Dust Management Plan

Project: Peacockes to Whatukooruru Drive

Contract No: 1298-2022

Downer Job No: DN 1205

Contract Plan Issue Date	Document Preparation & Control Project Manager	Document Authorisation Project Director
30 Sept 2022	Craig Lingard	Toby Davies

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The Document control requirements of Downer SPM/5 are applied to this plan as follows;

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Revision Register

Amendment No	Description	Date
2	Changes in Response to BBO review	13/10/22
3	Updated to include details of polymer use	10/11/22
4	Included details of water supply	

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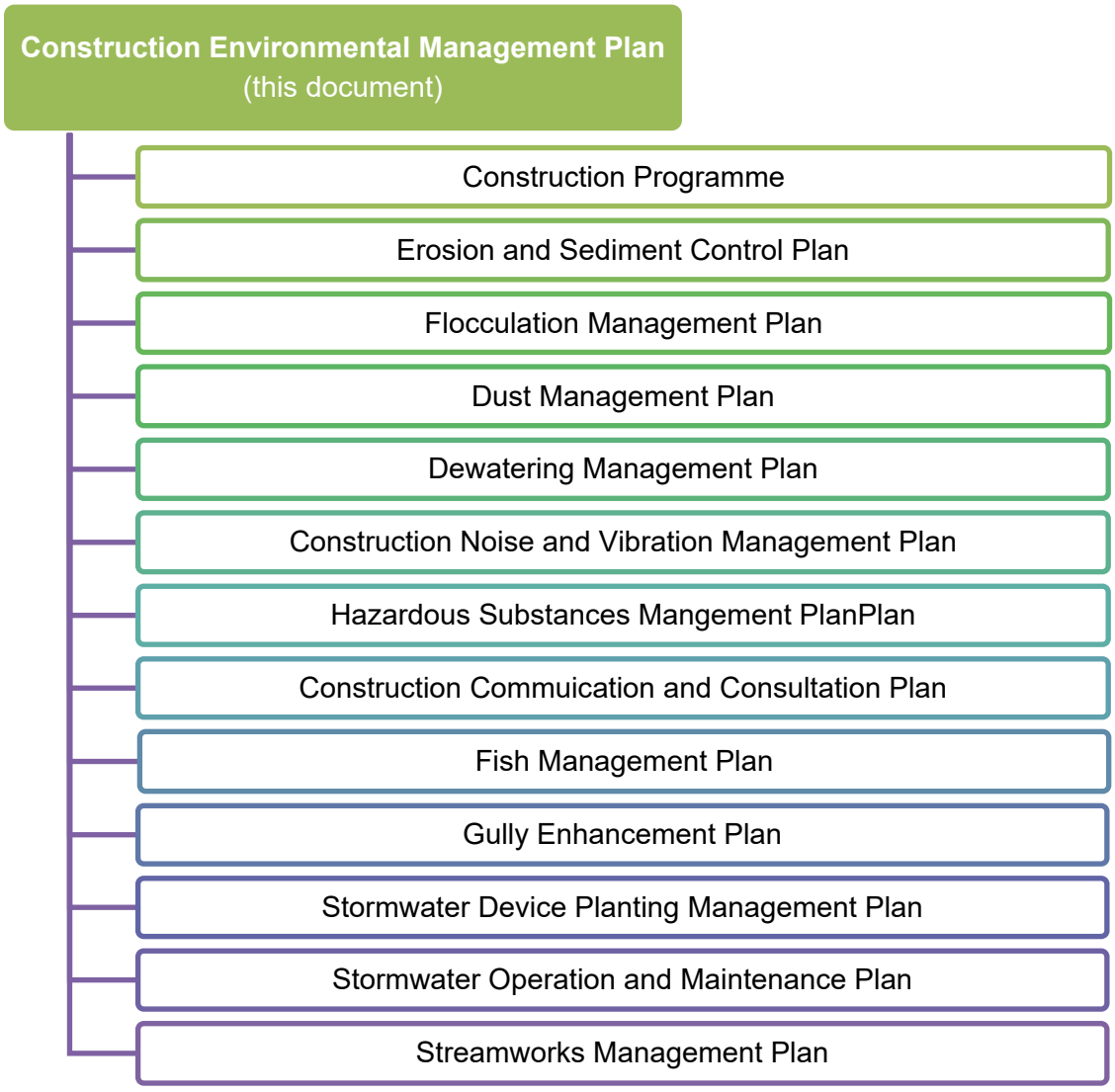
0 Introduction

Downer New Zealand Limited has been awarded a contract by Hamilton City Council (HCC) to undertake construction of Whatukooruru Drive, new major arterial road from Peacockes Road to Hall Road, and an accompanying upgrade of Peacockes Road. Works will be undertaken in Peacocke, a southern suburb of Hamilton.

Roading works include greenfield construction across existing pastoral land with two new bridges across the Mangakotukutuku stream and an unnamed tributary of the Mangakotukutuku stream, and the widening and resurfacing of the existing rural Peacockes Road.

As required by the Contract Documents, Resource Consents and Downer Environmental Management Policy in order to effectively manage the environmental issues on site a number of Environmental Management Plans are required.

These documents are incorporated into the overarching Construction Environmental Management Plan (CEMP). This CEMP includes the following sub-plans:



This Dust Management Plan (DMP) forms Appendix D of the CEMP.

1 DMP Purpose

The principal purpose of this DMP is to demonstrate to the Waikato Regional Council and Hamilton City Council how Downer will manage the potential air quality impacts associated with the construction of the project to ensure compliance with the requirements of the Contract, Designation and Resource Consent Conditions.

This DMP highlights the minimum standards that must be complied with, the nature of the construction activities and machinery associated with the project works as well as best practicable options for management of construction air quality associated with the project works. It is intended as a guide for those undertaking the works.

2 Objectives

The primary objective of the DMP plan is to provide a framework for the development and implementation of methodologies to avoid or reduce adverse construction air quality effects on the health and amenity values of residents. Compliance with this DMP will ensure the following outcomes:

- To mitigate the adverse effects that dust generated by construction activities could have on adjacent properties;
- To describe how this will be achieved for approval by consenting authorities, so as to meet consent conditions;
- To provide the methodologies for dust control for use by the construction team in work planning and execution;
- To provide the method and forms for dust monitoring

In order to remain effective, this DMP will be updated as appropriate, with the necessary approvals, throughout the course of the Project to reflect any significant changes associated with any construction methodologies or techniques or the surrounding environment.

3 Consent Conditions

	Resource Consents
	GENERAL CONDITIONS
32	All earthworks activities carried out on site shall be conducted and managed in such a manner as to ensure that all dust and particulate emissions are kept to a practical minimum to the extent that there are no dust discharges beyond the boundary of the site that cause an objectionable effect.
33	The consent holder shall ensure that, at all times, the soil moisture of exposed areas is maintained at sufficient levels, under prevailing wind conditions, to prevent dust generated by normal earthmoving operations from remaining airborne beyond the boundary of the work site.
34	The consent holder shall ensure that, outside of normal working hours, staff are available on-call at all times to operate the water application system for dust suppression.
35	If so required by the Waikato Regional Council, the consent holder carry out immediate sealing of any problematic dust generating surfaces within the site using hydro-seed/hydro-mulch, polymer soil stabilisers or a similar dust control product to provide instant remediation of any areas to prevent any ongoing dust effects.
36	The consent holder shall provide the Waikato Regional Council with a detailed Dust Management Plan (DMP), at least 10 working days prior to the commencement of activities authorised by this consent. The objective of the DMP shall be to outline the site management methods to ensure that compliance with conditions 32 to 35 is achieved throughout the earthworks and as a minimum shall address the following items: a) Confirmation of the parties responsible for dust management throughout the works; b) Detailed monitoring methods for weather/soil conditions to ensure that any periods of elevated dust risk are appropriately anticipated and managed; c) Finalised works staging plan to ensure exposed surfaces at any one time are minimised in accordance with the requirements of this consent; d) Proposed dust control methods to ensure damp ground conditions can be maintained within the site during high dust risk periods; e) Confirmation of a suitable capacity water supply for dust suppression; f) Methods for managing dust risk outside of standard working hours e.g weekends; g) Contingency methods for controlling any identified dust effects e.g cease works/site stabilisation; and h) Protocols for responding to and addressing any dust complaints received. The DMP shall be approved in writing by the Waikato Regional Council acting in a technical certification capacity prior to any works authorised by this consent commencing and the consent holder shall undertake all earthworks authorised by this consent in accordance with the approved DMP.
	Designation Conditions
19.0	DUST MANAGEMENT PLAN
19.1	Prior to the commencement of Construction Works, the Requiring Authority shall prepare a Dust Management Plan (DMP). The DMP shall be prepared by a suitably qualified and experienced person. The Requiring Authority shall implement the DMP at all times during the Project. The objective of the DMP shall be to ensure that Construction Works are undertaken in a manner to ensure that no discharge of airborne particulate matter (dust) causes an adverse effect on the amenity value of any person beyond the designation boundary.
19.2	The DMP shall be provided to the Territorial Authority Chief Executive or nominee for certification at least forty (40) working days prior to the commencement of Construction Works.
19.3	As a minimum the DMP shall include the following details: a) Mitigation measures to be implemented during construction to minimise dust emissions; b) Methods for the daily visual monitoring of dust emissions and assessing the effectiveness of the mitigation measures implemented; c) Procedures for responding to process malfunctions and accidental dust discharges; d) Criteria, including consideration of weather conditions and procedures, for the use of water sprays on stockpiles and operational areas of the Project; e) Continuous monitoring of meteorology; f) Monitoring of construction vehicle maintenance; g) Complaints investigation, monitoring and reporting; h) The identification of staff and contractors' responsibilities; and i) Appropriate DMP review procedures.

5 Key Construction Air Quality Effects

The primary effects of construction air quality relate to the visual soiling of clean surfaces, such as cars, window ledges, and household washing; dust deposits on flowers, fruit or vegetables; and the potential for contamination of swimming pools and of roof-collected water supplies. Excessive discharges of dust may also impact on visibility on roads and eventually cause sedimentation issues.

In addition, there is the potential for air quality to be adversely affected by odours as a result of stockpiled materials including topsoil, peat and vegetation.

Due to the relatively large size of construction dust particles, only areas within about 100m of the construction footprint are likely to be at high risk of significant exposure to dust discharges.

6 Timeframes

The project works are planned to commence in late October 2022 and continue until January 2025.

The project works will not occur continuously in the vicinity of individual receivers. Each receiver will be subject to varying potential for dust effects throughout the construction period.

7 Responsibility of the DMP

The Downer Project Manager, Craig Lingard, has the overall responsibility for meeting the requirements of this DMP. The Downer Environmental Manager will implement the plan, including all required monitoring and lead the review of results with appropriate communication to Local Authorities. Refer to the Construction Environmental Management Plan (CEMP) for more detail on the roles and responsibilities.

Specific consent conditions related to the Dust Management Plan have been included in Appendix N of the CEMP.

8 Training

The Environmental training for all staff will be undertaken as part of site inductions, re-start days and weekly toolbox talks. Environmental training should include (as appropriate depending on staff responsibilities):

- Information about activities and locations where there is a higher risk of dust or odour generation.
- Consent requirements
- Complaints and dust management procedures
- Air quality monitoring requirements.

9 Management Plan Review

Commitment and continuous improvement to the Environmental culture by management is critical to its success and continuation. As part of continuous improvement changes to the DMP may be appropriate during the course of the project.

These changes may be a result of:

- *Any significant changes to construction activities or methods*
- *Key changes to roles and responsibilities within the Project*
- *Changes in industry best practise standards or recommended dust controls*
- *Changes in legal or other requirements (social and environmental legal requirements, consent conditions, NZTA objectives and relevant policies, plans, standards, specifications and guidelines)*
- *Results of inspection and maintenance programmes, logs of incidents, corrective actions, internal or external assessments*
- *The outcome of investigations into discharges of contaminants.*

Reasons for making changes to the DMP will be documented. A copy of the original DMP document and subsequent versions will be kept for the Project records, and marked as obsolete. Each new/updated version of the DMP documentation will be issued with a version number and date to eliminate obsolete DMP documentation being used.

Any relevant revisions to the DMP will be submitted to the Engineer for review and approval at least 10 days before becoming operational.

10 Proposed Works

10.1 Project Overview

The Contract Works include the following activities:

a) Two new bridge (approx. 85m long each) carrying two lanes of traffic over the Mangakotukutuku Stream and an associated tributary ephemeral gully;

b) A new, greenfield section of arterial road extending over a distance of around 1.3km from Hall Road in the west to Peacockes Road in the east. The road carriageway will comprise a two lane road with a flush median strip, separated cycle lanes and pedestrian footpaths on either side;

c) The installation of service infrastructure including a stormwater management network extending along the road and into adjacent areas of drainage reserve with specific stormwater management devices including 1 x's stormwater wetland, 3 x's rain gardens, 1 x's attenuation basin and lengths of roadside swales;

d) Upgrade of an existing section of Peacockes Road comprising a 450m stretch of existing rural road carriageway extending northward from the planned intersection with the new Whatukooruru Drive carriageway, back towards Hamilton City..

e) Approximate volume of earthworks for road formation is described as 30,000m3 including a topsoil strip of around 22,000m3, cut/fill of around 8,000m3 and importation of around an additional 40,000m3 of structural fill material.

f) Relocation of utility services;

g) Landscaping and landscape planting and maintenance;

10.2 Construction Activities

The construction activities required by the project are typical of large roading projects and includes:

- General enabling works including demolition and removal of structures, fencing, tree felling and removal, relocation of underground and overhead services, and the establishment of site entrances;
- Environmental controls along the route including sediment ponds, diversion bunds etc;
- Vegetation removal, site clearance; fencing, service relocations and other accommodation works;
- Topsoil Stripping and stockpiling;
- Cut to fill, cut to waste and import to fill to form the design alignment;
- Culvert installation within farm drains and streams;
- Bridge construction;
- Retaining Wall construction;
- Stream diversions;
- Stormwater drainage;
- Pavement Construction;
- Pavement Sealing;
- Pavement Marking, lighting and signage;
- Landscaping.

10.3 Dust and/or Odour Sensitive Receptors

The Dust and Odour Sensitive Receptors are those properties located along and near the project alignment. The sensitivity of each property is typically determined by the distance from the construction activity and the nature of the construction activity. The use of each property also influences the sensitivity; rest homes, hospitals are considered more sensitive to dust, certain infrastructure, power pylons and telecommunication facilities are also considered sensitive.

As part of the Downer construction planning procedures a 'Work Pack' methodology is used. This operation utilises a documented iterative procedure to plan the works. This planning includes an assessment of construction activities and methodologies at an initial stage to confirm what subsequent management plans and or approvals are required and or have been completed. These potential additional plans can include:

- Site Specific Erosion and Sediment Control Plans;
- Traffic Management Plans;
- Temporary Work Designs;
- Ecological surveys or mitigation; etc

As part of this process an assessment will be made of the potential for dust or odour discharges.

Where it is predicted that there is an increased potential for dust or odour discharges, or if there are particularly sensitive receivers, then specific dust or odour control measures will be developed and implemented.

In general it is considered that those properties that are within 100m of an earthworks activity have an increased potential to be affected by dust.

Properties which meets this criteria are the following dwellings:

- 440 Peacockes Road
- 442 Peacockes Road
- 462 Peacockes Road
- 435 Peacoceks Road
- 378 Peacockes Road
- 362 Peacockes Road
- 361 Peacockes Road
- 89 Peacockes Lane
- 91 Peacockes Lane

Figure 1: Key Recievers Map (SP1)

11 Dust

11.1 Sources

Potential sources of dust include:

- Wind entrainment from exposed surfaces
- Dust from roads and access areas generated by trucks and other mobile machinery movements;
- Excavation and disturbance of dry material;
- Loading and unloading of dry materials to and from trucks;
- Stockpiling of materials including material placement and removal;
- Storage and handling of bulk cement; and
- Concrete grinding undertaken as part of the manufacture of pre-cast concrete bridge components.

Of these, the most significant sources of dust are likely to be from unstabilised, dry, exposed surfaces such as stockpiles, unsealed haul roads and open earthworks (excavations and embankments), particularly in areas of sandy soil.

There are five primary factors which influence the potential for dust to be generated from the site. These are:

- **Wind speed across the surface**. Dust emissions from exposed surfaces generally increase with increasing wind speed. However dust pick up by winds is only significant at wind speeds above 5m/s (Beaufort Scale 3). Above wind speeds of 10m/s (Beaufort Scale 6) dust pick up increases rapidly. Wind speed is used as a Project trigger.
- **Moisture content of the material**. Moisture binds particles together, preventing them from being disturbed by winds or vehicle movements. Similarly, vegetated or otherwise stabilised surfaces are less prone to wind erosion than bare surfaces.
- **The area of exposed surface**. The larger the area of exposed surfaces the more potential there will be for dust emission.
- **The percentage of fine particles in the material on the surface**. The smaller the particle size of material on an exposed surface the more easily the particles are able to be picked up and entrained in the wind.
- **Disturbances such as traffic and loading and unloading of materials**. Vehicles travelling over exposed surfaces tend to pulverise any surface particles. Particles are displaced from rolling wheels and the surface. Dust is also sucked into the turbulent wake created behind moving vehicles.

The discharge of dust from the Project has the potential to have effects on two scales:

- Individual sources where the effects of dust discharges are localised in the immediate area surrounding the construction area.
- Cumulative effects where the dust generated from all nearby dust sources combine to affect local air quality as a whole.

Therefore, it is important that all dust sources be minimised as far as practicable, including those well separated from sensitive locations, as all dust generated will have an effect on the overall air quality in the area.

11.2 Controls

Dust emissions can be reduced by:

- **Minimising the extent of unsealed areas**:
  - Limit earthworks extent and vegetation clearance as much as practical
  - Stabilise exposed surfaces as soon as practical and where they will be undisturbed for longer periods.
  - Stabilisation can include metal, paving, polymer, hydroseed, mulch and permanent planting.
  - Minimise the area of surfaces covered with fine materials
- **Modifying the condition of the materials** so that it has a lesser tendency to lift with the wind or disturbances such as vehicle movements:
  - Water exposed surfaces and materials using water carts, sprinklers or manual hosing
  - Ensure sufficient water is applied (i.e. enough water to prevent dust generation).[1]
  - Ensure sufficient water is available on site and consider locations of water bores/storage to minimise haul distances for water carts
  - Ensure water suppression is maintained during non-working days (e.g. Sundays and Christmas shutdowns) to avoid dust generation during these periods.
  - Apply dust suppressant polymers to bind the surface.
    - To be used mainly in areas where active earthworks are on hold pending other activities.
    - These areas will be trimmed and the dust suppressant applied in accordance with manufactures requirements.
    - These areas will then be isolated so that they are not trafficked, which breaks the surface and exposes loose material below.
    - If it is noted that watering the stabilised access tracks is not effective or is becoming onerous, utilisation of dust suppressant polymers on these access tracks will also be investigated.
- **Reducing the velocity of the wind at the surface**:
  - Install windbreak fences where practicable and appropriate[2].

In addition, daily forecast wind speed, wind direction and soil conditions should be taken into account before commencing an operation that has a high dust potential.

Table 1 below outlines dust control measures that should, where possible, be implemented for specific activities to reduce the potential for dust generation.

Table 1: Dust control methods that should be applied for specific activities.

Source of Dust	Control
Stockpiles (including material	• Limit the height and slope of stockpiles to reduce wind entrainment. Stockpiles exceeding 3m in height have a higher risk of discharging dust.

[1] As a general guide, the typical water requirements for most parts of New Zealand are up to 1 litre per square metre per hour. Section 8.2 of the MfE Good Practice Guide for Assessing and Managing the Environmental Effects of Dust Emissions, Ministry for the Environment, 2001

[2] Effectiveness of windbreak fences is greatest where fencing is perpendicular to the prevailing wind direction with a porosity of about 50%; however, wind breaks can induce turbulence and have a negative impact on dust generation if used improperly.

placement and removal)	• Locate stockpiles to maximise wind sheltering as much as possible.
	• Avoid disturbing stockpiles during very dry, windy conditions.
	• Keep the surfaces of stockpiles damp (active stockpiles) or otherwise stabilised (inactive stockpiles) if they are producing visible dust emissions.
	• Stabilisation methods can include:
	  o Polymer
	  o Mulch or straw
	  o Vegetation/hydroseed

Unpaved surfaces such as roads and yards	• Limit the amount of exposed/unstabilised surfaces by:
	  o Retaining as much vegetation as possible.
	  o Stabilising exposed surfaces and cleared areas not immediately required for construction, access or parking.
	  o Surfacing site compounds in the vicinity of sensitive receptors with a clean compacted aggregate.
	• Keep unpaved surface damp where dust generation is an issue.
	• Compact unconsolidated surfaces where practicable.
	• Regularly maintain aggregate surfaces by grading and the laying of new metal.

Sealed Surfaces	• Regularly remove dust through washing or vacuum sweeping (ensure dust is not washed into stormwater systems or streams).

Vehicles	• Ensure trucks are not overloaded to avoid spillages.
	• Minimise travel distances.
	• Cover loads of fine materials where significant travel is required.
	• Minimise tracking out from unsealed areas by:
	  o Establishing stabilised entranceways where required.
	  o Providing wheel wash facilities at road exits from construction areas if required.

Earthmoving and construction	• Limit the amount of exposed/unstabilised surfaces by:
	  o Retaining as much vegetation as possible.
	  o Progressively stabilising exposed surfaces with straw, mulch, polymer or hydroseed as soon as practical.
	• Keep exposed areas damp at all times where practical through the use of water carts or sprinkler systems (or rain).
	• When loading trucks, drop material from as low as possible within the tray of the truck.
	• Prior to a cut and fill activity in sand, pre-water the area to allow time for penetration of the soil (if possible).
	• Avoiding disturbing exposed areas during very dry, windy conditions.

11.3 Monitoring

11.3.1 Visual dust monitoring

Visual dust monitoring should be undertaken by site staff as follows:

Table 2: Visual monitoring requirements

Monitoring Activities	Frequency

Check weather forecasts for strong winds and rainfall to plan appropriate dust management response (7 day forecasts available on www.metvuw.co.nz)	Daily
Inspect land adjacent to the site, construction exits and adjoining roads for the presence of dust deposits,	Daily
Observe weather conditions, wind via observations and data outputs from weather stations and presence of rain.	Daily and as conditions change
Inspect all unsealed surfaces for dampness and to ensure that surface exposure is minimised, check for visible clouds being generated on site or carried off site.	Three times daily
Inspect stockpiles to ensure enclosure, covering, stabilisation or dampness. Ensure stockpile height is less than 3m or appropriately stabilised.	Weekly and at times of expected high winds
Inspect dust generating activities to ensure dust emissions are effectively controlled.	Regularly throughout the day and as new activities are commenced
Inspect watering systems (sprays and water carts) to ensure equipment is maintained and functioning to effectively dampen exposed areas.	Weekly
Additional monitoring of dust generating activities and water application rate.	In winds over 5.5 m/s (Beaufort scale 3)
Inspect site access and egress points to ensure effective operation of wheelwash/truckwash systems and/or judder bars (if installed).	Weekly
Ensure site windbreak fences, if used, are intact.	Weekly

11.4 Triggers

The primary trigger for the implementation of contingency measures will be the above visual inspections, and the secondary trigger will be public feedback (complaints).

11.5 Contingency measures

If any of the triggers above are reached, the following contingencies should be put in place at the same time as revisiting the control measures listed above to determine if there are any not being implemented that would assist with dust control.

If implementation of the contingency measures below does not prevent excessive dust leaving the site, consideration must be given to modifying works or temporarily ceasing the dust generating works until the dust can be brought under control.

Table 3: Trigger response requirements.

Trigger	Examples of response

Forecast of high winds (>5.5 m/s or 20 km/h – moderate breeze)[3]	• Ensure resources (fixed sprays and/or water carts) are in place to dampen stockpiles and uncovered areas of soil.
High winds (>10 m/s or 36 km/h – strong breeze)[4]	• Increase application of water to exposed areas. • Cease tipping materials if carrying out dust generating activities within 100 metres upwind of houses/sensitive receivers. • Avoid driving on unsealed roads where possible.
Visible dust discharges	• Apply additional water as necessary. • If possible, modify activities to reduce of dust discharges. • If visible dust discharges created by vehicle movements continue to leave site, vehicle speeds should be reduced to 10km/h.
Dust discharges cause excessive deposition / soiling beyond site boundary	Dust generating works in the immediate vicinity will be ceased until appropriate response measures have been agreed upon between the engineer responsible for the works, the Project Manager and the Environmental Manager Remediation measures may include: • Cleaning of roof water tanks and replenishment of water supplies • Cleaning of houses • Cleaning of other buildings and infrastructure • Cleaning of local roads.
Complaint received	See Stakeholder Communication Management Plan (CSCMP)
Breakdown of fixed water sprays / water cart	• Undertake alternative dust suppression (i.e. use water cart if sprinkler broken). • Modify activities to reduce likelihood of dust discharges.
No water available or no water carts/sprinklers available	• Modify activities to reduce likelihood of dust discharges • If visible dust discharges created by vehicle movements leave site, vehicle speeds should be reduced to 10km/h. • If visible dust continues to discharge across site boundaries, cease activities until dust suppression can be recommenced.

11.6 Water supply

The primary dust control and contingency measure implemented on site is water suppression.

In order to ensure this requirement is met an offsite water supply will be utilised.

A 50mm connection to the existing HCC 150 watermain main will be undertaken as a "live tap" saddle connection at an approved location, backflow preventer and water meter

[3] Beaufort scale 4: Moderate breeze = Dust and loose paper raised. Small branches begin to move

[4] Beaufort scale 6: Strong breeze = Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic garbage cans tip over.

installed, All connections are to be undertaken by approved water industry qualified personnel.

This line will be run over land and feed 3 x 30,000L tanks that will be used to fill water carts. This has been discussed with HCC and they are comfortable with the anticipated water use.

12 Odour

Nuisance odour discharges are considered unlikely to present an issue.

12.1 Introduction

Discharges of odour may occur from the disturbance or stockpiling of contaminated soils, topsoil, peat or vegetation.

12.2 Controls

If required, the following techniques can be utilised to control or minimise odour emissions:

- Limiting the time the odorous material is exposed
- Removing the odorous material from site as quickly as possible
- Covering the material at the end of the day
- Using chemical counteractant sprays and/or odour fences

Monitoring of any odour control fences or sprays for correct operation and positioning should be undertaken daily if used.

12.3 Monitoring

Odour monitoring is required if:

- Significant odour discharges occur;
- Contaminated soils are to be excavated and loaded onto truck; or
- Complaints are received regarding odour.

Odour monitoring will take the form of "odour scout" monitoring undertaken by the Environmental Engineer along the site boundaries between the suspected (or known) source and receivers as well as upwind of a suspected source. The purpose of the monitoring is to confirm that source and assess the effectiveness of any control measures implemented.

12.4 Contingency measures

If significant odour is detected, the material cannot be removed quickly and chemical counteractant sprays or odour fences are not immediately available:

- The material must be covered; and
- The related works must be suspended until suitable mitigation measures or altered methodology can be implemented.

13 Vehicle Exhaust Emissions

Engine exhaust emissions from construction vehicles contain a range of hazardous air pollutants, including fine particles, oxides of nitrogen, carbon monoxide and organics such as benzene, which can adversely affect human health.

13.1 Sources

Poorly maintained vehicle engines discharge many times the amount of air pollutants than well maintained engines. Unnecessary idling of vehicle engines while parked can also cause significant local effects.

13.2 Controls

The following actions should be carried out to minimise emissions:

- All construction machinery used on site must be maintained in accordance with manufacturers' recommendations as a minimum standard. In particular:
  - Plant and machinery operators are required to complete weekly check sheets of their equipment to identify and address any faults and servicing requirements. These sheets are collated by the project management team and actioned as required.
  - Drivers of fleet vehicles are responsible for ensuring that these vehicles are regularly serviced.
- Vehicles should not be left idling unnecessarily when parked or unattended. If vehicle idling issues are identified, the Environmental Team will undertake an awareness programme.

13.3 Contingency measures

Where excessive exhaust smoke[5] is identified from any construction vehicle, that vehicle should be serviced as soon as practical and, if any maintenance is required, taken out of use until such maintenance is completed.

14 Complaints

Any Environmental Management System (EMS)-related complaints will be dealt with as detailed in the CSCMP.

[5] Note: Excessive means greater than would normally be expected from that type of machinery undertaking that particular operation.

Appendix 1

Beaufort wind scale

Beaufort wind scale

Beaufort Scale	Wind Speed			Label	Observations on Land
	m/s	knots	km/h		
0	0 - 0.2	<1	<1	Calm	Calm. Smoke rises vertically.
1	0.3 - 1.5	1 - 3	1 - 5	Light Air	Wind motion visible in smoke.
2	1.6 - 3.3	4 - 6	6 - 11	Light Breeze	Wind felt on exposed skin. Leaves rustle.
3	3.4 - 5.4	7 - 10	12 - 19	Gentle Breeze	Leaves and smaller twigs in constant motion.
4	5.5 - 7.9	11 - 15	20 - 28	Moderate Breeze	Dust and loose paper raised. Small branches begin to move.
5	8 - 10.7	16 - 21	29 - 38	Fresh Breeze	Branches of a moderate size move. Small trees begin to sway.
6	10.8 - 13.8	22 - 27	39 - 49	Strong Breeze	Large branches in motion. Whistling heard in overhead wires. Umbrella use becomes difficult. Empty plastic garbage cans tip over.
7	13.9 - 17.1	28 - 33	50 - 61	Near Gale	Whole trees in motion. Effort needed to walk against the wind. Swaying of skyscrapers may be felt, especially by people on upper floors.
8	17.2 - 20.7	34 - 40	62 - 74	Gale	Twigs broken from trees. Cars veer on road.
9	20.8 - 24.4	41 - 47	75 - 88	Severe Gale	Larger branches break off trees, some small trees blow over. Construction/temporary signs and barricades blow over. Damage to circus tents and canopies.
10	24.5 - 28.4	48 - 55	89 - 102	Storm	Trees are broken off or uprooted, saplings bent and deformed, poorly attached asphalt shingles and shingles in poor condition peel off roofs.
11	28.5 - 32.6	56 - 63	103 - 117	Violent Storm	Widespread vegetation damage. More damages to most roofing surfaces, asphalt tiles that have curled up and/or fractured due to age may break away completely.
12	32.7 - 36.9	64 - 71	118 - 133	Hurricane	Considerable and widespread damage to vegetation, a few windows broken, structural damage to mobile homes and poorly constructed sheds and barns. Debris may be hurled about.