Appendix C – Air Quality Monitoring Plan (AQMP)

Environmental Services

Specializing in:

Acid Sulphate Soils
Contaminated Site Assessment
Air Quality Investigations

Remediation Advice and Design
Groundwater Management
Facility Maintenance

ABN 36 835 856 256

AIR QUALITY MANAGEMENT PLAN

LOT 20 ADELAIDE ST
HAZELMERE

October 2014

PREPARED FOR:

Wasterock Pty Ltd

Mobile Dewatering Environmental Services as trustee for
Mobile Dewatering Environmental Services Unit Trust
U1/22 Elmsfield Rd, Midvale, Western Australia 6056
P: +61 (0) 8 9250 6960 F:+61 (0) 8 92508269
W: www.environmentalservices.com.au

Environmental Services

DOCUMENT DETAILS

Title:	Air Quality Management Plan (AQMP)
Project Address	Lot 20, Adelaide Street, Hazelmere.
Job number:	E2012-031
Author:	Kevin White
Project Manager:	Greg Watts
Email:	greg@environmentalservices.com.au
Status:	V5
Date:	November 2014
Synopsis:	This Air Quality Management Plan (AQMP) details how air quality be will monitored across the site and at site boundaries. The plan focuses on implementation and management of the monitoring program plan for the duration of remedial site works. The plan sets out management criteria to ensure the risk of exposure to potential airborne contaminants during site works is kept as low as practicable by adherence to a range of accepted criteria.

DOCUMENT DISTRIBUTION

Version No	Written by Date	Reviewed by Date	Issued by Date	Distributed to	Copies
v1	Nathan Fuser 30/11/2012	Greg Watts 30/11/2012	Greg Watts 30/11/2012	Wasterock Pty Ltd DER AEA (Australian Environmental Auditors	Email and Hard Copy
v2	Fiona Trevenen 21/11/13	Mathew Bulmer 22/11/2013	Greg Watts 22/11/2013		
V3	Kevin White 21/03/2014	Mike Waite 24/03/2014	Greg Watts 24/03/2014		
Signed			G. J. Watts		
V4	Kevin White 23/10/2014	Mike Waite 23/10/2014	Greg Watts 23/10/2014		
Signed			G. J. Watts		
V4a	Kevin White 28/10/2014	Mike Waite 29/08/14			
Signed					
V5	Kevin White 24/11/2014	Mathew Bulmer 24/11/2014	Greg Watts 24/11/2014		
Signed			G. J. Watts		

Disclaimer

This document has been prepared in accordance with a scope of works, set out in a proposal, or as otherwise agreed, between the client and MDW Environmental Services (MDWES). The scope of work may have been limited by time, budget, access and or other constraints and has been prepared in the absence of any knowledge of the study area other than that stated in this document. This document has been prepared on behalf of and for the exclusive use of the client, and is subject to and issued in accordance with the agreement between MDWES and the client. MDWES accepts no liability or responsibility whatsoever in respect to its use, or reliance upon, by any third party outside of its intended use. This document has commercial confidence status. Copying of this report or any part thereof is not permitted without the authorisation of the client, for the expressed purpose of regulatory assessment. Unless specifically agreed otherwise, MDWES retains intellectual property rights over the contents of this document.

Unless otherwise stated, MDWES regards the extent of investigations and assessments reasonable in the context of the scope of works and the purpose of the investigation. The information contained in this document is provided in good faith in the general belief that no information, opinions, conclusions or recommendations made are misleading, but are reasonable and appropriate at the time of issue of this document. This document must be read in its entirety. Users are cautioned that assumptions made in this document may change over time and it is the responsibility of the user to ensure that assumptions remain valid. Reported results, while accurate at the time of reporting, cannot be considered absolute or conclusive without long term follow up studies.

Comments and opinions presented in this document are based on the extent of the scope of works and / or on information supplied by the client, their agents and / or third parties. In preparing this document MDWES has relied upon reports, data, surveys, analyses, designs, plans and / or other information provided by the client and other individuals and organisations outside its control. Except as stated otherwise in the document MDWES has not verified the accuracy or completeness of this information. To the extent that the statements, opinions, facts, information, conclusions and / or recommendations in the document are based in whole or part on this information, those are contingent upon the accuracy and completeness of the information. MDWES will not be liable in relation to incorrect conclusions should any information be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed.

Within the limitations imposed by the scope of work, the assessment of the study area and preparation of this document have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants and occupational hygienists under similar circumstances. No other warranty, expressed or implied, is made. MDWES will not be liable to update or revise the document to take into account any events, circumstances or facts occurring or becoming apparent after the date of this document.

Specific warning is given that many factors, natural or artificial, may render conditions different from those that prevailed at the time of investigation and should they be revealed at any time, they should be brought to our attention so that its significance may be assessed and appropriate advice may be offered.

MDWES, its agents and employees, expressly disclaim any and all liability for representations, expressed or implied, contained in, or omissions from, this report or any of the written or oral communications transmitted to the client or any third party.

Acceptance of this document denotes acceptance of these terms.

Table of Contents

Tables within report

Figures

Appendicies

1 INTRODUCTION

This Air Quality Management Plan (AQMP) has been prepared by MDW Environmental Services (MDWES) for Wasterock (client) to manage the potential release of dust, fibre and other potential airborne contaminants during remediation of the client's site which is located in the City of Swan at Lot 20 Adelaide Street, Hazelmere, Perth, herein referred to as 'the Site'.

Previous environmental Site investigations have confirmed varying concentrations of contaminants across the Site that will need to be addressed during remediation. Investigations conducted by Parsons Brinckerhoff (2006) identified asbestos, heavy metals, Total Petroleum Hydrocarbons (TPH's) and Monocyclic Aromatic Hydrocarbons (MAH's) present within the soil matrix. Parsons Brinckerhoff stated that investigations undertaken were not exhaustive and therefore further undetected contaminants could be present. In addition to this, the DER re-classified the Site in November 2010 to 'Contaminated – remediation required'. It is therefore necessary to ensure that appropriate management of the remediation works is undertaken to minimise the risk from potential airborne contaminants and related health effects of both on and off-site occupants.

Based on previous reports and site investigations, one of the most significant health hazards during the remediation works will be the generation of particulates. Potential particulates include all suspended particulates (TSP), inspirable (PM_{10}) and respirable ($PM_{2.5}$) dust, asbestos fibres, respirable crystalline silica and particles containing heavy metals. Each of the above particle size fractions tend to have different impacts e.g. TSP is generally considered as a nuisance from impacts such as deposition on vehicles. Inspirable particulates tend to be captured and cleared by the mucociliary system in the upper respiratory system. Respirable particles and fibres (such as asbestos) generally penetrate deep into the lungs and are more difficult to clear and consequently tend to have greater health impacts. Similarly airborne silica particles and particles containing heavy metals tend to be present as respirable particulates.

Although management guidelines are set out to ensure that the generation of particulate is minimised during remediation of the site, a separate Human Health Risk Assessment (HHRA) has been prepared to outline proposed practices to address these potential contaminants. These practices will be in conjunction with As Low as Reasonably Achievable (ALARA) and Best Practicable Means (BPM) principles for contaminated land sites applied to regulatory guidelines (DEC, 2011).

As part of the AQMP, a precautionary approach will be adopted with monitoring to include daily and weekly sampling of potential contaminants, both at the workface and Site boundaries. The objective of the AQMP is to manage any foreseeable risk to human health (site workers and local residents) caused by the release of particulates as a result of remediation works.

1.1 Previous Reports

Information provided in this AQMP is based on outcomes established in reports and investigations that have been completed on the Site from 2005 to present. The following documentation should be read in conjunction with this management plan:

- FOI 1233/05 by Department of Environment & Conservation (DEC) – Freedom of Information – Lot 20, Adelaide Street, Hazelmere (October 2005).
- 2145245A:PR2_16644.RevA by Parsons Brinckerhoff – Site Investigation (SI) – Hazelmere, WA (July 2006).
- V392/2007 grw4469 by Knight Frank – Valuation Report – Lot 20 Adelaide Street, Hazelmere, WA (July 2007).
- 476300-0kjcv070709a by Burgess Rawson – Valuation Report – Lot 20 Adelaide Street, Hazelmere, WA (July 2007).
- 60150301 by AECOM – District Storm water Management Strategy – Hazelmere Enterprise Area (June 2010).
- Drilling Logs by Banister Drilling & Irrigation for 20 Adelaide Street, WA. (May 2012).
- GRA 7729 by Greg Rowe & Assoc. – Community Management Strategy for Remediation of Site: Lot 20 Adelaide Street, Hazelmere. (March 2014).
- E2012-031 (GMI) – MDWES – Groundwater Monitoring Investigation #1 – Adelaide Street Hazelmere (June 2012).
- E2012-031 (GMI) – MDWES – Groundwater Monitoring Investigation #2 – Adelaide Street Hazelmere (October 2012).
- E2012-031 (GMI) – MDWES – Groundwater Monitoring Investigation #3 – Adelaide Street Hazelmere (February 2013).
- E2012-031 (GMI) – MDWES – Groundwater Monitoring Investigation #4 – Adelaide Street Hazelmere (June 2013).
- E2012-031 (GWAB) – MDWES – Groundwater Abstraction for Dust Suppression & Surface Compaction v2 – Adelaide Street Hazelmere (October 2012).
- 6045.k.09_09082_SMP by Waste Rock Pty Ltd – Site Remediation Works Agreement and Site Management Plan – Lot 20 Adelaide Street. (March 2014).
- E2012-031 (ESMP) – MDWES – Environmental Site Management Plan (ESMP) v5 – Adelaide Street Hazelmere, (October, 2014).
- E2012-031 (HHRA) – MDWES – Humans Health Risk Assessment (HHRA) v1 – Adelaide Street Hazelmere, (October, 2014).

2 SITE BACKGROUND AND CHARACTERISTICS

Wasterock is seeking to rejuvenate a 16.9 ha site within the Hazelmere area east of Perth (Figure 1). Redevelopment of the land will not only reduce the current environmental impact of a historical landfill, it will also address the associated stigma and visual impact. Currently the landfill rises above surrounding ground level some six to eight metres in places. It is unkempt, unsightly and has been used for ad-hoc illegal tipping and dumping.

The proponent aims to repackage the material within the historical landfill through excavation, sorting and reinstatement. This in turn will reduce the volume of the material and subsequent level of the site in conjunction with compaction. The material within the landfill is presumed to be predominantly inert material such as sands, builders' waste and rubble (concrete). However, records show a variety of waste material was accepted such as waste slurries, asbestos sheeting and waste metals. As part of the remediation concrete and larger material will be re-used and repackaged as a visible break layer and barrier to ensure that any future development does not disturb the underlying soil material.

The proponent also aims to divert certified Class I (hydrocarbon Impacted only) and Acid Sulfate Soils (ASS) from metropolitan licensed landfill facilities for use in the Capping Layer. These soils will be remediated on-site and validated to ensure the soils are fit for purpose.

The duration of the project has been estimated as 4-5 years, based on the volume of soils to be remediated and soils required for the capping layer.

Additional information on the Site is outlined in MDWES Environmental Site Management Plan (ESMP v5) (Oct, 2014).

2.1 Proposed Development

Wasterock proposes to remediate the Site using conventional excavation techniques to reduce the current height and fill content of the site and make it suitable for "commercial / industrial" use.

The remedial works of the Site will involve the following stages:

1. Excavation, sorting and processing (crushing and / or screening) of existing landfill material.
2. Acceptance of soil for amendment such as Acid Sulfate Soils (ASS) and Hydrocarbon Impacted Soils (HIS) (Class 1 only) for recycling and reuse. Once remediated, these soils will ultimately be used for the capping layer.
3. Processing (crushing and / or screening) of on-site construction and demolition (C&D) waste for reuse on Site as an engineered physical warning barrier.
4. Engineered placement, compaction and construction of excavated remediated soil material to form a controlled engineered cell.

The remediation of the site will include the outsourcing and acceptance of external off-site soil material for the capping layer, sourced from local building and development projects within the Perth metropolitan area. An engineered barrier layer will also be placed over the repackaged materials, followed by a validated layer of clean cover.

The use of the Site's resources to remediate the Site itself will minimise any requirement to transport waste to off-site waste facilities, or to transport large quantities of sand to Site. Although there may be a requirement for off-site disposal for this project; generally the principles of sustainable development would dictate reuse of on-site resource wherever practicable.

Remediation is estimated to be completed over a four to five year period, with Site operations running six days a week (Monday to Saturday). Daily operating hours will be 7:00 – 17:30 (Monday to Friday) and 8:00 – 16:00 (Saturday). The ultimate aim of the project is to rehabilitate the land, such that it can be utilised by subdivision into light industrial or commercial lots.

2.2 Climate

The annual climate at the Site is considered to be similar to that of Perth Airport's annual climate. The Bureau of Meteorology (BOM) summarises Perth (Table A) as being a temperate climate experiencing warm summers and cold winters.

Table A: Historical Weather Information

Month	Temperature °C		Relative Humidity %		Wind Speed km/hr		Rainfall mm
	Min	Max	9am	3pm	9am	3pm	Avg
December-February	28.9	**31.9**	52	**38**	17	**22**	**11.8**
March-May	13.1	25.7	66	46	13	17	52.2
June-August	**8.3**	18.4	**80**	59	**11**	16	**145.4**
September-November	10.6	22.8	56	45	16	**22**	47.8

Data sourced from BOM (2013)

NB:

- Results are averages of Monthly Climate Statistics obtained from Perth Airport Site (1944-2013)
- Red: denotes maximum value
- Blue: denotes minimum value

The average wind direction at Perth Airport varies from ENE at 9:00 am to WSW at about 3:00 pm (BOM, 2013). Monthly weather data and wind roses from previous years 2011, 2012 and 2013 are presented in the ESMP. Monthly data illustrates the variation in wind conditions seasonal and daily.

Summer wind conditions over the past three years show the morning winds tend to prevail from the east then by mid-afternoon from the SW. Winter conditions tend to prevail from the north to NE and by mid-afternoon from the west.

2.3 Soil Moisture

Soil moisture content is an important consideration because drier soils are more prone to release of particulates via wind.

The Perth metropolitan area remains one of Australia's driest capital cities, particularly through the summer months (December to February). As such, weather conditions during summer tend to provide warmer temperatures, minimal rainfall totals, low relative humidity and generally hot / dry prevailing wind conditions as outlined in Table A.

Soil moisture content on Site is considered to be low due to the nature of the soil matrix makeup, deep groundwater levels and raised temperature levels. An Increase of evaporation rates could result from increased seasonal sunlight throughout October-May (DEC, 2011). These factors could contribute to reducing soil moisture content for this time of year, further increasing the potential for particulates to become airborne if not managed appropriately.

2.4 Vegetation

Vegetation on Site mainly consists of grasses, weeds, shrubs and several semi-mature trees scattered sporadically throughout the Site. The current root mass reduces the potential for wind-blown dust particles. However, if not managed, the reduction of the vegetative ground cover as excavation progresses could contribute to increased potential of airborne particulates, especially when combined with the effects of local weather conditions.

2.5 Topography

Site elevation varies widely across the lot due to historical landfill activities raising the surface discontinuously. PB (2006) reported that the ground level has been raised significantly from pre-landfill activity ground levels of 27 mAHD. MDWES notes that about two thirds of the Site is a raised plateau averaging 4-6 metres above lot boundary levels. Most of the eastern half of the Site lies between 36-37 mAHD. Variation in elevation is more pronounced across the western half with land gradually falling from 36 to 34 mAHD.

A wedge of land at the base of the plateau, running along the southern boundary (east to west) of varying width, has similar levels to that of surrounding landfill levels.

It is likely that current Site topography will have no influence on local weather conditions, given Site vegetation, surface roughness and prevailing wind conditions.

2.6 Contaminants of Potential Concern

The Parsons Brinckerhoff Site Investigation (2006) detailed the following Contaminants of Potential Concern (CoPC), based on information regarding the materials accepted into the landfill.

- Total Petroleum Hydrocarbons (TPH)
- Monocyclic Aromatic Hydrocarbons (MAH's)
- Asbestos
- Heavy Metals

Based on the above CoPC findings and Site remediation operations, air monitoring will be required for the duration of the Site works. During excavation and engineering of the landfill, particulate matter has the potential to be liberated, if not managed properly. Therefore, the following CoPC may become present in the air:

- Particulates as TSP, PM_{10} and $PM_{2.5}$
- Asbestos fibres
- Metals
- Respirable Crystalline Silica (RCS)

2.7 Potential Receptors

As part of the exposure assessment process, it is important to define groups within the population who may potentially be exposed to site contaminants. This involves consideration of current and likely future activities in the area, the environmental distribution of contaminants and the location and behaviour of the potential receptor groups.

Risk characterisation is discussed in the HHRA, which describes the likely risk to receptors. The process defines the probable incidence, degree and severity of adverse impacts associated with the relevant exposure scenarios and provides a basis to assess the significance of different risks. The risk characterisation also examines the overall quality of supporting assessments, considering assumptions, uncertainties, and scientific judgments, to establish assessor confidence in risk estimates and conclusions drawn (Asante-Duah, 2002; enHealth, 2004).

Human receptors are considered to be most at risk from particulates. The Site poses a significant potential health risk for persons both on-site and off-site as they could potentially be exposed to airborne particulates and asbestos fibres irrespective of whether the Site is or is not being remediated. However the risk of exposure to particulates and fibre is likely to increase during remedial works unless measures are implemented to minimise the generation of airborne particulates and fibre. This is particularly so given the Site's history and the potential to encounter Asbestos Containing Material (ACM) and potential liberation of asbestos fibres during excavation, sorting and remediation of the Site. The period immediately following discovery and unearthing of ACM is considered the period of highest potential exposure, due to waste disturbance and potential fibre release.

Off-site impacts identified within the risk assessment (MDWES HHRA) suggest residents living on Adelaide Street adjacent to the southern side of the Site may be at risk of exposure to airborne contaminants during remediation activities. Potential exposure could include suspension of asbestos fibre and particulate matter on prevailing winds and deposition within the nearby residential areas.

The distance to properties along Adelaide Street is 30 metres from the southern western site boundary, 330 metres from the northern boundary and 640 metres from the north eastern corner of the site.

To mitigate potential dust exposure to the residents (sensitive receptors) adjacent to the Site, and to abate noise during remediation works, a bunded fence (as per below) has been proposed along the length of the site, between the Site and Adelaide Street.

- A soil bund will be engineered along Adelaide Street. The bund will be matted and allowed to "grass in" for additional stability and will be aesthetically pleasing.
- A fence / windscreen will be constructed on top of the bund, with tied shade cloth or hessian on the 1.8 metre high security fence.
- The gaps under the fence will be closed off (e.g. sandbags or similar) to reduce particulate and fibre from being released off-site.
- The fence will be inspected daily. Any rips in the coverings will be repaired on the same day.
- The remainder of the Site will be fenced and secured from the general public.

In addition, extracted water from licenced bores will be used by the client to suppress dust and fibres on-Site and keep them from become airborne, effectively lowering off-site dispersion and exposure. These steps will assist in reducing the risk to off-Site human health by retaining airborne particulates and fibre within the Site boundary. The bund will also reduce noise and the fence has been designed to reduce wind flow from the Site to publicly accessible areas and the properties of neighbouring residents.

The potential health risks to on-Site receptors are also significant. Although ACM has been identified during site walkovers and investigations, this has been at a superficial level limited to the surface and upper soil horizons. However, the underlying landfill material may exhibit pockets of ACM which would represent a significant risk if uncovered. While the risk of fibre release is potentially significant, the implementation of appropriate occupational health and safety practice and relevant site management measures will minimise exposure. This will be achieved by dust suppression and the wearing of Personal Protective Equipment (PPE), which will be validated through continuous air monitoring.

If Site exposure is limited and minimised, then the risks to residents may confidently be considered negligible and risks to remediation workers may be considered low. A summary of risks to receptor groups during different exposure periods (MDWES HHRA) is presented in Table B.

Table B: Risk Summary

Receptor	Current Landfill Risk if Landfill is not remediated	Remediation of Site (Excavation of Landfill) NO protective measures	Remediation of Site (Excavation of Landfill) WITH protective measures: suppression and PPE
Nearby Residents (Adelaide Street)	Moderate	High	Very Low
Remediation Worker *	n/a **	Very High	Low to Moderate
Site Manager / Office Staff ***	n/a**	High	Low

* The exact nature and duration of potential exposure cannot be reliably assessed at this stage.
** Not Applicable – Workers not present on Site.
***Intermittent exposure would be limited.

No environmental or ecological receptors have been identified as being potentially at risk from Site remedial works from airborne deposition. This is based on reported data and based on historic wind rose data that the Bush Forever Site #122, adjacent to south eastern corner of the Site is unlikely to receive any significant deposition from the remediation activities. This is evident from winter or summer wind roses (seasonal extremes) when deposition is most likely to occur.

No surface water bodies have been located on the Site.

A number of surface water bodies and waterways can be found from 1 to 3 kilometres (km) from the Site including Kadina Brook ~1.5 km to the north-east and Helena River ~2.7 km to the north, given the prevailing wind patterns and distance from the Site receptors. It is highly unlikely Site excavations will impact on surface water bodies identified in the area.

3 OBJECTIVES

The main objective of this AQMP is to detail measures which will be implemented by Wasterock Pty Ltd to protect both workers operating at the Site and residents in the neighbouring households (receptors) from potential airborne contaminants.

The AQMP aims to implement air quality monitoring procedures during excavation and soil disturbance activities being undertaken at the Site. Day-to-day activities have the potential to release airborne particulates and fibres. Monitoring is required to identify any potential exposure to Site personnel or local residents. The AQMP allows for dust management to be assessed continuously and a range of measures implemented, as required, to ensure the health of receptors is not adversely affected. Such measures include increased frequency and duration of dust suppression through to “stop work” notices.

3.1 The objectives of this AQMP are to:

- Protect life and well being of human and other forms of life, from possible exposure to ACM and airborne contaminants.
- Comply with relevant statutory environmental requirements – DEC (2011), NOHSC / Safe Work Australia (1995), WA EP Act (1986).
- Provide strategies and contingencies aimed at reducing potential environmental exposure to poor air quality during earthworks and soil removal activities.

3.2 The technical objectives of the plan are to:

- Implement an air quality monitoring program that provides representative data capture for potential airborne contaminants being generated on-site and potentially impacting neighbouring residents.
- Employ safe practices to minimise generation of dust and in doing so, maintain safe air quality for persons / personnel situated both on-site and off-site.
- Discuss all aspects of the Site remediation and any operations which may potentially cause contaminants to be present in air.
- State the location of all Air Monitoring Stations (AMS) and the data records required to be obtained for each.
- Stipulate Regulatory Context (regulators / guidelines / criteria) for airborne concentrations of potential contaminants found on-site.
- Incorporate contingency plans in the event that if any issue arises it is identified during the monitoring program. These include ambient air concentrations detected which approach or exceed relevant target action levels / stop work levels.
- Detail measures that will minimise any risk to human health, should asbestos fibres or other contaminants be detected on-site.

4 PROPOSED WORKS AND POTENTIAL IMPACTS

The proposed works for the project are estimated to be completed over a 4-5 year period. Air monitoring is to be carried out for the duration of the project. The proposed works which could potentially generate dust during remediation of the Site include:

- Soil excavation and dewatering.
- Mobile Crushing.
- Truck loading of remedial waste and export of unsuitable waste.
- Vehicle movement to and from the Site.
- Stockpiling of potentially contaminated soil.
- Replacement of inert landfill.
- Placement of engineered clean fill (imported) and a final capping layer once completed.

Particulates (as dust), asbestos fibres, RCS and particles containing heavy metals were identified as potential contaminants and are anticipated to be present in the soils being excavated. Exposure to these contaminants has the potential to trigger long-term health effects (especially for workers operating within the Site boundaries). In particular inhalation of asbestos fibres is a known cause of bronchial cancer, asbestosis and mesothelioma (IARC, 2012). Similarly exposure to elevated concentration of RCS can lead to respiratory related diseases such as silicosis.

On-site activities such as transportation, disturbance and re-distribution of material may increase airborne dust and fibre concentration. The propensity for dust particulates and ACM; as asbestos fibres, to have adverse health impacts and cause nuisance depends upon the characteristics, size and shape of the particle or fibre; where particle size is measured in terms of aerodynamic equivalent diameter (AED). Aerodynamic diameter is the diameter of a sphere of unit density that has aerodynamic behaviour identical to that of the particle in question; therefore, particles having the same aerodynamic diameter may have different dimensions and shapes. As such relatively large fibres with low density such as asbestos can behave the same as small spheroid particles which penetrate deeply into the lungs.

Typically Total Suspended Particulate (TSP) is a measure of nuisance e.g. deposition of particles on vehicles and tends to have limited impact on health due to the dominance of large particles (>100 microns AED). Particles less than 10 microns AED (PM_{10}) are generally measured to gauge the impact of dust and a sub-set of this to measure for respirable dust ($PM_{2.5}$) and for airborne fibres. Generally speaking dust concentration from earthworks tends to be dominated by particles larger than 2.5 µm AED that are either:

- Non-respirable.
- Don’t often contain asbestos fibres.

Incorporation of a range of dust suppression measures and wearing of appropriate PPE and respiratory protective equipment (RPE) will reduce the level of risk associated with exposure to concentrations of CoPC to acceptable levels.

5 ASSESSMENT OF SITE CHARACTERISTICS

Site characteristics are assessed to ensure that any likely causes of exposure to CoPC from the Site during earthworks are accounted for. The ESMP details mechanisms put in place to keep concentrations to a minimum, such as PPE and dust suppression. The AQMP essentially validates those mechanisms to ensure CoPC concentrations will comply with the relevant standards for management (WA EP Act, 1986) and relevant guidelines concerning contaminant concentrations in air, adopted by the WA DEC (2011) and WA DoH (NOHSC/Safe Work Australia, 1995). These measures will reduce the risk to human health for both onsite and offsite receptors from potential airborne concentrations of contaminants.

In accordance with the DEC (2011) guidelines concerning the management of ambient air quality for land development sites in WA, all surrounding land use(s) and details of average weather conditions, geography, surface and substrate geology have been considered within the MDWES ESMP and AQMP. Wind and drying soil conditions are identified as the major factors most likely to contribute to the generation of airborne CoPC's.

Sensitive human receptors are located off-site, with the closest residents on Adelaide Street located on the southern side of the Site boundary. The most sensitive human receptors are the on-site personnel who attend the Site to complete works. Other human receptors include the MDWES Environmental Scientists conducting the air quality monitoring program and visitors attending the site during the project.

5.1 Wind Conditions

Monthly weather data obtained from the Bureau of Meteorology (BOM) during 2011, 2012 and 2013 illustrate the seasonal and daily changes over the Perth region. For the purposes of this AQMP, weather data was sourced from the Perth Airport weather station, located approximately 12km from Site.

Daily wind roses demonstrate the direction of approaching winds, which in turn determine the direction and dispersion of potential dust and asbestos fibres. Data shows that wind direction changes from morning to afternoon, so static onsite monitoring will be completed twice daily. Monitors will be positioned downwind of the prevailing winds in the morning then repositioned in the afternoon to allow for any change in wind direction. MDWES will review the wind direction forecast each morning and afternoon before the stations are positioned.

A weather station will be located on-Site to provide real-time local wind direction. This will allow MDWES to determine the risk of exposure (if any) to the potential receptors. Monitoring details are outlined in Section 6.

Collated weather information is shown in Table C.

Table C: Collated Weather Information

Season	Month	Year	General Wind Direction		Wind Speed		Temperature				Rainfall
									Mean		
			9am	*3pm*	*9am*	*3pm*	*Min*	*Max*	*9am*	*3pm*	
Summer	January	2011	E	SW	23.3	18.6	19.0	33.7	25.8	31.8	43.2
		2012	E	SW	28.0	22.2	19.7	33.4	23.2	28.1	27.4
		2013	E	SW	21.1	18.6	18.5	32.3	25.9	30.0	8.2
	February	2011	E	SW	29.6	25.7	20.8	34.9	23.7	31.9	0.4
		2012	E	SW	28.0	25.4	18.3	31.3	23.6	28.6	19.0
		2013	E	SW	21.1	16.7	18.6	34.6	25.9	31.0	1.0
Autumn	March	2011	E	S/SW	26.1	24.1	18.5	32.8	25.3	30.8	0
		2012	E	S/SW	20.9	24.0	15.6	31.6	26.1	32.7	0
		2013	E	S/SW	21.4	15.9	15.2	28.4	23.6	29.1	60.2
	April	2011	E/NE	S/SW	22.5	21.9	14.2	27.9	23.8	30.0	26.2
		2012	N/NE	S/SW	25.1	22.0	14.0	26.4	20.0	24.3	53.2
		2013	E/NE	S/SW	17.7	19.9	16.1	28.7	24.0	30.7	7.8
	May	2011	E	E	14.8	19.1	11.0	23.6	17.7	24.7	58.6
		2012	NE	NE/S	22.0	15.6	10.2	23.0	18.7	21.8	39.8
		2013	E	W	16.9	18.0	10.6	21.7	17.8	23.2	112.2
Winter	June	2011	N/NE	N/W	19.5	15.3	10.0	19.7	13.8	18.2	143.2
		2012	N/NE	NE	19.0	20.9	10.1	19.3	15.9	19.3	134.4
		2013	N/NE	NE	17.5	11.9	7.8	19.9	13.1	18.9	23.0
	July	2011	NE	E	19.9	7.5	8.6	18.4	9.7	15.6	164.6
		2012	NE	NE/N	15.1	11.9	5.6	19.2	12.6	20.7	30.6
		2013	N	N/W	15.4	10.6	6.6	18.7	10.3	18.0	119.2
	August	2011	N/NE	W/SW	20.4	15.3	8.8	20.2	13.1	17.4	127.8
		2012	N/NE	W	21.4	11.9	8.2	20.0	13.3	17.8	117.8
		2013	N/NE	W/SW	23.6	10.6	9.9	20.3	14.9	20.9	160.6
Spring	September	2011	N/NE	SW	22.5	10.5	8.9	20.5	13.9	18.3	102.4
		2012	NE	W	25.4	13.0	8.8	21.4	13.3	17.8	103.8
	October	2011	NE/E	W/SW	18.6	11.6	12.2	24.4	18.2	22.1	63.4
		2012	N/E	W/SW	19.3	21.9	11.7	24.9	19.0	22.7	13.8
	November	2011	E	W	22.2	23.3	14.1	26.1	22.4	22.7	38.6
		2012	E/SW	SW	27.2	23.1	12.7	26.1	18.1	19.6	84.8
	December	2011	E	SW	27.4	27.5	17.5	30.6	24.9	30.4	67.4
		2012	E	SW	21.1	20.4	16.8	31.4	22.0	26.6	24.8

6 WEATHER MONITORING

6.1 Objective

The objective of the on-Site weather station is to obtain localised weather data and validate the locations of the air quality monitors. Data obtained from the weather station will aid in establishing and verify the positions of the air monitoring sites, as well as allowing MDWES to determine changes to the risk of exposure (if any) to the potential receptors.

Weather data will be logged for the duration of works. Data obtained will include: temperature, wind speed, wind direction, relative humidity, barometric pressure and rainfall.

6.2 Overview

Daily on-site weather conditions are considered to be a major factor in determining the potential risk of exposure to the potential receptors. Wind direction and speed is anticipated to be the most significant weather influence at the Site and surrounds, as it will:

- Influence the generation of dust particles.
- Influence the direction, dispersion and distance that deposition may extend to, including beyond the Site boundaries.

Other parameters, such as temperature, humidity and rainfall, may influence the moisture content of the soil. Warm temperatures, low humidity and limited rainfall (experienced during October – May months) have the potential to decrease the moisture content in the soil and therefore increase the likelihood of dust formation.

6.3 Rational for Weather Monitoring Position

The weather station will be positioned with consideration to AS3580.14-2011: Methods for sampling and analysis of ambient air – Meteorological monitoring for ambient air quality monitoring applications (Australian Standards, 2011) and Compact Weather Station - Operating Manual. The following points will be noted when the on-site weather station is installed:

General:

- Stable Subsurface.
- Free access to equipment for maintenance works.
- Reliable power supply.
- Good network coverage (transmitting over a mobile network).

Wind Measurement Sensors:

- Installation at top of the mast.
- Installation height at least 2 metres above surrounding ground level.
- Free field around sensor.

The installation of the weather station will be undertaken by a competent person, as per the instrument's operation manual.

6.4 Responsibilities

Responsibility for determining the daily static sampling locations within the excavation zone rests with the AQMP Manager (role further clarified in Section 7.4). In order to undertake this task, wind direction at the Site will be forecast, based on historic wind data, forecast meteorological data from the Commonwealth Bureau of Meteorology (BoM) website www.bom.gov.au and local observation data from the on-site weather station.

Based on the Site forecast and scheduled remediation works, the location of morning and afternoon sampling locations will be determined. Forecasts will also be used to assist in determining dust suppression measures for the Site.

The AQMP Manager will be responsible for the calibration and maintenance of the weather station and for the documentation of daily weather observations such as rainfall totals, temperature, wind speed and direction. Some of this data may be analytical or remotely sensed (yet to be determined).

6.5 Weather Equipment

The weather station that will be used on site by MDWES is a WS501-UMB Compact Weather Station. The weather station monitors the following parameters:

- **Wind Direction and Speed:** using four ultrasound sensors which take cyclical measurements in all directions, Wind speed and direction is calculated from the measured run-time sound differential.
- **Air Temperature and Humidity**: a NTC-resistor measures temperature and a capacity humidity sensor to measure humidity. To minimise the sensors being influenced by external factors such as solar radiation. Sensors are housed in a ventilated housing with radiation protection.
- **Air Pressure:** is measured with a built in sensor (MEMS). The relative air pressure referenced to sea level is calculated using a barometric formula with the aid of local altitude, which is user-configurable on the equipment.
- **Compass:** integrated digital compass used to check North-South adjustment of the sensor housing for wind direction measurement.
- **Precipitation:** additional bucket balance.

6.6 Equipment Maintenance

Maintenance and calibration of the weather station has been devised with consideration to AS3580.14-2011: Methods for sampling and analysis of ambient air – Meteorological monitoring for ambient air quality monitoring applications (Australian Standards, 2011) and Compact Weather Station - Operating Manual. Regular checks and calibration will ensure equipment is in good condition and that data being obtained is reliable. Table D outlines the proposed maintenance schedule.

Table D: Maintenance Schedule

Maintenance	Wind Speed and Direction	Temperature	Relative Humidity	Precipitation
External Calibration				
Onsite Operational Precision Check				
Onsite Visual Inspection				

Key:

	< 2 Years		6 Monthly
	Annual		3 Monthly

6.7 Data Logging and Reporting

Weather data will be reported and logged in accordance to AS3580.14-2011: *Meteorological Monitoring for Ambient Air Quality Monitoring Applications*. The report will include:

- Reference to the Australian standard (AS3580.14-2011).
- Reporting organisation.
- A recorded value for each parameter:
  - The type of instrument used to obtain the recorded value, including starting thresholds for wind direction and wind speed sensors.
  - The calibrated measurement range in the corresponding reporting units.
  - The measurement height above ground level (in meters).
- Date, time and period of sampling.
- Sampling location, including:
  - Coordinate reference.
  - Height above ground level (mAHD).
  - Classification of area with a description of the sampling location.
- Any non-conformance with the standard.
- Uncertainty associated with the measurement along with the confidence interval and coverage factor.
- Any other relevant data, for example;
  - Mean values (e.g. hourly, daily, monthly or annual).
  - Minimum/Maximum values (e.g. hourly, daily, monthly or annual).
  - Time/day, month or year certain values exceeded.

Table E: Reporting Weather Parameters & Units

Parameter	Units
Wind Speed	Meters/second (m/s)
Wind Direction	Degrees from true North (°)
Ambient Temperature	Degrees Celsius (°C)
Relative Humidity	Percent (%)
Barometric Pressure	Hectopascals (hPa)
Precipitation	Millimetres (mm)

7 AIR QUALITY MONITORING

7.1 Objective

Air quality monitoring will provide information to facilitate management of excavation works in order to minimise potential exposure of hazardous contaminants to on and off-site receptors. The program will have a strong focus on verifying that personnel are not being exposed to elevated airborne concentrations of CoPC as a result of excavation works.

The air quality monitoring program is intended to quickly identify if excavations, in possibly contaminated soils, result in airborne concentrations of CoPC exceeding the NIOSH / Safe Work Australia (1995) exposure limits (also endorsed by the WA DER), so that mechanisms such as increased spraying with water or, if necessary, a “stop work” instruction can be implemented, until the levels are again found to be safe.

7.2 Overview

Particulates and fibres may be present in air if contaminated soils are exposed to drier moisture levels and strong prevailing winds. To validate exposure levels, monitoring will be undertaken in two capacities on Site:

a. Boundary Monitoring – to ensure off-Site residents are not being exposed to potential elevated concentrations of dusts and asbestos fibres.
b. On-site Monitoring – to ensure personnel (on-site) are not being exposed to potential elevated concentrations of dusts and asbestos fibres.

7.3 Rationale for Monitoring Positions

The locations of the Air Quality Monitoring Stations (AMS) have been determined to provide full coverage of Site airborne emissions. The location of the various stations and related analytes is depicted in Figure 2 and summarised in Tables F and G. The majority of the monitoring stations are located on the Site’s boundary with a strong focus on the western portion of Adelaide Street boundary due to the proximity of receptors.

A Tapered Element Oscillating Microbalance (TEOM) located near the south western corner of the Site (at AMS1) will provide real-time, high quality, gravimetric data on dust concentration and fugitive emissions at the boundary. At the same location, a nephelometer will also provide real-time non-gravimetric data based on the amount of deflected light compared to a calibrated aerosol which is then expressed as mass. Once the nephelometer is calibrated to the Site’s typical aerosol, both the TEOM and nephelometer should output similar data. This cross checking allows for confidence in data obtained from the additional nephelometers around the Site (AMS3-6).

Boundary monitoring will be conducted at five additional fixed sample locations (AMS2-6) to provide characterisation of fugitive dust emissions along the entire boundary via real-time nephelometers. Some concurrent gravimetric sampling at these sampling stations will provide additional cross checking ensuring confidence in the data’s validity. One of the boundary monitoring stations will be located close to the crusher (AMS5) and will provide data associated with its emissions.

The monitoring station on the south western corner will also be used to collect time-weighted samples of fibre (for asbestos), RCS and metalloids. Both fibre and RCS samples will be collected daily, whereas the metalloid sample will be collected weekly over two days: once for mercury and once for other metalloids. Daily time-weighted airborne fibre sampling will also be undertaken at the other two southern stations along Adelaide Street (AMS2-3).

Time-weighted airborne fibre sampling will be undertaken at three ‘static’ judgemental locations in the vicinity of the excavation work zone (AMS7-9). While stationary during the sampling period, the monitoring stations will have no fixed locations with the locations based on forecast wind direction. Static sampling allows for the characterisation of potential fibre concentration downwind of the excavation work zone. Samples will be collected twice daily: once at midday to cover the morning and once at the end of the day to cover the afternoon. Such a scenario allows for significant changes in wind direction. Airborne fibre sampling will be used within the crib room (AMS10) to validate the ‘clean’ status of the area.

Time-weighed airborne fibre ‘personal sampling’ will also be undertaken at four non-fixed locations (AMS11-14). Personal monitoring will determine the airborne fibre concentration within workers breathing zone. Two sets of equipment will be set up in cabs of on-site vehicles and two on-the-ground on-Site workers will be required to wear personal sampling equipment (light-weight sampling pumps).

The weather station will be located in the north western quadrant of the Site, away from structures likely to impact on the direction of surface winds.

7.4 Visual Assessment

While much of the monitoring program focuses on quantification of CoPC concentration, visual assessment of dust levels at the active work zones is an important function of the monitoring program. Visual assessment provides immediate qualitative assessment of dust levels at the work zone and immediate implementation of corrective action e.g. increased dust suppression. A safe work procedure (SWP) will be developed to provide guidance to all site workers and particularly those engaged in remediation earthworks and implementation of dust suppression to actively assess dust levels across the Site and initiate appropriate action. The SWP will describe various levels of dust e.g. low; moderate; elevated and high and associated actions that could be undertaken to reduce dust levels. Site workers understanding and adherence to the SWP will be undertaken by portfolio and competency assessment by a qualified trainer.

Table F: Air Quality Monitoring Program

Location	ID	Analyte				Rationale
		Dust	Asbestos	Silica (RCS)	Metals	
Boundary Monitoring Stations						
Primary – South West Corner	AMS1					These positions will be on the southern boundary fence to assess any off site migration of particulate matter and/or asbestos fibres that may potentially impact the residents on Adelaide St.
Southern Boundary	AMS2					
Southern Boundary	AMS3					
North East Corner	AMS4					These positions located on the boundary fence to assess any off site migration of particulate matter and asbestos fibres.
Northern Boundary	AMS5					
North West Corner	AMS6					
On-site Monitoring Stations						
Static Station Excavation - Justified*	AMS7					Downwind close to the excavations to assess any windblown matter / site workers potential exposure.
Static Station Excavation – Justified*	AMS8					
Static Station Excavation – Justified*	AMS9					
Crib Room	AMS10					Potential risks if the hygiene process has not been adhered to.
Personal Monitor 1 (PM1)	AMS11					Exposure to site worker from landfill material.
Personal Monitor 2 (PM2)	AMS12					
Personal Monitor 3 (PM3) - Vehicles#	AMS13					
Personal Monitor 4 (PM4) - Vehicles#	AMS14					
Weather Monitoring Station – Green Zone	WMS1	Meteorological conditions				Provide on-site weather data to verify monitoring locations.

NB:

- *Sample locations will be positioned and evaluated, dependent on predicted daily (am and pm) wind directions obtained from BOM website each morning.

7.5 Roles and Responsibilities

Responsibility for the management and delivery of the AQMP will rest with the AQMP Manager. The AQMP manager will be an Environmental Scientist with air quality specialist knowledge employed by MDWES.

Implementation of site dust control measures is the responsibility of the Site Operations Manager. All Site personnel are responsible for visual assessment of dust levels across the Site and implementation of control measures appropriate to their role.

To ensure a high level of transparency MDWES will engage a NATA certified specialist organisation to supervise the operation, service and calibration of the TEOM and provide oversight in application of calibration factors for the nephelometers.

In order to maintain performance and continuity responsibility for the programme will be assigned to one person for the duration of the project (subject to operational constraints).

The role of the AQMP Manager will be to:

- Liaise with the NATA accredited specialist contractor to ensure TEOM performs as per requirements and meets AS/NZS 3580.9.8: 2008 (PM_{10}).
- Consult with the specialised contractor re: aerosol calibration of nephelometers.
- Ensure field equipment and instruments are operating correctly and are calibrated as per manufacturer and operational requirements.
- Review daily wind and weather forecast as described in Section 6.4 to determine static sampling locations within the excavation zone for that day.
- Ensure field technicians are sufficiently experienced to undertake appointed field tasks and are adequately supported in their role.
- Ensure sample and data collection tasks conform to any relevant guidance documents or standards and are performed as per documented MDWES operating procedures.
- Ensure quality control and assurance measures are appropriately managed and met.
- Analyse field and laboratory data on an on-going basis to determine daily fugitive emissions from the Site and provide predictive trend analysis.
- Liaise with Operations Site Manager to ensure they are fully apprised of fugitive emission concentrations and potential impacts on receptors.
- Liaise with major stakeholders to ensure transparency of the AQMP is maintained.
- Manage all mandatory reporting requirements relating to the AQMP and Works Approval and Licensing Conditions are met.

7.6 Tasks

As per the role, a diverse range of tasks needs to be undertaken on a daily basis to ensure the objectives of the AQMP are met. The AQMP Manager will undertake and appoint tasks as required. The integration of a NATA accredited specialty organisation into the programme is likely to impart an increased level of credibility and ultimately acceptance of the monitoring program by the community.

Specific tasks can be grouped together based on the CoPC being investigated. Table G summarises those tasks and responsibilities. The table is followed by a brief description of the task and relevant information pertaining to roles.

Table G: Roles & Responsibly for Air Monitoring Program

Parameter measured	Sampling Site / Locations	Task	Timing *	Completed by Whom	Analysis
PM10	AMS1	Ensure TEOM functioning correctly	Commissioning. Calibration. As required	NATA certified specialist consultant	Ensure instrument is installed and functioning correctly
	AMS1 - 6	Review calibration data	First two months	NATA certified specialist consultant	Review data to ensure appropriate aerosol calibration factors used in nephelometer.
	AMS1 - 6	Review real time data	Daily	AQMP Manager or Env. Scientist	Review real-time data
	AMS1, 3, 5	Gravimetric sample collection	Daily for one month and then once per month (over 3 days)	AQMP Manager or Env. Scientist	NATA accredited analysis of sample within 5 working days
	AMS1 - 6	Determine calibration factor for nephelometers	As required	AQMP Manager	Comparison of concurrent nephelometric and gravimetric data to produce Site specific calibration factor for nephelometers
TSP	AMS1	Review real-time data from nephelometers	After one month configure nephelometer to sample TSP rather than PM10	AQMP Manager or Env. Scientist	Review real-time data
	AMS1	Gravimetric sample collection	Weekly	AQMP Manager or Env. Scientist	NATA accredited analysis within 5 working days
Silica Dust (RCS)	AMS1	Sample collection	Weekly	AQMP Manager or Env. Scientist	NATA accredited analysis within 5 working days
Metalloids	AMS1	Sample collection	Two weekly	AQMP Manager or Env. Scientist	NATA accredited analysis within 5 working days
Asbestos	AMS1 – 6, 10	Sample collection	Daily Mon - Sat	AQMP Manager or Env. Scientist	NATA accredited analysis within 24 hours
	AMS7, 8, 9	Sample collection	Twice daily am: 07:00-12:30 pm:12:30-17:30	AQMP Manager or Env. Scientist	NATA accredited analysis within 24 hours
	AMS11, 12	Sample collection	Twice weekly for two months then schedule reviewed subject to historical results	AQMP Manager or Env. Scientist	NATA accredited analysis within 24 hours.
	AMS13, 14	Sample collection	Daily for two weeks then monthly for six months then schedule reviewed subject to historical results	AQMP Manager or Env. Scientist	NATA accredited analysis within 24 hours.
	NA	Review BoM and Site data	Daily (am)	AQMP Manager	Forecast likely conditions for sample locations

CoPC	MDWES office or Site office	Report	Weekly report for the previous week's results	AQMP Manager	Ensure compliance with Works Approval and Licensing Conditions.
Weather	WMS-1	Collect data	Daily	AQMP Manager or Env. Scientist	Review data, check robustness, check for gaps.
	MDWES office or Site office	Collate data	Daily	Env. Scientist	Check QA/QC of data, check robustness, data gaps, and check against assessment criteria.
Reporting	MDWES office or Site office	Variable	As required	AQMP Manager	NA

NB * unless otherwise stated, sample collection is from start to end of daily works, Monday to Saturday, for full duration of earthworks. Highlighted cells apply to contracted NATA accredited specialist.

NATA accredited ambient air specialist tasks

The programme incorporates a number of levels of complexity to provide a comprehensive assessment of ambient air quality across the Site and quantify likely fugitive emissions. At the centre of the programme is the operation of the TEOM which provides real-time gravimetric analysis of PM_{10} concentration. The engagement of a well credentialed NATA accredited organisation to install, calibrate, service and ensure the TEOM operates correctly day to day will ensure the accuracy of the primary monitoring station (AMS1).

The monitoring program assumes that PM_{10} is a surrogate for all airborne particulate matter. Conceptually then, accurately measuring and managing the concentration of PM_{10} will ensure that the concentration of all particulate based CoPC remains within acceptable limits.

Five nephelometers positioned about the perimeter of the Site will provide secondary real time monitoring of PM_{10} concentration. Unlike the TEOM, mass concentration is calculated based on the amount of light deflected from the aerosol being sampled and comparison to a standardised calibration aerosol. It is unlikely that the "aerosol" typically characterising the Site has the same characteristic as the standard calibration aerosol. Consequently concurrent time-weighted gravimetric sampling at AMS1, AMS3 and AMS5 will be undertaken to determine calibration factors that will scale all nephelometer data up or down as required. Application of the calibration factor to the AMS1 nephelometer will ensure both the primary and secondary PM_{10} mass concentrations at AMS1 are similar. Application of a calibration factor for the nephelometer at AMS2 will be based on the time-weighted gravimetric samples collected at AMS1. Application of a calibration factor for the nephelometers at AMS3, AMS4 and AMS6 will be based on the time-weighted gravimetric samples collected at AMS3. Time-weighted gravimetric samples from the nephelometer at AMS5 will be used only for that station because the station is located closest to the crusher and its "typical" aerosol is likely to be strongly influenced by the crusher. The engagement of a well credentialed NATA accredited organisation to provide guidance on development of calibration factors and is also likely to add confidence to data obtained from the secondary real-time monitors.

Silica (RCS) and metalloids

Collection of a daily respirable crystalline silica sample and two weekly airborne metalloid samples will be undertaken at AMS1. Performance of these tasks will be undertaken by MDWES staff using portable sampling pumps. In the case of RCS the pump will be coupled to a 25 mm filter fitted to an aluminium cyclone. In the case of metalloids the pump will be coupled to an inspirable SKC IOM filter. X-Ray diffraction is used to determine the quantum of silica present in the sample. Elemental analysis by digestion and ICP is used to determine the mass of various elements present in the metalloids sample. The above tasks will be performed by experienced MDWES staff.

Fibre (as asbestos)

Airborne fibre samples will be collected at all of the boundary sampling stations plus a range of on-site locations. Samples will be collected using programmable, battery operated sample pumps coupled to non-conductive 25 mm bell-nosed filter holders contained gridded mixed cellulose ester filters as per AS/ANZ Standards. The above tasks will be performed by experienced MDWES staff.

Meteorological data acquisition tasks

Meteorological data will be reviewed daily from the on-site weather station and BoM to forecast likely wind direction so that on-site static sampling stations can be positioned down wind of earthworks thereby measuring fibre concentration in the air shed immediately downwind of remedial earthworks. The above tasks will be performed by experienced MDWES staff.

Reporting

Reporting to various stakeholders will be the undertaken by the air quality manager as required by stakeholders and license conditions.

7.7 Qualifications and Experience

The management of the AQMP will be undertaken by a suitably qualified and experienced Environmental Scientist employed by MDWES. Responsibility for daily delivery of the air quality monitoring programme (execution of the air quality management plan) will rest with the AQMP Manager. Both the AQMP Manager and the Environmental Scientist will meet the following criteria:

- Tertiary qualifications in the field of Environmental Science or equivalent.
- Sound knowledge of Australian standards and guidelines relating to ambient air monitoring.
- History of ambient air monitoring (minimum of three years) demonstrating theoretical and practical knowledge of sampling methodology and reporting.
- Understanding of QA/QC requirements of sampling programs.
- Ability to manage small teams and ensure procedures and standards are met by all relevant project staff.
- Can analyse data and identify trends and non-conformances.

Occasionally, Field Technicians may work under the supervision of an Environmental Scientist to undertake routine daily on-site tasks. If so, they will meet the following criteria:

- Minimum of Diploma of Environmental Monitoring and Technology, qualifications in the field of Environmental Science or equivalent is desirable.
- Ambient air quality monitoring and field experience.
- Technical understanding how to use various types of monitoring equipment.
- Data interpretation and reporting experience.

A NATA accredited ambient air specialist organisation shall be contracted to install, calibrate, service and ensure day to day operations conform to Australian Standards. Staff from the contracting organisation must demonstrate the following:

- Experience in installation, calibration and service of TEOMs.
- Understand the AS/NZS standard's relating to the sighting and operation of TEOM's.
    - A strong knowledge of ambient air quality monitoring.
- Previous experience using nephelometers and scaling data by applying custom calibration factors.

7.8 Excavation Area (Red Zone) – Control Measures PPE and RPE

As per a hierarchy of control, Site equipment (vehicles) operating within the elevated asbestos risk area or the 'red zone' (Figure 2) will be fitted with High Efficiency Particle Arrestment (HEPA) filters to eliminate an occupant's potential exposure to fibres. Airborne samples will be collected from mobile cabins as per Table G to quantify fibre concentration.

Other control measures will be utilised within operational constraints, to minimise Site workers exposure to dust and fibre. Site workers on foot within the red zone will be required to be clean shaven, be fit tested and wear respiratory protection as per AS/NZS 1705: 2009, and wear disposable coveralls (appropriate for working with asbestos fibres), safety glasses, hats and dedicated steel capped boots. Personal monitoring of all Site workers will be undertaken as per Table G to quantity potential exposure to fibres. After two months, results of personal monitoring will be reviewed to assess the need to continue using half face respirators as opposed to P2 masks and wearing of disposable coveralls. Review of Respiratory Protection Equipment (RPE) and PPE requirements based on risk assessment outcomes.

As per Table F and G, three asbestos monitors will be set up twice daily around the excavation area. Sample locations within the excavation zone will be predicated by forecast weather conditions to allow to the monitoring station to be located directly downwind of the excavation works. At approximately noon, filter cassettes will be changed and the location of the samplers revised to accommodate afternoon prevailing wind patterns.

7.9 Training

All Site personnel and visitors will be required to undergo a site induction before being allowed entry to the Site. The induction will have a strong focus on risks posed from exposure to CoPC. The Site Induction will reinforce the Site's primary objective to minimise potential emissions of CoPC. All personnel will be instructed that visual assessment of dust levels is everyone's responsibility and that they are required to inform the Site Operations Manager of any increase in visual dust levels and take appropriate actions as per Site specific SWPs.

All Site workers will be required to participate in ACM hazard awareness and respirator protection training.

As noted in Section 7.4, the competency of site personnel undertaking remedial earth works to follow visual assessment of dust SWP will be assessed by qualified trainer. Assessment will be via portfolio review.

7.10 Stations for Public Exposure Monitoring

Boundary monitoring stations, as detailed in Sections 7.3 and 7.6 will be located outside of the excavation area with six Air Quality Monitoring Stations positioned around the Site boundary. These monitoring stations will assess daily ambient air quality concentrations with three monitoring stations on the northern boundary line and three along the southern boundary line. The station on the south western corner (AMS1) will be the primary monitoring station and consists of a TEOM, nephelometer, and three sampling pumps for 'fibre', particulate metalloids' and RCS. Stations AMS2 to AMS6 house nephelometers.

The objective of the boundary monitoring station placement is to characterise the airborne concentration of identified CoPC and potential migration off Site. The data will be used to validate that the occupants of Adelaide Street are not being exposed to elevated concentrations of airborne contaminants.

Air monitoring stations will be located in accordance with the guidelines outlined in AS/NZS 3580.1.1:2007:

- Avoid sites with restricted air flow such as near buildings and trees. The minimum clear sky angle for the sampling inlet should be 120 degrees.
- Avoid sites that may cause physical and chemical interference such as close proximity to motor vehicle emissions.
- Avoid sites that may adsorb and desorbs contaminants such as trees. Stations should be located at least 20 metres from trees and leafy vegetation.
- Locate the monitoring inlet near human breathing zones, 1 to 2 metres above ground level.

8 METHODOLOGY OF SAMPLING AND ANALYSIS

8.1 Dust (TSP and PM10)

Dust is made up of a wide range of particles varying in size, shape and density. These characteristics determine the transport fate of the particles. Typically, particles smaller than 100 μm in diameter are called Total Suspended Particulates (TSP). In the context of earthworks, TSP is generally considered from a nuisance perspective because the bulk of the mass consists of particles larger than 10 microns AED and therefore is unlikely to result in adverse health impacts. The smaller subset of TSP: PM_{10} is usually used to measure environmental concentrations of dust, while $PM_{2.5}$ is often used to measure occupational concentrations of dust.

The Federal Government has nominated national reporting standards for major ambient air quality contaminant as per the National Environmental Protection Measure (NEPM) for Ambient Air Quality. The NEPM list non-point source affected air shed criteria for PM_{10}, the NEPM also has an advisory reporting standard for $PM_{2.5}$ which has not been adopted and is currently under review. Given the above and the view that PM_{10} is considered a surrogate for all particulate matter, the measurement and management of PM_{10} to ensure it does not exceed the NEPM concentration guideline is a suitable goal. This supposition will be further supported by additional TSP measurement described further below.

As previously discussed in increasing complexity, PM_{10} will be measured using two methods: gravimetric and nephelometry. Both will give real-time PM_{10} dust concentrations across the Site and on boundaries.

A number of gravimetric standards have been developed to measure the mass concentration of dust in ambient air. However, the only instrument routinely used to measure temporal changes in particle mass concentration is a Tapered Element Oscillating Multi-balance (TEOM). AS/NZS 3580.9.8:2008 *Determination of suspended particulate matter – PM_{10} continuous direct mass method using a tapered element oscillating micro-balance analyser* provides guidance on the use of such instruments. As there have been reported differences in concentrations of PM between TEOM and other reference methods for PM_{10} measurement, the TEOM used on Site will be Thermo Fisher 1405-DF Dichotomous Ambient Particulate Monitor with FDMS, which can continuously measure PM_{10}.

Ambient air particle mass can also be measured gravimetrically via time weighted methods such as AS3640:1989 - Workplace Atmospheres - *Method for Sampling and Gravimetric Determination of Inspirable Dust for PM_{10}* which rely upon the collection of particles on filters over a known period of time.

Dust concentration can also be determined via non-gravimetric methods such as nephelometry, which measures the amount of deflected light passing through the dust stream and correlates this to mass based on a calibration aerosol. The advantages of nephelometry are ease of use and cost effectiveness. However, the disadvantage is that while it is widely recognised as a good tool for measuring real-time changes in mass concentration, it is dependent upon good characterisation of the aerosol being measured. Failure to calibrate nephelometers against an appropriate aerosol can lead to understating mass concentration. Inappropriate characterisation of calibration aerosol can be overcome by concurrently collecting a filter based gravimetric sample while monitoring with the nephelometer and then comparing the time weighted results to derive a calibration factor which can be used to scale the nephelometer data either on-board or during data analysis.

Six nephelometers: TES 7200 (QA-Lite) will be used on Site: one at the Primary Monitoring Station (AMS1) and five at the Secondary Monitoring Stations. The instruments will have a heated inlet to prevent artefacts from moisture vapour over reporting mass and can collect concurrent filter samples for gravimetric analysis. Utilisation of the built in filter in the nephelometers allows for the derivation of a calibration factor to be applied to the nephelometer to scale up or down the data so that it directly comparable to data collected from the TEOM. Similar to the Primary Monitoring Station: comparison of the time-weighted gravimetric values to the nephelometer derived data will allow development of an accurate calibration factor which can be input into the QA-Lite at the remaining four boundary monitoring stations.

8.2 Asbestos Fibres

Asbestos fibre concentrations will be measured in accordance with the National Occupational Health and Safety Commission's Membrane Filter Method (NOHSC: 3003, 2005) the method for estimating airborne asbestos fibres. Asbestos sample locations and frequency are outlined in Section 7.4.

Static monitors will be set up at all of the boundary monitoring stations, three excavation face static monitors and a one crib room monitor. GPS locations of the sampling locations will be taken when a monitor is relocated. Personal Monitors (including vehicle monitors) will be worn by the workers on-site. Filters will be worn within the workers 'breathing zone'. They will be attached via flexible tubing to a personal sampling pump on the workers' waist.

A known volume of air is passed through each filter using a SKC PCXR8 sampling pump. Rates for sampling will be adjusted in accordance with the type of sampling i.e. static, judgemental or personal to sample approximately 600 litres and conform to NOHS: 3003 membrane filter method. For example, based on 10 hour sampling for boundary stations the flow rate would be 1 litre per minute whereas afternoon judgemental sampling would be for five hours and 2 litres per minute.

Analysis of fibres will be carried out daily by a NATA Accredited laboratory, in accordance with (NOHSC: 3003, 2005). The filter will be treated to become transparent and then observed using a phase contrast microscopic and calibrated eyepiece. Fibres are sized and counted as per defined geometric criteria. Results will be expressed as fibres/mL, calculated from the number of fibres observed on the known filter area and the volume of air sampled.

As analysis does not identify the type of fibres present on the filter, fibre counts will be interpreted as representing asbestos fibre counts. If the initial fibre count exceeds the assessment criteria outlined in Section 10, the filter will be immediately sent to a NATA Accredited laboratory for electron microscope analysis to identify and speciate the fibres present on the filter.

One blank will be analysed per fifty samples for QC purposes.

8.3 Respirable Crystalline Silica (RCS)

The Respirable Crystalline Silica (RCS) is viewed as a low risk CoPC, given that the crusher; which operates for only a few hours per day, is likely to be the main source of RCS and dust suppression is likely to prevent any significant emission of this contaminant into the Site airshed. Respirable crystalline silica concentrations will be measured in accordance with NIOSH Method 7500 – *Silica, Crystalline, by XRD (filter re-deposition)* (NIOSH, 2004). It is noted that the above method is a para-occupational method. However, given the perceived low risk to off-site receptors and the relative high cost associated with a dichotomous sampler using an x-ray fluorescence spectrometer, the method is considered appropriate for determining RCS concentration at the Site boundary.

One RCS static sampler will be situated at the AMS1 monitoring station. Sampling will be completed daily, Monday to Saturday, for the duration of remediation. Sampling time will be representative of the site workers daily shift (7:00-17:30). A known volume of air will pass through an aluminium cyclone (size-selective sampler) to separate the respirable fraction, prior to being drawn through a poly-vinyl chloride filter which will be connected to a SKC PCXR8 sampling pump. The flow will be set to run at the required rate of 2.5 L/min, for the duration of the daily works. Sample run time will be approximately 10 hours. However, pump run will be approximately 6 hours and will be achieved via use of the pump's programmable functions. On completion of the gravimetric analysis, filters will be sent to a NATA accredited laboratory for x-ray powder diffraction analysis (XRD) to determine the crystalline silica concentration. Analysis will be conducted in accordance with NIOSH Method 7500 – *Silica, Crystalline, by XRD (filter re-deposition)* (NIOSH, 2004). Results will be expressed in mg/m^3. Results will be compared to the relevant assessment criteria as outlined in Section 10.

8.4 Metalloids

Metal concentrations will be measured in accordance with *NIOSH Method 7300 – Elements by ICP*. The metals of interest are based on the CoPC identified as part of the initial assessment. The metals being assessed for this project comprise Arsenic (As), Barium (Ba), Cadmium (Cd), Chromium (Cr), Copper (Cu), Manganese (Mn), Nickel (Ni), Lead (Pb), Mercury (Hg) and Zinc (Zn).

As with RCS, the stated method is para-occupational. Nevertheless, given the expected low airborne concentration (based on sampling experience), the method is considered appropriate for determining metalloid concentrations at the Site boundary.

Two (TSP) samples will be collected at AMS1; one on Tuesdays and one on Wednesdays. After gravimetric analysis has been undertaken, the filters will be analysed for As, Ba, Cd, Cr, Cu, Mn, Ni, Pb and Zn (Tuesday's sample) and Hg (Wednesday's sample). Sampling times will be representative of the site workers daily shift. Sampling will be completed weekly (Wednesdays) for the duration of remediation. Samples will be collected by pumping a known volume of air through a 37 mm sample cassette coupled to a SKC PCXR8 sampling pump. Flow will be set to run at the require rate of 2.0 L/min, for the duration of the daily works. Sample run times will be approximately 12 hours. However, pump run times will be approximately 6 hours and will be achieved via use of the pumps programmable functions. Given that sample collection is via TSP sampling, there will be no constraints on maximum sample volume for various metalloids.

9 Equipment

The following section provides a description and specifications of the equipment to be used as part of the air quality program.

9.1 QA Lite (TES-7200)

A QA Lite (TES-7200) will be set up to monitor dust concentrations at all the Air Monitoring Stations except AMS2. The QA Lite utilises nephelometry to measure dust levels and can measure up to six particle size fractions including TSP depending upon which PM inlet is fitted to the instrument. A PM_{10} inlet head fitted to each instrument will limit monitoring to PM_{10}. Instruments can be fitted with either a solar panel or connected to mains power to record data. The instrument can also collect filter samples for gravimetric analysis by passing the sampled air stream through the filter holder. Table H summarises the instrument specifications.

Table H: QA Light Specifications

Measuring Principle	Nephelometry with laser
Measurement Range	0 – 150 mg/m^3
Minimum Detection Limit	0.01 mg/m^3
Particle Size Range	0.2 – 18.0 micron diameter
Standard Inlets	TSP (Optical measure) PM10, PM2.5 and PM1.0
Logging Averages	Adjustable data logger 1 sec to 1 week averaging periods
Flow Rate	5LPM, Volumetric or Standardised
Operating Temperature	-5°C – 50°C

9.2 SKC AirChek XR5000 Sampling Pump

The SKC AirChek XR5000 sample pump is able to maintain a set flow rate from 5 – 5000 ml per minute. The pump uses a patented isothermal flow sensor to measure flow directly and acts as a secondary standard. A built in sensor compensates for changes in temperature that occur after calibration. For the purposes of this project, the air sampling pump will be used with the Asbestos Cassette Filters.

The XR5000 is a compact and light sampling device and therefore will be used in monitoring the personnel working onsite. Table I summarises the instrument specifications.

Table I: SKC Aircheck XR500 Sampling Pump Specifications

Flow Range	1000-5000 ml/min (5-500 ml/min require optional low flow adapter kit)
Flow Control	Holds constant flow to ±5% of the set point
Typical Run Time	20hrs (2L/min), 11hrs (5L/min)
Run Time, Run Delay and Continuous Run	1-9999 minutes (6.8 days). If run time exceeds 6.8 days, timer display rolls over.
Charging Time	Approximately 8hrs
Operating Humidity	0-95%
Operating Temperature	0 to 45 °C

9.3 SKC PCXR8 Universal Sampling Pump

PCXR8 is a constant flow air sampling pump with an operating range of 1000 to 5000 ml per minute. It is a battery-operated air sampling pump. For the purposes of this project, the air sampling pump will be used with the following collecting devices:

- Aluminium Cyclone
- Asbestos Cassette Filters
- IOM Sampler Heads

SKC PCXR8 pumps will be used for the static monitoring locations. The pump is fully programmable with delay start, set sample and run times. Table J summaries the instrument specifications.

Table J: SKC PCXR8 Sampling Pump Specifications

Flow Range	1000-5000 ml/min (adjustable to low flow 5-500ml/min if required)
Flow Control	Holds constant flow to ±5% of the set point
Run Time	NiMH Battery 12hrs minimum at 4000ml/min and 20 inches water back pressure
Resolution	±1 $\mu g/m^3$ (instantaneous)
Flow Indicator	Built in rotameter with 250ml division; scaled marked 1,2,3,4,5 L/min
Charging Time	6-8.5 hrs with Powerflex charger
Intrinsic Safety	Yes
Operating Humidity	0-95% non-condensing
Operating Temperature	0 to 45 °C

9.4 TEOM

The tapered element oscillating micro-balance (TEOM) used at the site will be a Thermo Fisher Scientific Model 1405-DF Dichotomous Ambient Particulate Monitor with FDMS. The instrument can provide simultaneous measurement of PM10, PM2.5 and extra-thoracic particulate matter fractions. Table K summaries the instrument specifications.

Table K: TEOM Specifications

Flow Rate	PM2.5 filter: 3.0 l/min; PM10 filter: 1.67 l/min; Auxiliary Flow Rate: 12.0 l/min
Measurement Range	0 to 5g/m^3; resolution 0.1 $\mu g/m^3$; precision ±1.5 $\mu g/m^3$ (1-hour)
Data Averaging Output	Real-time mass concentration average: 1 hour rolling average up dated every six minutes; long term averaging of 1, 8 & 24 hours, output rate every 10 seconds
Resolution	±1 $\mu g/m^3$ (instantaneous)
Operating Range	-40 to 60°C
Filter Media	Sample Filter: Pallflex TX40, 13 mm effective diameter; Sample Conditioner Filter: 47mm diameter housed in an FRM-style molded filter cassette, maintained at 4°C.
Power Requirements	Model 1405: 100-240 VAC/47-63 Hz; 230 VA; Pump: 120 VAC/60 Hz: 4.25 A 240 VAC/50 Hz: 2.25 A

9.5 Equipment Calibration and Maintenance

Maintenance and calibration of the equipment mentioned above has been devised with consideration to the relevant Australian Standard and Operation Manual. Regular checks and calibration will ensure equipment is in good condition and reliable data is being obtained. Table L outlines the proposed maintenance schedule.

Table L: Calibration and Maintenance Requirements

Maintenance	QA Lite (TES-7200)	SKC XR5000	PCXR8
Particle Mass Check			
Particle Mass Calibration			
Volumetric Flow Rate Check			
Volumetric Flow Rate Calibration			
Pressure Transducer Check & Calibration			
Temperature Sensor Check & Calibration			
Zero Check			
Leak Check			
Vacuum Pump Check			
Clean PM10 Air Inlet			
Clean Air Inlet System			
Clean Measurement Chamber			
External Calibration			

Key

	Annual Quarterly
	Quarterly
	3 Monthly
	Daily
	Pre and Post Sample

10 Air Quality Assessment Criteria

For the purposes of the AQMP, assessment criteria will be based on the NEPM Ambient Air Quality Measure as this is the most relevant benchmark for ambient airborne contaminants. Currently the NEPM does not provide guidance for all of the nominated CoPC but rather only guidance for PM_{10} and lead. The goal for PM_{10} is 50 µg/m^3; with an averaging period of one day and no more than five exceedances per year. Given Site conditions a goal of zero exceedances is recommended for fugitive PM_{10} emissions from the Site.

The DEC (2011) document: *"A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities"* sets out a daily TSP average of 90 µg/m^3. This criteria is taken from the Kwinana EPP. The Kwinana EPP also provides an upper TSP limit of 150 µg/m^3.

Exposure limits for on-site exposure to asbestos fibre is taken from the Work Safe Australia NOHSC 3008: 1995 *Workplace Exposure Standards for Atmospheric Contaminants in the Workplace* at 0.1 fibres/ml. Department of Health (DoH) guidelines state that Workplace Exposure Standard (WES) do not provide sufficient protection for non-occupational settings and set a goal of <0.01 fibres/ml. The adoption of occupational criteria for on-site exposure and para-occupational criteria for off-site exposure is consistent with DoH documents and in particular EnHealth (2005) *"Management of asbestos in the non-occupational environment"*.

Currently the NEPM goal for airborne lead is 0.50 µg/m^3; with an averaging period of one year. The US EPA ambient standard for lead is 0.15 µg/m^3; with an averaging period of three months. There are no published daily or weekly standards for lead in ambient air. Safe Work Australia WES (NOHSC 3008: 1995) sets a daily limit of 150 µg/m^3; based on a time weighted average (TWA) of eight hours. The US Department of Labor (OHSA) has a lower WES of 50 µg/m^3; with an action level of 30 µg/m^3. Based on the proposed Site monitoring program and TWA of approximately ten hours it would appear that a WES would be more appropriate standard than the AAQ NEPM. However it is acknowledged that WES can be one or more orders of magnitude higher than ambient standards for the same contaminants e.g. dust (not otherwise defined), SO_2 and NO_2. Given the above discussion it would prudent to choose an assessment criteria more suited to a daily averaging period which takes into account the difference between workplace and ambient standards and related dose-response models. Based on the above discussion the Site's daily exposure limit will be set at 15 µg/m^3 with the goal to meet the annual average AAQ NEPM criteria (Work Safe value reduced 10 fold, half OHSA trigger value).

There are no published ambient air quality (AAQ) standards for silica or RCS, although a number of international studies have over the last twenty years published air shed data. A US EPA 1996 study surmised that *"… average ambient levels (<15 µm AED) in U.S. metropolitan areas generally have ranged between 1 and 3 µg/m^3 and, in most circumstances, are not likely to exceed an 8 µg/m^3"*. In 1996 the US EPA adopted health benchmark levels for crystalline silica of 3 µg/m^3 in PM_{10}. Bhagia argues (2012) that an interim ambient air quality standard of 5 µg/m^3 in PM_{10} appears acceptable.

Safe Work Australia WES (NOHSC 3008: 1995) sets a TWA of 100 µg/m^3 for RCS which is supported by the Australian Institute of Occupation Health (AIOH) and mirrors other international WES. The 2009 AIOH position paper on RCS recommends *"that where there is a likelihood of 50% of the exposure standard being exceeded, control strategies and health surveillance should apply."* Based on the above discussion the Site's daily exposure limit will be set at 25 µg/m^3: four times lower than the WES and half the AIOH trigger value.

There are no Australian AAQ guidelines for mercury. In the wake of the Bellevue Waste Control fire, DEC adopted in 2003 WHO guideline of 1 µg/m^3: a concentration 50 times lower than the Safe Work Australia WES.

There are no Australian AAQ standards for other metalloids. As such Safe Work Australia WES will be used as a starting point. Based on NOHSC 3008: 1995 guidance notes longer working weeks require a reduction in the exposure limits. A typical 40 hour work week represents approximately 24% of total potential exposure (168 hours): based on a linear dose-response model this would equate to a four fold drop in exposure limit for healthy adults. Given the above a ten fold reduction in WES is deemed to be an appropriate assessment criteria.

Table M summarises the proposed assessment criteria based on the above discussion. The table lists time-weighted daily and annual (if applicable) exposure limits which can be used to trigger action to reduce future COPC airborne concentration. However the intent of the stated criteria is not to create a trigger for action but to set upper limits to what is acceptable. Action to reduce elevated airborne concentration of CoPC should commence prior to reaching the limits and the level of action should escalate as the limit is approached. This is particularly so for PM_{10} concentration; which is seen as a surrogate for all dust and fibre, and for asbestos fibre. As such the table list a range of action for some CoPC; additional action measures are discussed in Section 10.2 in relation to real-time data.

10.1 Sample Recovery

All gravimetric, fibre, silica and metalloid samples will be recovered as per Table G, Section 7.4 and sent to a NATA accredited laboratory. Dust monitoring data will be reviewed daily and results logged to ensure action trigger values are not exceeded, as per Table M. Results from all monitoring locations will be maintained on a daily logging record for reference and proof of air quality standards compliance, at the request of regulators and relevant stakeholders.

Table M: Assessment Criteria

CoPC	Limit	Trigger Values and Action
TSP	90 µg/m^3	Daily average > 75 µg/m^3 for more than two days per week:
		Increase dust suppression.
		Monthly average > 80 µg/m^3:
		Investigate additional dust suppression methods including use of ground covers.
PM_{10}	50 µg/m^3	Daily average >40 µg/m^3 at any of AMS1-6:
		Examine dust suppression regime, look at peaks and related site activity and undertake corrective actions as required.
		Daily average >40 µg/m^3 at any of AMS1-6 for two consecutive days:
		As per above, increase wetting down e.g. frequency of events and / or duration.
		Daily average >45 µg/m^3 at any of AMS1-6:
		As per above. Review wind speeds associated with exceedance and consider setting maximum wind speed threshold for reduced sorting throughput.
		Daily average >45 µg/m^3 at 1 pm at any of AMS1-6:
		As per above. Cease reclaimer and excavator operations.

CoPC	Limit	Trigger Values and Action
Asbestos Fibre	Off-site and green zone: 0.01 fibre/mL On-site, red zone: 0.1 fibres/mL	Daily average >6 fibres/100 fields at any station AMS1-6, AMS10:
		Investigate site conditions that were likely to have contributed to the result and take appropriate action e.g. increase dust suppression and wetting down. Recount sample. If at AMS10 check user behaviour, ensure boots cleaned before entry and decontamination procedures are being used.
		Daily average >8 fibres/100 fields at any station AMS1-6; AMS10:
		As per above, concurrently undertake SEM of sample to determine asbestos fibre content. Review wind speeds associated with works and consider setting maximum wind speed threshold for reduced sorting throughput until following result shows improvement or that SEM shows calculated asbestos fibres concentration is less than 0.006 fibres/ml. If at AMS10 as per above, Investigate integrity of crib room, look for uncontrolled opening, poor door and window seals, take corrective action.
		Daily average ≤0.01 fibres/ml at any station AMS1-6:
		As per above, significantly reduce reclaimer throughput, reduce amount of excavation undertaken.
		Daily average >0.01 fibres/ml at any station AMS1-6:
		Cease work, investigate source of fibre and rectify before works any remedial earthworks recommence.
		Shift average >0.02 fibres/ml at AMS7, 8 or 9:
		Location in vicinity of remedial earthworks likely to have elevated fibre count. Review dust control methodology, set maximum wind speed threshold for reduced sorting throughput until following result shows improvement or that SEM shows asbestos fibres concentration is less than 0.05 fibres/ml.
		Shift average ≥0.05 fibres/ml at AMS7, 8 or 9:
		As per above, significantly reduce sorting throughput until following result shows improvement or that SEM shows asbestos fibres concentration is less than 0.05 fibres/ml.
		Daily average > 0.01 fibres/ml in monitored vehicles:
		Investigate integrity of HEPA filter and cabin seals, take corrective action, recount sample, operator to wear P2 mask.
		Daily average > 0.02 fibres/ml in monitored vehicles:
		As per above, undertake SEM, operator to wear half face respirator.
		Daily average >0.01 fibres/ml in personnel monitoring samples:
		Investigate site conditions that were likely to have contributed to the result and take appropriate action. Limited access to operations excavation and resorting zone until reduction in concentration.
		Daily average >0.02 fibres/ml in personnel monitoring samples:
		As per above, concurrently undertake SEM scanning of sample to determine asbestos fibre content.
Silica	25 $\mu g/m^3$	Investigate dust suppression at crusher and increase dust suppression control measures as required
Arsenic	5 $\mu g/m^3$	Investigate potential sources of analyte and take appropriate action
Barium	50 $\mu g/m^3$	As per above
Cadmium	1 $\mu g/m^3$	As per above
Chromium	50 $\mu g/m^3$	As per above
Copper	100 $\mu g/m^3$	As per above
Manganese	100 $\mu g/m^3$	As per above
Nickel	100 $\mu g/m^3$	As per above
Lead	15 $\mu g/m^3$	As per above
Zinc	1 mg/m^3	As per above
Mercury	1 $\mu g/m^3$	As per above

Notes:

Daily average for real-time averages based on 00:00 am start to day.
Green highlight denotes off-site and green asbestos zones; orange highlight denotes on-site red asbestos zones
Silica is considered to be crystalline.

10.2 Contingency Measures

Table M details the adopted assessment criteria which collectively set upper concentration limits for the identified CoPC. The table details an escalating series of actions with the goal of ensuring the specified assessment criteria are not exceeded.

PM10

The monitoring program assumes that PM_{10} is a surrogate for all airborne particulate matter. Conceptually then, accurately measuring and managing the concentration of PM_{10} will ensure that the concentration of all particulate based CoPC remains within acceptable limits.

Three tiers of action criteria provide increasing levels of triggered action to ensure the likelihood of PM_{10} exceedance is minimised. The bulk of Table M details action based on daily averages from the preceding day; however the one day lag in data acquisition could potentially lead to unexpected exceedances. To overcome this problem two tiers of additional control will also be implemented. As noted in Table M: daily 1 pm interrogation of the TEOM and nephelometer at AMS3 will allow the AQMP manager to quickly determine what the current day's average PM_{10} concentration and what actions, if any are required.

Overarching the above controls is the use of programmable alarms on all of the nephelometers. These alarms will signal when the most recently logged concentration exceeds the programmed limits. It is proposed that the instruments are setup with a 10 second time constant and 15 minute logging interval. Such a setup means the instruments measure PM_{10} concentration every 10 seconds, holding these instantaneous measurements for 15 minutes, and then calculating and logging the average. In this way brief peaks in concentration associated with passing trucks or strong gusts of wind; which can be in the order of mg/m^3, are evened out which prevents redundant alarming. It is proposed that the first alarm set-point is limit is set at 50 $\mu g/m^3$ with a second alarm set-point at 100 $\mu g/m^3$. Alarms will be set to SMS appropriate stakeholders.

All alarms will be investigated and available real-time data scrutinised to determine the most appropriate course of action as per Table M. Concurrent 50 $\mu g/m^3$ alarms will escalate implementation of control measures. Activation of the 100 $\mu g/m^3$ alarm, with trigger SMS messages being sent to key stakeholders. It is likely that the alarm set-points will be routinely assessed and modified as required to ensure a good balance between production and minimising the risk of PM_{10} exceedances occurring.

Exceedance of action trigger values will generally be related to insufficient dust suppression of the access tracks, excavation zone, remediated land (cover) that has insufficient vegetation cover, the crusher, or a combination of these elements. Dust issues will be exacerbated by strong winds and high temperatures. It is likely that the Site will need to develop a procedure that slows or ceases earthworks and/ or increases dust suppression activities based on weather patterns which includes wind speeds etc. The adoption of wind speeds as a control measure is likely to develop, as working characteristics of the Site unfold over time. In the above context, development and improvement of dust suppression methodologies is likely to be triggered by exceedances of CoPC trigger values.

TSP

TSP is considered a nuisance. At concentrations below 90 μg/m^3 it is unlikely any complaints of nuisance dust will be attributed to the Site. However, as the concentration increases, so too does the risk of complaint. As per PM_{10} contingency discussion: two alarm set-points will be configured on the nephelometers; the first one at 200 μg/m^3 and the second at 400 μg/m^3. If TSP concentration remains elevated above 90 μg/m^3 for more than two consecutive weeks, then measures will need to be undertaken to reduce windborne soil leaving the Site. Such measure could include increased ground cover via mulch or vegetative cover. Unsealed roads tend to emit significant amounts of TSP if insufficiently watered. As such, watering rates may need to be increased also.

Asbestos Fibre

Given the 24 hour lag time in sample turnaround, returning a single exceedance should not trigger a shutdown of Site. However, sorting should cease until Site conditions leading to the exceedance have been examined and appropriate steps taken to prevent future exceedance. It is expected that such an investigation could be complete within one hour. Concurrently, the offending sample would be further analysed by SEM to differentiate the type of fibre present. If asbestos fibre concentration exceeds half the trigger value, then sorting rates may need to be reduced for several days or until personnel are confident asbestos fibre concentrations have been reduced.

If SEM results indicate asbestos fibre concentration has exceeded the action criteria, relevant stakeholders will be advised.

Crystalline Silica

If average daily concentrations exceed the Silica criteria on two or more consecutive days, then additional dust suppression will be undertaken at the crusher. If this fails to ameliorate concentrations, then additional dust suppression will need to be undertaken within the excavation zone.

Metalloids

Exceedance of metals criteria should trigger efforts to locate the point source of metal laden dust and rectify.

Complaints

Any complaint will be logged with the Site Production Manager. Complaints related to poor air quality, nuisance dust, dust management or odour will be investigated by the AQ Manager. Outcomes of the complaint investigation will be forwarded to relevant stakeholders.

If corrective actions are taken, these may comprise of the following:

- Any identification of potential off-site ACM, TSP or Silica deposition is to be confirmed by analytical analysis.
- Ensure that vehicles / mobile plant are operating in wetted down areas, particularly if shallow soils are being disturbed through excavation.
- Increase the water application rate for disturbed areas, particularly if potential ACM has been located. Or exceedances have been identified.

- Potentially reduce the level of earthmoving activity if evaporation rates are drying the soil out quicker than the watering can be applied.
- A potential requirement to apply additional / more suitable physical dust suppressants to inactive work areas if local winds are high.
- Cease all work, if extreme weather conditions are determined to be the prime reason for fibre, TSP or Silica concentrations exceeding the trigger values, particularly if levels have been exceeded on a previous day in similar weather conditions.

Odour Complaint

It is proposed that hydrocarbon impacted sands are delivered to the north eastern portion of the Site. These sands will be 'farmed' conventionally by application of a bio-active compound which enhances biological digestion of the hydrocarbons and turned periodically to maintain the natural attenuation process. Anecdotally visits to soil-farms at other locations suggest the distance to the nearest potential receptors from the wind rows of impacted soil should be sufficient to prevent detection of any VOC odour. To date no information on odour modelling for land farming operations in Australia has been identified. Discussions with The Odour Unit (WA manager): a company who specialise in odour assessment, state they have not undertaken any odour modelling for land farming which suggests complaints for such activities are rare. Based on the lack of case studies MDWES must defer to Anecdotal information which suggests the likelihood of odour complaints is low.

It should be noted that NSW and SA have land farming and soil bioremediation guidance documents and these documents will be relied on to assist in minimising potential for odour complaints.

In the event that a complaint is received relating to hydrocarbon odour an investigation will be undertaken at the fill sands area. The investigation will:

- Log the complaint for future reporting purposes.
- Map current volatile organic compound concentration along the wind rows using a PID which provides measurements in real-time.
- If required, carry out several longitudinal transect to determine distance to threshold odour.
- If evidence is documented that odour concentration is elevated a odour specialist will be engaged to map odour distribution and devise recommendations to ameliorate effects of odour.

REFERENCES

AIOH (2009). *Position Paper: Respirable Crystalline Silica and Occupational Health Issues*. AIOH Exposure Standards Committee.

IARC (2012) *A Review of Human Carcinogens: Arsenic, Metals, Fibres and Dusts.* Website: http://monographs.iarc.fr/ENG/Monographs/vol100C/index.php .

Bhagia, L (2012). Non-occupational exposure to silica dust. *Indian Journal of Occupational & Environmental Medicine.*

BOM (2013) *Bureau of Meteorology* (Online), http://www.bom.gov.au.

Commission of Occupational Safety and Health, *Occupational Safety and Health Management and Contaminated Sites Work* (2005)

Department of Environment and Conservation (2011). *A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities. Department of Environment and Conservation - March 2011.*

Department of Environment and Conservation (2006) *The Use of Risk Assessment in Contaminated Site Assessment and Management* (2006)

Department of Environment and Conservation, *Draft - A Guideline for the Development and Implementation of a Dust Management Program* (2008)

Department of Environmental Protection (2001) *Development of Sampling and Analysis Programs* (2006)

Department of Environmental Protection (2000). Annual Summary of Ambient Air Quality Monitoring in Western Australia (Technical Series 111 – January 2002).

Department of Environmental Protection (2000) *Guidance Statement for Remediation Hierarchy for Contaminated Land* (2000)

Department of Environmental Protection (2004) *Environmental Protection (Controlled Waste) Regulations (*2004)

Department of Environment Protection (2003) *Assessment Levels for Soil, Sediment and Water* (2003)

Department of Environmental Protection (2001) *Reporting of Site Assessments* (2001)

Department of Environment (2005) *Landfill Waste Classifications and Waste Definitions 1996* (As Amended) (2005)

Department of Health (2005). *Management of asbestos in the non-occupational environment.*

Department of Health (2006). *Health Risk Assessment in Western Australia.*

Department of Health (2009). *Guidelines for the Assessment Remediation and Management of Asbestos-Contaminated Sites in Western Australia – May 2009.*

Environmental Protection Act (1986).

Environmental Protection Regulations 1987

IARC (2012) *A Review of Human Carcinogens: Arsenic, Metals, Fibres and Dusts.* Website: http://monographs.iarc.fr/ENG/Monographs/vol100C/index.php.

National Environmental Protection Council (1998). *National Environmental Protection Measure for Ambient Air Quality.* Government of Australia: Canberra, ACT.

National Environmental Protection Council (2003) *National environment protection (ambient air quality) measure – as amended*. Government of Australia: Canberra, ACT.

NIOSH (2003) *NIOSH Manual of Analytical Methods (NMAM), Fourth Edition - NIOSH Method 7500 - Silica, Crystalline, by XRD.*

National Occupational Health and Safety Commission (1995) *Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment [NOHSC: 1003(1995)].* Government of Australia: Canberra, ACT.

National Occupational Health and Safety Commission (2005) *Guidance Note on the Membrane Filter Method for Estimating Airborne Asbestos Fibres, 2nd Edition [NOHSC: 3003(2005)].* Government of Australia: Canberra, ACT.

National Environmental Protection Council (1998). *National Environmental Protection Measure for Ambient Air Quality.* Government of Australia: Canberra, ACT.

National Occupational Health and Safety Commission (2005), *Code of Practice for the Management and Control of Asbestos in Workplaces*, Australian Government, Canberra.

Nearmap (2013) *PhotoMaps by Nearmap* (Online), http://www.nearmap.com

New South Wales EPA (2014). Best Practice Note: Landfarming.

NIOSH (2003) *NIOSH Manual of Analytical Methods (NMAM), Fourth Edition - NIOSH Method 7500 - Silica, Crystalline, by XRD.*

Parsons Brinckerhoff [PB] (2006) *Site Investigation (SI) – Hazelmere*, WA.

South Australia EPA (2005). EPA Guidelines: Soil Bioremediation.

Standards Australia (2003). Australian/New Zealand *AS/NZS 3580.9.6:2003 Methods for sampling and analysis of Ambient Air – Method 9.3: Determination of Suspended Particulate Matte - PM10 – High Volume Sampler Gravimetric Method*. SAI Global.

Standards Australia (2007). Australian/New Zealand Standards AS 3580.1.1:2007 – Methods for Sampling and Analysis of Ambient - Air-Guide for Siting Air monitoring Equipment. SAI Global.

Standards Australia (2008). *Australian/New Zealand Standards AS 3580.9.11:2008 – Methods for Sampling and Analysis of Ambient – Determination of Suspended Particulate Matter – PM10 Beta Attenuation Monitors*. SAI Global.

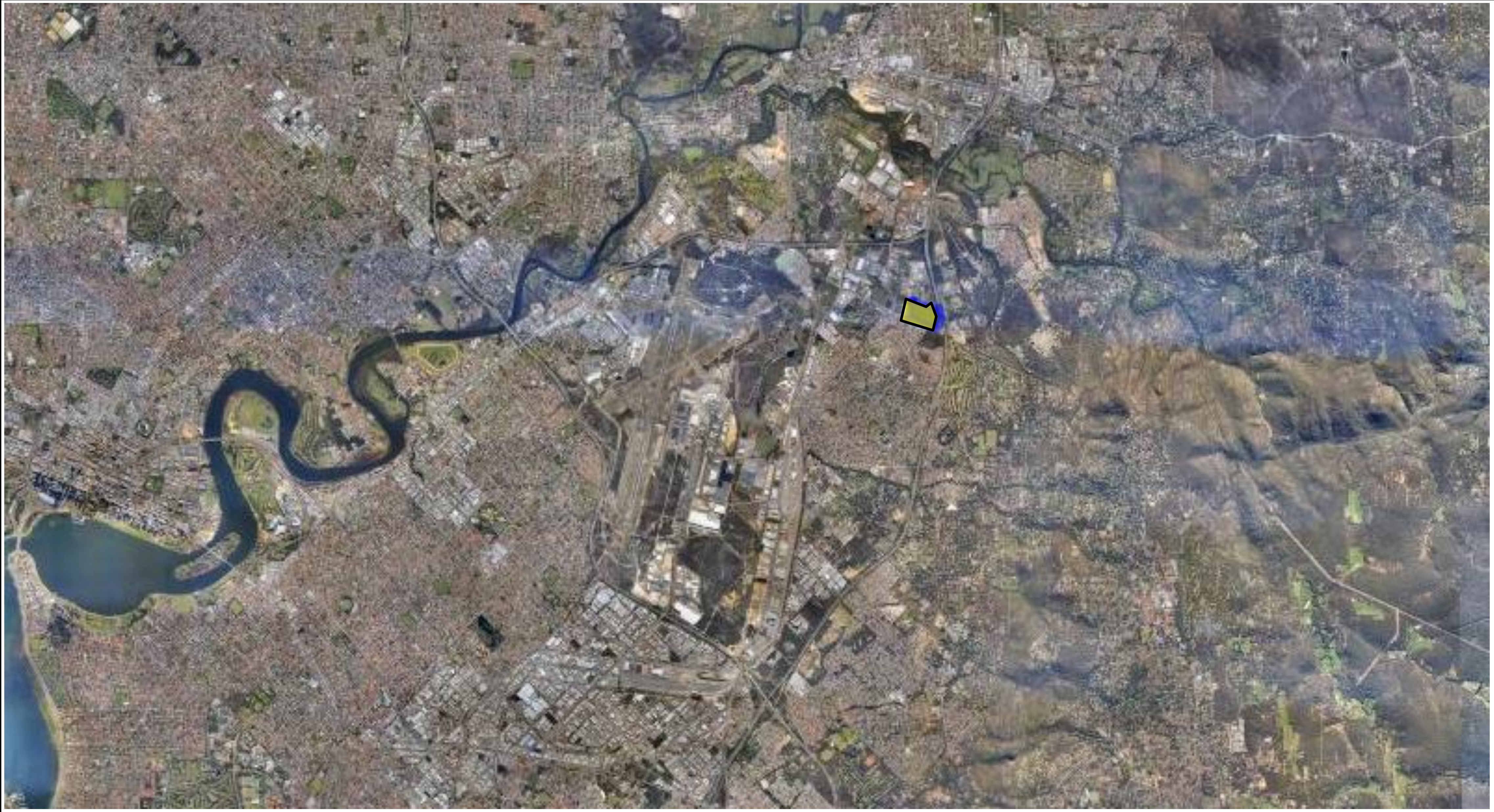
Standards Australia (2011). *Australian/New Zealand Standards AS 3580.14-2011 – Methods for Sampling and Analysis of Ambient – Meteorological Monitoring for Ambient Air Quality Monitoring Applications.* SAI Global.

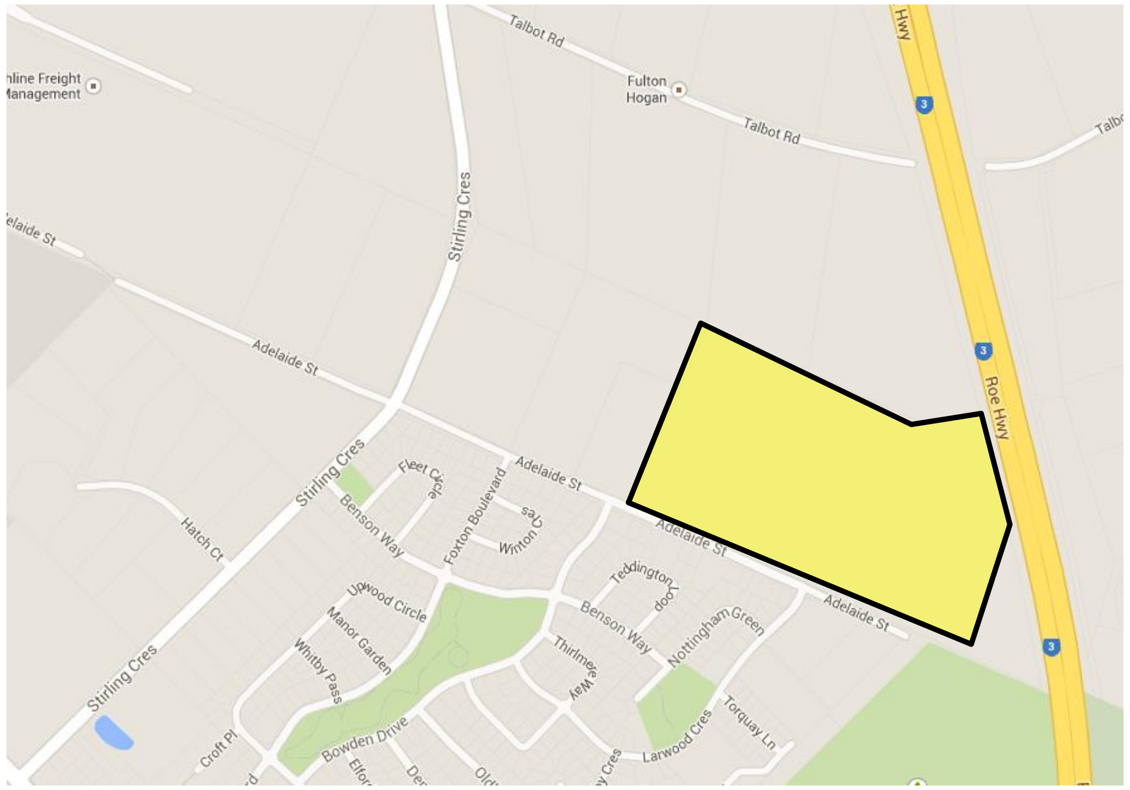
Australian Standard (2001) *Australian/New Zealand Standards* AS/NZS 4801-2001 **-** *Occupational health and safety management systems - Specification with guidance for use* SAI Global

USEPA (1996) *Ambient Levels and Non-cancer Health Effects of Inhaled Crystalline and Amorphous Silica.*

USEPA (2013) US EPA Code of Federal regulations – Protection of Environment 40 CFR part 53 Subpart D. United States of America

FIGURES





MDW Environmental Services

PERTH | PEEL

T: (08) 9250 6960

F: (08) 92508269

www.environmentalserivces.com.au

info@environmentalservices.com.au

Client:

WASTEROCK PTY LTD

Project:

Hazelmere Remediation and Regeneration Project

Location:

Lot 20 Adelaide Street, Hazelmere

Drawing Title:

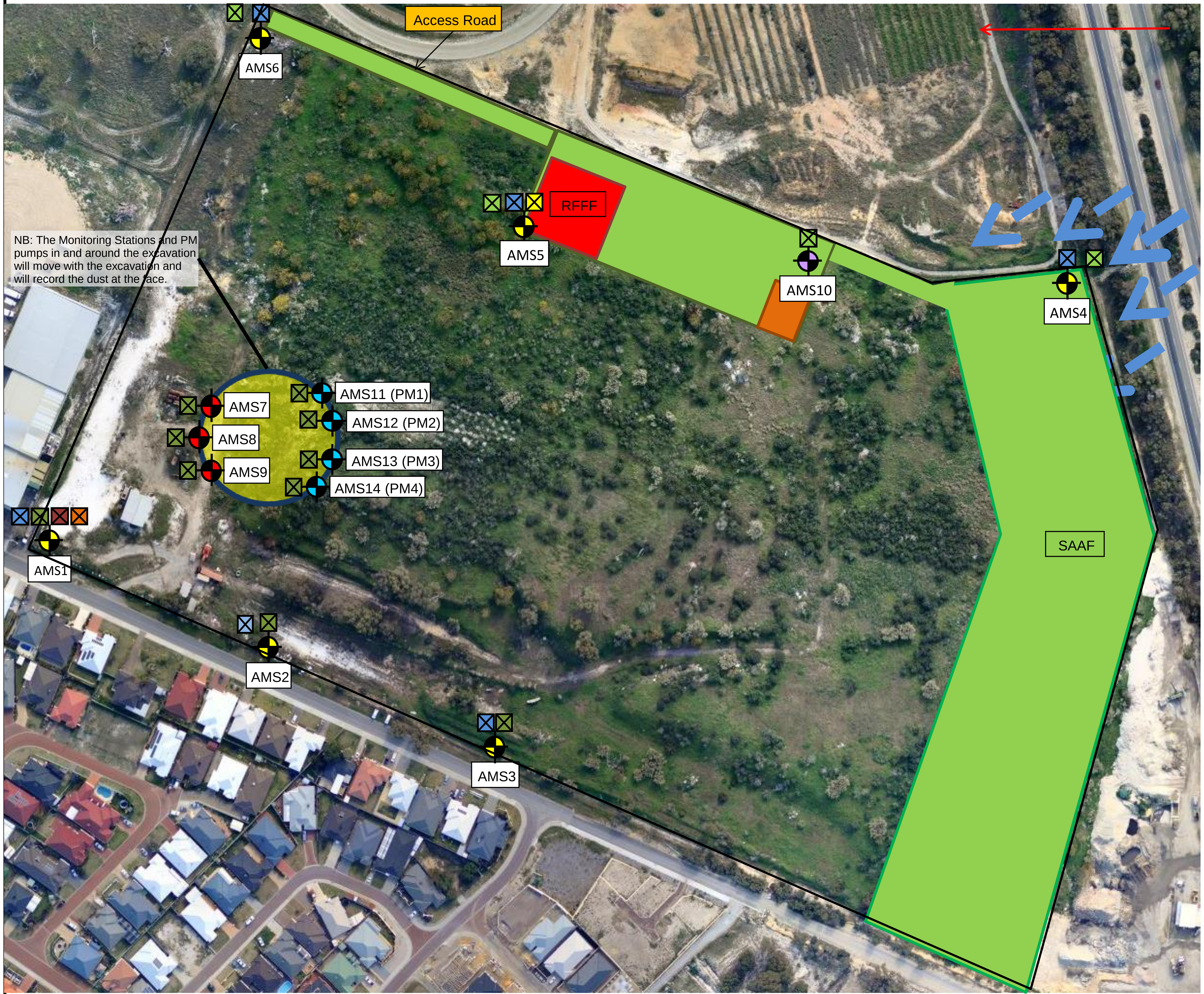
SITE AND REGIONAL VIEW

Notes:

Site Location

Drawn by:	Scale:	
Dale A.	Scale Not Used	North
Date: 10/09/2013		

Project No:	Figure No:	Rev:
E2012 - 031	1	v1



MDW Environmental Services

PERTH | PEEL

T: (08) 9250 6960
F: (08) 92508269
www.environmentalserivces.com.au
info@environmentalservices.com.au

Client:

WASTEROCK PTY LTD

Project:

Hazelmere Remediation and Regeneration Project

Lot 20 Adelaide Street, Hazelmere

Drawing Title:

Air Quality Monitoring Station Locations

Notes:

- AMS = Air Monitoring Stations
- Movable monitoring Stations, to follow the excavation , dust generation at the face.
- Personal Monitoring (PM) pumps
- Crib room inside green zone compound. To ensure decontamination is happening.
- Site Compound (Greenzone)
- Red Zone Areas Also includes the Remediation of the historical landfill.
- Changing Room and Shower Block

Dust	TES 7200 / TEOM
Asbestos	(SKCPCXR8 / XR5000)
Silica	(SKCPCXR8)
Metals	(SKCPCXR8)
Weather Station	

Wind Direction

Excavation Zone (example)

Drawn by: MB

Date: 10/09/2013

Scale: 0 50 m

North

Project No:	Figure No:	Rev:
E2012 - 031	**2**	V2

Appendix A – Technical Data Sheets for Proposed Site Sampling Equipment

Product Specifications

U.S. EPA Automated Equivalent PM_{10} Method: EQPM-1102-150

CARB California Approved Sampler (CAS) for PM_{10} and $PM_{2.5}$

True "Continuous Real-Time" Measurement

FH 62 C14 Series

Continuous Ambient Particulate Monitor

Key Features:

New technology that provides continuous "real-time" measurement by a C14 monitor

Radon gas activity measurement eliminates interference of natural airborne radioactivity

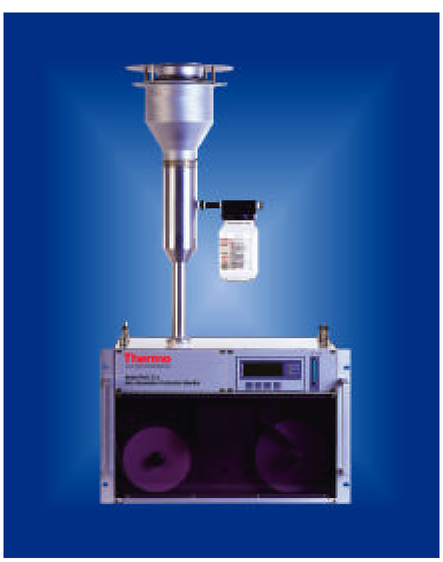
Control and data exchange over two serial interfaces possible

Storage of half-hour average concentrations over a whole year

User selectable reporting of mass concentration based on standard or actual flow rate

Processor controlled calibration of all sensors

Insensitive to vibration and diurnal temperatures



Refined Sensitivity

The FH 62 C14 Continuous Ambient Particulate Monitor measures the mass concentration of suspended particulate matter (e.g., TSP, PM_{10}, $PM_{2.5}$, PM_C and PM_1) by use of beta attenuation. In addition, the ambient radioactive influence of natural Radon (Rn-222) gas is measured as a refinement step toward better sensitivity at lower ambient particulate concentrations.

Accurate Results

The FH 62 C14 particulate sample collection area is located between both the C14 source and the proportional detector. While ambient particulate matter is being deposited onto a filter tape sample spot, the dynamic filter loading is measured continuously by the attenuation of the C14 source beta rays. As a result, a continuous "real-time" measurement of airborne particulate is provided. It is not necessary to move the filter spot from the sample position to the detector position for zero and mass determination.

FH 62 C14 Series Specifications

Measuring Principle	Continuous & simultaneous particulate collection coupled with beta ray attenuation
Source	Carbonium-14 (C14), <3.7 MBq (<100µCi)
Ranges	0 to 5,000 µg/m^3 or 0 to 10,000 µg/m^3
Minimum Detection Limit	<1 µg/m^3 (24-hour average); <4 µg/m^3 (1-hour average)
Precision of Two Monitors	± 2 µg/m^3 (24-hour)
Resolution	± 1 µg/m^3 (instantaneous)
Correlation Coefficient	R > 0.98
Measurement Cycle	Single filter spot in position for 24 hours (default); user selectable 30-minutes to 24-hours
Data Averages	Each full 1/2, 1, 3 and 24 hour values automatically stored
Air Flow Rate	1 m^3/h (16.67 lpm) measured across an internal subsonic orifice; user selectable from 0 to 20 lpm
Output	4-20mA or 0-10V output of concentration (µg/m^3)
Operating Temperature	-22 to 140°F (-30 to 60°C)
Power Supply	Instrument: 100-240V, 50/60Hz, 330W max., 15W without pump or heater Pump: 100-110/100-120V, 50/60Hz or 220/240V, 50/60Hz, 100W
Dimensions	Instrument: 19” (W) x 12.25” (H) x 13” (D) / 483mm (W) x 311mm (H) x 330mm (D) Pump: 8.25” (W) x 8.75” (H) x 4.25” (D) / 210mm (W) x 222mm (H) x 108mm (D)
Weight	Instrument: 50 lbs (22.5 kg) Pump: 13.5 lbs (6.1 kg)

Available Options

Adjustable Tube Heaters

Analog I/O Expansion Board

Filter Tape Printer

Foil Separation

RS485 Interface

TSP or PM_{10} Inlets

Mass & Flow Rate Calibration Kits

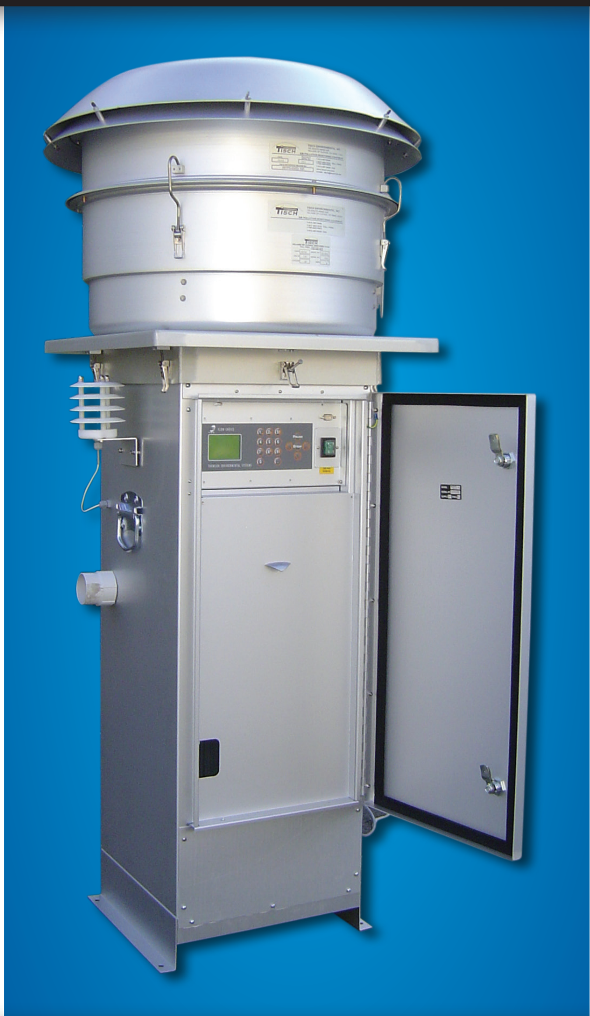
WINS Impactor, Sharp-Cut Cyclone & Very Sharp-Cut Cyclone for $PM_{2.5}$

Environmental Instruments
Air Quality Products
27 Forge Parkway
Franklin, MA
02038
(866) 282-0430 toll free
(508) 520-0430
(508) 520-1460 fax
www.thermo.com/aqp

QA FLOW 7000

HIGH VOLUME AIR SAMPLER

Your only choice for accurate, reliable, user friendly Gravimetric Air Sampling



The QA Flow 7000 **High Volume Air Sampler** utilises a **precise and versatile**, venturi sampling system featuring **electronic flow control**, and meets the most recent international methods for atmospheric particulate matter measurement.

Available configurations include: Total Suspended Particulates (TSP), PM10 and PM2.5.

Each instrument includes a speed controlled brushless blower for accurate, quiet operation and 2 filter holders for easy exchange in the field.

An integrated real time clock, wide graphic display and dedicated keypad allows for user friendly sample programming including TES's EPA mode. No reprogramming or manual start/stops required. The user can select from automatic 3 and 6 day runs or create their own program selectable from 1 min to 168 hours.

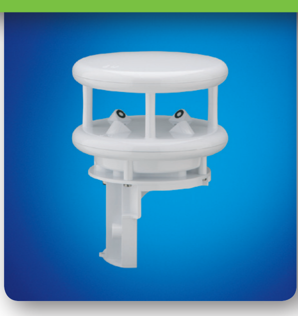
The microprocessor controlled system allows for measurement of ambient and orifice flow temperatures, ambient and venturi pressures and allows true mass or volumetric flow standardized to a user selectable reference temperature.

Measured parameters are logged every five seconds and recorded as five minute averages for the 24 hour run period. Run time, averages flow and standard deviation are just some of the obtainable results from the QA Flow 7000 allowing the user to validate the sample run. Data is accessible on the display and can be downloaded to a PC via RS232 or Modem (optional).

An RS485 input allows for logging of external sensors such as **Wind Speed and Wind Direction**.

The QA Flow 7000 offers the following features:

- TSP, PM10 or PM2.5 Configurations
- Easy Programming - EPA mode (automatic 3 or 6 day runs) or user selectable programs
- Quality Assurance System - Flow rate, total volume, temperature and pressure are logged and data is available for download to your PC
- Brushless Blower - Provides accurate flow and quiet operation
- Remote Control via Modem (optional)
- Inputs for logging additional parameters such as wind speed and wind direction
- Meets International and Australian Standards



Add on Wind Speed and Wind Direction or a Complete Met Station – Logged locally by the QA Flow 7000

Thomson Environmental Systems
air quality & process control

Outstanding Quality, Unprecedented Customer Support

QA FLOW 7000

Specifications

Inputs:	RS485 available for logging of external parameters such as Wind Speed and Wind Direction. Analogue, Counter Channels or RS485.
Outputs:	RS232, Analogue, Operational alarm if modem fitted.
Electronic sampling flow rate controlled at standard or actual condition	
Wide retrofitted light graphic display, dedicated keypad, real time clock and date.	
Construction material:	Anodized aluminium shelter (other materials available if required)
Brushless blower:	Speed controlled to limit noise and provide extremely accurate flow control
Flow Range:	1000-1400 L/min Standardised and Volumetric flow available
Power Requirements:	220-240 Vac, 50Hz (110 Vac 50/60 Hz Optional), 10 amp (Standard) or 15amp
Allowable environmental temperature operating range:	-5ºC—50ºC
Weight:	42 kgs. Plus Inlet head.
Dimension:	62cm x 43cm x 110cm (WxDxH) for TSP unit.
Detachable base. Inlet head easily attached on site.	
Supplied with dual filter cassettes to allow rotating of cartridge with filter changes in lab	
Warranty:	12 Month

Optional Accessories

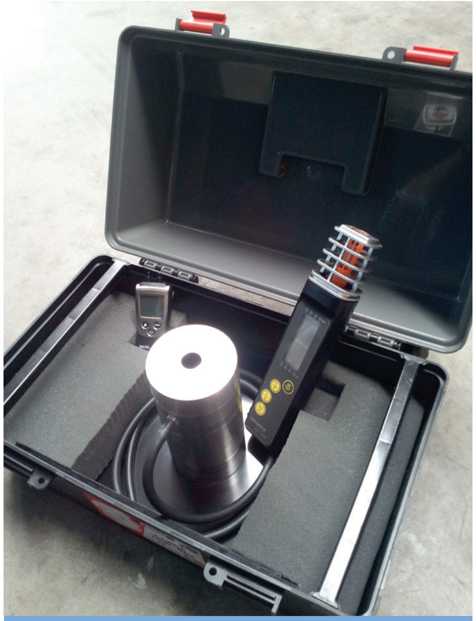
Part Number	Description
QA 7000 CAL	Calibration Kit including orifice plate, slack tube manometer and carry case (Temperature sensors available if required)
QA 7000 CAL DIG	Calibration Kit including orifice plate, Digital manometer and carry case (Temperature sensors available if required)
QA 7000 COMM	Remote control via GSM Modem
QA 7000 DAMP	Muffler for further noise reduction
QA 7000 FIL – X (X=Filter Type)	Filter Paper 8” x 10” Quartz, Glass Fibre or Cellulose available.
Calibration Contracts (Conducted by qualified technicians)	
QA MET WS 200	Sonic Wind Speed + Wind Direction Sensor (other parameters available on request)

Ordering Options:

Inlet Head:	TSP PM10 PM2.5
Power Requirements:	240V 110V

Also Supplied by Thomson Environmental Systems:

- Ambient Gas & Particulate Monitors
- Meteorological Equipment
- Indoor Air Quality Monitoring Equipment
- Laboratory Equipment
- Reach-In and Walk-In Equipment Shelters
- CEMS and Process systems for monitoring Gases, Opacity/Particulates and Flow/Velocity
- System Design, Installation & Commissioning
- Parts & Service performed by Factory Trained Technicians
- Rental Equipment
- Maintenance Contracts



Digital Calibration Kit pictured above

Thomson Environmental Systems
air quality & process control

tes@thomsongroup.com.au
www.thomsongroup.com.au

Sydney Office:
3/65 Captain Cook Dr, Caringbah NSW 2229
PO Box 2233, Taren Point NSW 2229
Phone: +61 (0)2 9526 8199 Fax: +61 (0)2 9526 8299

Perth Office:
4/9 McCamey Ave
Rockingham WA 6168
Phone: +61 (0)8 9529 3366 Fax: +61 (0)8 9529 3377

QA LITE

REAL TIME PARTICULATE MONITOR

Your only choice for accurate, reliable, user friendly Real Time Air Sampling

The **QA Lite** utlilises nephelometry to measure, in real time, the level of particulate activity in the air.

The QA Lite is easily and quickly deployed making it ideal for:

- site control
- long term background studies
- short term site remediation studies
- road works
- mining operations
- ongoing sampling regimes

Inlet heads are available in TSP, PM10 and PM2.5

Each QA Model offers an intuitive menu structure, graphical display and digital input/output. Measurements can be averaged to one minute or longer. Data can be viewed and instruments programmed locally using the instrument display screen or laptop connected via serial port.

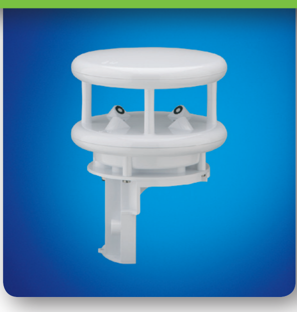
Remote Access Options are available by adding a Modem, Radio or Broadband, allowing remote programming and data downloading, concentration alarm alerts and fault alarms via SMS. Audible and Visual alarms are also available.

Quality Data is assured with an integrated inlet heater to eliminate moisture and fog interference. **Paired Filters** eliminate the need for pre-weighing, this allows for minimal filter handling and the filters offer sample speciation analysis. The Optical unit is calibrated on Arizona road dust and interchangeable **Calibrated Optical Modules** are available for easy field calibration of your instrument as required.

Weather Sensors can be connected to the QA Lite and logged internally – eliminating the need for additional costly data loggers. The Lufft range of meteorological sensors has all your meteorological requirements covered. Providing equipment suited specifically for your application, the Lufft sensors incorporate as many or as few parameters as you need.

The QA Lite offers the following features:

- TSP, PM10 or PM2.5 configurations
- Portable, Quick Response Installation
- Integrated paired filters – minimises filter handling and allows for sample post analysis
- Heated inlet – Eliminates moisture and fog interference
- Calibrated Optical Module
- Remote Control via Modem (Optional)
- Inputs for logging additional parameters such as wind speed and wind direction, temperature, pressure, relative humidity, solar radiation and precipitation
- Solar Powered Option



Add on Wind Speed and Wind Direction or a Complete Met Station – Logged locally by the QA Lite

QA LITE

Specifications

Feature	Description
Display	Graphical 128 x 64 bits. Display shows 1 sec to 1 min average as selected.
Keypad	12 button function with keys
Alarms/Digital Output	GSM, 3 relays (NC/COM/NO) Siren, text to mobile phone, visual beacon and email
Security	Password Protection
Logger Averaging	Adjustable data logger 1 sec to 1 week averaging periods.
Other Logging Inputs	Two 0 to 5 volt analogue inputs or 4-20mA)
Meteorological Inputs	Wind speed and direction, rainfall, temperature and humidity and BP. Solar Rad
Digital Input	3 Optically isolated inputs; Voltage free
Analogue Input	2 Channels: Voltage/Current
Analogue Output	0-5V or 4-20mA
Data Storage	Internal with separate battery backup 128KB
Filter Holder	Integrated filter holder: 37mm Millipore filter cartridge (paired)
Serial Connectivity	2 x RS232, RS485/RS422, CAN BUS
Barometer	Ambient static pressure
Temperature Probes	2 Internal and 2 External Channels: RTD (PT100)
Operating Temperature	-5*C to + 50*C
Standard Inlets	TSP (Optical measure) PM10, PM2.5 and PM1.0
Heated Inlet	Heating controlled to RH levels
Flow Rate	5LPM, Volumetric or Standardised
Measurement Range	0 to 150 milligrams per cubic metre
Detection Limit	0.01 micrograms per cubic metre
Indicator Range	0 to 60mg/m3 without particle sizing
Particle Size Range	0.2 to 18.0 micron diameter
Power Options	Solar, Mains, Battery
Detector Method	Nephelometry with laser
Sampling Current Drain	Included heated inlet and backlight – 1.0 amp @ 12VDC
External Power Pack	80 to 260v AC input, weatherproof
RS232 I/O	9600 baud via modem link to 115200 direct
Enclosure Mount	35mm Diameter post
Case Protection	To IP66 (excluding inlet and exhaust)
Dimensions (mm)	W x 300, D x 200 , H x 350, Heater = 500L x 60 diameter
Weight	<6kg for enclosure and 0.5kg for heater

Optional Accessories

Part Number	Description
QA TRIPOD	Tripod to suite QA Lite or QA Flow 5
QA Lite SOLAR	Solar Panel Kit to suit QA Lite
QA Lite CAL	Calibrated Optical Module for easy field exchange
QA Lite COMM	Remote control via GSM or Next G Modem
QA Lite ALM	Relay board for connecting Visual or Audiable Alarms
QA Lite FIL-X	Pack of 50 37mm Filters. X= Teflon or Quartz
QA MET WS 200	Sonic Wind Speed & Wind Direction Sensor (other parameters available on request)
QA Lite LTF	Long term filter option – for longer unattended operation

Ordering Options:

Inlet Head:	TSP PM10 PM2.5
Power Requirements:	240V 110V Solar Powered Battery Operated

Also Supplied by Thomson Environmental Systems:

- Ambient Gas & Particulate Monitors
- Meteorological Equipment
- Indoor Air Quality Monitoring Equipment
- Laboratory Equipment
- Reach-In and Walk-In Equipment Shelters
- CEMS and Process systems for monitoring Gases, Opacity/Particulates and Flow/Velocity
- System Design, Installation & Commissioning
- Parts & Service performed by Factory Trained Technicians
- Rental Equipment
- Maintenance Contracts

Thomson Environmental Systems
air quality & process control

Sydney Office:
3/65 Captain Cook Dr, Caringbah NSW 2229
PO Box 2233, Taren Point NSW 2229
Phone: +61 (0)2 9526 8199
Fax: +61 (0)2 9526 8299

Perth Office:
4/9 McCamey Ave
Rockingham WA 6168
Phone: +61 (0)8 9529 3366
Fax: +61 (0)8 9529 3377

tes@thomsongroup.com.au
www.thomsongroup.com.au

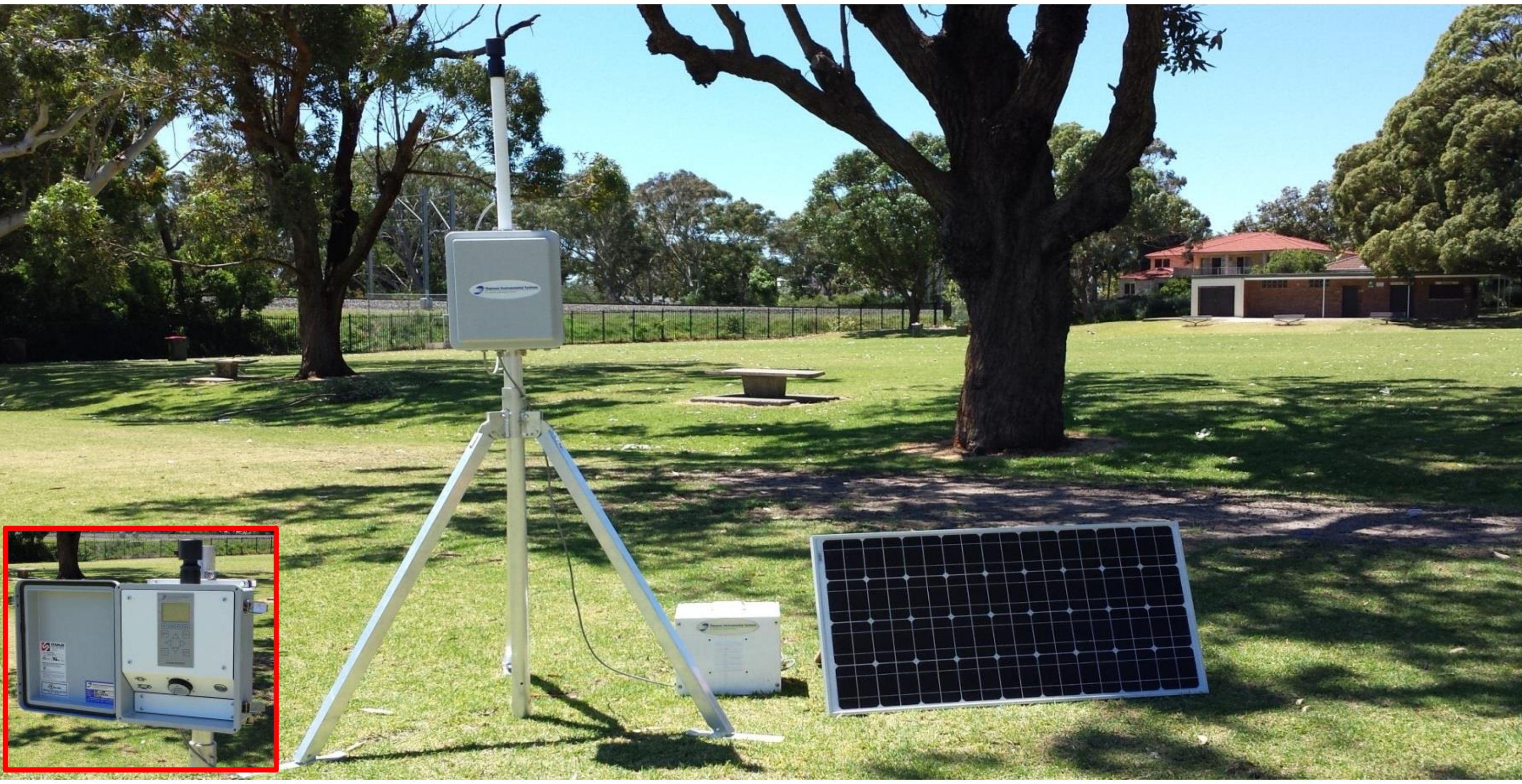
Thomson Environmental Systems
Scientific & Environmental Equipment Specialists

2 YEAR WARRANTY

TES 7200 REAL-TIME DUST MONITORING STATION

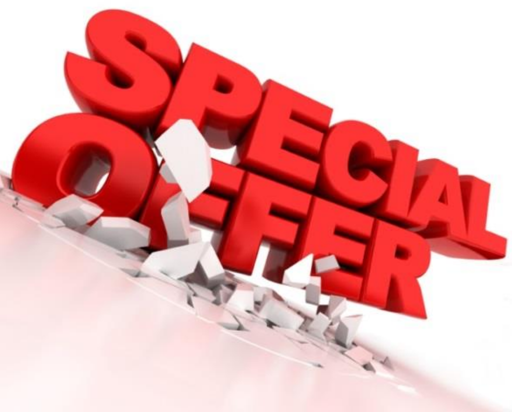
A COMPLETE TRIPOD BASED, SOLAR POWERED, DATA LOGGING REAL-TIME DUST MONITORING STATION FOR ONLY $14,995

WITH 6 SIMULTANEOUS PM SIZE FRACTION MEASUREMENTS



THE LATEST *2014* DUST MASTER PRO SERIES TECHNICAL ADVANTAGES

- Rugged, reliable & designed for the harsh outdoors ✓
- 12 tripod based and fixed systems available ✓
- Low power consumption, only 330mA at 12 volts ✓
- PM1, PM2.5, PM4, PM7, PM10 & TSP **simultaneously** ✓
- User definable sizing channels in 0.1um steps ✓
- Professional low power heated inlet included **FREE** ✓
- Fully calibrated to **ISO12103-1** international standards ✓
- 365 day (once a minute) built-in data logging ✓
- Over 116 inputs for countless other external sensors ✓
- Full temperature & pressure compensation, no zero drift ✓
- 2.8 lpm flow rate with superior sampling efficiency ✓
- 0.1um to 18um wide particle size range ✓
- 0.1um to 500um wide particle size sensitivity ✓
- Dual 37mm filters for filter sample collection ✓
- Automatic laser light level adjustments ✓
- User definable aerosol calibration factors ✓
- Smart, field replaceable optics module ✓
- Optional weather stations and sensors available ✓
- Fully serviced, supported and calibrated by TES ✓
- Lifetime FREE support & 2 year warranty ✓



Take Advantage of the Latest 2014 Technology Today

Higher flow rate, better sampling efficiency, wider particle size range, larger data logging capacity, more inputs & outputs, 6 simultaneous real-time PM dust fraction measurements, field replaceable optics, auto laser light level adjustments and much more, all with a full 2 year warranty.

Call us today to learn more and for an obligation free quote

Melbourne	Sydney	Perth
(03) 9808 1295	(02) 9526 8199	(08) 9529 3366

Web: www.thomsongroup.com.au

Thomson Environmental Systems
Scientific & Environmental Equipment Specialists

WS600-UMB - TEMPERATURE, RELATIVE HUMIDITY, PRECIPITATION, AIR PRESSURE, WIND

From the WS product family of professional intelligent measurement transducers with digital interface for environmental applications.

Integrated design with ventilated radiation protection for measuring:

- **Air temperature**
- **Relative humidity**
- **Precipitation intensity**
- **Precipitation type**
- **Precipitation quantity**
- **Air pressure**
- **Wind direction**
- **Wind speed**

Relative humidity is measured by means of a capacitive sensor element; a precision NTC measuring element is used to measure air temperature.

Precipitation is measured by way of a 24 GHz Doppler radar, which measures the drop speed of an individual drop of rain/snow.

Precipitation quantity and intensity are calculated from the correlation between drop size and speed.

The difference in drop speed determines the type of precipitation (rain/snow).

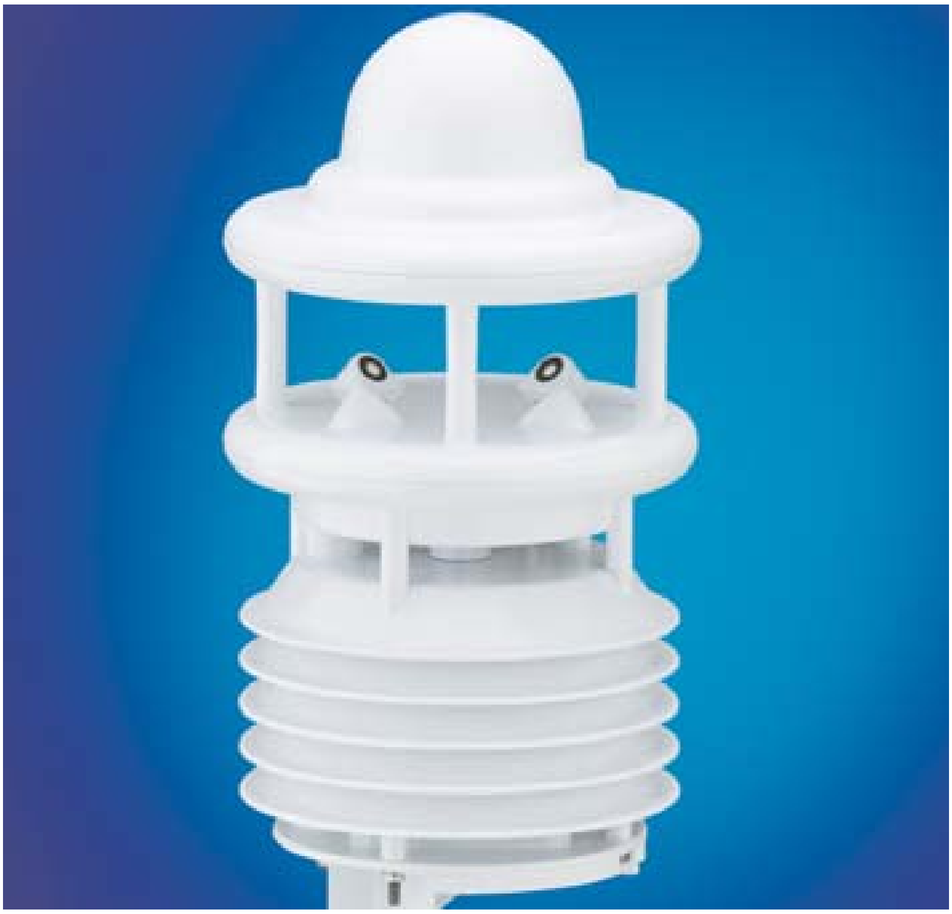
Maintenance-free measurement offers a major advantage over the common tipping spoon and tipping bucket processes.

Ultrasonic sensor technology is used to take wind measurements (WS600 only).

Measurement data are available for further processing in the form of a standard protocol (Lufft-UMB protocol).

All in One
aspirated temperature/
humidity measurement
maintenance-free operation
open communication protocol

Technical Data	Order No.
WS600-UMB Compact weather station	**8370.U01** EU, USA, Canada / **8370.U02** UK
Dimensions	Ø ca. 150mm, Height ca. 345mm, Weightt approx. 1,5kg
Temperature	
Principle	NTC
Measuring range	-30…70°C
Accuracy	±0,2°C (-20°C...+50°C), otherwise ± 0,5°C
Relative humidity	
Principle	capacitive
Measuring range	0…100 % RH
Accuracy	±2% RH
Precipitation intensity	
Resolution	0,01mm
Measuring range drop size	0,3…5mm
Reproducibility	typ. >90%
Precipitation type	Rain/snow
Air Pressure	
Principle	MEMS capacitive
Measuring range	300…1200 hPa
Accuracy	±1,5hPa
Wind direction	
Principle	Ultrasonic
Measuring range	0…359,9°
Accuracy	± 3°
Wind speed	
Principle	Ultrasonic
Measuring range	0…60m/s
Accuracy	± 0,3m/s or ±3% (0...35m/s)
Heating	30VA at 24VDC
General information	
Interface	RS485, 2-wire, half-duplex
Operating power consumption	24VDC +/- 10% <4VA (without heating)
Operating humidity range	0…100%
Operating temperature range	-30…70°C
Accessories	**Order No.**
Surge protection	**8379.USP**
Power supply 24V/4A	**8366.USV1**
UMB interface converter ISOCON	**8160.UISO**



WS500-UMB - TEMPERATURE, RELATIVE HUMIDITY, AIR PRESSURE, WIND

From the WS product family of professional intelligent measurement transducers with digital interface for environmental applications.

Integrated design with ventilated radiation protection for measuring:

- **Air temperature**
- **Relative humidity**
- **Air pressure**
- **Wind direction**
- **Wind speed**

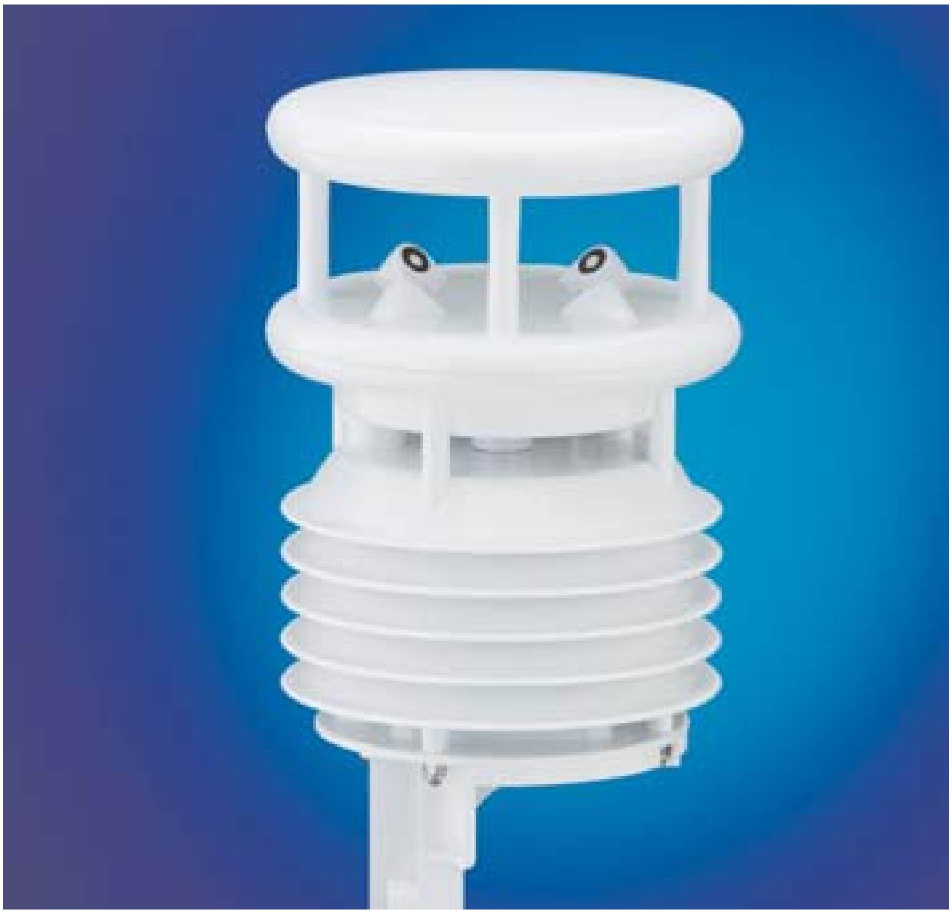
Relative humidity is measured by means of a capacitive sensor element; a precision NTC measuring element is used to measure air temperature.

Maintenance-free measurement offers a major advantage over the common tipping spoon and tipping bucket processes.

Measurement data are available for further processing in the form of a standard protocol (Lufft-UMB protocol).

Ultrasonic wind sensor
maintenance-free operation
open communication protocol

Technical Data	Order No.
WS500-UMB Compact weather station	**8373.U01**
Dimensions	Ø ca. 150mm, Height ca. 290mm, Weight approx. 1,3kg
Temperature	
Principle	NTC
Measuring range	-30…70°C
Accuracy	±0,2°C (-20°C...+50°C), otherwise ± 0,5°C
Relative humidity	
Principle	capacitive
Measuring range	0…100 % RH
Accuracy	±2% RH
Air Pressure	
Principle	MEMS capacitive
Measuring range	300…1200 hPa
Accuracy	±1,5hPa
Wind direction	
Principle	Ultrasonic
Measuring range	0…359,9°
Accuracy	± 3°
Wind speed	
Principle	Ultrasonic
Measuring range	0…60m/s
Accuracy	± 0,3m/s or ±3% (0...35m/s)
Heating	10VA at 24VDC
General information	
Interface	RS485, 2-wire, half-duplex
Operating power consumption	24VDC +/- 10% <4VA (without heating)
Operating humidity range	0…100%
Operating temperature range	-30…70°C
Accessories	**Order No.**
Surge protection	**8379.USP**
Power supply 24V/4A	**8366.USV1**
UMB interface converter ISOCON	**8160.UISO**



WS400-UMB - TEMPERATURE, RELATIVE HUMIDITY, PRECIPITATION, AIR PRESSURE

From the WS product family of professional intelligent measurement transducers with digital interface for environmental applications.

Integrated design with ventilated radiation protection for measuring:

- **Air temperature**
- **Relative humidity**
- **Precipitation intensity**
- **Precipitation type**
- **Precipitation quantity**
- **Air pressure**

Relative humidity is measured by means of a capacitive sensor element; a precision NTC measuring element is used to measure air temperature.

Precipitation is measured by way of a 24 GHz Doppler radar, which measures the drop speed of an individual drop of rain/snow.

Precipitation quantity and intensity are calculated from the correlation between drop size and speed.

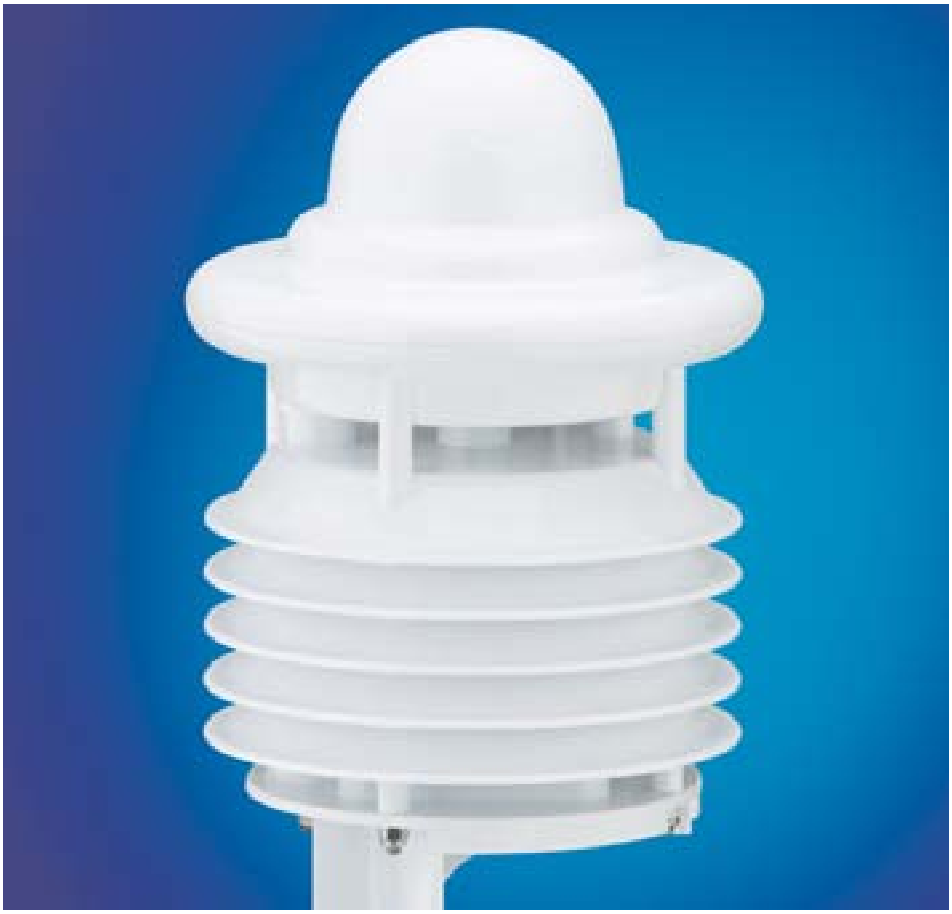
The difference in drop speed determines the type of precipitation (rain/snow).

Maintenance-free measurement offers a major advantage over the common tipping spoon and tipping bucket processes.

Measurement data are available for further processing in the form of a standard protocol (Lufft-UMB protocol).

Radar-based precipitation detection
Aspirated temperature/humidity measurement
Open communication protocol

Technical Data	Order No.
WS400-UMB Compact weather station	**8369.U01** EU, USA, Canada
WS400-UMB Compact weather station	**8369.U02** UK
Dimensions	Ø ca. 150mm, Height ca. 280mm, Weight approx. 1,4kg
Temperature	
Principle	NTC
Measuring range	-30…70°C
Accuracy	±0,2°C (-20°C...+50°C), otherwise ± 0,5°C
Relative humidity	
Principle	capacitive
Measuring range	0…100 % RH
Accuracy	±2% RH
Precipitation intensity	
Resolution	0,01mm
Measuring range drop size	0,3…5mm
Reproducibility	typ. >90%
Precipitation type	Rain/snow
Air Pressure	
Principle	MEMS capacitive
Measuring range	300…1200 hPa
Accuracy	±1,5hPa
General information	
Interface	RS485, 2-wire, half-duplex
Operating power consumption	24VDC +/- 10% <4VA (without heating)
Operating humidity range	0…100%
Operating temperature range	-30…70°C
Heating	20VA at 24VDC
Accessories	**Order No.**
Surge protection	**8379.USP**
Power supply 24V/4A	**8366.USV1**
UMB interface converter ISOCON	**8160.UISO**



WS300-UMB - TEMPERATURE, RELATIVE HUMIDITY, AIR PRESSURE

From the WS product family of professional intelligent measurement transducers with digital interface for environmental applications.

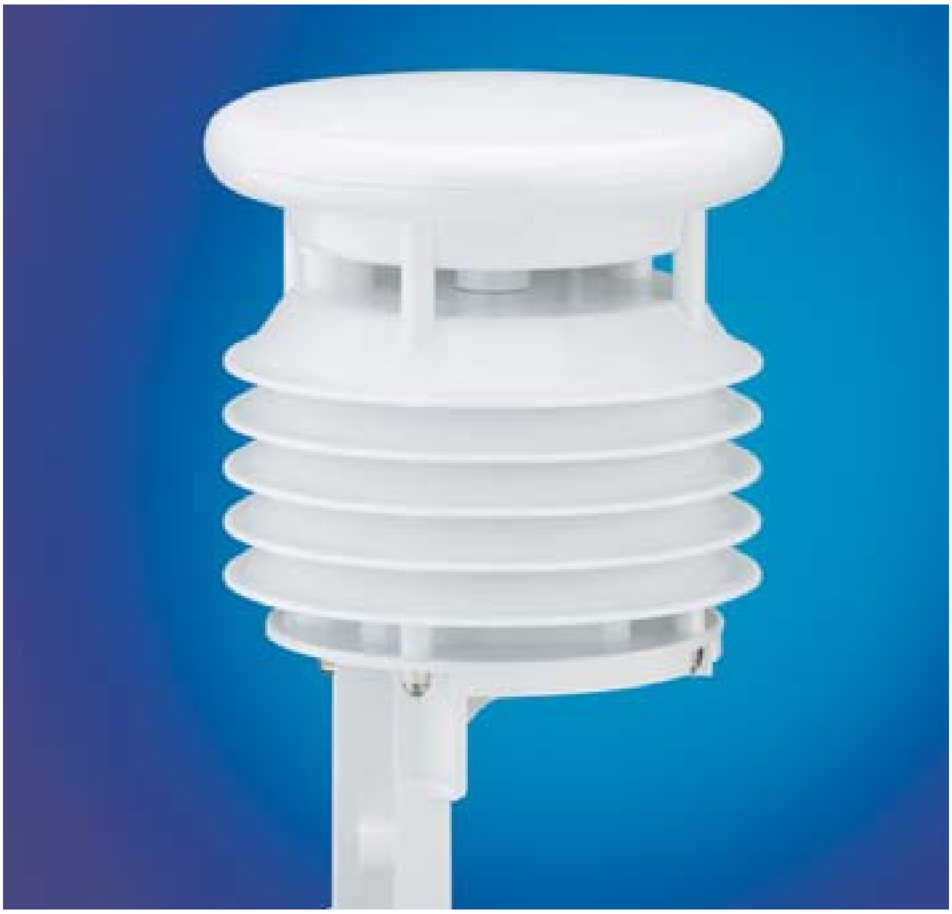
Integrated design with ventilated radiation protection for measuring:

- **Air temperature**
- **Relative humidity**
- **Air pressure**

Relative humidity is measured by means of a capacitive sensor element; a precision NTC measuring element is used to measure air temperature.

Measurement data are available for further processing in the form of a standard protocol (Lufft-UMB protocol).

Technical Data	Order No.
WS300-UMB Compact weather station	**8372.U01**
Dimensions	Ø ca. 150mm, Height ca. 225mm, Weight approx. 1,2kg
Temperature	
Principle	NTC
Measuring range	-30…70°C
Accuracy	±0,2°C (-20°C...+50°C), otherwise ± 0,5°C
Relative humidity	
Principle	capacitive
Measuring range	0…100 % RH
Accuracy	±2% RH
Air Pressure	
Principle	MEMS capacitive
Measuring range	300…1200 hPa
Accuracy	±1,5hPa
General information	
Interface	RS485, 2-wire, half-duplex
Operating power consumption	24VDC +/- 10% <4VA
Operating humidity range	0…100%
Operating temperature range	-30…70°C
Accessories	**Order No.**
Surge protection	**8379.USP**
Power supply 24V/4A	**8366.USV1**
UMB interface converter ISOCON	**8160.UISO**



Radar-based precipitation detection
Aspirated temperature/humidity measurement
Open communication protocol

WS200-UMB - WIND

From the WS product family of professional intelligent measurement transducers with digital interface for environmental applications.

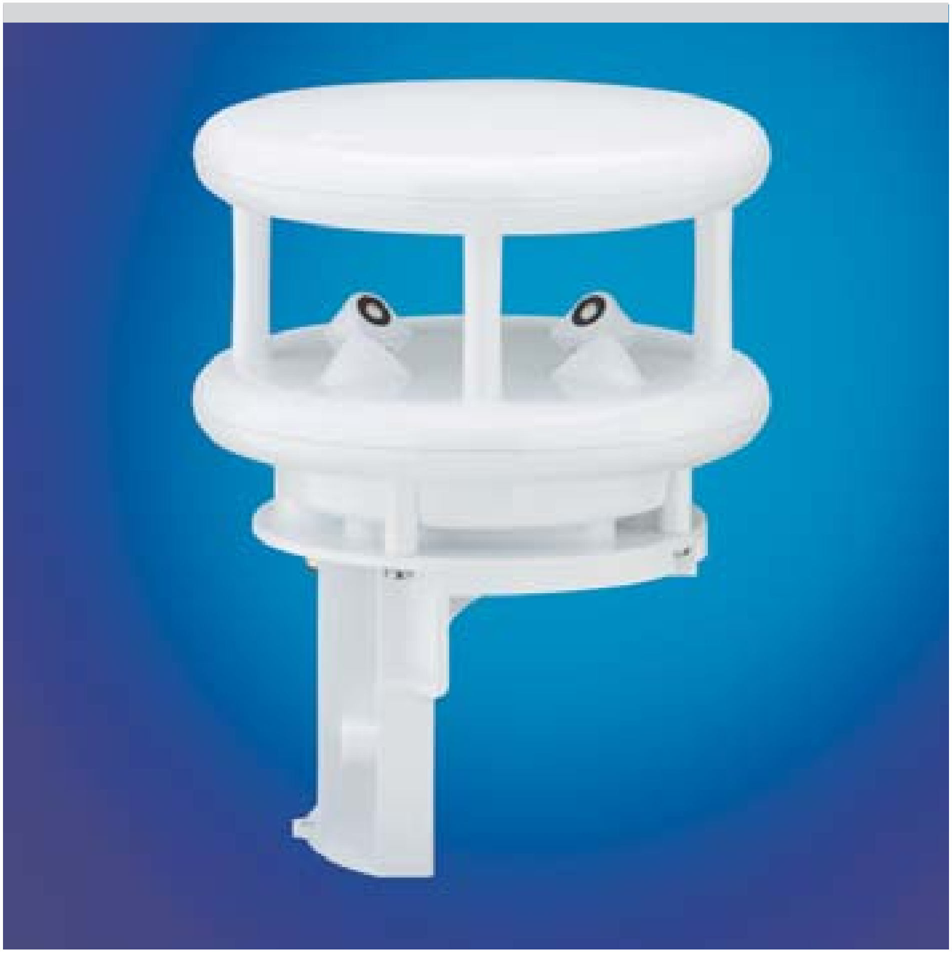
Integrated design with ventilated radiation protection for measuring:

- **Wind direction**
- **Wind speed**

Ultrasonic sensor technology is used to take wind measurements.

Measurement data are available for further processing in the form of a standard protocol (Lufft-UMB protocol).

Technical Data	Order No.
WS200-UMB Compact weather station	**8371.U01**
Dimensions	Ø ca. 150mm, Height ca. 200mm, Weight approx. 1kg
Wind direction	
Principle	Ultrasonic
Measuring range	0…359,9°
Accuracy	± 3°
Wind speed	
Principle	Ultrasonic
Measuring range	0…60m/s
Accuracy	± 0,3m/s or ±3% (0...35m/s)
Heating	10VA at 24VDC
General information	
Interface	RS485, 2-wire, half-duplex
Operating power consumption	24VDC +/- 10% <4VA (without heating)
Operating humidity range	0…100%
Operating temperature range	-30…70°C
Accessories	**Order No.**
Surge protection	**8379.USP**
Power supply 24V/4A	**8366.USV1**
UMB interface converter ISOCON	**8160.UISO**



Ultrasonic wind measurement
open communication protocol

R2S-UMB - PRECIPITATION SENSOR (PRESENT WEATHER DETECTOR)

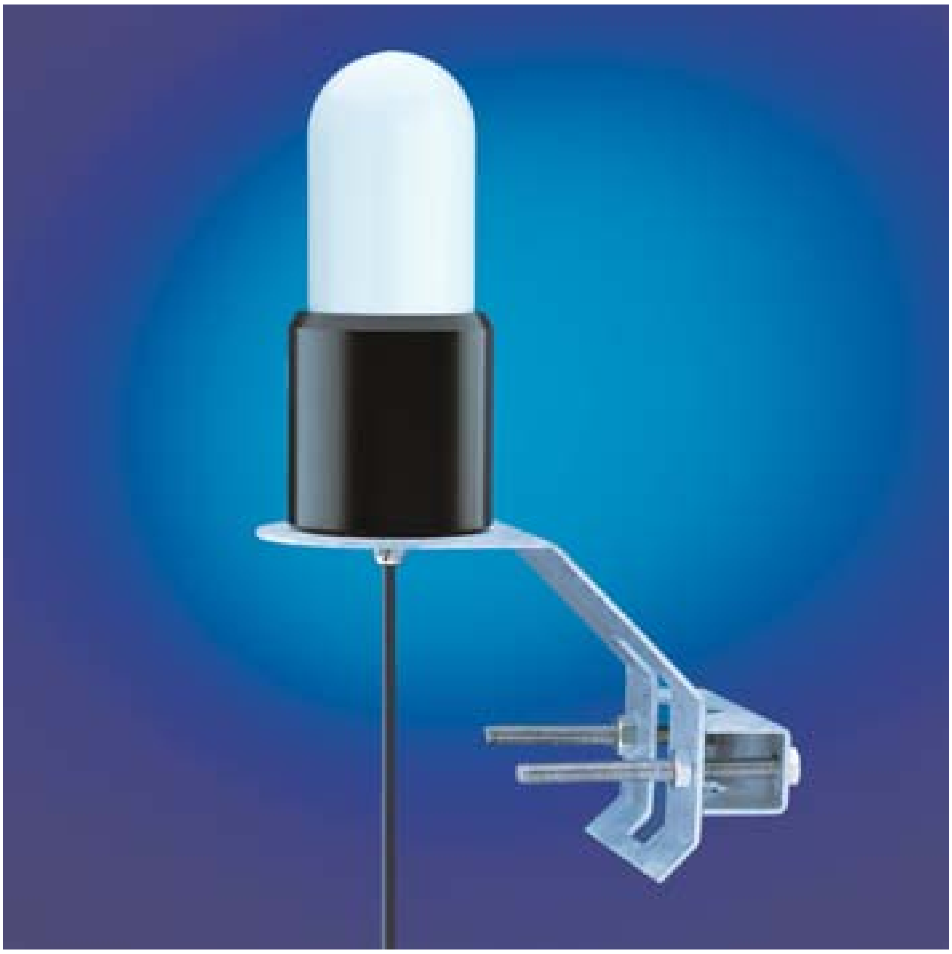
The drop speed is captured with a 24-GHz-Doppler radar.

The precipitation quantity and intensity is calculated from the correlation between drop size and speed.

The type of precipitation (rain, snow, sleet, freezing rain, hail) is detected from the difference in drop speed.

The measurement data are available for further processing in the form of a standard protocol (Lufft UMB protocol).

Technical Data	Order No.
R2S-UMB Precipitation sensor	**8367.U01** EU, USA, Canada
with UMB, pulse and frequency interface	**8367.U02** UK
Measuring range drop size	0.3...5.0mm
Measuring range hail	5.1...ca. 30mm
Resolution liquid precipitation	0.01...0.1...1.0mm/m²
Type of precipitation	Rain, snow, sleet, freezing rain, hail
Reproducibility	Typical >90%
Interface	RS485 half-duplex, UMB protocol
Power consumption	24VDC (22...28VDC)
Power supply	ca. 30VA (24V)
Operating temperature range	-30...70°C
Operating humidity range	0...100%
Connecting cable	Included in delivery
Accessories	**Order No.**
UMB interface converter ISOCON	**8160.UISO**
Power supply 24V/4A	**8366.USV1**
Protection shield for R2S	**8367.SCHIRM**
Surge protection	**8379.USP**



Maintenance-free
Fast response time
Present Weather detector
Resolution 0.01 mm