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Dear John

Shoalhaven Starches Mod 13 Air Quality Assessment Cumulative Air Quality Assessment

1 Introduction

GHD was engaged by Shoalhaven Starches Pty Ltd (Manildra) to conduct a cumulative air quality impact assessment for the proposed modification 13 (MOD 13) at the Shoalhaven Starches manufacturing facility located on Bolong Road, Bomaderry, New South Wales (NSW).

MOD 13 includes modification of Boilers No. 2 and 4 and the installation of an additional baghouse on Boiler 6 for the proposed optimisation of energy use and steam production.

EPA requested that Manildra perform a cumulative assessment of air pollutants in accordance with the EPA Approved Methods 2016.

This letter outlines the assessment methodology and the predicted cumulative odour impacts of MOD 13 and other approved modifications at the site.

This letter should be read in conjunction with Air Quality Assessment Proposed Modifications to Boilers No. 2, 4 and 6 Shoalhaven Starches Bolong Road, Bomaderry NSW (Stephenson Environmental Management Australia, July 2017) and Shoalhaven Starches Ethanol Upgrade Air quality Assessment (GHD, 2008).

2 Assessment overview

GHD conducted a cumulative air quality assessment of the site in 2008 which included assessment of TSP, PM₁₀, NO_x, SO_x, CO, Heavy Metals (Type I & II), VOC, and PAH. Various modifications have been conducted since then, however since the original assessment predicted pollutants to be significantly below the criteria, no cumulative assessments have been undertaken for some time. EPA has requested that a cumulative assessment be conducted including all existing and proposed sources up until and including MOD 13. The EPA also advised to include the following:

- PM_{2.5} (if PM₁₀ levels are significant)
- Hydrogen Fluoride (HF)
- Take into account background TSP levels (nearest monitoring station is Albion Park)

- Provide some commentary around what the available best practice emissions controls are.

3 Background air quality

The OEH runs a state wide air quality monitoring network, with the nearest monitoring site to Shoalhaven Starches being Albion Park South. Data from this station for the year 2016 was reviewed for this assessment and a summary is provided in Table 1. As discussed in the 2008 assessment, recorded ambient PM₁₀ levels recorded at Albion Park will likely be an over-estimate of the levels occurring near the project site. As such, GHD expect that a reasonable representation of ambient PM₁₀ (24-hour) concentration levels would be in the order of 15 – 20 µg/m³ (the 70th percentile at Albion Park South was 18.3 µg/m³). Background air quality from 2016 cannot be directly added to the model predictions which uses meteorology from 2004. Background air quality data at Albion Park South can be used as a guide to give indicative average totals over daily and longer timeframes.

Table 1 Background Air Quality Data – Albion Park South (2016)

Pollutant	Averaging Period	Concentration (100 percentile)	Units
Nitrogen dioxide (NO ₂)	1 hour	80.8	µg/m ³
	Annual	7.1	
Sulphur dioxide (SO ₂)	1 hour	57.6	µg/m ³
	24 hour	1.6	
	Annual	15.7	
Carbon monoxide (CO) ¹	1 hour	1.0	mg/m ³
	8 hour	0.6	
PM ₁₀	24 hours	43.2	µg/m ³
	Annual	14.9	
PM _{2.5}	24 hours	30.7	µg/m ³
	Annual	7.2	

¹ CO was sourced from the Wollongong monitoring station as this was not available at Albion Park South

In order to review potential maximum predicted impacts on days when the background PM₁₀ and PM_{2.5} levels are elevated, the top 10 days measured in 2016 at Albion Park South are presented in Table 2. Results show the maximum measured particulate levels drop considerably. Days with elevated particulate levels are often attributed to changes in weather, bushfires and dust storms.

Table 2 Top ten days for PM₁₀ and PM_{2.5} at Albion Park South 2016

Date	PM ₁₀	Date	PM _{2.5}
22/05/2016	43.1	22/05/2016	30.7
25/02/2016	40.5	07/05/2016	27.8
07/11/2016	37	29/04/2016	20.8
22/11/2016	36.7	09/05/2016	16.5
13/12/2016	36.3	05/12/2016	16.3
07/05/2016	34.4	07/11/2016	15.9
29/04/2016	34.3	21/10/2016	15.8
11/01/2016	33.4	10/03/2016	15.2
06/04/2016	32.7	24/01/2016	14.7
19/01/2016	32.6	19/01/2016	14.5

Shoalhaven Starches engaged Stephenson Environmental Management Australia to conduct targeted background ambient air quality monitoring at 26 Coomea Street, Bomaderry over four seasons. (AMBIENT AIR QUALITY MONITORING –SUMMARY REPORT 2015-2016, Stephenson Environmental Management Australia, April 2016). The maximum measured levels of pollutants measured over the monitoring periods with a 24 hour averaging period were:

- SO₂ – 10.2 µg/m³
- NO₂ – 54.5 µg/m³
- PM₁₀ – 28.1 µg/m³

The results show all pollutants are significantly lower than the levels recorded at Albion Park South, and would include any emissions from the Shoalhaven Starches site. The maximum levels all readily comply with the relevant criteria. Using the background data from Albion Park South in this assessment allows for additional conservatism.

4 Emissions inventory

Air emissions associated with the operation of the Shoalhaven Starches facility and proposed ethanol upgrade may include:

- Odour;
- Particulate matter; and
- Products of combustion.

Odour for MOD13 has been addressed in GHD's assessment "Shoalhaven Starches Mod 13 Air Quality Assessment Cumulative odour assessment".

- Emission rates used in the assessment are presented below in Table 3.

All modelling assumptions are the same as the 2008 Air Quality Assessment (GHD, 2006) with the exception of the following sources:

- Boiler 2, 4 and 5/6 have been based on monitoring data and scaled where appropriate
- Ring dryer 5 emissions based off measured in stack emissions and a flow rate of 853 m³/min
- Gluten dryer 7 based on data provided in the SEMA report "Stack Emission Survey – TSP emissions Gluten Dryers 6 and 7" (June 2014)
- Packing plant based on emission rates in the SEMA report "Air Quality Impact Assessment Proposed Modifications to Approved Packing Plant (December 2015)
- New flour mill B based on emission rates in the SEMA report "Air Quality Impact Assessment Proposed Flour Mill B (October 2016)

Table 3 Emission Inventory – Particulate Matter

Discharge Point	Emission Control	TSP g/s	PM ₁₀ g/s
Boiler No. 1	Gas-fired	0.07	0.07
Boiler No. 2	Cyclone and fabric filter	0.14	0.07
Boiler No. 3	Gas-fired	0.04	0.04
Boiler No. 4	Cyclone and fabric filter	0.25	0.13
Boiler No. 5/6	Cyclone & Fabric filter	1.03	0.53
Gluten dryer No. 1	Fabric filter	0.015	0.0003
Gluten dryer No. 2	Fabric filter	0.015	0.001
Gluten dryer No. 3	Fabric filter	0.02	0.02
Gluten dryer No. 4	Fabric filter	0.02	0.02
Starch dryer No. 1	Wet-scrubber	0.59	0.18
Starch dryer No. 3	Wet-scrubber	0.04	0.013
Starch dryer No. 4	Wet-scrubber	1.2	0.31
Starch dryer No. 5	Cyclone	0.39	0.12
Spray dryer	Fabric filter	0.48	0.14
Flour Mill	Fabric filter	0.03	0.009
DDG Pellet Plant	Fabric Filter	0.25	0.25

Discharge Point	Emission Control	TSP g/s	PM ₁₀ g/s
Packing Plant (proposed)	Fabric Filter	0.016	0.016
Flour Mill B (proposed)	Fabric Filter	0.0054	0.0054
Gluten dryer No. 6	Fabric filter	0.02	0.02
Gluten grinder	Fabric filter	0.02	0.02
Boiler No. 7	Gas-fired	0.07	0.07
Co-generator turbine No. 1 (proposed)	Gas-fired	0.1	0.1
Co-generator turbine No. 2 (proposed)	Gas-fired	0.1	0.1

All modelling assumptions for combustion sources are the same as the 2008 Air Quality Assessment (GHD, 2006) with the exception of the following:

- Manildra undertakes quarterly air quality sampling of the existing coal fired boiler (No. 5/6). A review of the sampling results for the last year shows that quarter 3 (sampling undertaken on 1 December 2016) has the highest overall emissions for most pollutants. Emissions were sourced from the Stephenson report "Compliance stack emission survey – Quarter No 3 2016-2017 Emission Survey – Boilers 5 & 6" (December 2016). Emissions from this boiler have been scaled to approximate emissions from Boiler 2 and Boiler 4 when they are converted to run on coal.
- Stack parameters for Boilers No. 2 and No. 4 were taken from SEMA report "Air quality impact assessment Proposed Modifications to boilers 2, 4 and 6" (June 2017).

Pollutants from combustion in the site boilers and turbines are presented in Table 4.

Table 4 Emission Inventory - Products of Combustion

Discharge Point ¹	Boiler No. 1	Boiler No. 2	Boiler No. 3	Boiler No. 4	Boiler No. 5/6	Boiler No. 7	Turbine No. 1 & 2
Status	Existing	Existing	Existing	Existing	Existing	Existing	Proposed
Fuel type	Natural gas	Coal	Natural gas	Coal	Coal	Natural gas	Natural gas
Stack height (m)	25	39	20	39	54	25	30
Exhaust temp. (°K)	180	138	180	138	150	180	160
Stack diameter (m)	0.9	0.63	0.9	1.16	2.05	1.0	0.5

Discharge Point ¹	Boiler No. 1	Boiler No. 2	Boiler No. 3	Boiler No. 4	Boiler No. 5/6	Boiler No. 7	Turbine No. 1 & 2
Exhaust velocity (m/s)	25	19.9	25	5.8	16.8	25	25
Oxygen (%)	ND	ND	ND	ND	9.2	ND	ND
Moisture (%)	ND	ND	ND	ND	6.6	ND	ND
Exhaust Flow rate (Nm ³ /s)	ND	4.5	ND	8.4	33.8	ND	ND
Emission rates (g/s)							
Carbon monoxide	0.82	0.59	0.42	1.09	4.39	0.82	0.3
Oxides of nitrogen	2.7	2.11	1.4	3.92	15.83	2.7	2.0
Sulphur dioxide	3.8E-05	2.54	2.0E-05	4.71	19.04	3.8E-05	0.012
Heavy metals (type 1)	2.0E-05	1.33E-04	1.0E-05	2.47E-04	9.99E-04	1.5E-05	ND
Heavy metals (type 2)	5.9E-05	2.22E-04	3.1E-05	4.12E-04	1.66E-03	5.9E-05	ND
Total VOC	5.3E-02	5.40E-03	2.8E-02	1.00E-02	4.05E-02	5.3E-02	4.2E-02
PAH	6.2E-06	3.67E-06	3.2E-06	6.82E-06	2.75E-05	6.2E-06	4.4E-05
HF	ND	2.91E-02	ND	5.40E-02	2.18E-01	ND	ND

ND: No Data.

5 Predicted impacts

5.1 Particulates

The air quality impacts of PM₁₀ and TSP emissions from Shoalhaven Starches operation have been assessed using atmospheric dispersion modelling.

The impact of dust emissions principally relates to the potential effect on human health on inhalation of particles in the air column, and it is the finer fraction (PM₁₀) that have the greater potential to cause respiratory health effects.

The worst case predicted incremental PM₁₀ level is at R1 with a level of 9.2 µg/m³. When added to the 70th percentile level of 18.3 µg/m³ the cumulative level is 27.5 µg/m³, which is well below the criteria of 50 µg/m³. When looking at the maximum measured levels at Albion Park South throughout the year in Table 2, only one day with an elevated PM₁₀ level of 43.1 µg/m³ would not comply with the criteria of 50

$\mu\text{g}/\text{m}^3$. It is unlikely that the measured background and predicted worst case level would occur on the same day.

EPA have advised to assess $\text{PM}_{2.5}$, if PM_{10} impacts are significant. The $\text{PM}_{2.5}$ emissions from many sources on site are not known, however guidance is available for estimates of $\text{PM}_{2.5}$ from boilers in the NPI. NPI emission factors for coal boilers with a baghouse states that $\text{PM}_{2.5}$ emissions are half of PM_{10} emissions and the ratio of $\text{PM}_{2.5}$ to PM_{10} in gas fired boilers is the same. $\text{PM}_{2.5}$ emissions for the site are expected to be much lower than PM_{10} , however results show even the predicted PM_{10} levels would comply with the $\text{PM}_{2.5}$ criteria which is $25 \mu\text{g}/\text{m}^3$ over a 24 hour period.

Table 5 Maximum Predicted Ground Level PM_{10} and TSP Concentrations

Pollutant	Averaging Period	Criteria $\mu\text{g}/\text{m}^3$	Predicted Incremental Ground Level Concentration ($\mu\text{g}/\text{m}^3$)			
			Bomaderry (R1)	North Nowra (R2)	Nowra (R3)	Terara (R4)
PM_{10}	24-hour	50	9.2	5.6	7.6	6.3
PM_{10}	annual	25	0.9	0.5	0.7	1.1
TSP	annual	90	2.0	1.0	1.4	2.2

Plots of the predicted 24 hour maximum PM_{10} levels are provided in Figure 1 (incremental impact) and in Figure 2 (cumulative impact with 70th percentile PM_{10} levels at Albion Park South 2016).





5.2 Products of combustion

The primary pollutants in coal and gas fired boiler emissions are oxides of nitrogen (NO_x), formed by the high temperatures in the combustors, sulphur dioxide (SO₂), formed from the sulphur content of the fuel, VOCs, polycyclic aromatic hydrocarbons (PAH), carbon monoxide (CO) and hydrogen fluoride (HF) all formed by incomplete combustion of the fuel.

NO₂, SO₂, and CO have all been assessed against their 'worst case' 1 hour criteria from the Approved Methods as these were found to be closest to the criteria in the 2008 assessment. Predicted levels all readily comply with the criteria

Table 6 Maximum Predicted Ground Level Sulphur Dioxide Concentrations

Receptor	Averaging Period	Incremental Impact (µg/m ³)	Background Concentration (µg/m ³)	Total Impact (µg/m ³)	Criteria (µg/m ³)
Bomaderry (R1)	1 hour	102	57.6	159	570
North Nowra (R2)	1 hour	66	57.6	124	570
Nowra (R3)	1 hour	70	57.6	128	570
Terara (R4)	1 hour	62	57.6	120	570

Table 7 Maximum predicted Ground Level Nitrogen Dioxide Concentrations

Receptor	Averaging Period	Incremental Impact (µg/m ³)	Background Concentration (µg/m ³)	Total Impact (µg/m ³)	Criteria (µg/m ³)
Bomaderry (R1)	1 hour	127	80.8	208	246
North Nowra (R2)	1 hour	94	80.8	175	246
Nowra (R3)	1 hour	127	80.8	207	246
Terara (R4)	1 hour	91	80.8	172	246

Table 8 Maximum Predicted Ground Level Carbon Monoxide Concentrations

Receptor	Averaging Period	Incremental Impact (mg/m ³)	Background Concentration (mg/m ³)	Total Impact (mg/m ³)	Criteria (mg/m ³)
Bomaderry (R1)	1 hour	0.04	1	1.04	30

Receptor	Averaging Period	Incremental Impact (mg/m ³)	Background Concentration (mg/m ³)	Total Impact (mg/m ³)	Criteria (mg/m ³)
North Nowra (R2)	1 hour	0.03	1	1.03	30
Nowra (R3)	1 hour	0.04	1	1.04	30
Terara (R4)	1 hour	0.03	1	1.03	30

Table 9 Maximum Predicted Ground Level Hydrogen Fluoride Concentrations

Receptor	Averaging Period	Incremental Impact (µg/m ³)	Background Concentration (µg/m ³)	Total Impact (µg/m ³)	Criteria (µg/m ³)
Bomaderry (R1)	24 hours	0.30	-	0.30	1.5
North Nowra (R2)	24 hours	0.23	-	0.23	1.5
Nowra (R3)	24 hours	0.18	-	0.18	1.5
Terara (R4)	24 hours	0.13	-	0.13	1.5

6 VOCS

The maximum predicted (99.9 percentile, 1-hour average) ground level aggregate VOC concentration, at and beyond the factory site boundary, was 0.001 mg/m³, which is lower than the respective EPA principal toxic air pollutant criteria for all the VOC compounds.

The maximum predicted (99.9 percentile, 1-hour average) ground level total VOC, at the most exposed sensitive receptor (R3), was 0.00025 mg/m³, which is lower than the respective EPA principal toxic air pollutant criteria for all the VOC compounds.

7 PAH

The maximum predicted (99.9 percentile, 1-hour average) ground level total PAH concentration, at and beyond the factory site boundary, was 4.2 x 10⁻⁷ mg/m³, which is lower than the EPA PAH criterion of 0.0004 mg/m³.

The maximum predicted (99.9 percentile, 1-hour average) ground level total PAH, at the most exposed sensitive receptor (R3), was 2.25 x 10⁻⁷ mg/m³, which is 0.05% of the criterion – that is more than 1000-fold below the criterion at the most exposed receptor.

8 Metals

The maximum predicted (99.9 percentile, 1-hour average) ground level heavy metal type 1 concentration, at the most exposed sensitive receptor (R1), was 0.0000038 mg/m³ which is lower than the respective air quality criteria for all constituents (the lowest is cadmium at 0.000018 mg/m³). The EPA criteria also require consideration of the maximum predicted ground level concentration at and beyond the site boundary of the factory. The maximum predicted level of type 1 metals at the site boundary is 0.0000073 mg/m³ which is also below the worst case criteria. This is shown in Table 10.

The maximum predicted (99.9 percentile, 1-hour average) ground level heavy metal type 2 concentration, at the most exposed receptor (R1), was 0.0000068 mg/m³, which is lower than the respective air quality criteria for all constituents, except for beryllium at 0.000004 mg/m³. The maximum predicted (99.9 percentile, 1-hour average) ground level beryllium concentration at the most exposed sensitive receptor (R1) was 0.000000068 mg/m³, which complies with the criterion.

The maximum predicted type 2 metals level at the site boundary is 0.000013 mg/m³ which is also below the worst case criteria except for beryllium. The maximum predicted (99.9 percentile, 1-hour average) ground level beryllium concentration at the site boundary is 0.0000013 mg/m³, which complies with the criterion. This is shown in Table 10.

Table 10 Maximum Predicted Ground Level Metals Concentrations

Pollutant	Receptor	Averaging Period	Predicted Impact (mg/m ³)	Criteria (mg/m ³)
Total type 1 metals	Bomaderry (R1)	1 hour	0.0000038	Cadmium 0.000018
Total type 1 metals	Site boundary	1 hour	0.0000073	Cadmium 0.000018
Total type 2 metals	Bomaderry (R1)	1 hour	0.0000068	Beryllium 0.000004
Total type 2 metals	Site boundary	1 hour	0.000013	Beryllium 0.000004
Beryllium	Bomaderry (R1)	1 hour	0.000000068	Beryllium 0.000004
Beryllium	Site boundary	1 hour	0.0000013	Beryllium 0.000004

9 Best practice controls

Based on this air quality assessment, compliance is predicted for all pollutants at sensitive receptors and the site boundary where relevant. GHD finds the current controls in place cyclone and fabric filters on Boilers 2, 4 and 5/6 to be best practice and no additional controls are currently recommended.

In the future, Shoalhaven Starches should include PM_{2.5} sampling on all sources of combustion emissions during commissioning and ongoing air quality sampling.

10 Conclusion

GHD has undertaken a cumulative air quality assessment of site wide emissions. Results of the assessment show compliance with the air quality goals at all nearby receptors and at the site boundary. Shoalhaven should continue to monitor air emissions in accordance with their licence requirements.

Sincerely
GHD Pty Ltd



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