camping Ground – Camping and caravan ground currently administered by the Shire of Northampton. Located approximately 2,200 m from the operations boundary.
- Receptor 3: Residence on a rural property approximately 3,600 m from the operations boundary.

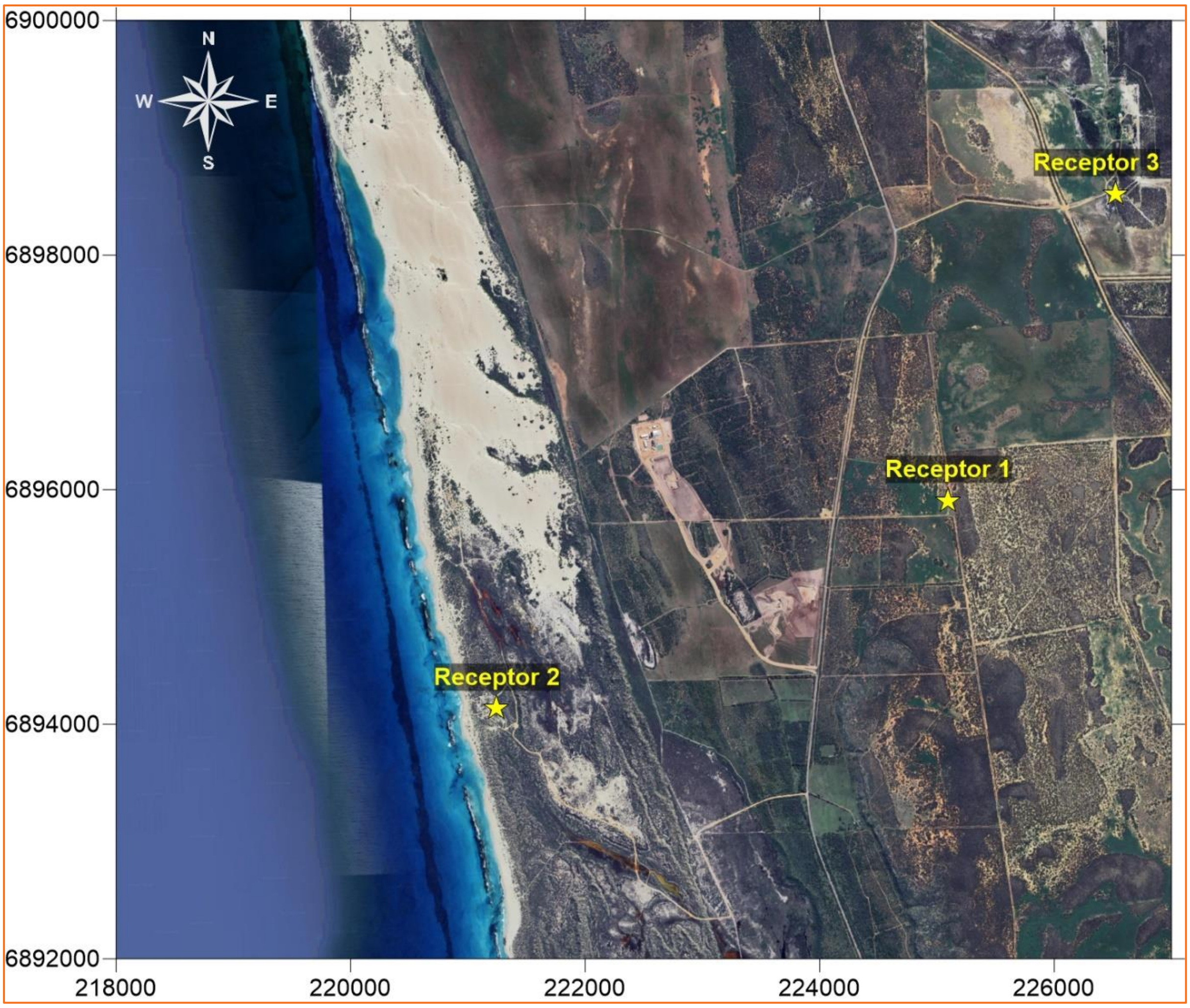

Figure 2-1: Sensitive receptor locations

2.2 Regional Meteorology

As there is no Bureau of Meteorology (BoM) station within the immediate region that records continuous meteorological data the hourly averaged (from 1-minute data) wind speed and direction data was sourced from the BoM Automatic Weather Station (AWS) at the Geraldton Aero (Station ID 008315). The data from this station is expected to be broadly similar to that experienced at the Australian Garnet operations.

The annual wind rose, derived from hourly wind speed and direction measurements from 2012 to 2022 is presented in Figure 2-2. From this figure it is apparent that:

- The main prevailing wind direction is from the south, with a significant proportion of these winds above 6 m/s, which is the nominal wind speed at which wind erosion occurs.
- There is a prevailing wind direction from the southeast, though the wind speeds from this direction are primarily below 6 m/s.
- The third prevailing wind direction is from the northeast with the wind speed being below 6 m/s for the majority of the time.

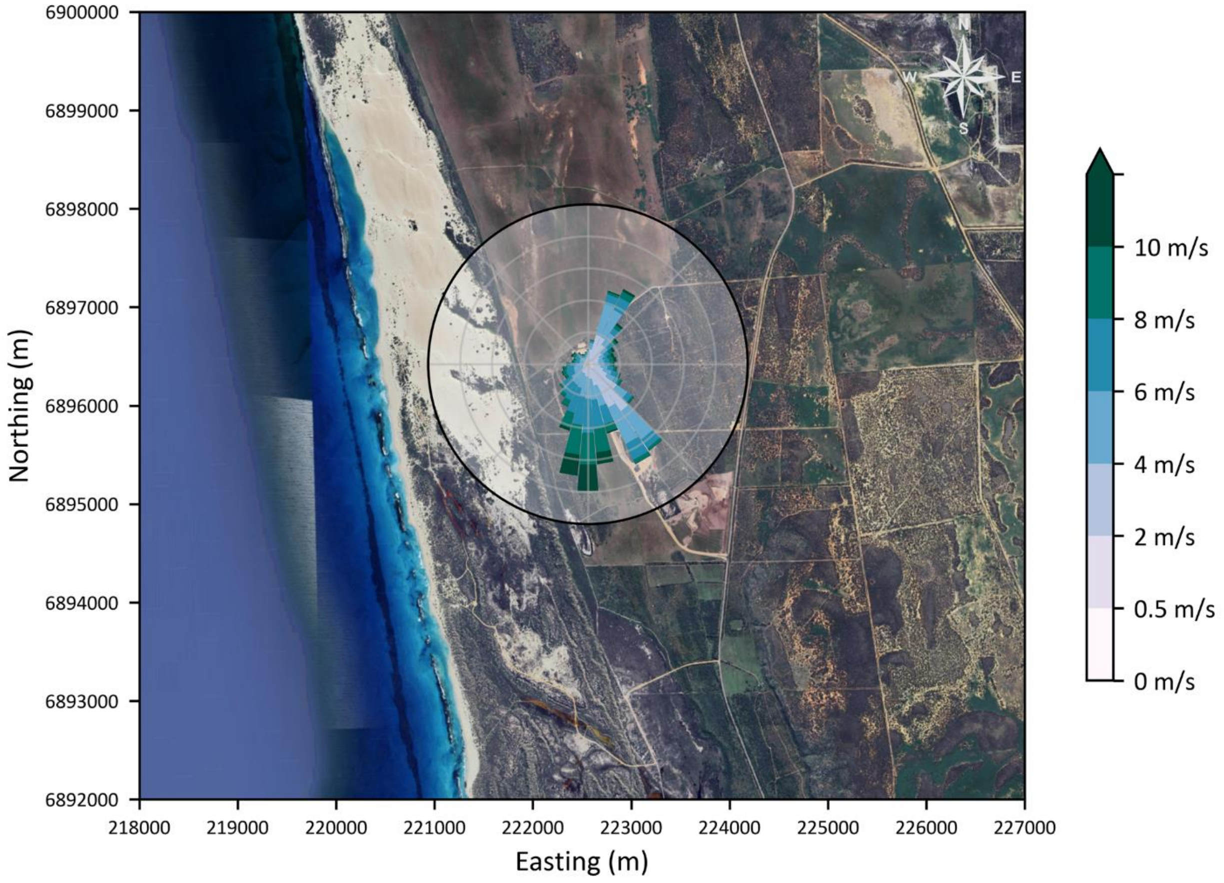

Figure 2-2: Annual wind rose (BoM Geraldton Aero 2012 – 2022)

The wind speed and direction data from the Geraldton Aero AWS, for the period 2012 to 2022, is presented as monthly wind roses in Figure 2-3.

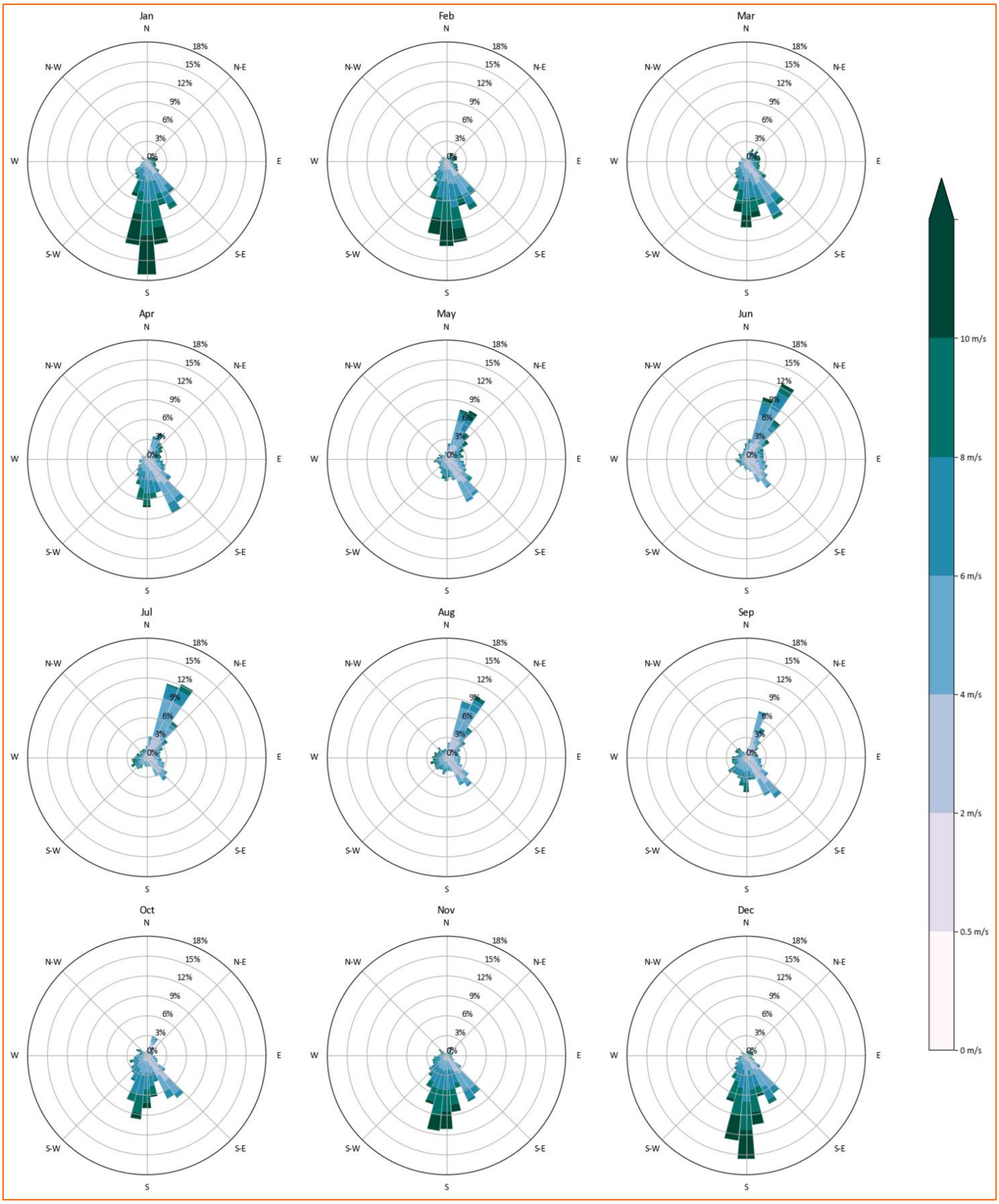

Figure 2-3 Monthly wind roses (BoM Geraldton Aero 2012 – 2022)

From the monthly wind roses presented in Figure 2-3 it can be inferred that:

- The southerly winds occur for 6 months of a year from October through to March.
- The frequency of strong winds from the south occurs from November through to February.
- The months of April and September are transitional months in that the wind direction can vary from the south, southeast or northeast.
- The months from May to August have prevailing northeasterly winds.

2.3 Dust Generation

Ore mining, handling, processing and transport activities give rise to dust generation through two main mechanisms:

- Mechanical processes that generate and potentially release particulate matter include material movement (such as grinding operations, dropping at conveyor transfer points, stacking, reclaiming and ship loading), blasting and vehicular movement over unsealed or dust laden surfaces. The amount of particulate matter generated from these processes does not have as high a wind speed dependency as that from wind erosion, but is more dependent on the moisture properties of the material being transferred, the particle size distribution of the material, drop heights and the dust management measures and emission controls in place for the sources.
- Wind generated dust occurs when the wind speed exceeds a "threshold" velocity, nominally in the 5 – 10 (m/s) range, for erosion of the underlying surface. Under these conditions, particles greater than 100 µm in diameter that protrude above the surface are dislodged by shear forces and bounce and creep across the surface. These particles (through their bouncing or skipping motion) commonly known as saltating particles, can dislodge smaller particles, which then remain suspended in the air. The amount of particulate matter generated is highly dependent upon the wind speed: below the wind speed threshold, no particulate matter is generated, whilst above the threshold, particulate matter generation tends to increase with the cube of the wind speed.
  The amount of particulate matter generated by wind is also dependent on the surface properties; including whether the material is crusted, the amount of non-erodible particles present (particles greater than several millimetres that tend to protect the smaller particles) and the size distribution of the material.

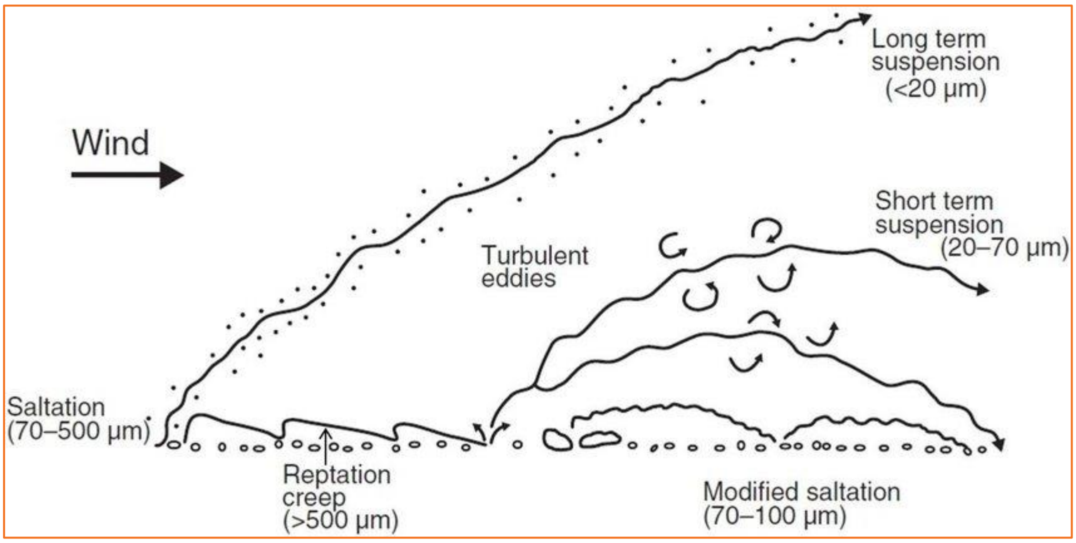

Figure 2-4: Example of wind erosion mechanisms

3 Site Investigation

The following sections outline the observations and recommendations derived during the site investigation, carried out 28-30 August 2023.

3.1 Mining

The mining operations are undertaken using conventional sand mining practises including:

- Clearing of vegetation.
- Removal, and stockpiling, of topsoil.
- Bulldozers are used to push ore downwards onto pit floor.
- Ore is picked up by front end loaders (FEL) and stockpiled for blending (grade control).
- The ore is then loaded into the Mobile Mining Unit (MMU) plant and then pumped as a slurry to the processing plant.

An overview of the mining operations is presented in Figure 3-1. From this figure the cleared land is clearly either side of the mined area. The dozed areas can be clearly seen around the edge of the mining area, along with the two blending stockpiles in the middle of the pit. The MMU is clearly visible in the centre of the pit, though no FEL's were operational at the time.

Figure 3-1: Overview of mining operations (Australian Garnet, 2023)

During the site investigation no activities were occurring in the pit and no wind erosion emissions were evident from either within the pit or the cleared areas.

3.2 Tailings storage

Waste material from the processing plant is currently pumped back to the Tailings Storage Stockpile (TSS) which is located immediately to the south of the operations. An overview of the operations is presented in Figure 3-2 where bulldozers can be observed pushing damp waste material to the sides of the stockpile.

During the site investigation visible dust emissions were observed coming from the TSS, particularly from the sides. Although the material is wet when it is stacked it dries very quickly and becomes highly susceptible to wind erosion. An example of this is presented in Figure 3-3 which presents a close view of the western side of the TSS.

As outlined in Section 2.3 wind erosion occurs once the wind speed exceeds a certain threshold value allowing for saltation and creep to occur. There are additional factors that occurs at the tailings storage stockpile that increase the liklehood of wind erosion occuring including:

- Wind speed up – this is simply the compression of a body of air as it encounters an obstacle resulting in an increased velocity to ensure that the same volume of air passes through. This results in increased airflow over, and around, the tailings storage stockpile increasing the potential of wind erosion emissions occuring.
- Increased wind speed with height: As a wind field increases with height there is less surface friction resulting in higher wind speeds.

Both of these factors combine to increase the potential of wind erosion emissions from occuring at the TSS.

The emissions from the TSS will result in additional issues including:

- The emissions will be visible from nearby sensitive receptors which result in a potnetial increase in complaints.
- Emissions will be visible from along George Grey Road which may result in additional complaints or adverse media exposure.
- During southerly winds, which are prevalent from October to March (Section 2.2), wind conditions will direct the emissions throughout the operation including:
    - Into the air inlets of the diesel generators resulting in increased maintenance, with potential failure of one, or more, generators.
    - Air conditioner units, including those cooling the Motor Control Centre (MCC) as presented in Figure 3-4. It will be imperative that the air conditioners throughout the site have a regular cleaning regime to prevent their failure.
    - Increased deposition throughout the site, potentially resulting in clogging of drainage channels. An example of this is presented in Figure 3-5 where a drain within the concrete bund for one of the transformers was filled with material.

The TSS is the primary source of fugitive dust emissions at the operations and reduction of emissions from this source is critical to reducing the overall emissions from the operations. It should also be noted that failure to reduce emissions from the TSS will effectively negate all other dust abatement strategies as fugitive emissions from this source will deposit throughout the operations with the potential to be re-emitted by either vehicle movements or wind erosion.

ETA is aware that TSS stabilisation plans have been discussed within Australian Garnet including the following:

- Re-contouring of the stockpile.

- Applying topsoil and seeding.

These activities are currently planned for mid 2024 with topsoil and seeding due to occur in July/August 2024 to coincide with known rainfall periods. Until these stabilisations activities are undertaken the TSS will be the largest emitter of fugitive dust from the operations – particularly during the coming months (October 2023 – March 2024) when consistent high speed southerly winds are predicted to occur (Section 2.2).

It is highly recommended that Australian Garnet investigate the possibility of applying an abatement solution for the coming summer months to reduce the potential emissions from this source. Potential solutions to temporarily cap the stockpile include:

- Application of a polymer emulsion over exposed, inactive surfaces – noting that numerous applications can be applied as required.
- Applying 'slimes' over exposed, inactive surfaces.
- Application of a hydomulch product to exposed, inactive surfaces.

Please note that there is a limited timeframe to undertake these potential abatement methodologies to limit the potential for ongoing dust generation during the coming summer months.

Figure 3-2: Overview of dry tailings storage stockpile (Australian Garnet, 2023)

Figure 3-3: Dry tailings storage facility – close view of western face (ETA, 2023)

Figure 3-4: Air conditioners for the MCC are directly north of the tailings stockpile (ETA, 2023)

Figure 3-5: Recovery drain for potential oil spills from the transformers filled with sand (ETA, 2023)

3.3 Processing plant

The actual processing plant is a wet process so fugitive emissions are expected to be minimal. The primary emissions are associated with the final products including Garnet, Ilmenite and Heavy Mineral Concentrate (HMC). The stacking of the HMC is outlined in Section 3.5.

3.4 Roads and open areas

During the site investigation it was observed that all roads within the facility are unsealed and that there are large expanses of open areas. Unsealed roads result in dust emissions via the movement of vehicles and wind erosion and an example of this is presented in Figure 3-6 where a highly visible dust plume, derived from wind erosion, is apparent. Additional examples include:

- Undefined roads and open area near the administration building, including both visitor and general carparks as presented in Figure 3-7. This large area is highly conducive to multiple emission sources including:
    - Vehicle emissions – the large undefined area that vehicles can travel increases the potential for vehicle emissions and decreases the effectiveness of watering (via the water truck) as more water has to applied to achieve a suitable reduction. It would be preferable to incorporate a traffic management plan with defined roads, parking areas and pedestrian walkways (noting that the current arrangement does not allow for safe egress from the visitor parking bay to the Administration Building).
    - Large open area – the large areas allow for deposition of material from the TSS which can be resuspended by either vehicle movements or wind erosion.
- Large open areas adjacent to the Ilmenite Shed, as presented in Figure 3-8, are highly susceptible to wind erosion emissions. The ground at the forefront of Figure 3-8 shows the classic pattern indicative of ongoing wind erosion. The roads around the laydown pad, visible at the top of the figure, appear to be insufficiently constructed with a high percentage of surface fines material which will result in increased emissions associated with vehicle movements.

Additional issues resulting from emissions from open areas and roads within the plant area include:

- Decrease in quality of working environment – a high dust environment decreases employee perception of the operations, increases potential health related issues and may increase the probability of an incident.
- As can be seen in Figure 3-9 several air conditioners throughout the facility are located at ground level and dust emissions from vehicle movements and wind erosion will result in increased maintenance (filter cleaning) and potentially reduces the reliable operating life of the air conditioners.

Figure 3-6: Wind erosion from open areas within processing plant area (ETA, 2023)

Figure 3-7: Large open area near admin building (inclusive of visitors and admin carparking) (ETA, 2023)

Figure 3-8: Open areas near ilmenite shed and laydown yard (ETA, 2023)

Figure 3-9 Air conditioners for control room at ground level (ETA, 2023)

Roads and open areas can be considered to be the second largest particulate emissions source at the operations and should be considered a high priority for emission abatement. However, as discussed in Section 3.2, it will be critical to remediate the TSS before finalising any remediation on the roads and open areas.

The following steps are considered critical to reducing emissions from roads and open areas:

- Design, and implementation, of a traffic management plan – this plan should include the following components:
    - Reduction in trafficable area by reducing the width of roads and clearly demarcating them, noting that this can be accomplished relatively cheaply by using waste material to create bunds of approximately 40-50 cm in height.
    - Consideration can be given to making roads within, or around, the plant area one-way only.
    - Clearly defined parking bays with the parking area covered in gravel (road base material or railway ballast in the short term).
    - Ideally all roads and parking bays should be sealed but this should not be undertaken until the TSS has been fully rehabilitated to reduce the potential for suspended material building up on the road. Also note that sealed roads should have gutters installed to reduce material being tracked onto the road. Furthermore sealed roads still need to be cleaned which may necessitate the purchase, or lease, of a dedicated street sweeper.
    - In the interim the potential of utilising a polymer chemical product to assist in binding the surface of unsealed roads should be considered.
- Laydown pads – should, at the very least, be covered in gravel (road base material or railway ballast in the short term).
- Open areas required for short term operational purposes, such as shutdowns, should be bunded off with clear entry/exit points, and the area can be treated with a polymer chemical, with no further access allowed until the area is required again.
- Ongoing rehabilitation – all areas no longer required for construction or operational purposes should be progressively rehabilitated.

3.5 Stockpiles – HMC

Stacking operations at the HMC stockpiles are protected from southerly winds by the simple process of stacked shipping containers (2 containers long, and 3 containers high) as presented in Figure 3-10. This simple, and cheap, methodology appears to be highly effective in reducing emissions from both stacking and wind erosion on the HMC stockpile.

The only potential issue appears to be when the HMC is moved to a secondary 'dead' stockpile adjacent to the primary stockpile. This secondary stockpile is outside the protection of the shipping containers and, as can be seen in Figure 3-11, is susceptible to wind erosion.

To reduce the potential of wind erosion emissions from this source it is recommended that the shipping container wind wall be extended to the east (to cover the secondary stockpile), noting it would need to be two containers high at this point to be effective.

Figure 3-10: Product stacking protected by stacked shipping containers (ETA, 2023)

Figure 3-11: Product exposed to wind, note rilling indicative of wind erosion (ETA, 2023)

3.6 Stockpiles - waste

At the northern end of the operation are a series of open stockpiles (Figure 3-12) that were a visible source of wind erosion emissions during the site investigation. These stockpiles appear to be in place for a considerable amount of time (years) and it is highly recommended that they be stabilised to minimise emissions.

In the short term it is recommended that these stockpiles by sprayed with a polymer chemical (see Section 3.2), and in the longer-term consideration should be for rehabilitation of the stockpiles.

Figure 3-12: Visible wind erosion from stockpiles immediately to the north of the operations (ETA, 2023)

3.7 Generators – diesel

The operations currently utilise three diesel fired generators to provide power to the operations. These generators are contained within containers and are located immediately to the west of the Motor Control Centre (MCC). There are no exhaust stacks for the generators with exhaust emissions released immediately into the environment via a vent on the roof of the container. Given their location immediately adjacent to, and below, the MCC, the exhaust emissions are heavily influenced by building downwash, especially during easterly winds.

Building downwash is the process where the air flow creates a turbulent wake on the leeward side of a building. Plumes, such as those derived from the diesel generators, become trapped in the wake and are brought to the ground almost immediately exposing the main administration block, including the medical office, to potentially high concentrations of diesel particulate matter, oxides of nitrogen (NO_X) and Carbon monoxide (CO) amongst other pollutants. This should be considered to be a significant risk to site-based personnel, and it is highly recommended that the option of adding discharge stacks to elevate the exhaust emissions be undertaken.

Figure 3-13: Diesel generators adjacent to MCC (ETA, 2023)

Figure 3-14: Diesel generators adjacent to MCC (ETA, 2023)

4 Ambient Air Quality Monitoring

Within the Australian Garnet Dust Management Plan (DMP) there is a requirement for monitoring of air quality be undertaken across the Luck Bay project. However during the site investigation it was apparent that no ambient air quality monitoring is conducted at the operations, and it is therefore imperative that a monitoring program be initiated as soon as practicable.

4.1 Establishing Monitoring Network

When establishing a monitoring network, regardless of the number of monitors, it is critical that it is both appropriately planned and subsequently implemented (including the selection of monitoring equipment) with appropriate quality assurance and analysis of the monitoring data to ensure that the initial aim of the program is achieved. As outlined by the United States Environmental Protection Agency (USEPA) there are five primary steps to establishing a monitoring network which are presented in Figure 4-1.

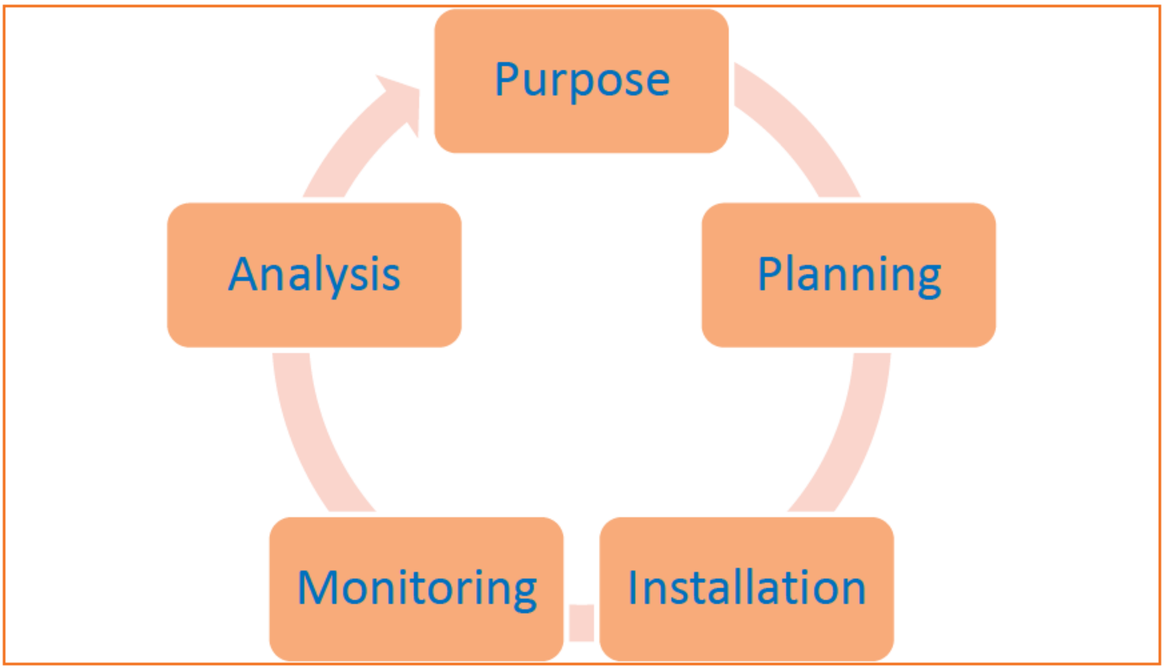

Figure 4-1: Outline of the primary steps in establishing a monitoring network

A brief explanation of each of the five steps contained in Figure 4-1 is as follows:

Purpose: It is critical to define the aim, and intended goals, of a monitoring program. This allows for a range of factors to be determine including:

- Purpose of monitoring program – short term research (suspected flow of particulates), boundary monitoring for early warning, source apportionment, community or background monitoring.
- Response time for monitoring data – monthly, daily, hourly, sub-hourly.
- Required quality of the data – regulatory reporting requirement, early warning or source apportionment (with no requirement to report the data to the regulator).

- Type of monitoring equipment required (regulatory or non-regulatory monitor, meteorological parameters etc).
- Data collection period – short term research project (less than a year), activity related (mobile crusher) or life of mine.

For the Australian Garnet operations the proposed ambient particulate monitoring network will primarily be comprised of peak/boundary monitors.

Planning: A detailed plan is a critical component of any monitoring network. A plan should clearly outline the following:

- Purpose of each monitor within the network (noting that some monitors may fill more than one function).
- Roles and responsibilities: Who is responsible for each level of the monitoring including overall Project Manager, and who is responsible for liaison with stakeholders, liaison with contractors, monitoring performance tracking etc.
- Required data quality: Includes data recovery targets, data verification/validation.
- Monitoring methodology:
    - Type of monitor (including any associated meteorological measurements)
    - Siting criteria
    - Monitoring location
    - Frequency of testing and calibration
    - Emergency maintenance.
- Data management:
    - Data collection and storage
    - Data processing – is the data adjusted? How is it adjusted?
    - Data verification and validation (if required) – a clear description of the process.
    - Ongoing verification of monitor calibration.

Installation: This section includes both choosing an appropriate location and the actual installation of the monitor. When choosing a location for the monitor it will be critical to start the process as soon as possible to ensure access to a site. It is also important to consider a range of parameters, as outlined in AS/NZS 3580.1.1:2016, including, but not limited to:

- Clear sky angle of 120^{o} around the inlet for the monitor.
- Ensure that there is no restriction of air flow around the monitor (buildings, trees, walls etc).
- Distance to the nearest road, and whether it is sealed or unsealed along with the potential traffic volume.
- Potential access issues as well as security of the station.
- Is not prone to natural disasters (floods/wildfires).
- Communication services.
- Power requirements (noting that the proposed monitors will utilise solar power).
- Extraneous sources.

Monitoring: Unfortunately this component of a monitoring program is often a set and forget process whereby it is assumed that the monitors are collecting valid data, and any potential issues are not identified for weeks, and sometimes months. During a monitoring campaign, irrespective of duration, the following steps should be undertaken:

- Data review – this should be undertaken, at a minimum, on a weekly basis. Some of the basic steps that should be undertaken include:
    - Confirmation of data collection efficiency.
    - Basic plotting of data such as a simple time series plot – this allows for trends to be observed as well as instances where data may have been collected but at almost constant readings.
    - QA/QC checks including verification of data that may not be picked up by automatic checks.
- Maintenance – Additional maintenance beyond that supplied by 3rd party contractors may be required. This may include cleaning of solar panels and cleaning of inlets on peak monitors, cleaning of microsensors etc.

Analysis: A critical component of any monitoring program that is often either overlooked, undertaken poorly or has poor communication of the results. There are required steps that should be taken for analysis of the monitoring data including:

- Data cleaning: An important step and one which can often require up to 70 – 80% of the total time for data analysis. Some checks can be automated – such as removal of invalid numbers (beyond sensor range) and missing or duplicate date/time stamps, while other checks may still require a manual process. Manual checks may include checking the data to ensure trends are evident (noting that a vane anemometer may be slightly stuck, and the readings vary by 1-2^{o} over timestamps – this would not be enough to trigger an automatic removal but becomes evident in a manual check of a time series plot). It is always recommended that manual checks of monitoring data be conducted to determine if there are issues that were not identified in the validation process.
- Analysis: The type of analysis should be dependent on the purpose of the monitor. Additional factors to consider include:
    - Is any additional data required such as:
        - Meteorological data
        - Process or activity data
        - Additional monitoring data (for example to support a PM_{10} to $PM_{2.5}$ comparison)
        - Exceptional events (wild fires, dust storms).
    - Required averaging period – For Australian Garnet the averaging period should be aligned with the Trigger | Action | Response | Plan (TARP).
- Data presentation – How to communicate the monitoring data. It is important to understand who your audience is – for the community a time series plot of 24-hour averaged data with the criteria level may be all that is required. For internal managers an hourly plot of PM_{10} concentrations, wind speed and direction may be required to highlight specific conditions or periods of concern.

As part of a TARP the information should be kept relatively simple but still be able to assist operational personnel to respond to triggers – a monitor has triggered the action concentration, and the wind direction data and peak monitors indicate that the source is from a certain area.

4.2 Recommendation for Ambient Monitors

In locations, or situations, that require ambient monitoring, to support operational control or management dust, then a type of monitor called a 'nephelometer' can be used. A nephelometer uses light scattering to count the particles which are then converted into a mass concentration. The conversion is based on Arizona road dust and if a more representative concentration is required then a correction factor, commonly stated as a k-factor, is required. This can be determined by co-locating the monitor adjacent to a regulatory monitor for a period of time, determining the difference in the readings, and calculating the required correction factor.

Historically these monitors have included monitors such as the Met-One ES-642 and E-Sampler, which can be relatively expensive and difficult to install. Another form of a nephelometer that is becoming popular is known as a 'microsensor'. These monitors effectively use a miniaturised version of the light scattering process to achieve a similar result. Care should be taken when utilising these monitors as most of these monitors do not operate continuously, rather they are designed to sample for a limited period of time (i.e. sample for 1 minute every 10 minutes, or 30 seconds every 5 minutes). This assists in prolonging both the life of the battery and sampling module. Furthermore although advertised as 'particulate' monitors, the majority can only sample for particulates in the $PM_{2.5}$ range.

For Australian Garnet it is recommended that the monitoring be undertaken using the KUNAK Air Pro with Particulate Sensor Cartridges package along with the 26w solar panel pack so that the units can be operated in 'high power' mode ensuring continuous monitoring. This monitor (and configuration) will allow for the continuous monitoring of PM_{10}, PM_4, $PM_{2.5}$ and PM_1 (noting that only PM_{10} is required).

4.3 Monitoring Locations

Based on the identified sensitive receptors in the region (Section 2.1), the prevailing wind conditions (Section 2.2) and the location of the operations, three potential monitoring locations have been identified and these are presented in Figure 4-2. The aim, or purpose, of each monitor is as follows:

- Monitor 1: This monitor is located to the west of the operations and is designed to:
  - Act as a downwind monitor during northeasterly winds to track potential impacts to the Lucky Bay Shacks and Camping Ground.
  - Act as an upwind, or background, monitor during southerly winds to determine the concentrations of particulates entering the operations. This allows for regional dust events to be identified to reduce the potential of a high dust alert being activated when dust controls implemented will not lead to reductions.
- Monitor 2: This monitor is located to the east of the operations and is designed to:
  - Act as a downwind monitor during southerly to southeasterly winds to track potential impacts to Receptor 1 (Figure 2-1).
  - Act as an upwind, or background, monitor during northeasterly winds to determine the concentrations of particulates entering the operations. This allows for regional dust events to be identified to reduce the potential of a high dust alert being activated when no reductions can be implemented.
- Monitor 3: This monitor is located to the east of the operations and is designed to:
  - Act as a downwind monitor during southerly to southeasterly winds to track potential impacts from the operations heading northwards (Figure 2-1). Although there are no receptors to the north of the operations this monitor will allow for elevated concentrations to be identified to allow for the implementation of appropriate abatement strategies. Note that elevated concentrations of particulates may also be highly visible from nearby receptors including George Grey Drive.

The actual trigger values for the TARP will need to be determined once the monitors are installed and monitoring data becomes available.

Figure 4-2: Proposed locations of ambient monitors

The approximate coordinates of the recommended locations are presented in Table 4-1 – noting that these locations are approximate recommendations only and the exact location should conform to the requirements set out in *AS/NZS 3580.1.1:2016 – Methods for sampling and analysis of ambient air: Guide to siting air monitoring equipment*.

Table 4-1: Approximate coordinates of proposed monitoring locations (GDA2020, zone 50).

Monitor	Easting	Northing	Comment
Monitor 1	222880	6895005	Boundary monitor for Lucky Bay Shacks and Camping Ground.
Monitor 2	224060	6895820	Boundary monitor for Receptor 1.
Monitor 3	222215	6897775	General boundary monitor for TARP during prevailing southerly winds.

5 Summary and Recommendations

Australian Garnet own, and operate, an integrated mining, processing, packaging and distribution operation at Lucky Bay, approximately 110 kilometres (km) northwest of Geraldton in Western Australia. During August 2023 Environmental Technologies & Analytics Pty Ltd (ETA) undertook a site investigation to determine potential dust emission sources and to provide recommendations for the management and monitoring of dust.

5.1 Mining Recommendations

Mining

During the site investigation no activities were occurring in the pit and no wind erosion emissions were evident from either within the pit or the cleared areas. This is not to say that there are no emissions just that none were observed.

Tailings Storage Stockpile

The TSS was observed to be the primary source of fugitive dust emissions at the operations and reduction of emissions from this source are critical to reducing the overall emissions from the operations.

It should also be noted that failure to reduce emissions from the TSS will effectively negate the effectiveness of all other dust abatement strategies as fugitive emissions from this source will deposit throughout the operations with the potential to be re-emitted by either vehicle movements or wind erosion.

It is highly recommended that Australian Garnet investigate the possibility of applying an abatement solution to the TSS immediately for the coming summer months to reduce the potential emissions from this source. Potential solutions to temporarily cap the stockpile include:

- Application of a polymer emulsion over exposed, inactive surfaces – noting that numerous applications can be applied as required.
- Applying 'slimes' over exposed, inactive surfaces.
- Application of a hydomulch product to exposed, inactive surfaces.

Note that there is a limited timeframe to undertake these potential abatement methodologies in order to successfully abate the immediate risk.

Roads and Open Areas

All roads within the facility are unsealed and there are large expanses of open areas. Collectively these can be considered to be the second largest particulate emissions source at the operations and should be considered a high priority for emission abatement.

To assist in reducing emissions from roads and open areas it is recommended that the following be adopted:

- Design, and implementation, of a traffic management plan – this plan should include the following components:
  - Reduction in trafficable area by reducing the width of roads and clearly demarcating them, noting that this can be accomplished as a relatively low-cost options by using waste material to create bunds of approximately 40-50 cm in height.
  - Consideration be made to making roads within, or around, the plant area one-way directional movement only.

  - Clearly defined parking bays with the parking area covered in gravel (road base material or railway ballast in the short term).
  - Ideally all roads and parking bays should be sealed but this should not be undertaken until the TSS has been fully rehabilitated to reduce the potential of suspended material building up on the road. Also note that sealed roads should have gutters installed to reduce material being tracked onto the road. Furthermore sealed roads still need to be cleaned which may necessitate the purchase, or lease, of a dedicated street sweeper.
  - In the interim the potential of utilising a polymer chemical product to assist in binding the surface of unsealed roads should be considered.
- Laydown pads –at the very least, should be covered in gravel (road base material or railway ballast in the short term).
- Open areas required for short term operational purposes, such as shutdowns, should be bunded off with clear entry/exit points, and the area can be treated with a polymer chemical, with no further access allowed until the area is required again.

Ongoing rehabilitation – all areas no longer required for construction or operational purposes should be progressively rehabilitated.

Stockpiles – HMC

The primary issue at the HMC stockpile is the storage of material at the secondary or 'dead' stockpiles adjacent to the primary stockpile as these areas are not protected from southerly winds.

To reduce the potential of wind erosion emissions from this source it is recommended that the containerised wind wall is extended to the east (to cover the secondary stockpile), though it would only need to be two containers high.

Stockpiles – Waste

There are a series of open stockpiles at the northern end of the facility that were a visible source of wind erosion emissions during the site investigation.

In the short term it is recommended that these stockpiles by sprayed with a polymer chemical, and in the longer-term consideration should be for rehabilitation of the stockpiles.

Generators - Diesel

It was noticed that emissions from the diesel fired generators were brought to ground level very quickly due to the influence of building wake effects from the MCC. This has the potential to result in the main administration block, including the medical office, being exposed to potentially high concentrations of diesel particulate matter, oxides of nitrogen (NO_X) and Carbon monoxide (CO) amongst other pollutants. This should be considered to be a significant risk to site-based personnel, and it is highly recommended that the potential of adding stacks to elevate the exhaust emissions be undertaken.

5.2 Monitoring Requirements

It is recommended that Australian Garnet install three 'KUNAK Air Pro' microsensor monitors at the locations nominated in Figure 4-2. The monitors should be located in accordance to AS/NZS 3580.1.1:2016 – Methods for sampling and analysis of ambient air: Guide to siting air monitoring equipment.

The aim, or purpose, of each monitor is as follows:

- Monitor 1: This monitor is located to the west of the operations and is designed to:
    - Act as a downwind monitor during northeasterly winds to track potential impacts to the Lucky Bay Shacks and Camping Ground.
    - Act as an upwind, or background, monitor during southerly winds to determine the concentrations of particulates entering the operations. This allows for regional dust events to be identified to reduce the potential of a high dust alert being activated when no reductions can be implemented.
- Monitor 2: This monitor is located to the east of the operations and is designed to:
    - Act as a downwind monitor during southerly to southeasterly winds to track potential impacts to Receptor 1.
    - Act as an upwind, or background, monitor during northeasterly winds to determine the concentrations of particulates entering the operations. This allows for regional dust events to be identified to reduce the potential of a high dust alert being activated when no reductions can be implemented.
- Monitor 3: This monitor is located to the east of the operations and is designed to:
    - Act as a downwind monitor during southerly to southeasterly winds to track potential impacts from the operations heading northwards. Although there are no receptors to the north of the operations this monitor will allow for elevated concentrations to be identified to allow for the implementation of appropriate abatement strategies. Note that elevated concentrations of particulates may also be highly visible from nearby receptors including George Grey Drive.

The actual trigger values for the TARP will be determined once the monitors are installed and monitoring data becomes available to inform this.

[redacted]