Appendix G – Air Quality Management Plan (MDWES)

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AIR QUALITY MANAGEMENT PLAN

LOT 20 ADELAIDE ST HAZELMERE

March 2014

PREPARED FOR:

Wasterock Pty Ltd

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DOCUMENT DISTRIBUTION

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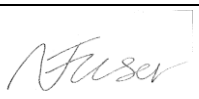
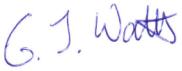
Signed					
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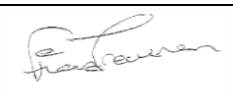
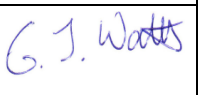
Signed					
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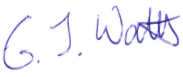
Signed					

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1 INTRODUCTION

This Air Quality Management Plan (AQMP) has been prepared by MDWES for Wasterock (client) to manage the release of 'nuisance' dust and other potential airborne contaminates during remediation of the client's site which is llocated 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 and levels of contaminants will have 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 also stated that investigations undertaken were not exhaustive and therefore further undetected contaminates 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 of potential airborne contaminants and the attributed 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 nuisance dust. Which has the potential to release potential contaminants via the excavation of already contaminated soils during the earthworks and groundwork's phase. This dust has the potential to contain asbestos fibres, silica and heavy metals and must be managed accordingly.

Management guidelines are set out to ensure that the generation of dust is minimised during remediation of the site. These practices will be in conjunction with ALARA (As Low As Reasonably Achievable) for contaminated land sites and BPM (Best Practicable Measures) principles 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 & local residents) caused by dust, airborne contaminants and noise being present 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) v4 – Adelaide Street Hazelmere, (March 2013).

2 SITE BACKGROUND AND CHARACTERISITICS

The following is a summary of background information relevant to this AQMP. Further detailed information on the Site is outlined in MDWES Environmental Site Management Plan (ESMP) (Mar, 2014) which should be read in conjunction with this updated management plan.

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 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. These soils will ultimately be used for the capping layer.
3. Processing (crushing and/or screening) of construction and demolition (C&D) waste for recycling and reuse on Site to engineer a physical warning barrier.
4. Engineered placement, compaction and construction of excavated remediated soil material to form a controlled engineered cell.

Wasterock is proposing to redevelop the area by remediating the Site via excavation and repackaging of materials. 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 appropriate waste facilities off-site, or to transport large quantities of sand to site. Although there may be a requirement for off-site disposal for this project, if a resource can be reused and does not have an environmental impact, then Site re-use should be paramount as it is the only cost-effective mechanism for sustainable remediation of the site.

Remediation is estimated to be completed over a 4-5 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 within the community, through subdivision into light industrial/commercial lots.

2.2 Climate

The potential climate which may be experienced at the Site is considered to be representative of the annual climate in Perth, Western Australia. The Bureau of Meteorology (BOM) describes Perth 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**
April-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 east-north-east at 9:00 am to west-south-west 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 south west. Winter conditions tend to prevail from the north to north east and by mid-afternoon from the west.

2.3 Soil Moisture

The Perth metropolitan area remains one of Australia's driest capital cities, particularly through the summer months (December to February). As a consequence, the weather conditions can provide minimal rainfall totals, warmer temperatures, low humidity levels and prevailing wind conditions as outlined in Section 2.2.

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 dust and contaminates to become airborne if not managed correctly.

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, the reduction of the vegetative ground cover as excavation progresses could contribute to increased airborne dust potential. This should be 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, reported with the ground level (PB, 2006) to be raised significantly from pre-landfill activity ground levels 27mAHD (PB, 2006). 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 runs 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 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 CoPC findings above and Site operations during the Sites remediation, air monitoring will be required for the duration of the works. During excavation and engineering of the landfill, dust and particulate matter has the potential to be liberated if not managed properly. Therefore, the following CoPCs may become present in the air:

- Asbestos fibres
- Metals
- TSP
- Nuisance Dusts (PM10 & PM2.5)
- Silica Dust

2.7 Potential Receptors

Human receptors are considered to be most at risk from nuisance dust, due to the potential release of airborne contaminates during remediation activities at the site. This poses a potential health risk for persons both on-site and off-site as they could potentially be exposed to asbestos fibres and airborne contaminants liberated during excavation, sorting and remediation of the Site.

Off-site impacts identified within the risk assessment (MDWES ESMP) suggest residents living on Adelaide Street adjacent to the southern side of the Site may be at risk and exposured to airborne contaminants during remediation activities. Exposure is likely to be via suspension of fibre and particulate matter (<100 μm: typically referred to as TSP) on prevailing winds and deposition and within the nearby residential areas. Transport of large particles off-site via creep and saltation is unlikely to present risk to human and ecological receptors, given the geomorphic characteristics of the largely sandy matrix of the Site.

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 to protect both workers operating at the Site and residents in the neighbouring households 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 will have the potential to release 'nuisance' dusts (PM10 & PM2.5), asbestos fibres, silica and heavy metals. Monitoring is required to identify any potential exposure to Site personnel/ local residents. The AQMP allows for dust management to be assessed continuously this will allow for measures to be amended, or "work to stop" notices, prior to any long-term health effects for Site workers and local residents.

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 other 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 environmental exposure during earthworks and soil removal activities to possible poor air quality.

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 onsite 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 onsite.
- 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 approaches or exceeds 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 could potentially generate nuisance 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.

CoPC's outlined in Section 2.6, in particular ACM, has the potential to be generated as a consequence of the above activities. The severity may be exacerbated, due to the possible uplift of particulates which have the capacity to be inhaled. However, the majority of particulates are expected to be in the >10 µm or larger TSP range, that are either:

- Not inhalable.
- Won't become airborne.
- Don't often constitute ACM fibres.

ACM fibres, metals and silica were identified as potential contaminants and are anticipated to be present in the soils being excavated. These contaminants have the potential to trigger long-term health effects (especially for workers operating within the Site boundaries). In particular, if inhaled, asbestos fibres are a known cause of asbestosis, mesothelioma, and cancer of the lungs, oesophagus, stomach, colon and rectum cancer (IARC, 2012).

The ESMP details that if controls measures such as dust suppression and PPE are put in place the potential for impact would significantly be reduced.

5 ASSESSMENT OF SITE CHARACTERISTICS

Site characteristics are assessed to ensure that any likely causes of CoPC's 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. 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). This measure 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) detail the following characteristic: 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 in the generation of airborne CoPc's.

The most sensitive human receptors are located off-site, with the closest residents on Adelaide St located on the southern side of the Site boundary. The most sensitive human receptors located on-site personnel who attend the Site to complete works. Other human receptors include the MDWES Environmental Scientists conducting the air quality monitoring program. Other persons who may be receptors are visitors attend 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 determine the direction and dispersion of potential dust and asbestos fibres. Data shows that wind direction changes from morning to afternoon. Due to this, 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 the change in wind direction. MDWES will review the wind direction forecast each morning and afternoon before the stations are positioned. The ESMP details the wind roses and examples of sampling locations based on wind direction.

A weather station will be located onsite 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.

Table B: 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 onsite 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 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) has 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 installing the weather station on-site;

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 2m above the ground.
- 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 4 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 minimize 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 considerations to *AS3580.14-2011: Methods for sampling and analysis of ambient air – Meteorological monitoring for ambient air quality monitoring applications* (Australian Standards, 2013) 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 C outlines the proposed maintenance schedule.

Table C: 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 the 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 D: 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	Millimeters (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 poor air quality to on and off-site persons/personnel. However, the main purpose of the monitoring will be to verify that personnel are not being exposed to elevated concentrations of contaminates as a result of excavations works.

The air quality monitoring program proposes the intended to ensure that excavations in possibly contaminated soils do not result in harmful contaminants exceeding the NIOSH/Safe Work Australia (1995) level, also endorsed by the WA DEC.

7.2 Overview

Dust (as nuisance dust (PM10, PM2.5, metals and silica) and asbestos fibres. These potential contaminants 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 – is established to assess exposure levels and to mitigate any posed risk from asbestos fibres or dust deposition off-site.

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

7.3 Rational for Monitoring Positions

The location of the Air Quality Monitoring Stations has been determined to provide full coverage of Site airborne emissions (Table E) also see MDWES ESMP report. A Tapered Element Oscillating Microbalance (TEOM) located near the south western corner of the Site will provide real-time high quality gravimetric data on fugitive Site emissions. At the same location, a real-time nephelometer will allow for the determination of a calibration factor by comparison of gravimetric and nephelometric data.

Boundary monitoring will be implemented at an additional four locations to provide characterisation of fugitive dust emissions via the real-time nephelometer.

Static sampling will be utilised at three judgemental locations, based on wind direction forecasts, and will characterise potential fibre concentration downwind of the excavation work face.

Airborne fibre sampling will be used within the crib room to validate the ‘clean’ status of the area.

Further monitoring of the personnel in-vehicle will be conducted through fibre monitoring which will profile fibre exposure of workers within the vehicle.

Monitoring on the southern boundary will be used to assess fugitive concentrations of CoPC adjacent to nearby off-site human receptors: primarily residents fronting Adelaide Street.

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.

Reference is made to Figure 11 located within the MDWES ESMP report. The figure depicts the location of the monitoring stations discussed above and shown on Table E below.

Table E: Air Quality Monitoring Program

Location	ID	Analyte				Rationale
		Dust	Asbestos	Silica	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.

7.4 Roles and Responsibilities

The management of the AQMP will be undertaken by an Environmental Scientist employed by MDWES. Responsibility for daily delivery of the AQMP (execution of the air quality management plan) will rest with the AQMP Manager. To ensure a high level of performance, transparency 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:

- 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 Works Approval and Licensing Conditions are met.

Tasks

A diverse range of task(s) 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. Table F summarises tasks, roles and responsibilities. However:

- Meteorological data will be reviewed daily from the on-site weather station and compared with the air quality results to determine the potential deposition of dust and silica. Data will validate the static monitoring locations for that day and assist in Site dust suppression activities.
- Real-time data will be collected on weather conditions at the Site.
- Real-time data on dust emissions from five boundary locations will provide information on background and fugitive dust concentration at the Site and this will allow for source appointment analysis.
- Numerous air quality samples will be collected from across the Site to measure concentration of a range of CoPC. Sample collection will be initiated at the start of work each day, with sampling completed as specified in Section 7.3: Table E.
- Site documentation will include: air sample log, laboratory documentation, Chains of Custody (COCs), records of daily climatic observations including rainfall totals, temperature, wind speed and direction, equipment checks and calibrations.

Table F: Roles & Responsibly for Air Monitoring Program

Parameter Measured	Sampling Site / Locations	Task	Timing *	Completed by Whom	Analysis
Dust PM10 PM2.5	AMS1,3,4,5,6	Review Data	Daily	AQMP Manager or Environmental Scientist	Review real-time data.
	AMS1,3,4,5,6	Sample collection	Daily for one month	AQMP Manager or Environmental Scientist	NATA accredited analysis of sample within 5 working days.
	AMS3,4,5,6	Sample collection	Once per month (over 3 days)	AQMP Manager or Environmental Scientist	NATA accredited analysis of sample within 5 working days.
Dust TSP, PM10	AMS1	Sample collection	Two, once per week	AQMP Manager or Environmental Scientist	NATA accredited analysis of sample within 2 working days.
	NA	Determine calibration factor for TES 7200's	To suite above sampling	AQMP Manager	Comparison of concurrent nephelometeric and gravimetric data to produce Site specific calibration factor for nephelometers.
Silica Dust	AMS1	Sample collection	Daily	AQMP Manager or Environmental Scientist	NATA accredited analysis within 1 working days
Metals	AMS1	Sample collection	Two, once per Week	AQMP Manager or Environmental Scientist	NATA accredited analysis within 5 working days
Asbestos	AMS1-3	Sample collection	Daily	AQMP Manager or Environmental Scientist	NATA accredited analysis of sample within 24 hours.
	AMS7-9	Sample collection	Twice Daily am: 07:00-12:30 pm:12:30-17:30	AQMP Manager or Environmental Scientist	NATA accredited analysis of sample within 24 hours.
	AMS 10	Sample collection	Daily Mon - Sat	AQMP Manager or Environmental Scientist	NATA accredited analysis of sample within 24 hours.
	AMS 11-12	Sample collection	Twice weekly for one month then schedule reviewed subject to historical results	AQMP Manager or Environmental Scientist	NATA accredited analysis of sample within 24 hours.
	AMS 13-14	Sample collection	Daily for 2 weeks then monthly for 6 months. Schedule to be reassessed after subject to historical results	AQMP Manager or Environmental Scientist	NATA accredited analysis of sample within 24 hours.
Weather	NA	Review BoM and Site data	Daily (am)	AQMP Manager	Forecast likely conditions for sample locations.
	WMS-1	Collect data	Daily	AQMP Manager or Environmental Scientist	Review data, check robustness, check for gaps.

CoPC	MDWES office or Site office	Collate data	Daily	Environmental Scientist	Check QA/QC of data, check robustness, data gaps, and check against assessment criteria.
Reporting	MDWES office or Site office	Report	Weekly Report for the previous week's results	AQMP Manager	Ensure compliance with Works Approval and Licensing Conditions.
Manage Air Quality Issues	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.

7.5 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.

Calibration of TEOM and primary flow rate calibration devices will be undertaken by appropriately qualified technicians.

7.6 Excavation Area (Red Zone) – Control Measures PPE

As per a hierarchy of control, Site equipment (vehicles) within the red zone will be fitted with High Efficiency Particle Arrestment (HEPA) filters to eliminate an occupant's potential exposure to fibres. Two samples will be collected from mobile cabins as per Table F 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 wear respiratory protection as per AS/NZS 1705: 2009, disposable coveralls (appropriate for working with asbestos fibre), safety glasses, hats and dedicated steel capped boots. Personal monitoring of all Site workers will be undertaken as per Table F to quantity potential exposure to fibres.

As per Table E and F, three asbestos monitors will be set up daily around the excavation area. Sample locations within the excavation zone will be predicated by forecast weather conditions to allow optimum position to as much dust and fibre laden air to the monitoring station; i.e. located directly downwind of the excavation works. At noon filter cassettes will be changed and the location of the samplers revised to accommodate afternoon prevailing wind patterns.

7.7 Stations for Public Exposure Monitoring

Boundary monitoring stations, as detailed in Section 7.3, will be located outside of the excavation area with six (6) 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', 'TSP, metals' and 'silica'. Stations AMS3 to AMS6 house nephelometers. Station AMS2 houses one sample pump. The objective of the boundary monitoring station placement is to characterise the airborne concentration of identified CoPCs and ponteiual 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 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 (motor vehicle emissions).
- Avoid sites that may adsorb and desorbs contaminants such as trees. Stations should be located at least 20 m from trees and leafy vegetation.
- Locate the monitoring inlet near human breathing zones, 1 to 2 meters above ground level.

8 Methodology of Sampling and Analysis

8.1 Dust (TSP, PM10 & PM2.5)

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 are generally considered from a nuisance perspective as only particles smaller than 10 μm aerodynamic equivalent diameter (AED) are likely to have adverse health impacts. Consequently, PM10 is usually used to measure environmental concentrations of dust. A smaller subset of PM10 is PM2.5 which is typically used to measure occupational concentrations of dust.

Dust concentrations at the Site will be measured using two methods: gravimetric and nephelometry. Both will give real-time PM10 and PM2.5 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 – PM10 continuous direct mass method using a tapered element oscillating micro-balance analyse* 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 PM10 measurement, the TEOM used on Site will be Thermo Fisher 1405-DF Dichotomous Ambient Particulate Monitor with FDMS, which can continuously measure PM10 and PM2.5.

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 PM10 and AS2985:1987 - *Workplace Atmospheres - Method for Sampling and Gravimetric Determination of Respirable Dust* for PM2.5. These methods rely upon deposition of particles onto 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 advantage of nephelometry is 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.

Five nephelometers: TES 7200 (QA-Lite) will be used on Site; the instrument has a heated inlet to prevent artefacts from moisture vapour over reporting mass and can collect concurrent filter samples for gravimetric analysis.

Monitoring station AMS1 consists of one TEOM and one QA-Lite. Comparison of both gravimetric samples will ensure gravimetric values for the TEOM and filter method are similar. Comparison of the gravimetric values to the non-gravimetric data will allow development of an accurate calibration factor which can be input into the QA-Lite at AMS1 and other boundary monitoring stations. The monitoring schedule allows for one full month of daily calibration factor development at AMS1. Thereafter, a weekly calibration factor will be derived for the duration of earthworks. Additional daily reviews of real-time TEOM and QA-Lite data from AMS1 will be undertaken to examine any potential variations between the two methods.

The same comparison process will be repeated as per Table F at the remaining four boundary monitoring stations that are fitted with QA-Lites. Such a program of calibration factor derivation will allow for a high level of robustness and confidence in real-time PM10 and PM2.5 data across the entire Site and on Site boundaries.

PM10 and PM2.5 real-time gravimetric, time-weighted gravimetric and nephelometer data will be compared to NEPM ambient air standards.

One of the sampling pumps located at AMS1 will be utilised to collect two TSP samples. After determining sample mass, the samples will be analysed for metal content. Typically there is a fair degree of correlation between ambient TSP and PM10. Consequently, PM10 will also be used to provide additional insights into TSP concentration along the entire Site boundary. There are no air quality guidelines for TSP in ambient air. NHMRC recommended in 1996 a guideline of 90 mg/m^3 as an annual average. However, this has not been adopted on a national or state basis. The World Health Organisation guideline for 24-hour average is 120 mg/m^3. Despite the lack of formal Australian guidelines the concentrations provide useful action trigger points.

A duplicate and replicate PM10 sample will be collected weekly at ASM1 via the use of two additional sample pumps, coupled to PM10 filter cassettes. However, it should be noted that given the active nature of the sample collection process i.e. via pumping at similar rates, total mass between 'duplicate' samples may differ; although mass per unit volume of air should be similar.

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 the four AMS's (4) boundary, three (3) excavation face static monitors and a crib room monitor (1). GPS locations of the sampling location 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 a piece of 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 duration of daily earthworks, to ensure that a minimum of 500 L or maximum of 1000 L is obtained per sample pump and are representative of site conditions.

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 Silica Dust

Silica is viewed as a low risk CoCP, given that the crusher (which operates for only a few hours per day), is likely to be the main source of silica dust and dust suppression is not likely to prevent any significant emission of this contaminant into the Site airshed.

Silica dust 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 silica concentration at the Site boundary.

One silica dust static monitor will 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 require rate of 2.5 L/min, for the duration of the daily works. Sample run time will be approximately 12 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 Metals

Metal concentrations will be measured in accordance with *NIOSH Method 7300 – Elements by ICP*. The metals of interest are based on the CoPCs 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).

It is noted that as with Silica, 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 dust AMS's. The QA Lite utilises nephelometry to measure dust levels and can simultaneously measure up to six particle size fractions including TSP. A PM10 inlet head fitted to each instrument will limit monitoring to PM10 and finer fractions. 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 G summaries the instrument specifications.

Table G: 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 5-5000ml/min. 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 H summarises the instrument specifications.

Table H: 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 it has an operating range of 1000 to 5000 ml/min. 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 I summaries the instrument specifications.

Table I: 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 µg/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 Equipment Calibration and Maintenance

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

Table J: 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 Safe Work Australia *Workplace Exposure Standards for Atmospheric Contaminants in the Workplace* and the National Environmental Protection (Ambient Air Quality) Measure (NEPM). The occupational exposure standard for asbestos fibres, silica and metalloid as dust within the machinery cabin and for personnel working within the excavation area (wearing PPE), are based on the NOHSC/Safe Work Australia Standards (1995). Contaminant concentrations are based on an 8 hour Time Weighted Average (TWA). Workers that are operating vehicles or mobile plant will be protected with HEPA filtering within the air conditioning systems. Workers operating on foot will be equipped with recommended PPE at all times, whilst within the boundaries of the Site where shallow soils are being disturbed. Table K details the trigger proposed action if concentrations exceed CoPC trigger actions, dependent upon the nature of the CoCP.

Table K: Assessment Criteria

Contaminant	Unit	Safe Work Australia *(TWA)*	NEPM *(24 hours)*	WHO *(24 hours)*	Action
Dust					
TSP	µg/m^3			120	Increase dust suppression
PM 10	µg/m^3		50*		Increase dust suppression, review wind speeds associated with exceedance and consider setting maximum wind speed threshold for reduced sorting throughput.
PM 2.5	µg/m^3		25*		Increase dust suppression, reduce sorting and crushing throughput until concentration is below 20 µg/m^3
Asbestos					
Asbestos Fibre (Mixed Fibres)	fibre/mL	0.1$^{\#}$			Stop sorting, investigate site conditions that were likely to have contributed to the exceedance and take appropriate action; Includes report to major stakeholders. Concurrently undertake SEM scanning of sample to determine asbestos fibre content. If asbestos fibre count exceeds trigger value undertake steps to reduce fugitive emissions.
Silica					
Crystalline Silica	mg/m^3	0.1			Investigate dust suppression at crusher and increase dust suppression control measures as required.
Metals					
Arsenic	mg/m^3	0.05			Investigate potential sources of analyte and take appropriate action
Barium	mg/m^3	0.5			As per above
Cadmium	mg/m^3	0.01			As per above
Chromium	mg/m^3	0.5 $^{\#}$			As per above
Copper	mg/m^3	1			As per above
Manganese	mg/m^3	1			As per above
Nickel	mg/m^3	1			As per above
Lead	mg/m^3	0.15	0.0005		As per above
Zinc	mg/m^3	10			As per above
Mercury	mg/m^3	0.025			As per above

NB:

- * No current Safe Work Australia Standards for Dust as PM10 and PM2.5, therefore assessment criteria will be based on the daily Ambient Air NEPM Guidelines. Note 2.5 guideline is an advisory standard.
- $^{\#}$ In the event concentrations exceed the assessment criteria further analysis will be conducted to speciated contaminates.
- In the event contaminates exceed in excess of the assessment criteria works may have be stopped and reassessment of work practices will be required.

10.1 Sample Recovery

All gravimetric, fibre, silica and metalloid samples will be recovered as per Table F, 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 K, Section 10. 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.

10.2 Contingency Measures

Table K details the immediate action if assessment criteria are exceeded.

Exceedance of action trigger values will generally be related to insufficient dust suppression of access tracks, the excavation zone, remediated land that has insufficient ground cover, the crusher, or a combination of these elements. Dust issues will be exacerbated by strong winds. It is likely that the Site will need to develop a procedure that slows or ceases earthworks and / or increases dust suppression activities as wind speed across the Site increase. 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.

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 with one hour. Concurrently, the offending sample would be further analysed by SEM to quantify the type of asbestos fibre. 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.

TSP

TSP is considered a nuisance. At concentrations below 120 mg/m^3, it is unlikely any complaints of nuisance dust could be attributed to the Site. However, as concentration increases, so too does the risk of complaint. If concentrations exceed 120 mg/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.

PM10

The NEPM states that the future goal of PM10 is not to exceed the NEPM criteria more than 5 times per year. If daily average PM10 concentration at any boundary as a result of remediation works exceed the criteria more than once per week, then a review of dust suppression within the Site will be undertaken, including examining the frequency of road wetting, and appropriate action undertaken.

PM2.5

If average daily concentrations exceed the NEPM advisory standard two or more days in a row, then additional dust suppression will be undertaken.

Silica

If average daily concentrations exceed the criteria two or more days in a row, 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.

Metals

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

Complaints

Any complaint will be followed up with a review of the Site earthworks schedule and air monitoring regime. A change in the management plan and/or the monitoring scope may require an amendment, to improve human safety off-site.

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, TSP, Silica 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 ACM, TSP or Silica concentrations exceeding the trigger values, particularly if levels have been exceeded on a previous day in similar weather conditions.

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MDW
ENVIRONMENTAL SERVICES

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 $PM_{2.5}$

Lit 62C14M403

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Environmental Instruments
Air Quality Products
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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

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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:	-5°C—50°C
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

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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

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Outstanding Quality, Unprecedented Customer Support

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

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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.

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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).

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**

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

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).

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**

Ultrasonic wind sensor
maintenance-free operation
open communication protocol

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).

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**

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

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