Ella Castillo
Principal Consultant
Air Quality Support
ella@airqualitysupport.com.au

2 August 2020

Martin Doyle and Gary Graham
Northstar Air Quality

By email: martin.doyle@northstarairquality.com
gary.graham@northstarairquality.com

D19A-3: Technical Support – Dispersion Modelling Study – King's Park, NSW

Dear Martin and Gary

Air Quality Support (AQS) was commissioned by Northstar Air Quality to update the dispersion modelling of a facility in King's Park, NSW.

The update to the dispersion modelling comprised:

- change of the period for dispersion modelling to 2018;
- increase of number of sensitive receptors;
- update to the emissions inventory, including changes to source locations, parameters, and emission rates.

The site-specific three-dimensional meteorological dataset was generated for 2018 using the TAPM/CALMET meteorological modelling systems, as configured for the previous job. The generated dataset was validated using observations data provided for the Bureau of Meteorology (BoM) station at Horsley Park AWS.

The emissions spreadsheet *20.1074.EE6.xlsx* was provided and used as the basis for the update. Source characterisation and CALPUFF configuration remain consistent with previous dispersion modelling.

This memorandum summarises the information received and used for the updated modelling. This memo accompanies the dispersion modelling outputs (timeseries and GRD files). All other model input/output files will be uploaded to an FTP server, and a link will be sent once the files are ready for download.

If you have any questions or comments regarding this memorandum, please feel free to contact the undersigned.

Kind regards,

Ella Castillo

Principal Consultant
Air Quality Support
E: ella@airqualitysupport.com.au
M: +61 424 707794

1 Validation of TAPM model

The data validation process took into account statistical measures as described in the meteorological monitoring guidance for regulatory modelling applications (USEPA, 2000). Model predictions were validated using the following statistical measures:

- Root Mean Square Error (RMSE)
- Systematic Root Mean Square Error ($RMSE_S$)
- Unsystematic Root Mean Square Error ($RMSE_U$)
- Mean Error (ME)
- Mean Absolute Error (MAE)
- Index of Agreement (IOA)
- Skill E
- Skill V
- Skill R

In addition to these measures, basic statistics such as the minimum, mean, maximum, and standard deviation were also derived and compared.

Table 1-1 Statistics for meteorological observations and TAPM model predictions at Horsley Park Eq Centre AWS

Parameter	Units	Source	Average	Standard deviation	Minimum	Maximum
Wind speed	m/s	Obs	2.2	1.7	0.0	9.7
		TAPM	2.9	1.6	0.5	12.3
U component	m/s	Obs	0.0	2.1	-7.0	9.0
		TAPM	0.3	2.4	-5.8	12.3
V component	m/s	Obs	0.4	1.9	-6.9	7.6
		TAPM	0.3	2.2	-6.3	9.0
Temperature	°C	Obs	17.6	6.4	-1.3	44.1
		TAPM	17.1	5.6	4.4	40.4

Table 1-2 Correlation statistics for TAPM meteorological model performance

Statistic	Ideal score	Wind speed	U component	V component	Temperature
Root Mean Square Error	0	1.6	1.6	1.6	2.4
Systematic RMSE	0	1.8	2.1	1.9	6.4
Unsystematic RMSE	0	1.6	2.4	2.2	5.6
Mean Error	0	0.6	0.3	-0.1	-0.5
Mean Absolute Error	0	1.2	1.2	1.2	1.9
Index of Agreement	1	0.8	0.9	0.8	1.0
$Skill_e$	< 1	1.0	1.2	1.2	0.9
$Skill_v$	1	1.0	1.2	1.2	0.9
$Skill_r$	< 1	0.9	0.8	0.9	0.4

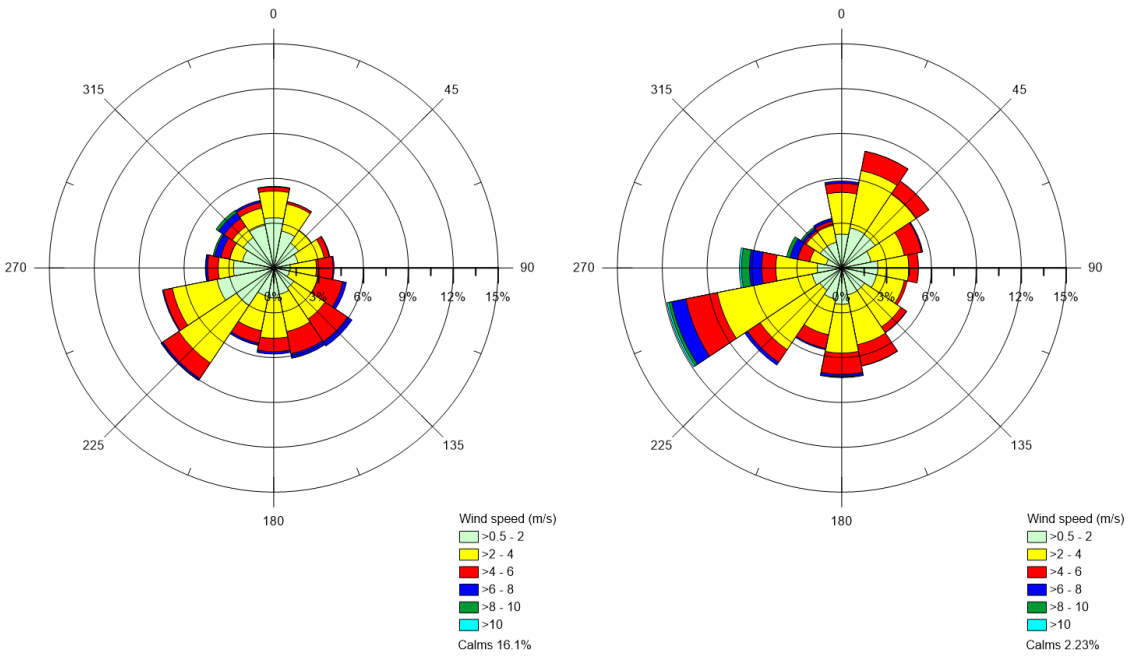

Figure 1-1 Distribution of observed (left) and modelled (right) winds

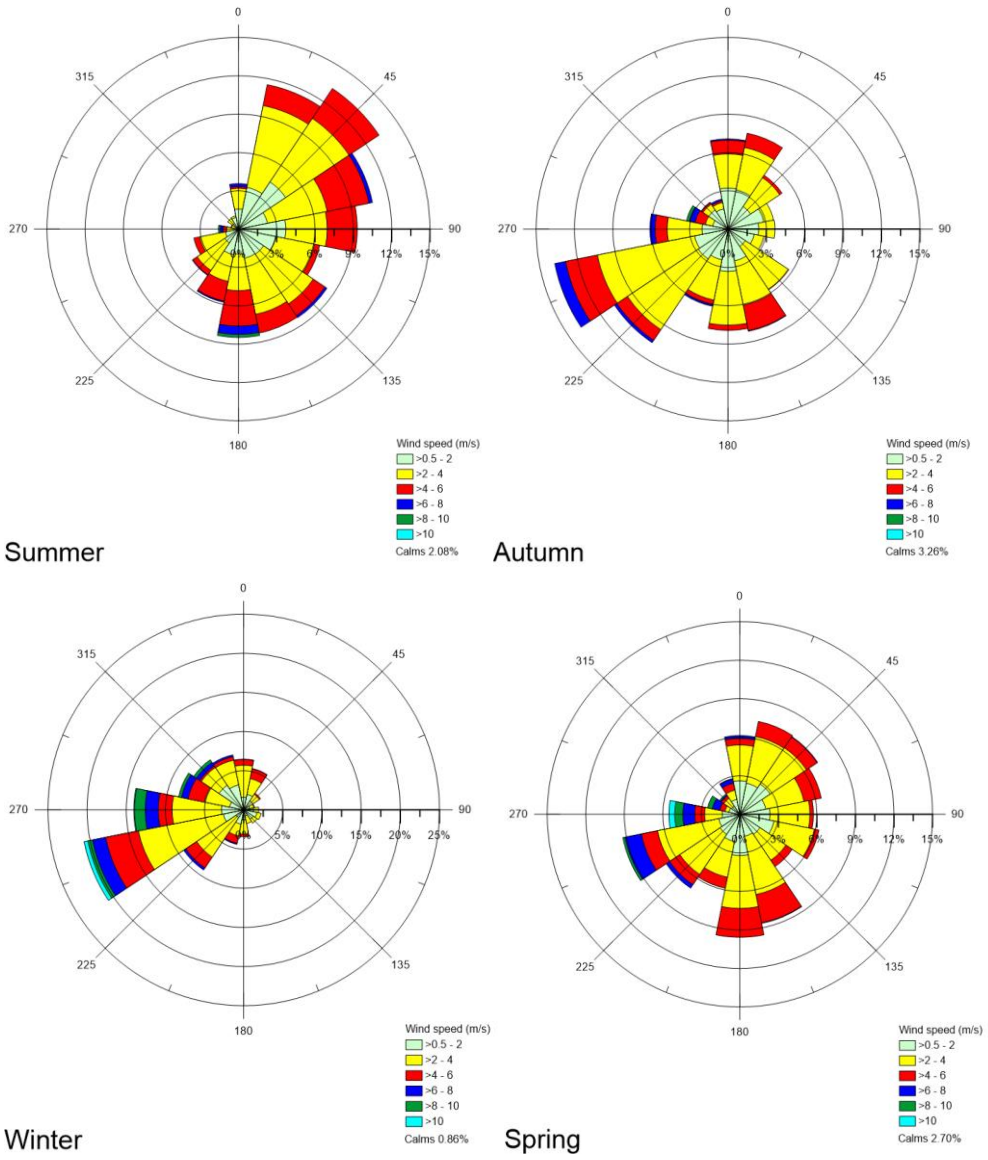

Figure 1-2 Seasonal distribution of modelled winds

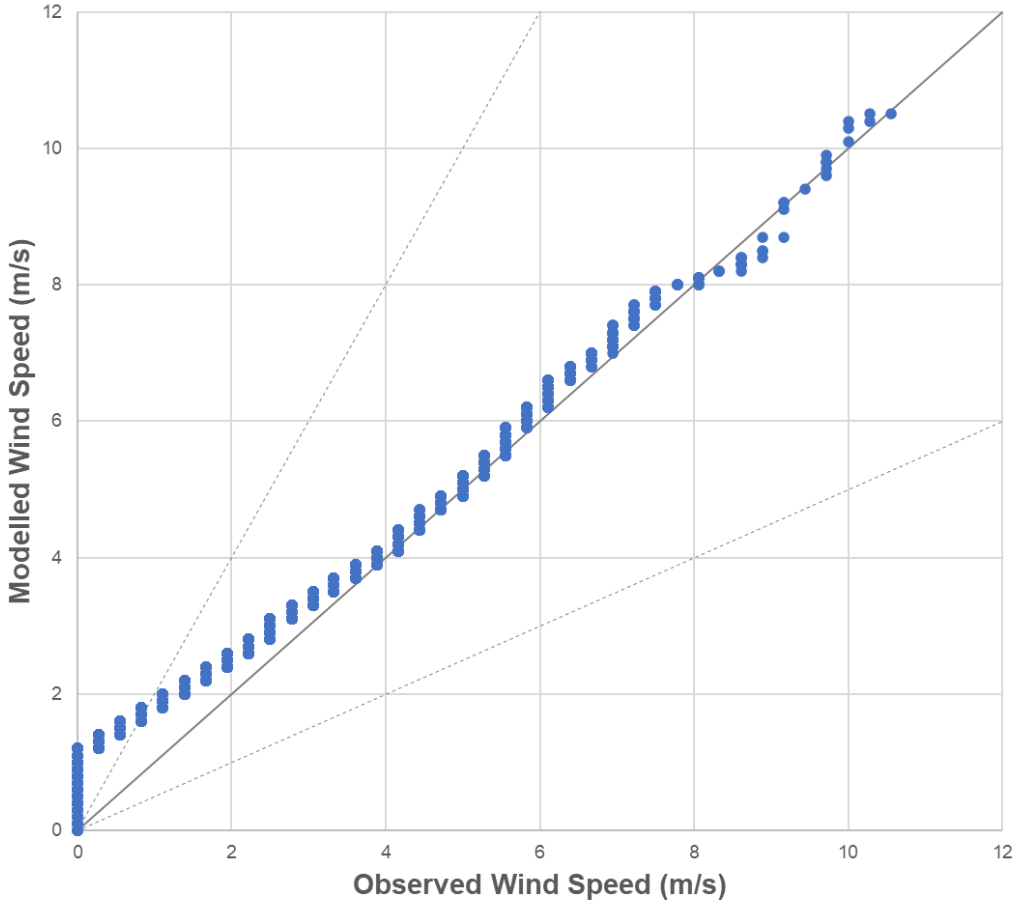

Figure 1-3 Quantile-quantile (QQ) plot of Horsley Park Eq Centre AWS

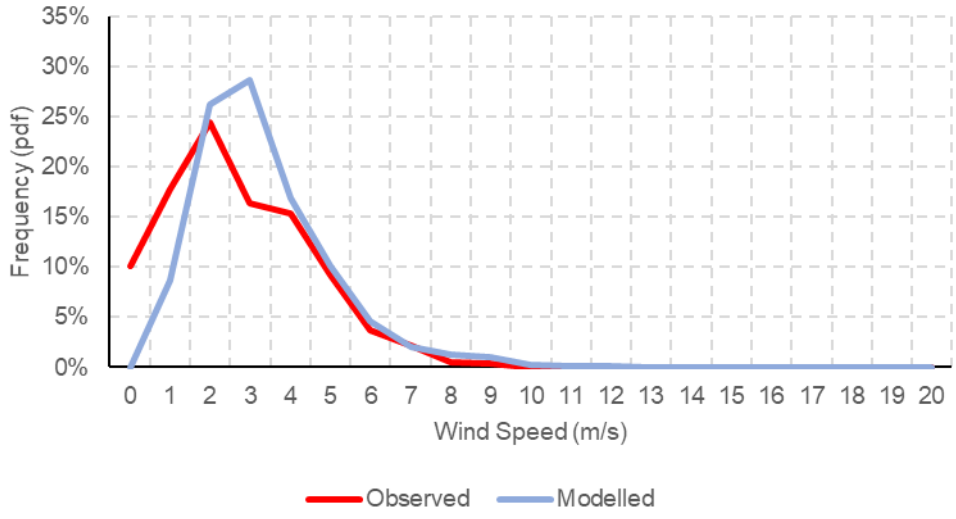

Figure 1-4 Distribution of wind speeds

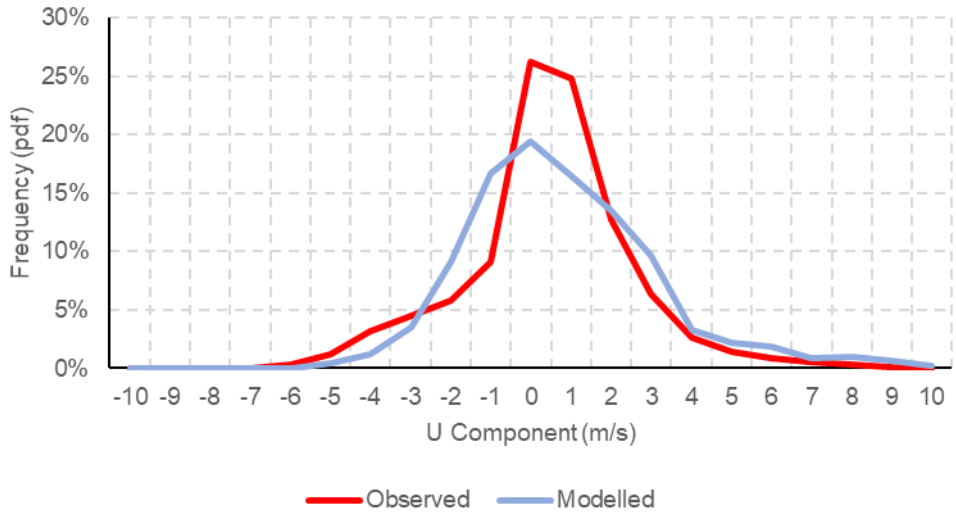

Figure 1-5 Distribution of U-component of wind

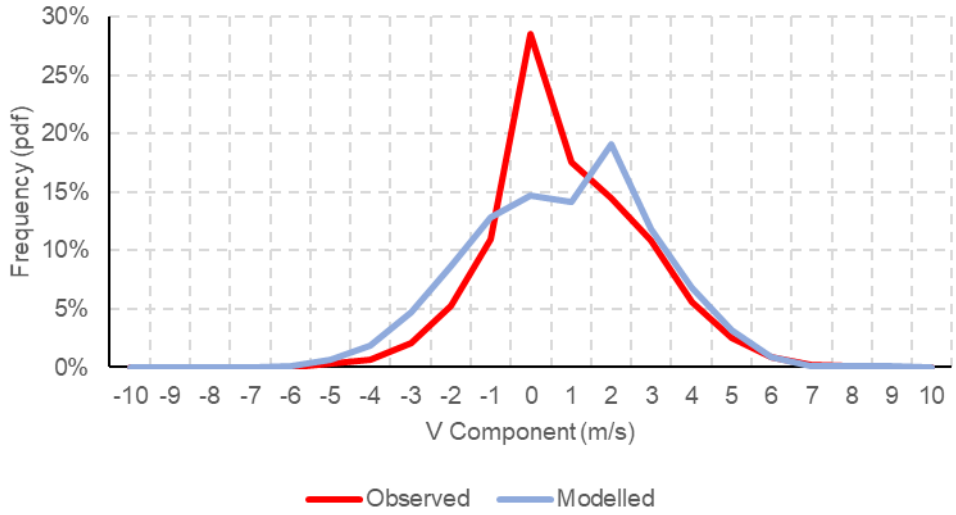

Figure 1-6 Distribution of V-component of wind

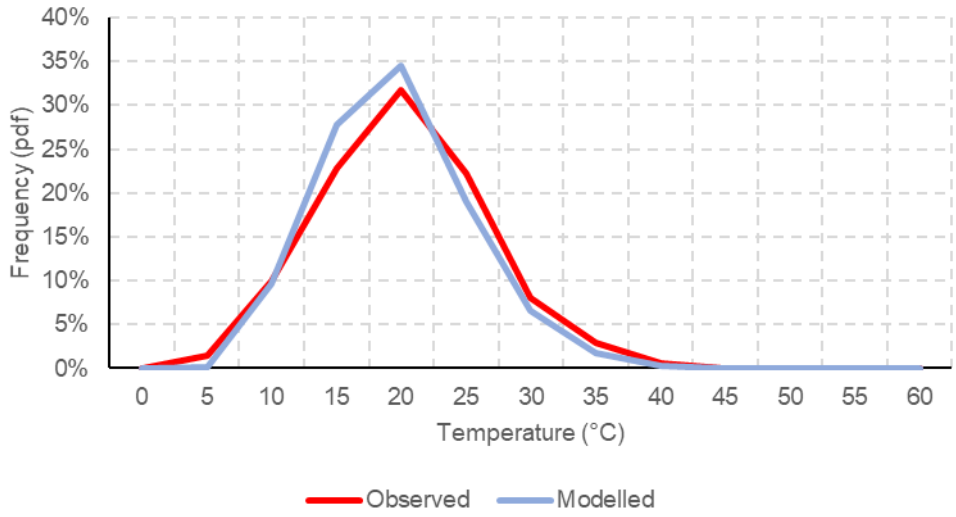

Figure 1-7 Distribution of temperature

2 CALPOST post-processing

- Sensitive receptors – (one-hour timeseries, 24-hour timeseries)
    - odour - OU
    - dust deposition rates – g/m²/s
    - dust (TSP, PM_{10}, $PM_{2.5}$) - µg/m³
    - other pollutants (NO_X, Cr, Cu, Fe, Pb, Mn, Ni, Ti, V, Zn) - µg/m³
- GRD (maximum one-hour, maximum 24-hour, annual average, 99th percentile (odour only))
    - odour – OU
    - dust deposition rates – g/m²/s
    - dust (TSP, PM_{10}, $PM_{2.5}$) - µg/m³
    - other pollutants (NO_X, Cr, Cu, Fe, Pb, Mn, Ni, Ti, V, Zn) - µg/m³

3 Scenarios

3.1 Current scenario

- odour: 2 sources (Table 4-1)
- other pollutants: 2 sources (Table 4-1)
- dust
    - point sources - constant emissions during operation hours (Table 4-1)
    - volume sources (materials handling and transfer points) - constant emissions during operation hours (Table 4-2)
    - volume sources (trucks dumping) – hourly-varying emissions during operation hours (Table 4-3)
    - volume sources (wind erosion) - hourly-varying emissions for 24 hours (Table 4-4)

3.2 Proposed scenario

- odour: identical to current scenario
- other pollutants: identical to current scenario
- dust
    - point sources - identical to current scenario (Table 4-1)
    - volume sources (materials handling and transfer points) - constant emissions during operation hours (Table 4-2)
    - volume sources (trucks dumping) – hourly-varying emissions during operation hours (Table 4-3)
    - volume sources (wind erosion) - identical to current scenario (Table 4-4)

4 Emissions Sources

Table 4-1 Source parameters and emissions rate for point sources

Parameter	Units	Source 1	Source 3
Src Id	-	C1	WSS01
Description	-	metal cutting at scrap area	wet scrubber stack
Easting [a]	m	306613	306567
Northing [a]	m	6263608	6263613
Elev	m	44.73	44.21
Operation hours	#	6	15
Start time	hh:mm	09:00	06:00
End time (exc)	hh:mm	15:00	21:00
Stack height	m	1.0	15.5
Stack Diameter	m	0.05	0.595
Exit velocity	m/s	0.01	25
Stack temperature	° C	700	40
Odour emission rate	OU m^3/s	0.018	11111.111
NO_X emission rate	g/s	0.043	-
Cr emission rate	g/s	-	7.29E-06
Cu emission rate	g/s	0.000005	1.82E-05
Fe emission rate	g/s	0.0003	1.05E-03
Pb emission rate	g/s	-	8.93E-05
Mn emission rate	g/s	0.00003	1.60E-05
Ni emission rate	g/s	-	5.65E-06
Ti emission rate	g/s	-	4.55E-06
V emission rate	g/s	-	1.82E-07
Zn emission rate	g/s	-	3.83E-04
TSP emission rate	g/s	-	0.12113951
PM_{10} emission rate	g/s	-	0.05693557
$PM_{2.5}$ emission rate	g/s	-	0.018219382

Table note: [a] WGS-84 UTM Zone 56S

Table 4-2 Materials Handling and Transfer Points – hours of operation (15 Hours: 06:00 am to 09:00 pm)

Id	Type	Easting [a]	Northing [a]	Elev	Rel Ht	σ_y	σ_z	Current Scenario (g/s)			Proposed Scenario (g/s)		
		m	*m*	*m*	*m*	*m*	*m*	*TSP*	*PM_{10}*	*$PM_{2.5}$*	*TSP*	*PM_{10}*	*$PM_{2.5}$*
MH01	MH	306607	6263635	44.42	4.00	1.02	0.37	5.35E-04	2.53E-04	3.83E-05	9.18E-04	4.34E-04	6.57E-05
MH02	MH	306519	6263572	44.13	3.50	1.02	2.16	8.03E-03	3.80E-03	5.75E-04	1.38E-02	6.51E-03	9.86E-04
MH03	MH	306503	6263664	43.03	4.00	1.02	0.37	8.03E-03	3.80E-03	5.75E-04	1.38E-02	6.51E-03	9.86E-04
MH04	MH	306509	6263576	43.99	3.50	1.02	2.16	3.21E-03	1.52E-03	2.30E-04	5.51E-03	2.60E-03	3.94E-04
MH05	MH	306522	6263569	44.19	4.00	1.02	0.37	3.21E-03	1.52E-03	2.30E-04	5.51E-03	2.60E-03	3.94E-04
MH06	MH	306523	6263581	44.08	2.00	1.02	2.16	3.21E-03	1.52E-03	2.30E-04	5.51E-03	2.60E-03	3.94E-04
MH07	MH	306503	6263664	43.03	4.00	1.02	0.37	3.21E-03	1.52E-03	2.30E-04	5.51E-03	2.60E-03	3.94E-04
MH08	MH	306503	6263664	43.03	2.00	1.02	2.16	1.12E-02	5.32E-03	8.05E-04	1.93E-02	9.11E-03	1.38E-03
MH09	MH	306483	6263652	42.94	2.00	1.02	0.37	1.12E-02	5.32E-03	8.05E-04	1.93E-02	9.11E-03	1.38E-03
MH10	MH	306542	6263691	43.19	3.50	0.84	2.21	8.46E-03	4.00E-03	6.06E-04	1.45E-02	6.86E-03	1.04E-03
MH11	MH	306533	6263680	43.2	4.00	0.84	0.37	8.46E-03	4.00E-03	6.06E-04	1.45E-02	6.86E-03	1.04E-03
TP01	TP	306525	6263577	44.14	7.00	0.47	0.23	1.07E-02	5.06E-03	7.67E-04	1.84E-02	8.68E-03	1.31E-03
TP02	TP	306517	6263691	42.9	1.00	0.47	0.09	2.82E-02	1.33E-02	2.02E-03	4.83E-02	2.29E-02	3.46E-03
TP03	TP	306529	6263701	42.94	1.00	0.47	0.09	2.82E-02	1.33E-02	2.02E-03	4.83E-02	2.29E-02	3.46E-03
TP04	TP	306541	6263711	42.98	7.00	0.47	0.23	2.82E-02	1.33E-02	2.02E-03	4.83E-02	2.29E-02	3.46E-03
TP05	TP	306512	6263687	42.88	1.00	0.47	0.09	1.43E-03	6.75E-04	1.02E-04	2.45E-03	1.16E-03	1.75E-04
TP06	TP	306494	6263732	42.74	3.00	0.7	0.09	8.56E-03	4.05E-03	6.13E-04	1.47E-02	6.94E-03	1.05E-03
TP07	TP	306563	6263721	43.27	3.00	0.7	0.09	8.56E-03	4.05E-03	6.13E-04	1.47E-02	6.94E-03	1.05E-03
TP08	TP	306551	6263643	43.76	3.00	0.7	0.09	8.56E-03	4.05E-03	6.13E-04	1.47E-02	6.94E-03	1.05E-03

Table note: [a] WGS-84 UTM Zone 56S.

Table 4-3 Trucks dumping – hours of operation (21 Hours: 06:00 am to 09:00 pm) – modelled as hourly varying volume source

Id	Easting [a]	Northing [a]	Elev	Rel Ht	σ_y	σ_z	Control	Current Scenario (g/s)		Proposed Scenario (g/s)	
	m	*m*	*m*	*m*	*m*	*m*	*%*	*Throughput*	*TSP, PM_{10}, $PM_{2.5}$*	*Throughput*	*TSP, PM_{10}, $PM_{2.5}$*
TRKD01	306502	6263580	43.88	4.0	1.0	1.0	70%	1500 tpd 100 tph	Eq A	2571 tpd 171.4 tph	Eq A
TRKD02	306503	6263664	43.03	4.0	1.0	1.0	70%	300 tpd 20 tph	Eq A	514 tpd 34.3 tph	Eq A

Table note: [a] WGS-84 UTM Zone 56S.

Table 4-4 Wind erosion (24 hours) – modelled as hourly varying volume source

Id	Type	Easting [a]	Northing [a]	Elev	Rel Ht	σ_y	σ_z	Emission rates (g/s) [b]		
		m	*m*	*m*	*m*	*m*	*m*	*TSP*	*PM_{10}*	*$PM_{2.5}$*
WE01	Scrap SP	306494	6263578	43.83	3.5	2.33	3.26	1.76E-03	8.80E-04	1.32E-04
WE02	Scrap SP	306507	6263543	44.32	3.5	2.33	3.26	1.15E-03	5.77E-04	8.65E-05
WE03	Post pre-shredder SP1	306631	6263571	45.25	3.5	1.16	3.26	5.66E-03	2.83E-03	4.25E-04
WE04	Post pre-shredder SP2	306503	6263664	43.03	3.5	2.33	3.26	6.91E-03	3.45E-03	5.18E-04
WE05	Ferrous product SP	306542	6263709	43.01	3.5	2.33	3.26	8.17E-04	4.08E-04	6.13E-05
WE06	Ferrous product SP	306544	6263695	43.17	3.5	2.33	3.26	8.17E-04	4.08E-04	6.13E-05

Table note: [a] WGS-84 UTM Zone 56S.
[b] Hourly varying emission rates calculated using Equation B.

Equation A:

$$ER = EF * A * (1 - CF) * 1000/3600$$

$$EF = k * 0.0016 * \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{2}{2}\right)^{1.4}}$$

ER	emission rate (g/s)
EF	emission factor (kg/t)
A	throughput (t/h)
CF	control factor (%) – assumed to be 70%
k	particle size multiplier (dimensionless): TSP: 0.74; PM_{10}: 0.35; $PM_{2.5}$: 0.053
U	hourly wind speed (m/s)
M	material moisture content (%) – assumed 2% based on information provided

Equation B:

$$WeightFactor_{hr} = \begin{cases} 0 & U \leq 3.1 \\ \frac{(U^*_{hr} - U^*_t)^3}{\sum_{hr=1}^{8760}(U^*_{hr} - U^*_t)^3} & U > 3.1 \end{cases}$$

$$ER_{TSP,hr} = WeightFactor_{hr} * ER_{TSP}$$

$$ER_{PM10,hr} = WeightFactor_{hr} * ER_{PM10}$$

$$ER_{PM2.5,hr} = WeightFactor_{hr} * ER_{PM2.5}$$

$WeightFactor_{hr}$	hourly weighting factor
U^*	wind speed (m/s)
U^*	friction velocity (m/s) – assumed to be 0.11 * U
U^*_t	threshold friction velocity (m/s) for 3.1 m/s
$ER_{TSP,hr}$	hourly emission rate – TSP (g/s)
$ER_{PM10,hr}$	hourly emission rate – PM_{10} (g/s)
$ER_{PM2.5,hr}$	hourly emission rate – $PM_{2.5}$ (g/s)
ER_{TSP}	annual average emission rate – TSP (g/s) - Table 4-4
ER_{PM10}	annual average emission rate – PM_{10} (g/s) - Table 4-4
$ER_{PM2.5}$	annual average emission rate – $PM_{2.5}$ (g/s) - Table 4-4

5 Sensitive Receptors

Table 5-1 Receptor Locations (WGS-84 UTM Zone 56S)

Receptor Id	Easting m	Northing m	Elevation (m)
R1	306993	6263656	49.81
R2	306975	6263528	48.97
R3	306963	6263414	49.5
R4	305627	6263452	38.57
R5	305527	6263624	38.31
R6	305475	6263762	38.52
R7	305584	6264114	43
R8	306081	6264458	60.1
R9	307080	6264227	58.55
R10	306442	6263762	43.24
R11	306531	6263749	43.57
R12	306602	6263739	44.13
R13	306653	6263748	44.91
R14	306728	6263659	45.41
R15	306723	6263581	45.93
R16	306489	6263446	45.11
R17	306406	6263371	44.52
R18	306325	6263369	43.27
R19	306423	6263682	42.38
R20	307599	6264228	56.57
R21	307887	6263160	67.61
R22	306919	6263049	53.84
R23	307124	6262564	64.93
R24	306559	6262232	55.86
R25	305557	6263991	42.33
R26	305892	6262648	43.24
R27	305458	6262957	42.51
R28	306709	6262724	51.64
R29	307037	6263846	50.45
R30	306386	6264424	59.99
R31	306723	6264372	57.35
R32	305695	6264456	50.68
R33	305974	6262378	46.82
R34	306589	6263715	43.48
R35	306434	6263491	43.92