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Response to Submission (RTS) for NSW EPA Comments DOC16/206758 for the Revised Air Quality Impact Assessment – Lightweight Aggregate Project – Brickworks, Horsley Park, NSW

1. INTRODUCTION

WillowTree Planning Pty Ltd (WillowTree), on behalf of Brickworks NSW Pty Ltd (Brickworks) commissioned Airlabs Environmental Pty Ltd (Airlabs) to undertake an Air Quality Impact Assessment (AQIA) for the proposed Lightweight Aggregate (LWA) Project, which would be developed at the existing Brickworks site at 780 Wallgrove Road, Horsley Park, NSW.

The original AQIA[1] (Report No: JAN15015.4) accompanying the Environmental Impact Statement (EIS) for the Project was issued on 2nd October, 2015 for public exhibition. Post the public exhibition period, comments were received for the AQIA from the New South Wales – Environment Protection Authority (NSW-EPA) (DOC15/485122, dated: 4th December, 2015)[2]. A revised AQIA[3] (Report No: FEB16028.1) addressing the NSW-EPA comments (dated: 4th December, 2015) was issued on the 31st March, 2016. The NSW-EPA then provided additional comments pertaining to the revised AQIA (Report No: FEB16028.1) on the 28th April, 2016 (DOC16/206758)[4]. This Response to Submissions (RTS) addresses the comments raised by NSW-EPA for the revised AQIA.

Brickworks and Airlabs met with the NSW-EPA on the 9th September, 2016 to discuss the comments raised in relation to the revised AQIA. In addition to providing responses to the comments received for the revised AQIA, this RTS also addresses issues raised by the NSW-EPA during the meeting with Brickworks and Airlabs.

This RTS is to be read in conjunction with the revised AQIA (Report No: FEB16028.1) issued by Airlabs on 31st March, 2016.

Please contact the undersigned if there are any questions or queries in regards to the contents presented in this RTS.

Bipin Bhensdadia
Senior Air Quality Consultant

Abhilash Aitharaju
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[1] *Air Quality Impact Assessment, Lightweight Aggregate (LWA) Project – Brickworks, Horsley Park, NSW, Report No: JAN15015.4*, Prepared for: McKenzie Group, 2nd October, 2015
[2] *Comments from the New South Wales – Environment Protection Authority (NSW-EPA), Air Quality Impact Assessment, Lightweight Aggregate Project*, DOC15/485122, 4th December, 2015
[3] *Revised Air Quality Impact Assessment, Lightweight Aggregate (LWA) Project – Brickworks, Horsley Park, NSW, Report No: FEB16028.1*, Prepared for: McKenzie Group, 31st March, 2016
[4] *Comments from the New South Wales – Environment Protection Authority (NSW-EPA), Revised Air Quality Impact Assessment, Lightweight Aggregate Project*, DOC16/206758, 28th April, 2016

2. COMMENTS AND CORRESPONDING RESPONSE

Comments issued by the NSW-EPA (DOC16/206758)[4] for the revised AQIA[3] (Report No: FEB16028.1) and Brickworks' response for the issued comments are discussed in this section.

Comments issued by the NSW-EPA are incorporated in this RTS as screenshots and the response to the specific comments are provided below.

2.1 Particulates

1) Particulates

The EPA notes that the revised assessment predicts cumulative impacts above NEPM standards for $PM_{2.5}$ (annual) at discrete receptors assessed. The predicted concentrations are largely attributable to background concentrations, with particulate emissions from the proposal likely to be attributed to fugitive sources related to material handling.

The EPA considers that the Proponent should adopt proactive and reactive management measures for particulate matter and include the management measures within an Air Quality Management Plan for the site.

Dispersion modelling results presented in the revised AQIA[3] (Report No: FEB16028.1) predict exceedance of the National Environment Protection Measures (NEPM) annual average standard for $PM_{2.5}$ at the identified discrete receptors for LWA Stage 1 (300,000 tonne per annum) and Stage 2 (600,000 tonne per annum) operations. However, it is observed that the Project's contributions to the cumulative annual average $PM_{2.5}$ concentrations are circa. 10%, which has been agreed by NSW-EPA. $PM_{2.5}$ emissions from the Project are largely attributed to fugitive sources related to material handling.

To effectively adopt and implement proactive and reactive management measures for particulate matter, an Air Quality Management Plan (AQMP) has been prepared by Brickworks through correspondence with Airlabs.

Brickworks Light Weight Aggregate Project – Stage 1 and Stage 2 Operations

Air Quality Management Plan

1.0 INTRODUCTION

This Air Quality Management Plan (AQMP) is a document that has been prepared by Brickworks through consultation with Airlabs to manage and minimise particulate matter emissions generated from fugitive sources associated with brick manufacturing and LWA manufacturing. The AQMP aims to ensure that fugitive particulate matter emissions generated from the operational activities comply with relevant regulatory guidelines for the protection of human health and well-being.

This AQMP outlines the dominant sources of fugitive particulate matters associated with the operational activities for the existing brick manufacturing and proposed LWA manufacturing (Stage 1 and Stage 2) operations.

This AQMP deals with source identification and management measures specific to operational activities associated with existing brick manufacturing operations and proposed Stage 1and Stage 2 LWA operations. Particulate matter emissions generated from construction activities and their management measures have been addressed in Section 6.9 of the revised AQIA[3] (Report No: FEB16028.1)

2.0 SPECIFIC OBJECTIVES

Specific objectives of the AQMP are to:

- Effectively manage and control particulate matter emissions generated from existing brick manufacturing and Stage 1 and Stage 2 LWA operations;
- Ensure that operations do not adversely impact air quality at the receptors identified in the revised AQIA[3] (Report No: FEB16028.1);
- Implement identified control measures to effectively manage and contain particulate matter emissions generated from existing brick manufacturing and Stage 1 and Stage 2 LWA operations;
- Undertake dust monitoring to assess effectiveness of the mitigation measures;
- Allocate specific responsibilities for effective management of air quality.

3.0 IDENTIFICATION OF FUGITIVE PARTICULATE MATTER EMISSION SOURCES

Key material handling sources associated with existing brick manufacturing and proposed Stage 1and Stage 2 LWA operations that have the potential to generate fugitive particulate emissions have been identified from the emissions inventory prepared in the revised AQIA[3] (Report No: FEB16028.1) and are presented below.

- Haul trucks unloading material;
- Loading and unloading operations via front end loader (FEL);
- Material handling / conveying activities;
- Crushing and grinding operations;
- Heavy vehicle haulage on gravel surfaces;
- Wind erosion from raw and product stockpiles.

4.0 IDENTIFICATION OF PROACTIVE DUST CONTROL MEASURES

To effectively manage and minimise fugitive particulate emissions generated from the aforementioned key sources, a variety of proactive dust control measures have been identified, which are summarised below. These control measures will be implemented at all times during the operational activities.

- Real-time weather monitoring stations providing data on wind speed, direction and rainfall can be used to manage daily operational activities. Weather monitoring stations also assist with the dust management strategies and identify periods of adverse meteorological conditions during which additional mitigation measures would be commissioned to contain particulate emissions. Furthermore, weather monitoring systems provide guidance on determining appropriate material drop heights (for trucks and FELs), vehicle haulage speeds and scheduling of material handing activities which have the potential to generate particulate matter. Moreover, rainfall data can be used to provide better scheduling of water carts. Brickworks plan to install a real-time weather monitoring station as a part of the proactive dust management system;
- Crushing operations will be undertaken in enclosed facilities. In addition to enclosed facilities, water sprays would be used to suppress dust generation from the operations;
- Grinding and screening operations will be undertaken in enclosed facilities. In addition to enclosed facilities, water sprays would be used to suppress dust generation from the operations;
- Dust generation from light and heavy vehicle haulage on unsealed surfaces is a key source. Based on the control efficiencies used for estimating particulate emission rates for haulage from light and heavy vehicles, it is understood that the following measures will be implemented by Brickworks:
    - Usage of watercarts to wet down haul roads twice a day;
    - Implementing speed restrictions of 40km/hour for light and heavy vehicles whilst travelling on any unsealed surfaces inside the facility;
    - Application of gravel and or suitable materials on long-term and frequently used haul roads.
- Conveying of materials will be enclosed as practicable as possible. Water sprays will be utilised to suppress dust generation;
- Wind erosion from stockpiles will be minimised by utilisation of water carts and providing wind-breaks wherever possible;
- Any large exposed area which is not in use will be progressively vegetated or rehabilitated to minimise the potential for dust generation;
- All haul trucks transporting material to and from the Project site would be fully covered to prevent windblown dust emissions and spillage;
- Spillage of material from loading and unloading operations will be minimised;
- Any spillage will be cleaned up as soon as practicable.

5.0 REACTIVE DUST CONTROL MEASURES

Reactive dust management measures will be undertaken using visual inspection of any significantly visible dust plumes in conjunction with real-time wind data. Under normal weather conditions, particulate emissions will be managed through the proactive dust control measures. However, during adverse weather conditions an electronic alarm will trigger a "*Critical Wind Alert*", which corresponds to a wind speed threshold of 7.5m/sec in any direction.

The *Critical Wind Alert* of 7.5m/sec in any direction typically represents the capacity of the wind to carry dust a sufficient distance to other potential receptors and in sufficient quantities to cause a nuisance[5]. Trigger of the *Critical Wind Alert* for at least two consecutive hours will initiate the requirements for additional mitigation measures presented below. The additional mitigation measures will be undertaken until such time that no significant visible dust plumes are observed from the identified dust sources. The trigger for initiating additional mitigation measures include:

- Significant visible dust plumes emanating within the Project site boundary; **or**
- *Critical Wind Alert* for two consecutive hours.

Additional mitigation measures include:

- Increasing intensity of water sprays for crushing operations;
- Increasing intensity of water sprays for grinding and screening operations;
- Increasing the frequency of watering of haul roads from twice a day to four times a day;
- Implementing speed restrictions of 30km/hour for light and heavy vehicles whilst travelling on any unsealed surfaces inside the facility;
- Increasing intensity of water sprays during conveying of materials;
- Increasing intensity of water sprays on stockpiles and large exposed areas; and
- Expedite cleaning of any material spillage.

[5] *Gunns Limited: Bell Bay Pulp Mill Management Plan*, available online at (http://www.gunnspulpmill.com.au/permits/Dust_Management_Plan.pdf), accessed: 27th October, 2016

6.0 SUMMARY OF DUST CONTROL MEASURES

A summary of the proactive and reactive dust control measures that would be implemented by Brickworks are presented in **Table 1**.

Table 1: Summary of Dust Mitigation Measures

<table>
<tr><th>Dust Control Measures
To be implemented at all times</th><th>Trigger for Additional Mitigation Measures</th><th>Additional Mitigation Measures</th></tr>
<tr><td>Use of water sprays for crushing operations</td><td rowspan="10">Significant visible dust plumes emanating within the Project site boundary

or

Critical Wind Alert (i.e. wind speeds > 7.5m/sec in any direction) for at least two consecutive hours</td><td>Increase intensity of water sprays</td></tr>
<tr><td>Use of water sprays for grinding and screening operations</td><td>Increase intensity of water sprays</td></tr>
<tr><td>Use of watercarts to water unpaved surfaces twice a day</td><td>Increase frequency of watering to four times a day</td></tr>
<tr><td>Imposing speed restrictions of 40km/hour for all light and heavy vehicles whilst travelling on any unsealed surfaces</td><td>Reduction of hauling speed to 30 km/hr</td></tr>
<tr><td>Use of water sprays during conveying of material</td><td>Increase intensity of water sprays</td></tr>
<tr><td>Provision of wind breaks and watering of stockpiles to minimise wind erosion</td><td>Increase intensity of water sprays</td></tr>
<tr><td>Progressive vegetation or rehabilitation for any large exposed areas</td><td>Use of water sprays</td></tr>
<tr><td>Covering haul trucks while transporting material to and from the Project site</td><td>Ensuring all haul trucks are fully covered</td></tr>
<tr><td>Minimising spillage from loading and unloading operations.</td><td>Ensuring spillage is minimum</td></tr>
<tr><td>Cleaning spillage as soon as practicable.</td><td>Expedite cleaning of any material spillage</td></tr>
</table>

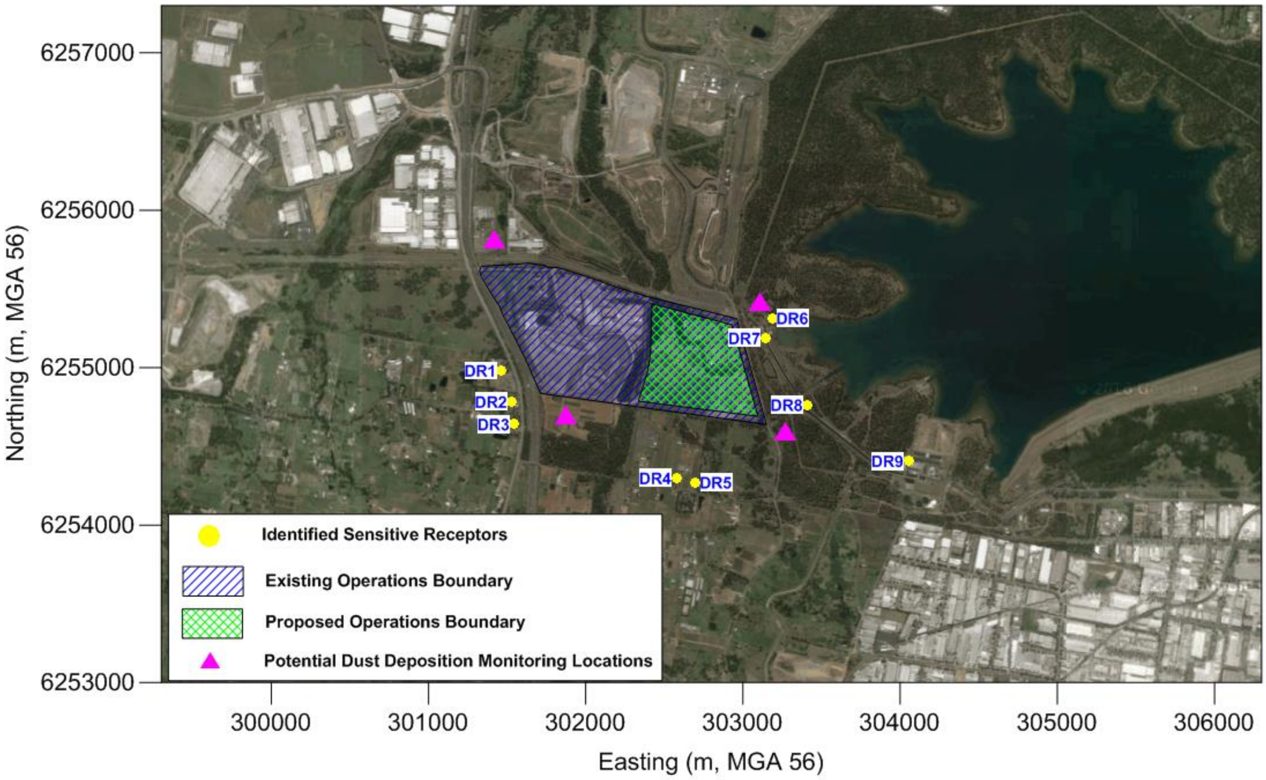
If in the event that dust levels cannot be managed and controlled despite implementation of the additional mitigation measures, it is recommended that all operational activities be suspended until such time that no significant visible dust plumes are observed within the Project site boundary.

7.0 DUST MONITORING

The following dust monitoring activities are being proposed by Brickworks:

- Visual monitoring of stockpiles, haul roads and other dust sources on a regular basis to assess the effectiveness of dust control measures employed during normal weather conditions;
- Real-time weather monitoring of wind speeds, direction and rainfall. *Critical Wind Alert* would be issued to all operators when wind speeds exceed 7.5m/sec in any direction for at least two consecutive hours;
- Compliance monitoring in the form of deposited dust, assessed as insoluble solids. Dust deposition monitoring will be undertaken in accordance with *AS/NZS 3580.10.1:2003: Methods for sampling and analysis of ambient air – Determination of particulate matter – Deposited matter – Gravimetric method.*
- Deposition monitoring will be undertaken at four locations (two upwind and two downwind) to measure long-term impacts of nuisance dust. The exact location of the deposition gauges will be determined through consultation between Brickworks and Airlabs prior to commencing the monitoring program.

Figure 1: Location of Potential Dust Deposition Gauges



8.0 REPORTING OF MONITORING PROPGRAM

Results from the monthly dust deposition monitoring program will be summarised and submitted to the NSW-EPA on an annual basis to coincide with the annual stack emissions monitoring program. Monthly deposited dust levels across all the monitoring locations will be compared to the criterion of 4 g/m^2/month which is the total deposited dust level.

9.0 COMPLAINT MANAGEMENT

All complaints concerning air quality (including dust) would be considered and registered. Complaints will be recorded and investigated to identify the cause and corrective measures will be implemented if required. The Complaints Register will document information pertaining to:

- Date and time of the complaint;
- Details of the complaint;
- Prevailing meteorological conditions during the time of the complaint;
- Identifying the cause of the complaint;
- Corrective measures initiated to address the complaint.

It is expected that all the complaints and their investigations and outcomes will be kept for a minimum period of three years.

10.0 ROLES AND RESPONSIBILITES

Air quality management roles and responsibilities are summarised in **Table 2**.

Table 2: Roles and Responsibilities

Responsibility	Project Manager	Environmental Manager	Operators and Contractors
Air Quality Management Plan (AQMP) is implemented at all times during the Project	√		
Proactive dust control measures are implemented at all times during normal meteorological conditions		√	√
Identification of trigger events (significant visible dust clouds)		√	√
Identification of trigger events (Critical Wind Alert)		√	
Notification to operators about trigger events		√	
Implementation of additional mitigation during trigger events		√	√
Training of operators and contractors in undertaking dust management measures		√	
Addressing community complaints to ensure all complaints are investigated and appropriate mitigation measures are put in place	√	√	
Annual reporting of deposited dust monitoring results	√	√	

The AQMP would be updated whenever there are any changes in the operational activities or when changes have been made to the dust control measures.

2.2 Commissioning of Scrubber

> 2) Emission Control Measures – Wet Scrubber
>
> The assessment outlines the installation of a wet scrubber during phase 2 of the proposed LWA facility to reduce particulate, fluoride, hydrogen chloride and sulphur dioxide emissions. However, the EPA notes that existing operations represent a large portion of emissions for compounds that the wet scrubber would aim to mitigate. The EPA considers that the Proponent should commit to installing the proposed wet scrubber prior to undertaking construction and operation of Stage 1 of the proposal, on the basis that:
>
> a) Existing sources represent the highest emission load for HF;
> b) The assessment only considers existing operations for Plant 2 at half capacity. There is no guarantee that this operation will continue to operate at half capacity;
> c) The assessment predicts concentrations equal to the impact assessment criteria for Stage 1; and
> d) Reasonable and feasible controls have been identified by the proponent as available for implementation.
>
> *The EPA recommends that the Proponent commit to installing the proposed wet scrubber prior to undertaking construction and operation of Stage 1 of the proposed LWA facility.*

- The NSW-EPA in their comments concerning the scrubber note that the existing operations (i.e. brick manufacturing operations) represent a large portion of the Hydrogen Fluoride (HF) emissions;

- As a part of the LWA Project, Brickworks propose to commission a scrubbing system during both Stage 1 and Stage 2 operations. Based on the literature provided by the supplier of the scrubber system it is understood that $Ca(OH)_2$ would be injected into the airstream for scrubbing before the airstream passing through a series of bag filters. The proposed $Ca(OH)_2$ injection and bag filter system is expected to reduce fluoride (as HF) emissions by 95% as per specifications provided by the supplier (refer **Figure 3**);

- During the meeting with NSW-EPA on the 9th September, 2016, it was brought to Brickworks' and Airlabs' attention that because reasonable and feasible controls have been identified (i.e. scrubber for Stage 1 and Stage 2 LWA operations) for reducing HF emissions, NSW-EPA expects that a similar system be installed on the existing Plant 2 operations prior to undertaking construction and operation works for the LWA Project;

- Taking into consideration the NSW-EPA position on existing HF emissions, <u>Brickworks have agreed to install a *Cascade Scrubber* system for Plant 2 to reduce the HF emissions. The *Cascade Scrubber* system would be installed on the existing Plant 2 operations prior to undertaking construction and operation works for the Stage 1 LWA Project</u>;

- As per the Good Practice Guide (1999)[6] for reducing fluoride emissions in bricks, tile and pipe manufacture, a typical *Cascade Scrubber* system also known was a dry bed limestone scrubbing system consists of a silo containing a granular bed of limestone chips through which the flue gases pass. Contaminants within the gas react with the limestone and are removed. The limestone flows continuously from top to bottom through the silo and is usually recycled. Although the system is designed to reduce fluorides, it also removes low levels of chloride and sulfur oxides. A typical *Cascade Scrubber* system is illustrated in **Figure 4**;

[6] *Reducing Fluoride Emissions in Brick, Tile and Pipe Manufacture, Good Practice Guide*, published by the Environmental Technology Best Practice Programme, January 1999

- The *Cascade Scrubber* system which is a dry scrubbing system using limestone as a sorption medium is typically expected to reduce HF emissions by approximately 95% (US-EPA, 1997)[7]
- Ektimo (2015) undertook stack emissions monitoring in December 2015 for a brick manufacturing facility owned and operated by The Austral Brick Company (Brickworks) in Craigieburn, Victoria[8]. Testing was undertaken to meet the Victorian EPA Licence (No.11517) requirements and to determine the efficiency of the *Cascade Scrubber* system installed on the Wollert East Kiln. Based on the results presented in Ektimo (2015), the efficiency of the Wollert East Kiln scrubbing unit for water soluble fluoride (as HF) was observed to be 92% (refer **Figure 5**). The efficiency was determined based on the difference in average concentrations measured at the inlet and outlet;
- Based on the above referenced literature, it is expected that the *Cascade Scrubber* system would offer a 90-95% control efficiency in reducing HF emissions from Plant 2;
- To determine the improvements in the HF ground level concentrations, revised dispersion modelling was undertaken. The revised dispersion modelling exercise takes into account the following HF emission control systems:
  - Plant 1 (existing operations) – no HF controls
  - Plant 2 (existing operations) – Installation of a Cascade Scrubber – providing a 95% control efficiency for HF emissions
  - Stage 1 LWA operations – $Ca(OH)_2$ injection and bag filter system – providing a 95% control efficiency for HF emissions
  - Stage 2 LWA operations – $Ca(OH)_2$ injection and bag filter system – providing a 95% control efficiency for HF emissions
- The revised HF emission rates used in the dispersion model are summarised below in **Table 3**.

[7] *Chapter 11.3 Brick and Structural Clay Product Manufacturing*, AP-42 Emission Factors, United States – Environmental Protection Agency (US-EPA), 1997

[8] *Emission Testing Report, East Kiln – December 2015, The Austral Brick Company (Wollert), VIC, Report No: R002102, Ektimo*

Table 3: Revised HF Emission Rates

Source	HF Emission Rate (g/sec)	Notes
Plant 1 – Existing Operations	0.63	• Airlabs, December 2015[9]
Plant 2 – Existing Operations	0.01735 [(a)]	• HF emission rate estimated from Plant 1 stack emission test data (Airlabs, December 2015)[9] • Plant 2 HF emission rates determined by scaling emission rates from Plant 1 based on respective annual brick production rates (55,115,000 bricks for Plant 1 and 30,000,000 bricks for Plant 2) and implementation of Cascade Scrubber – which provides a 95% reduction efficiency
LWA – Stage 1 Operations – 100% Natural Gas	0.14	• Refer Section 6.5 of the revised AQIA[3] (Report No: FEB16028.1)
LWA – Stage 1 Operations – 100% Pulverised Coal	0.04	
LWA – Stage 2 Operations – 100% Natural Gas	0.28	
LWA – Stage 2 Operations – 100% Pulverised Coal	0.08	

(a) *Based on discussions between Brickworks and Airlabs, it is understood that the annual brick production rate at Plant 2 would not exceed the stipulated 30,000,000 bricks despite implementation of the Cascade Scrubber System. As-such, the ratio of 0.55 (determined from production rate of Plant 2 / production rate of Plant 1) for estimating Plant 2 emission rates would still be applicable*

- Ground level incremental and cumulative HF concentrations determined from the revised modelling exercise have been predicted at each of the sensitive receptors identified in the revised AQIA[3] (Report No: FEB16028.1) and are presented in **Table 4** to **Table 9**;
- As mentioned in the revised AQIA[3] (Report No: FEB16028.1), the 90-day average and 24-hour average HF impacts have been identified as the key pollutant across all the modelling scenarios (i.e. existing operations, Stage 1 and Stage 2 LWA operations). As-such, concentration isopleths for these pollutants obtained from the revised dispersion modelling are presented in **Appendix A**.

[9] *Air Emissions Monitoring of the Kiln 1 Exhaust Duct (DP4) at the Austral Bricks Horsley Park – Plant1, Date of Testing: 9th June, 2015*, Airlabs Environmental, December 2015

Table 4: Predicted Incremental and Cumulative HF Ground Level Concentrations at Receptors – Existing Operations without Cascade Scrubber on Plant 2

Pollutant	Criteria (µg/m³)	Bkg. Conc. (µg/m³)	Av. Period	Predicted Incremental Concentrations (µg/m³)									Predicted Cumulative Concentrations (µg/m³)								
				DR1	DR2	DR3	DR4	DR5	DR6	DR7	DR8	DR9	DR1	DR2	DR3	DR4	DR5	DR6	DR7	DR8	DR9
HF	2.90	N.A.	24-Hr	1.22	0.92	1.03	0.62	0.71	1.38	1.89	0.85	0.47	1.22	0.92	1.03	0.62	0.71	1.38	1.89	0.85	0.47
	1.70	N.A.	7-Days	0.39	0.32	0.30	0.26	0.29	0.41	0.42	0.38	0.21	0.39	0.32	0.30	0.26	0.29	0.41	0.42	0.38	0.21
	0.84	N.A.	30-Days	0.31	0.28	0.21	0.21	0.22	0.32	0.35	0.23	0.12	0.31	0.28	0.21	0.21	0.22	0.32	0.35	0.23	0.12
	0.50	N.A.	90-Days	0.22	0.20	0.16	0.17	0.17	0.27	0.26	0.17	0.08	0.22	0.20	0.16	0.17	0.17	0.27	0.26	0.17	0.08

Green text indicates compliance with relevant assessment criteria

Table 5: Predicted Incremental and Cumulative HF Ground Level Concentrations at Receptors – Existing Operations with Cascade Scrubber on Plant 2

Pollutant	Criteria (µg/m³)	Bkg. Conc. (µg/m³)	Av. Period	Predicted Incremental Concentrations (µg/m³)									Predicted Cumulative Concentrations (µg/m³)								
				DR1	DR2	DR3	DR4	DR5	DR6	DR7	DR8	DR9	DR1	DR2	DR3	DR4	DR5	DR6	DR7	DR8	DR9
HF	2.90	N.A.	24-Hr	1.18	0.86	0.99	0.50	0.46	0.61	0.60	0.40	0.26	1.18	0.86	0.99	0.50	0.46	0.61	0.60	0.40	0.26
	1.70	N.A.	7-Days	0.36	0.28	0.25	0.17	0.16	0.16	0.20	0.20	0.12	0.36	0.28	0.25	0.17	0.16	0.16	0.20	0.20	0.12
	0.84	N.A.	30-Days	0.26	0.22	0.16	0.12	0.11	0.10	0.11	0.11	0.06	0.26	0.22	0.16	0.12	0.11	0.10	0.11	0.11	0.06
	0.50	N.A.	90-Days	0.18	0.15	0.13	0.08	0.07	0.07	0.08	0.07	0.04	0.18	0.15	0.13	0.08	0.07	0.07	0.08	0.07	0.04

Green text indicates compliance with relevant assessment criteria

Table 6: Predicted Incremental and Cumulative HF Ground Level Concentrations at Receptors – Stage 1 Operations (100% Pulverised Coal)

Pollutant	Criteria (µg/m³)	Bkg. Conc. (µg/m³)	Av. Period	Predicted Incremental Concentrations (µg/m³)									Predicted Cumulative Concentrations (µg/m³)								
				DR1	DR2	DR3	DR4	DR5	DR6	DR7	DR8	DR9	DR1	DR2	DR3	DR4	DR5	DR6	DR7	DR8	DR9
HF	2.90	N.A.	24-Hr	1.18	0.87	1.00	0.51	0.48	0.61	0.62	0.50	0.29	1.18	0.87	1.00	0.51	0.48	0.61	0.62	0.50	0.29
	1.70	N.A.	7-Days	0.36	0.29	0.26	0.18	0.17	0.19	0.21	0.24	0.14	0.36	0.29	0.26	0.18	0.17	0.19	0.21	0.24	0.14
	0.84	N.A.	30-Days	0.26	0.23	0.17	0.13	0.12	0.13	0.13	0.13	0.07	0.26	0.23	0.17	0.13	0.12	0.13	0.13	0.13	0.07
	0.50	N.A.	90-Days	0.18	0.16	0.13	0.10	0.09	0.11	0.11	0.09	0.05	0.18	0.16	0.13	0.10	0.09	0.11	0.11	0.09	0.05

Green text indicates compliance with relevant assessment criteria

Table 7: Predicted Incremental and Cumulative HF Ground Level Concentrations at Receptors – Stage 1 Operations (100% Natural Gas)

Pollutant	Criteria (µg/m³)	Bkg. Conc. (µg/m³)	Av. Period	Predicted Incremental Concentrations (µg/m³)									Predicted Cumulative Concentrations (µg/m³)								
				DR1	DR2	DR3	DR4	DR5	DR6	DR7	DR8	DR9	DR1	DR2	DR3	DR4	DR5	DR6	DR7	DR8	DR9
HF	2.90	N.A.	24-Hr	1.19	0.88	1.01	0.55	0.52	1.04	0.87	0.76	0.38	1.19	0.88	1.01	0.55	0.52	1.04	0.87	0.76	0.38
	1.70	N.A.	7-Days	0.37	0.30	0.27	0.20	0.24	0.42	0.29	0.33	0.18	0.37	0.30	0.27	0.20	0.24	0.42	0.29	0.33	0.18
	0.84	N.A.	30-Days	0.28	0.24	0.18	0.15	0.16	0.27	0.22	0.19	0.09	0.28	0.24	0.18	0.15	0.16	0.27	0.22	0.19	0.09
	0.50	N.A.	90-Days	0.19	0.17	0.14	0.12	0.13	0.22	0.19	0.14	0.07	0.19	0.17	0.14	0.12	0.13	0.22	0.19	0.14	0.07

Green text indicates compliance with relevant assessment criteria

Table 8: Predicted Incremental and Cumulative HF Ground Level Concentrations at Receptors – Stage 2 Operations (100% Pulverised Coal)

Pollutant	Criteria (µg/m³)	Bkg. Conc. (µg/m³)	Av. Period	Predicted Incremental Concentrations (µg/m³)									Predicted Cumulative Concentrations (µg/m³)								
				DR1	DR2	DR3	DR4	DR5	DR6	DR7	DR8	DR9	DR1	DR2	DR3	DR4	DR5	DR6	DR7	DR8	DR9
HF	2.90	N.A.	24-Hr	1.19	0.87	1.00	0.53	0.50	0.61	0.63	0.59	0.33	1.19	0.87	1.00	0.53	0.50	0.61	0.63	0.59	0.33
	1.70	N.A.	7-Days	0.36	0.29	0.26	0.19	0.19	0.26	0.23	0.27	0.15	0.36	0.29	0.26	0.19	0.19	0.26	0.23	0.27	0.15
	0.84	N.A.	30-Days	0.27	0.23	0.17	0.14	0.14	0.18	0.16	0.16	0.08	0.27	0.23	0.17	0.14	0.14	0.18	0.16	0.16	0.08
	0.50	N.A.	90-Days	0.19	0.17	0.14	0.11	0.10	0.16	0.15	0.11	0.06	0.19	0.17	0.14	0.11	0.10	0.16	0.15	0.11	0.06

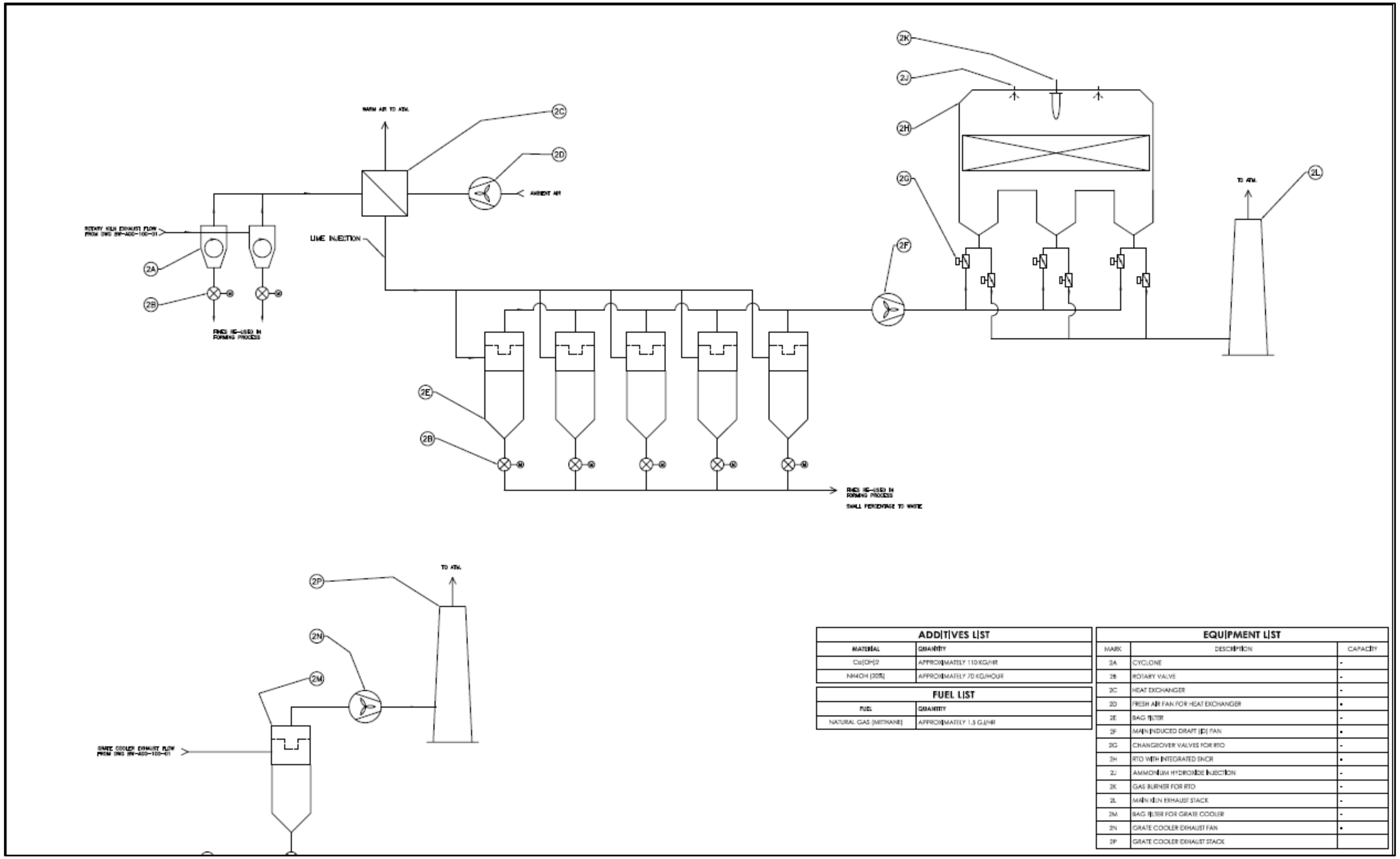
Green text indicates compliance with relevant assessment criteria

Table 9: Predicted Incremental and Cumulative HF Ground Level Concentrations at Receptors – Stage 2 Operations (100% Natural Gas)

Pollutant	Criteria (µg/m³)	Bkg. Conc. (µg/m³)	Av. Period	Predicted Incremental Concentrations (µg/m³)									Predicted Cumulative Concentrations (µg/m³)								
				DR1	DR2	DR3	DR4	DR5	DR6	DR7	DR8	DR9	DR1	DR2	DR3	DR4	DR5	DR6	DR7	DR8	DR9
HF	2.90	N.A.	24-Hr	1.20	0.90	1.02	0.61	0.76	1.82	1.75	1.23	0.59	1.20	0.90	1.02	0.61	0.76	1.82	1.75	1.23	0.59
	1.70	N.A.	7-Days	0.38	0.31	0.29	0.25	0.32	0.82	0.63	0.45	0.23	0.38	0.31	0.29	0.25	0.32	0.82	0.63	0.45	0.23
	0.84	N.A.	30-Days	0.30	0.27	0.20	0.19	0.22	0.49	0.44	0.27	0.12	0.30	0.27	0.20	0.19	0.22	0.49	0.44	0.27	0.12
	0.50	N.A.	90-Days	0.21	0.19	0.16	0.16	0.18	0.37	0.34	0.21	0.09	0.21	0.19	0.16	0.16	0.18	0.37	0.34	0.21	0.09

Green text indicates compliance with relevant assessment criteria

Figure 2: Updated Process Flow Diagram – Lightweight Aggregate Manufacturing



ADDITIVES LIST	
MATERIAL	QUANTITY
Ca(OH)2	APPROXIMATELY 110 KG/HR
NH4OH (20%)	APPROXIMATELY 70 KG/HOUR

FUEL LIST	
FUEL	QUANTITY
NATURAL GAS (METHANE)	APPROXIMATELY 1.5 GJ/HR

EQUIPMENT LIST		
MARK	DESCRIPTION	CAPACITY
2A	CYCLONE	-
2B	ROTARY VALVE	-
2C	HEAT EXCHANGER	-
2D	FRESH AIR FAN FOR HEAT EXCHANGER	-
2E	BAG FILTER	-
2F	MAIN INDUCED DRAFT (ID) FAN	-
2G	CHANGEOVER VALVES FOR RTO	-
2H	RTO WITH INTEGRATED SNCR	-
2J	AMMONIUM HYDROXIDE INJECTION	-
2K	GAS BURNER FOR RTO	-
2L	MAIN KILN EXHAUST STACK	-
2M	BAG FILTER FOR GRATE COOLER	-
2N	GRATE COOLER EXHAUST FAN	-
2P	GRATE COOLER EXHAUST STACK	

Figure 3: Fluoride Absorption Rates Proposed by Supplier of the Scrubber System for Stage 1 and Stage 2 LWA operations

Noxious substances in the raw gas			absorption rate	stöch. Faktor	Ca(OH)2 stöch.	absorbed components
	mg/Nm^3	kg/h	%		kg/h	kg/h
HF	709	46,52	95	1,85	81,754	44,192
HCl	147	9,645	35	1,01	3,409	3,376
SO_2	217	14,24	40	1,16	6,606	5,695
SO_3	200	13,122	90	0,93	10,983	11,810
Dust	20	1,312	100			

Figure 4: A typical layout of a Cascade Scrubber System to be installed at Plant 2

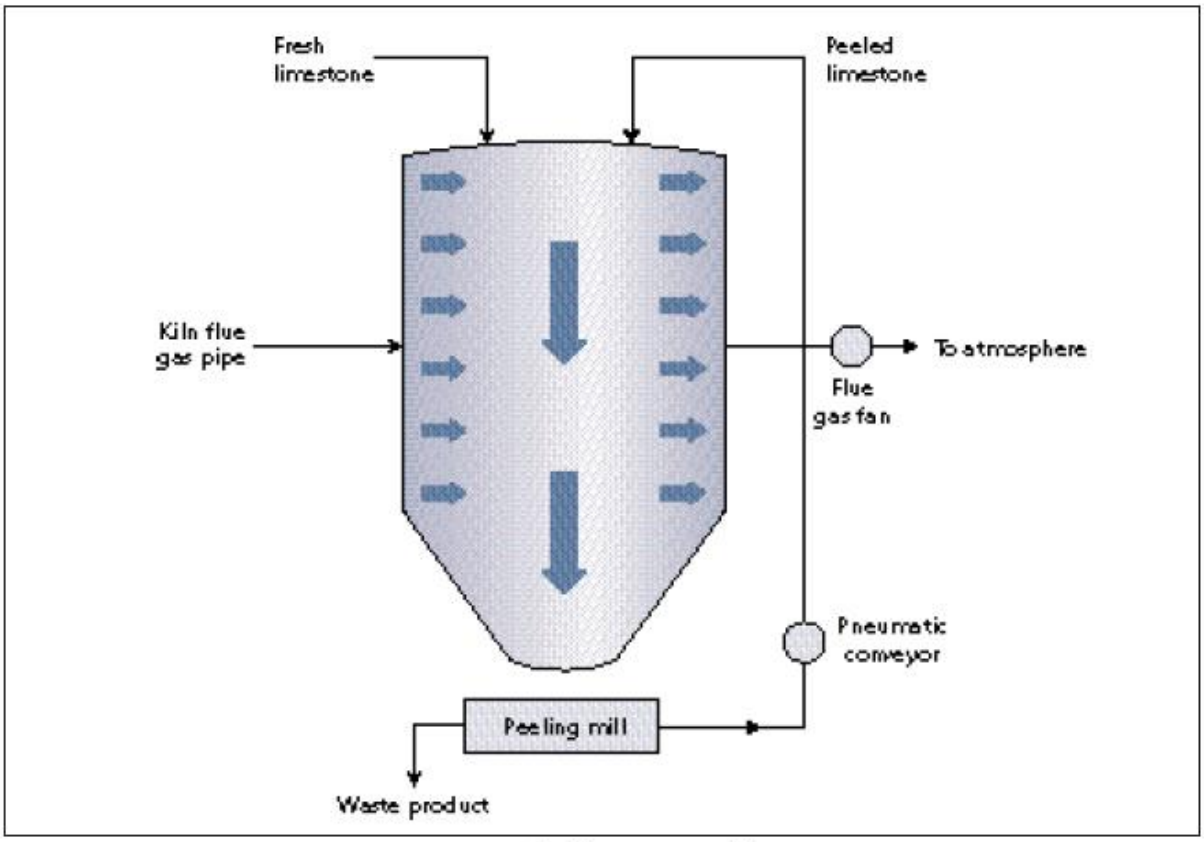


Fig 3 Dry bed limestone scrubber

Referenced from the Good Practice Guide (1999)6

Figure 5: Efficiency of the HF Scrubbing System – The Wollert East Kiln – Ekitmo 2015

Parameter	Inlet Concentration (mg/m3)	Exit Concentration (mg/m3)	Scrubber Efficiency (%)
Water soluble fluoride (as HF)	220	18	92
Hydrogen chloride (as HCl)	250	200	20

2.3 Emission Performance of Regenerative Thermal Oxidiser (RTO)

> 3) Emission Performance of Regenerative Thermal Oxidiser (RTO)
>
> A detailed description of the RTO has not been included within the assessment, notably the purpose of the "*integrated SCR*" component. If the SCR component has been incorporated to reduce NOx emissions, control efficiencies should be included within the assessment.
>
> Additionally the EPA notes that the emission estimates for the proposal are based on emission factors that are represented as quantity of pollutant per quantity of material produced. On this basis it is not clear if the assessment includes emissions from the fuel used for operation of the RTO (if required), any NOx generation from the RTO (if it occurs), or any NOx reduction from the SCR component (if it occurs).
>
> The process diagram also outlines the injection of Ammonium Hydroxide within the RTO. Further information is required to clarify the use of Ammonium Hydroxide, including an assessment of ammonia emissions from the proposal.
>
> *The EPA requests further information to:*
>
> - *Clarify the SCR component of the proposed emission controls;*
> - *Outline any control efficiencies and emissions associated with the SCR component of the RTO, specifically for NOx and ammonia;*
> - *Include an assessment of ammonia discharges from the process;*
> - *Clarify that the assessment has adequately considered emissions from fuel used for all operations (including the RTO); and*
> - *Revise the Air Quality Impact Assessment where required, to address the comments above.*

- Brickworks are proposing to install a Regenerative Thermal Oxidiser (RTO) in the emissions control system for Stage 1 and Stage 2 of the LWA Project. The RTO will treat organic emissions generated from the rotary kiln such as Volatile Organic Compounds (VOCs) and Carbon Monoxide (CO). Brickworks are proposing to install an RTO system incorporating a Selective Non-Catalytic Reduction (SNCR) mechanism to effectively reduce NO_x emissions generated from the LWA manufacturing, which includes emissions generated from the RTO itself. A brief description of the RTO incorporating the SNCR is provided below:
  - Oxidation reaction will take place via an oxidation chamber inside the structure of the oxidiser (refer **Figure 2** and **Figure 6**);
  - A gas burner will heat the incoming raw gas to a minimum temperature of 850^0 C with a minimum 2-second retention time to oxidise the organic compounds in the exhaust stream;
  - The 'regenerative' nature of the RTO is achieved via the usage of inert ceramic media inside the structure for heat recovery;
  - Based on the particulars provided by the supplier, the incoming raw gas enters the bottom of the chamber and flows through a bed of ceramic media before reaching the oxidation chamber. The 'incoming' bed of media reaches an equilibrium temperature equal to the temperature of the exhaust gases. After passing through the combustion chamber (post combustion), the clean gases then pass through the second bed of media before being discharged to the atmosphere. The second bed of media will absorb the heat from the exhaust stream that has been heated in the combustion chamber up to 850^0 C. The direction of the flow is then reversed via air dampers in the base of the RTO (as shown in **Figure 6**), such that the incoming raw gases passes through the bed of media that has absorbed heat from the cleaned gases, preheating the exhaust stream before it reaches the combustion chamber. This mechanism contributes to energy saving as less thermal input is required from the burner in the combustion chamber due to heat recovered from the ceramic media;
  - As mentioned earlier, it is noted that the burner heats up the raw incoming gas up to 850^0 C, where the pollutants are mainly oxidised to carbon dioxide (CO_2) and water vapour (H_2O). This reaction is exothermic implying that additional energy (heat) is

released, contributing to an auto-thermal oxidation process, where in the power of the burner is reduced automatically and can even be totally switched off at a certain concentration. Moreover, if the heat of the reaction is even higher than necessary to run the RTO, the excess energy can be recovered by secondary heat-exchangers;

- As per the supplier specifications, it is anticipated that the natural gas consumption of the RTO under the proposed operating conditions will be less than 1GJ/hour (Giga-Joule/hour) (up to a maximum of 1.5GJ/hour), which accounts to less than 2% of the energy expended by each LWA kiln (760 Tetra-Joule (TJ) per annum);
- A destruction efficiency of up to 97% (refer **Figure 6**) of organics is anticipated with the proposed RTO system as per supplier specifications;
- As mentioned earlier, Brickworks also proposes to incorporate SNCR of NOx emissions in the RTO (refer **Figure 2**) by injection of ammonium hydroxide (NH_4OH) at a concentration approximately 25% by weight. Typical NOx reduction efficiencies of approximately 50% have been demonstrated commercially by the injection of NH_4OH into the RTO, as the elevated temperature in the combustion chamber of the RTO greatly improves the rate of reaction;
- As per information provided to Airlabs, for the SNCR reaction, the nozzles will be positioned to inject the NH_4OH solution over the entire length of the RTO's oxidation chamber (refer **Figure 7**). The presence of ceramic thermal media, combined with the elevated temperatures in the combustion chamber, ensures thorough mixing of the raw gas and NH_4OH solutions, thereby resulting in higher control efficiency;
- Based on supplier specifications, the anticipated consumption of NH_4OH solution at 25% by weight is approximately 70 kg/hour, which will ensure compliance with the POEO Group 6 Emission Standards (350 mg/Nm^3);
- With relation to Ammonia (NH_3) Slip – based on supplier specifications, the maximum ammonia slip through the SNCR process in the RTO will be less than 20 mg/Nm^3, which is a typical value with other similar installations and is typically permitted in other jurisdictions where this technology is employed. However, to address NSW-EPA's concerns regarding NH_3 emissions and its impacts on the receiving environment, dispersion modelling was undertaken, whose details are provided below:
  - Based on the supplier specified maximum NH_3 slip of 20 mg/Nm^3 and the normalised volumetric flow rate of 65,610 Nm^3/hour for each LWA kiln, NH_3 mass emission rate for each LWA kiln was estimated to be 0.36 g/sec;
  - Results from the NH_3 modelling are presented in **Table 10**;
  - Based on the NH_3 modelling results presented in **Table 10**, it is observed that the highest 1-hour average NH_3 ground level concentrations outside the Project site boundary are well under the assessment criteria for both LWA Stage 1 and Stage 2 operations. As the predicted concentrations are well under the assessment criteria (<10% of the assessment criteria), no concentration isopleths have been provided.

Table 10: Predicted Incremental Ground Level Ammonia Concentrations at Receptors for LWA Stage 1 and Stage 2 Operations – Based on a Maximum Ammonia Slip of 20mg/Nm^3

Scenario	Assessment Criteria (µg/m^3)	Background Concentration (µg/m^3)	Averaging Period	Predicted Incremental NH_3 Concentrations (µg/m^3) Reported as Maximum Outside Project Boundary
LWA Stage 1 Operations (100% Pulverised Coal)	330	N.A.	1-Hour	21.7
LWA Stage 1 Operations (100% Natural Gas)	330	N.A.	1-Hour	21.7
LWA Stage 2 Operations (100% Pulverised Coal)	330	N.A.	1-Hour	30.7
LWA Stage 2 Operations (100% Natural Gas)	330	N.A.	1-Hour	30.7

Green text indicates compliance with relevant assessment criteria

- NSW-EPA makes a comment that the '*emission estimates for the proposal are based on emission factors that are represented as quantity of pollutant per quantity of material produced and on this basis it is not clear if the assessment includes emissions from the fuel used for the operation of the RTO*'. As mentioned in Section 6.5 of the revised AQIA[3] (Report No: FEB16028.1), taking into account the similarities between the raw materials used for brick, clay and LWA manufacturing, pollutant emission factors have been principally referenced from the *National Pollutant Inventory (NPI), Emission Estimation Technique Manual for Bricks, Ceramics and Clay Product Manufacturing* (hereafter 'NPI-EET'). On Page 9 of the NPI-EET, it is specified that particulate matter is the main substance released from clay and brick product manufacturing. Substances such as oxides of nitrogen, sulphur dioxide, carbon monoxide and fluorides are likely to be emitted from the combustion processes. Therefore, it is noted that the emission factors published for oxides of nitrogen in the NPI-EET relate to the fuel combustion process, though the emission factors are expressed in kilograms of pollutant released per tonne of material produced (kg/tonne). However, in order to determine NOx emissions generated exclusively from the RTO, the following methodology has been adopted:
    - Energy consumed by the RTO for Stage 1 LWA operations would be approximately 15,200 GJ/annum (estimated from 2% of 760 TJ /annum - energy expended by each LWA kiln);

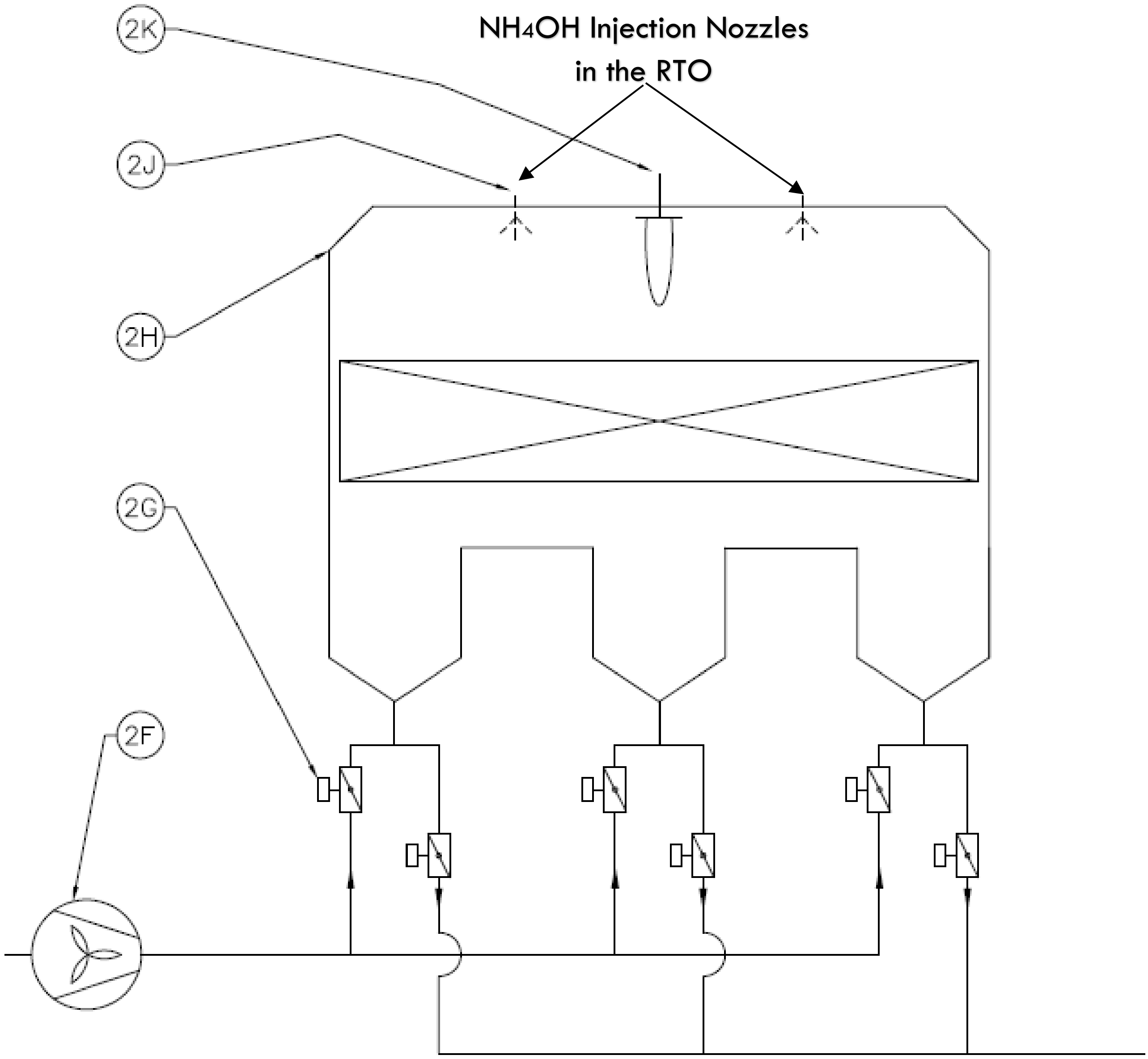
- Noting that the RTO would be fuelled by natural gas and considering a calorific value of 53.6 GJ/tonne for natural gas[10], it is estimated that the amount of natural gas used by the RTO for Stage 1 LWA operations would be approximately 284 tonne/annum;
- The NPI-EET Manual for *Combustion in Boilers*[11] provides an emission factor for uncontrolled NOx emissions released from a ≤30MW wall-fired natural gas boiler, which is 2.16 kg of NOx released/tonne of fuel;
- Assuming that the profile of NOx emissions generated from the fuelling of an RTO is similar to that of a natural-gas fired boiler, the uncontrolled NOx emissions for Stage 1 LWA operations exclusively from the RTO are expected to be in the order of 0.06-0.07 kg/hour (~ 0.02-0.03 g/sec), which is insignificant (circa. 1%) compared to the NOx emissions generated from the LWA process. Furthermore, any NOx emissions generated from the RTO would be treated by the SNCR component of the integrated RTO-SNCR system;
- Therefore, based on the relatively minor energy requirements of the RTO, NOx emissions generated exclusively from the RTO would not be considered significant and hence were not considered further in the assessment.

[10] http://www.natural-gas.com.au/about/references.html

[11] *Emission Estimation Technique (EET) Manual for Combustion in Boilers, National Pollutant Inventory (NPI), Version 3.6, December 2011*

Figure 6: Overview of the Regenerative Thermal Oxidiser System Proposed for the LWA Project

Figure 7: Positioning of the Ammonium Hydroxide Injection Nozzles in the RTO Combustion Chamber



2.4 Oxides of Nitrogen and Ozone

4) Oxides of Nitrogen and Ozone

The assessment adopts emission factors for estimating emissions of oxides of nitrogen (NOx), referenced from *National Pollutant Inventory Estimation Technique Manual for Brick, Ceramics and Clay Product Manufacturing* which are reproduced below:

2

Page 3

- Emission factor adopted for natural gas combustion: 0.175 kg/tonne;
- Emission factor adopted for pulverised coal combustion: 0.255 kg/tonne.

The EPA notes that the referenced emission factors are for different operations, and not specifically Light Weight Aggregate Plants. The US EPA publish emission factors for Light Weight Aggregate Production facilities with their AP-42 emission factor database. An emission factor for NOx emissions of 1 kg/Mg (or 1 kg/tonne) for a Rotary Kiln (with scrubber) is noted from the US EPA database. This is higher than the emission factors adopted within the assessment, and indicates a degree of uncertainty with predicted NOx emission rates, and hence predicted NO_2 impacts.

The EPA considers that based on the emission factor published by the US EPA, that the proposal could potentially be a significant source of NOx that requires further consideration with respect to proposed emission controls for NOx, and also with respect to the potential for ozone impacts. The EPA has published a framework for assessing significant sources of NOx emissions (*Tiered Procedure for Estimating Ground-Level Ozone Impacts from Stationary Sources*). Additionally no detail on emission controls for NOx are included within the assessment.

The EPA recommends that the proponent be requested to provide further information to:

- *Demonstrate that the emissions are representative of the proposal;*
- *Provide further clarity on any proposed controls for Oxides of Nitrogen;*
- *Provide an assessment of Ozone, with reference to the EPA's Tiered Procedure for Estimating Ground-Level Ozone Impacts from Stationary Sources; and*
- *Revise the Air Quality Impact Assessment where required, to address the comments above.*

- It is to be noted that there are no emission factors corresponding to LWA manufacturing operations in Australia. US-EPA have published emission factors for LWA manufacturing within their AP-42 database. During the time of preparing the original AQIA[1] (Report No: JAN15015.4) and the revised AQIA[3] (Report No: FEB16028.1) , consultants at Airlabs reviewed the LWA US-EPA AP-42 documentation corresponding to LWA manufacturing and decided against using the emission factors presented in the AP-42 based on the following reasons;
    - To understand the emission factors published in the LWA AP-42 (especially for NOx), a review of the *Background Report* corresponding to the published emission factors was undertaken. Based on the findings in the Background Report – it is noted that NOx emission factors have been determined from stack emission test reports for coal-fired LWA manufacturing facilities between 1981-1985. As the measured data used for calculating the emission factors is not recent (>30 years old) and considering that there have been significant improvements in the field of air pollution control since that time of publishing the emission factors, the representativeness of this information was taken into consideration. Furthermore, Brickworks are proposing to install Best Available Technology (BAT) comprising a suite of air pollution control measures including bag filters, lime scrubber, RTO and SNCR (refer **Figure 2**). Taking into consideration that the background data used for estimating the AP-42 NO_X emission factors dates back to more than 30 years coupled with the BAT proposed by Brickworks, the usage of the AP-42 LWA emission factors were considered to be extremely conservative and unrepresentative and subsequently the AP-42 emission factors were not used in the assessment. During the meeting on 9th September, 2016, NSW-EPA concurred with Airlabs' justification of not using the US-EPA AP-42 NO_X emission factors;

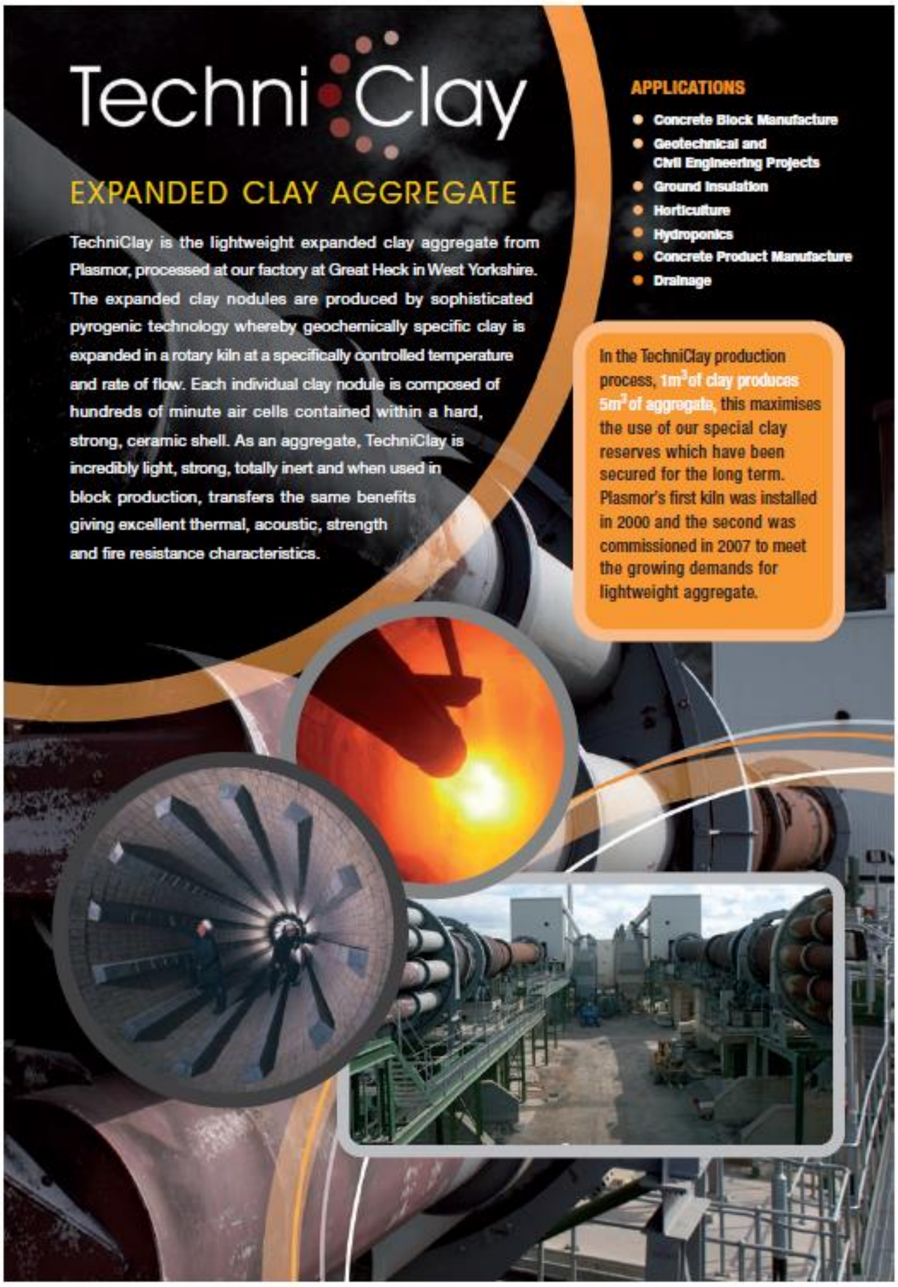
- Since the time of submitting the revised AQIA[3] (Report No: FEB16028.1), Brickworks provided Airlabs stack emission test data for an expanded clay aggregate manufacturing facility in the United Kingdom (UK). *Techniclay* – is a lightweight expanded clay aggregate manufactured by Plasmor – a UK based concrete block and concrete block paving manufacturer;
- As per the *Techniclay* product brochure (refer **Figure 8**), expanded clay nodules are produced by a sophisticated pyrogenic technology whereby geochemically specific clay is expanded in a rotary kiln at a specifically controlled temperature and rate of flow. This process is similar to the LWA production process, as mentioned in Section 6.1 of the revised AQIA[3] (Report No: FEB16028.1). Based on operational similarities, a detailed investigation into their stack emissions test data was undertaken;
- For the study, reference was drawn to the following information:
    - Stack Emissions Monitoring Report, Kiln 1 – Plasmor, October 2015, Environmental Scientifics Group (ESG) Ltd[12];
    - Stack Emissions Monitoring Report, Kiln 2 – Plasmor, October 2015, Environmental Scientifics Group (ESG) Ltd[13];
    - Plasmor material feed rate data for Kiln 1 and Kiln 2 during the time of testing (i.e. October 2015) – information supplied to Airlabs by Brickworks; and
    - Details of pollution control systems currently implemented at Plasmor Kiln 1 and Kiln 2 – information supplied to Airlabs by Brickworks.
- Key information from the October 2015 stack test reports[12,13] for Plasmor Kiln 1 and Plasmor Kiln 2 are summarised in **Table 11**.

Table 11: Summary of Emission Test Data for Plasmor Kiln 1 and Plasmor Kiln 2

Parameter	Kiln 1	Kiln 2
Product Details	Techniclay – Lightweight Expanded Clay Aggregate	
Date of Testing	8th October, 2015	
Testing Company	Environmental Scientifics Group (ESG) Ltd	
Raw Material Feed Rate (kg/min) at the time of Testing	240 kg/min	250 kg/min
Fuel used during Monitoring	Natural Gas	
Oxides of Nitrogen (as NO_2) concentration (mg/m^3)	73 mg/m^3	77 mg/m^3
Oxides of Nitrogen (as NO_2) Emission Rate (g/hour)	4584 g/hour	3830 g/hour
Oxides of Nitrogen (as NO_2) Emission Rate (g/sec)	1.27 g/sec	1.06 g/sec
NOx Controls	None	
Installed Air Quality Control Systems	• Electrostatic Precipitator (ESP); and • Lime Injection into the Burner Zone for Acid Gas Control	

[12] *Stack Emissions Monitoring Report, Kiln 1*, Plasmor Limited, EPR Permit: A (2) 19P/V1, Report No: LNO 12639, Version 1, Environmental Scientifics Group (ESG) Ltd., 28th October, 2015
[13] *Stack Emissions Monitoring Report, Kiln 2*, Plasmor Limited, EPR Permit: A (2) 19P/V1, Report No: LNO 12639, Version 1, Environmental Scientifics Group (ESG) Ltd., 28th October, 2015

Figure 8: Techniclay – Plasmor Expanded Clay Aggregate



- Considering the operational similarities between the proposed Brickworks LWA Stage 1 and Stage 2 operations and Plasmor's *Techniclay*, NOx emissions for Stage 1 and Stage 2 LWA operations have been determined based on the NO_X emissions measured for Plasmor Kiln 1 and Kiln 2 in October, 2015. In addition to the operational similarities, it is to be noted that unlike the US-EPA AP-42 data which dates back to more than 30 years, the Plasmor test data is more recent (i.e. October, 2015) and is considered representative in comparison with the US-EPA AP-42 emission factors. During the meeting on 9th September, 2016, NSW-EPA consented to using Plasmor Kiln 1 and Kiln 2 data to determine the LWA NO_x emissions;

- Stage 1 LWA NO_x emissions were estimated by scaling the Plasmor Kiln 1 and Kiln 2 measured NO_X emission rates (refer **Table 11**) with their respective material feed rates (i.e. material feed rates of Stage 1 LWA and Plasmor Kiln 1 and material feed rates of Stage 1 LWA and Plasmor Kiln 2);

- Based on a 300,000 tonne per annum (tpa) of LWA production for Stage 1 operations, Brickworks anticipate that the raw material feed rate will be 846 kg/min, which is approximately 3.3-3.5 times higher than the raw material feed rate of Plasmor Kiln 1 (240 kg/min) and Kiln 2 (250 kg/min) (refer **Table 11**);

- However as shown in **Table 11** , it is to be noted that there are no NOx controls currently implemented on Plasmor Kiln 1 and Plasmor Kiln 2, whereas, as mentioned earlier, Brickworks are proposing to implement an integrated RTO system incorporating an SNCR mechanism to effectively reduce NO_x emissions generated from Stage 1 and Stage 2 LWA operations. As per supplier specifications, it is expected that the injection of ammonium hydroxide (NH_4OH) into the RTO, will offer NOx reduction efficiencies of approximately 50%;

- Therefore, based on scaling the NO_X emission rate measured at Plasmor Kiln 1 and Kiln 2 (**Table 11**) proportionately with the material feed rates and applying a 50% control efficiency, the Stage 1 LWA emission rates for 100% natural gas are obtained. An average of the scaled Plasmor Kiln 1 and Kiln 2 NO_X emission rate was used in the dispersion model as shown in **Table 12**;

- As per **Table 11**, it is noted that natural gas is the main fuel used by Plasmor to manufacture the *Techniclay* product. To determine Stage 1 LWA NO_x emission rates from 100% pulverised coal, reference was drawn to the ratio of NO_x emission factors for a natural gas fired kiln (0.175 kg/tonne) and a coal fired kiln (0.255 kg/tonne) as published in the National Pollutant Inventory (NPI), *Emission Estimation Technique Manual for Bricks, Ceramics & Clay Product Manufacturing (August, 1998)*[14].

- 100% pulverised coal fuelled Stage 1 LWA NOx emission rates were obtained by scaling the estimated 100% natural gas fired Stage 1 LWA NOx emission rates with the ratio of NOx emission factors for a natural gas fired kiln (0.175 kg/tonne) and a coal fired kiln (0.255 kg/tonne) as published in the NPI-EET (August, 1998)

- A summary of the Stage 1 and Stage 2 LWA NO_X emission rates using 100% natural gas and 100% pulverised coal are presented in **Table 13**.

- To predict NO_2 ground level concentrations from the Stage 1 and Stage 2 LWA operations, revised dispersion modelling was undertaken using the emission rates presented in **Table 13**.

[14] *Emission Estimation Technique Manual for Bricks, Ceramics & Clay Product Manufacturing*, National Pollutant Inventory (NPI), Environment Australia, August 1998

Table 12: Brickworks LWA Stage 1 NO_X Emission Rates – Determined from Plasmor Kiln 1 and Kiln 2

<table>
<tr><th>Parameter</th><th colspan="2">Value</th></tr>
<tr><td>Stage 1 LWA Production Rate (tpa)</td><td colspan="2">300,000 tpa</td></tr>
<tr><td>Raw Material Feed Rate (kg/hour) corresponding to Stage 1 LWA Production Rate of 300,000 tpa</td><td colspan="2">846 kg/min</td></tr>
<tr><td>Estimated NOx Control Efficiency (%) – Integrated RTO with SNCR</td><td colspan="2">50%</td></tr>
<tr><td rowspan="2">Stage 1 LWA NO_x Emission Rate (g/sec) - estimated from scaling NO_X emission rates measured at Plasmor Kiln 1 and Kiln 2 in October, 2015 with respective material feed rates and applying a 50% NOx reduction control efficiency</td><td>Plasmor Kiln 1</td><td>Plasmor Kiln 2</td></tr>
<tr><td>2.2 g/sec</td><td>1.8 g/sec</td></tr>
<tr><td>Average Stage 1 LWA NO_x Emission Rate (g/sec) – 100% Natural Gas</td><td colspan="2">2.02 g/sec</td></tr>
</table>

Table 13: Summary of Stage 1 and Stage 2 LWA NOx Emission Rates using 100% Natural Gas and 100% Pulverised Coal

Scenario	NOx Emission Rate (g/sec)
Stage 1 LWA NO_x Emission Rate – 100% Natural Gas	2.02 g/sec
Stage 1 LWA NO_x Emission Rate – 100% Pulverised Coal	3.07 g/sec
Stage 2 LWA NO_x Emission Rate – 100% Natural Gas	4.04 g/sec
Stage 2 LWA NO_x Emission Rate – 100% Pulverised Coal	6.14 g/sec

- Incremental and cumulative NO_2 ground level concentrations predicted at the identified sensitive receptors are summarised in **Table 14**.
- Cumulative NO_2 ground level concentrations for all scenarios (i.e. existing operations and Stage 1 and Stage 2 LWA operations) were predicted in accordance with the *8.1.1 Method 1: 100% conversion of NO_x to NO_2* outlined in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, Department of Environment and Conservation, NSW (EPA, 2005)[15], where in it was conservatively assumed that 100% of the NO_X emitted is converted to NO_2. Furthermore, the NO_2 cumulative ground level concentrations were determined by adding the maximum predicted 1-hour and annual average ground-level incremental concentrations with the maximum 1-hour and annual average background concentrations respectively. Predicted 1-hour average NO_2 cumulative concentration isopleths for all modelled scenarios are presented in **Appendix A**.

[15] *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, Department of Environment and Conservation, NSW-EPA, 2005

Table 14: Predicted Incremental and Cumulative NO_2 Concentrations at Identified Sensitive Receptors – All Scenarios

Pollutant	Criteria (µg/m³)	Bckg. Conc. (µg/m³)	Avg. Period	Predicted Incremental Concentrations (µg/m³)									Predicted Cumulative Concentrations (µg/m³)								
				DR1	DR2	DR3	DR4	DR5	DR6	DR7	DR8	DR9	DR1	DR2	DR3	DR4	DR5	DR6	DR7	DR8	DR9
Existing Operations																					
NO_2	246	88	1-Hr	4.9	5.1	3.9	7.7	6.7	9.6	12.8	15.1	7.7	93.3	93.4	92.3	96.0	95.0	98.0	101.1	103.4	96.1
	62	19	Annual	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	18.9	18.9	18.9	19.0	19.0	19.0	19.0	18.9	18.9
LWA Stage 1 Operations – 100% Pulverised Coal																					
NO_2	246	88	1-Hr	17.3	19.1	20.9	48.4	100.4	51.8	56.7	72.0	41.0	105.7	107.5	109.3	136.8	188.7	140.2	145.0	160.4	129.4
	62	19	Annual	0.3	0.3	0.3	0.7	0.9	2.2	1.9	1.1	0.4	19.1	19.1	19.1	19.5	19.7	21.0	20.7	19.9	19.2
LWA Stage 1 Operations – 100% Natural Gas																					
NO_2	246	88	1-Hr	12.1	12.8	14.7	32.5	66.5	35.7	39.5	52.5	29.2	100.4	101.2	103.1	120.8	154.9	124.0	127.9	140.9	117.6
	62	19	Annual	0.3	0.3	0.2	0.5	0.6	1.5	1.4	0.8	0.3	19.1	19.1	19.0	19.3	19.4	20.3	20.2	19.6	19.1
LWA Stage 2 Operations – 100% Pulverised Coal																					
NO_2	246	88	1-Hr	34.2	47.8	43.4	63.0	108.7	93.3	118.2	122.1	74.1	122.5	136.2	131.7	151.3	197.1	181.7	206.6	210.5	162.4
	62	19	Annual	0.5	0.6	0.5	1.3	1.6	4.1	3.9	2.1	0.7	19.3	19.4	19.3	20.1	20.4	22.9	22.7	20.9	19.5
LWA Stage 2 Operations – 100% Natural Gas																					
NO_2	246	88	1-Hr	23.1	31.6	28.6	41.5	71.5	63.2	80.0	85.5	50.9	111.5	120.0	116.9	129.8	159.9	151.6	168.3	173.8	139.3
	62	19	Annual	0.4	0.4	0.4	0.9	1.1	2.8	2.7	1.4	0.5	19.2	19.2	19.2	19.7	19.9	21.6	21.5	20.2	19.3

Green text indicates compliance with relevant assessment criteria

- As a part of the comments (DOC16/206758)[4], NSW-EPA required an assessment of ozone (O_3) impacts from the proposed Stage 1 and Stage 2 LWA operations;
- Ozone is a secondary pollutant that is formed when NO_X and VOCs react in the presence of sunlight. Considering that NO_x is one of the main precursors for O_3 formation and taking into account the estimated NO_X emission rates (refer **Table 13**), it is unlikely that there would be any adverse ozone impacts associated with either Stage 1 or Stage 2 LWA operations. However, a desktop assessment has been undertaken to address NSW-EPA comments;
- The ozone assessment has been undertaken in accordance with the *Tiered Procedure for Estimating Ground-Level Ozone Impacts from Stationary Sources* (ENVIRON, 2011)[16] (hereafter 'Tiered Procedure')
- It is to be noted that at the time of preparing this RTS, the *NSW-EPA Level 1 Screening Procedure Tool for Estimating Ground-Level Ozone Impacts from Stationary Sources in the NSW Greater Metropolitan* Region (Version 3.0, July 2015)[17] was available online on the NSW-EPA website and this Level 1 Screening Procedure Tool was utilised to determine ozone impacts as per the Tiered Procedure;
- The Tiered Procedure provides an impact assessment framework for determining ground level ozone concentrations. An overview of the framework is shown in **Figure 9**;
- The first step of the framework is to determine whether the source is in an ozone attainment area or a non-attainment area. As per the Tiered Procedure, to determine whether an area is classified as ozone attainment or non-attainment area, reference is made to measured ambient ozone concentrations from the NSW-Office of Environment and Heritage (NSW-OEH) ambient air quality monitoring stations recorded over the last five years. The maximum 1-hour and 4-hour average ozone concentrations recorded over the most current five-year period are averaged to obtain the five-year 1-hour and 4-hour maximum ozone concentrations for each monitoring station. These averages are compared against an acceptable limit, which is expressed as 82% of the Air NEPM Standard. Areas where the five-year average 1-hour maximum ozone concentration is greater than 0.082 parts per million (ppm), and / or where the five-year average 4-hour maximum ozone concentration is greater than 0.0656 ppm are classified as non-attainment areas. Remaining areas are classified as attainment areas. As per the Level 1 Screening Tool, the area where the Brickworks LWA Project is located is categorised as non-attainment area;
- The second step of the framework is to determine if the source emissions are above the emission threshold (refer **Figure 10**). If new or modified scheduled activities are above the specified emission thresholds, the next step of the process is to undertake a Level 1 assessment using the Level 1 Screening Tool. Based on the inventoried emission rates, a Level 1 assessment is required for Stage 1 and Stage 2 LWA Operations. An overview of the ozone assessment procedure is presented in **Table 15**;
- As a Level 1 assessment is required, the Level 1 Screening Tool was utilised and the following information was provided (refer **Table 16**) to determine the ozone impacts;

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[16] *Tiered Procedure For Estimating Ground Level Ozone Impacts from Stationary Sources*, Prepared for the NSW Office of Environment and Heritage (NSW-OEH), Project No: AS12313, ENVIRON Australia, 2011

[17] *Level 1 Screening Procedure Tool for Estimating Ground-Level Ozone Impacts from Stationary Sources in NSW Greater Metropolitan Region*, Version 3.0, NSW-EPA, July 2015 (www.epa.nsw.gov.au/resources/air/150507-ozone-procedure-tool.xls)

Figure 9: Ground-Level Ozone Impact Assessment Framework

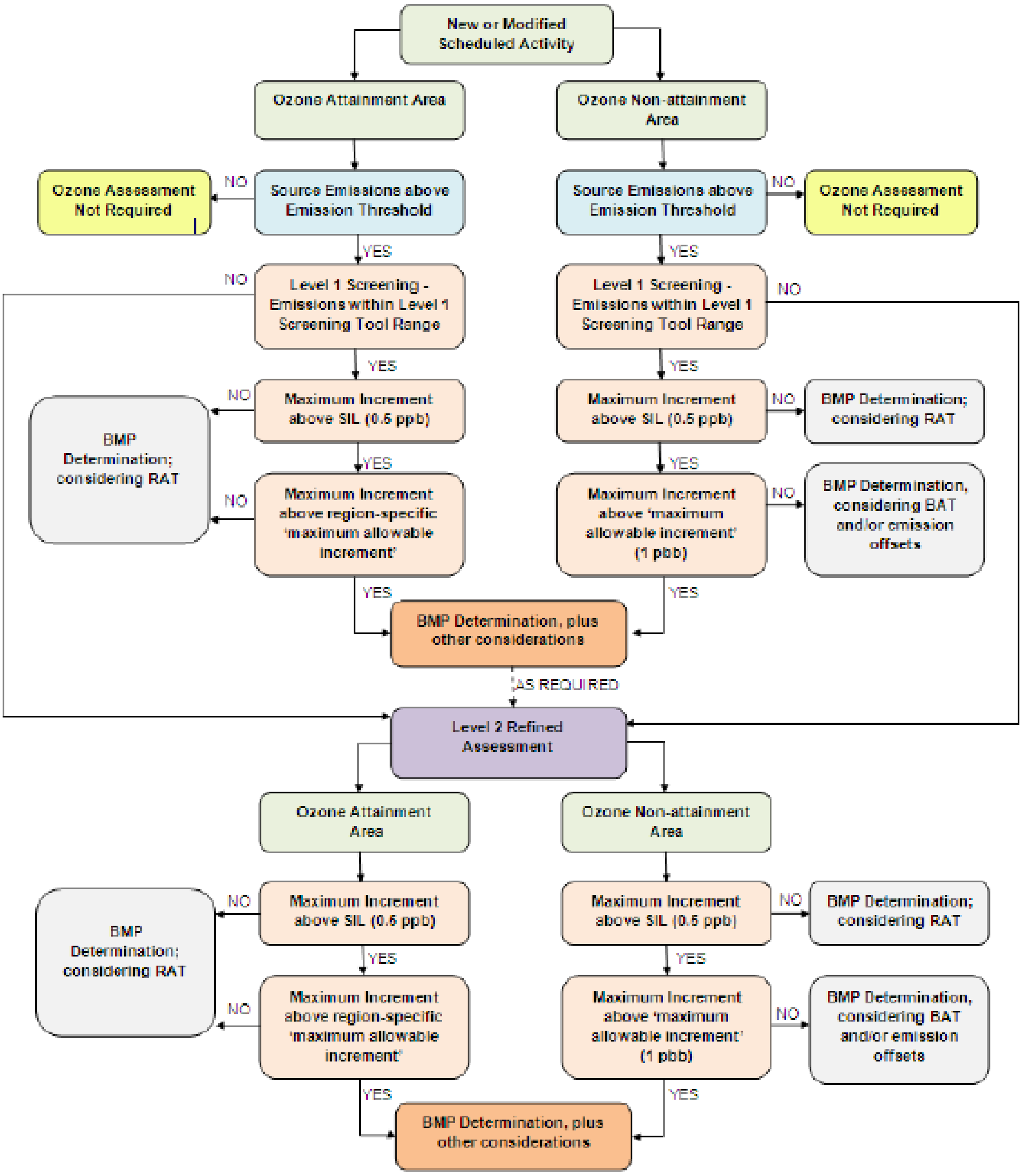

Figure 10: Emission Thresholds for Schedule 1 Activities in Ozone Non-Attainment Areas

Table 42: NO_x and VOC Emission Thresholds for New or Modified Sources within Ozone Non-attainment Areas

Source Type	NO_x / VOC Emission Rate tonnes/year
New Source	
Any scheduled activity listed in Schedule 1 of the *Protection of the Environment Operations Act 1997* located in all Other Areas	>90
Any scheduled activity listed in Schedule 1 of the *Protection of the Environment Operations Act 1997* located in Serious Ozone Non-attainment Area (Area has a 5-year average 1-hour maximum ozone concentration in the range of 0.13 to 0.15 ppm, and/or a 5-year average 4-hour maximum ozone concentration in the range of 0.11 to 0.12 ppm.)	>45
Any scheduled activity listed in Schedule 1 of the *Protection of the Environment Operations Act 1997* located in Severe Ozone Non-attainment Area (Area has a 5-year average 1-hour maximum ozone concentration in the range of 0.15 to 0.23 ppm, and/or a 5-year average 4-hour maximum ozone concentration in the range of 0.12 to 0.19 ppm.)	>25
Any scheduled activity listed in Schedule 1 of the *Protection of the Environment Operations Act 1997* located in Extreme Ozone Non-attainment Area (Area has a 5-year average 1-hour maximum ozone concentration in the range of 0.23 ppm and above, and/or a 5-year average 4-hour maximum ozone concentration in the range of 0.19 ppm and above.)	>10
Modified Source	
Any scheduled activity listed in Schedule 1 of the *Protection of the Environment Operations Act 1997* located in all Other Areas	>35
Any scheduled activity listed in Schedule 1 of the *Protection of the Environment Operations Act 1997* located in Serious or Severe Ozone Non-attainment Area	>25
Any scheduled activity listed in Schedule 1 of the *Protection of the Environment Operations Act 1997* located in Extreme Ozone Non-attainment Area	Any Increase

Table 15: Overview of the Ozone Assessment Procedure for LWA – Stage 1 and Stage 2 Operations

Stage	LWA Stage 1 Operations (100% Natural Gas)	LWA Stage 1 Operations (100% Pulverised Coal)	LWA Stage 2 Operations (100% Natural Gas)	LWA Stage 2 Operations (100% Pulverised Coal)
Scheduled Activity New or Modified	New	New	New	New
Ozone Area Region Classification	Non-attainment	Non-attainment	Non-attainment	Non-attainment
Emission threshold of NO_x/VOC based on Scheduled activity and attainment area [(a)]	>90 tonnes/year	>90 tonnes/year	>90 tonnes/year	>90 tonnes/year
Above Emission Threshold?	63.7 (No)	96.8 (Yes)	127.4 (Yes)	193.6 (Yes)
Level 1 Screening Assessment Required	No	Yes	Yes	Yes

(a) Based on the five-year average 1-hour maximum ozone concentrations and/or the five-year 4-hour maximum ozone concentrations, the scheduled activity is in all other non-attainment areas (i.e. not in serious, severe or extreme ozone non-attainment areas)

Table 16: Level 1 Screening Tool Inputs

Stage	LWA Stage 1 Operations (100% Pulverised Coal)	LWA Stage 2 Operations (100% Natural Gas)	LWA Stage 2 Operations (100% Pulverised Coal)
Source Region	Sydney West		
VOC Input Option	Default VOC Reactivity		
CH_4 emissions (tonnes/day)	Nil		
CO emissions (tonnes/day)	0.017	0.052	0.035
NO_X emissions (tonnes/day)	0.27	0.35	0.53
VOC emissions (tonnes/day)	0.001	0.007	0.002

- As per the Tiered Procedure, upon providing the input information (**Table 16**), if the maximum 1-hour and maximum 4-hour incremental ozone concentrations calculated for the source using the Level 1 Screening Tool are less than the Significant Impact Level (SIL) of 0.5 parts per billion (ppb), no further ozone impact assessment is required, but a Best Management Practice (BMP) determination, considering Reasonably Available Techniques (RAT) should be undertaken;
- The results from the Level 1 Screening Tool for Stage 1 and Stage 2 LWA operations are summarised in **Table 17**. The Level 1 Screening Tool results demonstrate that the maximum 1-hour (0.190 ppb) and maximum 4-hour incremental ozone concentrations (0.165 ppb) are less than the SIL of 0.5 ppb and as-such, a Level 2 assessment is not required for either Stage 1 or Stage 2 LWA operations;
- Though a Level 2 assessment is not required for either Stage 1 or Stage 2 LWA operations, the Tiered Procedure specifies that a BMP determination, considering RAT is to be undertaken;
- RAT as per the Tiered Procedure refers to control technology that is both reasonably available, and technologically and economically feasible. NO_X and VOCs are the main precursors for ozone formation. As mentioned earlier, Brickworks are proposing to install an integrated RTO-SNCR system for Stage 1 and Stage 2 operations of the LWA Project. The RTO will treat organic emissions generated from the rotary kiln such as Volatile Organic Compounds (VOCs) and Carbon Monoxide (CO) and a destruction efficiency of up to 97% (refer **Figure 6**) of organics is anticipated with the proposed RTO system as per supplier specifications. NO_X emissions in the integrated RTO-SNCR system are reduced by injection of ammonium hydroxide (NH_4OH), which would typically reduce NO_X emissions by up to 50%;
- Based on compliance demonstrated by the Level 1 Screening Tool (**Table 17**) and implementation of RAT through the integrated RTO-SNCR system for both Stage 1 and Stage 2 LWA operations, no adverse ozone impacts would be expected from the Project.

Table 17: Level 1 Screening Tool Outputs

Stage	LWA Stage 1 Operations (100% Pulverised Coal)	LWA Stage 2 Operations (100% Natural Gas)	LWA Stage 2 Operations (100% Pulverised Coal)
Incremental Ozone Concentrations Maximum 1-hour (ppb)	0.097	0.126	0.190
Incremental Ozone Concentrations Maximum 4-hour (ppb)	0.085	0.110	0.165
Maximum Incremental above SIL (0.5 ppb)	No	No	No
Level 2 Assessment required	No	No	No
Outcome	BMP Determination considering RAT	BMP Determination considering RAT	BMP Determination considering RAT

3. CONCLUSION

Airlabs was commissioned to undertake an Air Quality Impact Assessment (AQIA) for the proposed Lightweight Aggregate (LWA) Project, which would be developed at the existing Brickworks site at 780 Wallgrove Road, Horsley Park, NSW.

Post submission of the original AQIA[1] and subsequently addressing the NSW-EPA comments[2], a revised AQIA[3] (Report No: FEB16028.1) was issued on the 31st March, 2016. The NSW-EPA then provided additional comments pertaining to the revised AQIA (Report No: FEB16028.1) on the 28th April, 2016 (DOC16/206758)[4]. This Response to Submissions (RTS) addresses the comments issued by NSW-EPA for the revised AQIA.

Based on the responses provided by Airlabs in this RTS which aim to address the revised comments issued by NSW-EPA[4], it is expected that there would not be any adverse air quality impact associated with the Stage 1 and Stage 2 operations of the LWA Project.

Furthermore, the Best Available Techniques (BAT) Reference Document (BREF) for Ceramic Manufacturing Industry (August, 2007)[18], published by the European Integrated Pollution Prevention and Control (IPPC) specifies BAT for expanded clay products which includes – scrubbing for acid gases; and filtration control for particulates. As far as NOx emissions are concerned, the BATs include controlling NOx emissions through minimisation of nitrogen compounds in raw materials and additives, using low NOx burners and temperature control. No reference is made to incorporation of non-catalytic or catalytic reduction systems. However, Brickworks are planning to implement a suite of control measures (refer **Figure 2**) including bag filters, lime injection and an integrated RTO-SNCR system for both Stage 1 and Stage 2 LWA operations. Additionally, Brickworks have also agreed to install a Cascade Scrubber system on Plant 2 prior to undertaking construction and operation works for the Stage 1 LWA Project. Based on the proposed control measures, it is noted that Brickworks are implementing BATs to minimise pollutant discharges to the atmosphere.

[18] *Reference Document on Best Available Techniques in the Ceramic Manufacturing Industry (BREF)*, European Integrated Pollution Prevention and Control (IPCC), August 2007

APPENDIX A – CONCENTRATION ISOPLETHS

Figure A-1: Existing Operations (without Cascade Scrubber on Plant 2) – Predicted Incremental HF 90-Day Average Concentrations (µg/m³) (Criteria: 0.5 µg/m³)

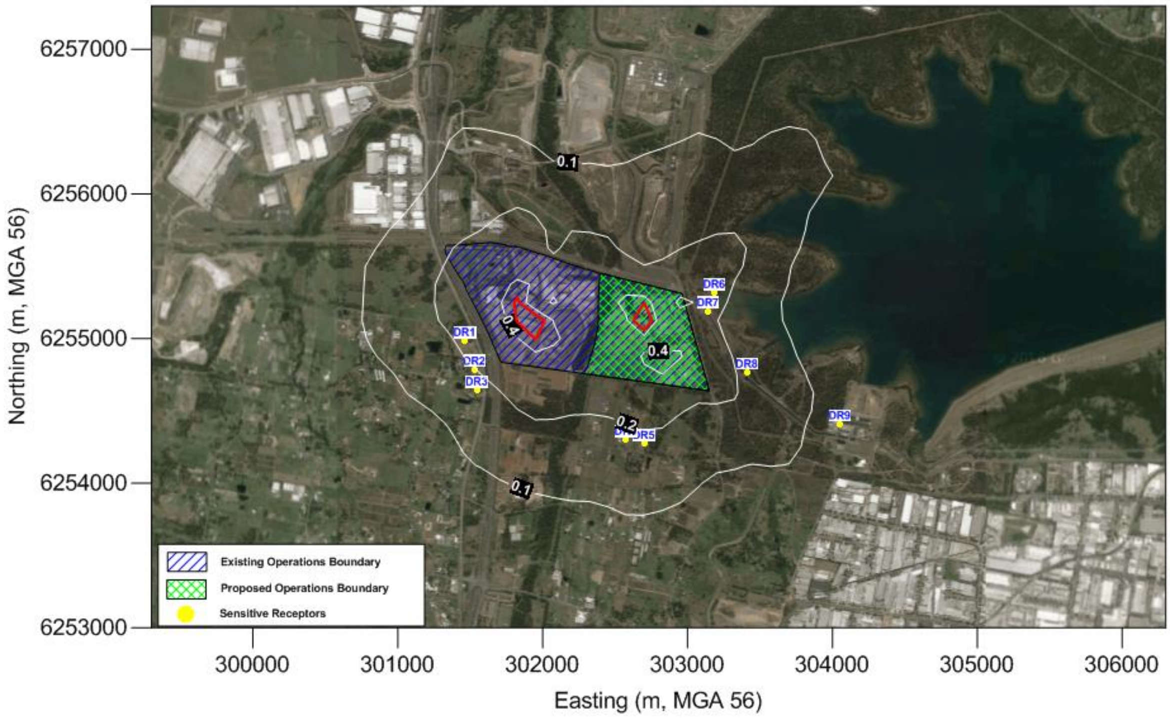

Figure A-2: Existing Operations (with Cascade Scrubber on Plant 2) – Predicted Incremental HF 90-Day Average Concentrations (µg/m³) (Criteria: 0.5 µg/m³)

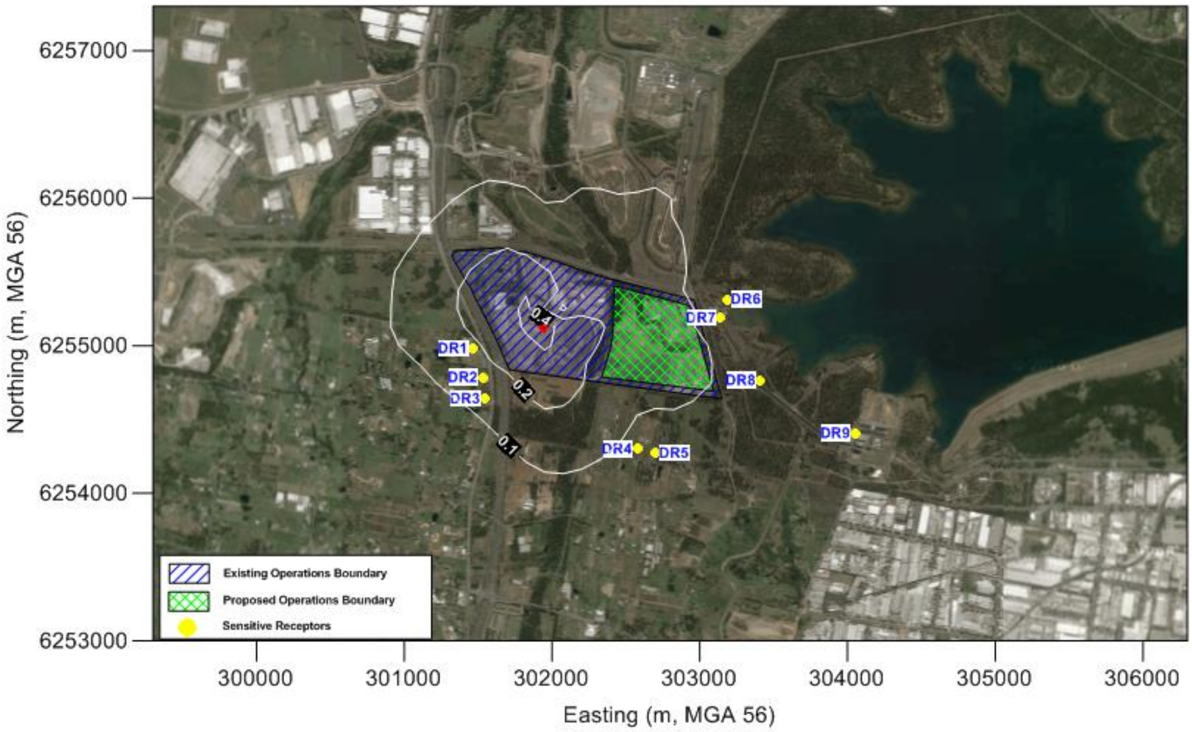

Figure A-3: LWA Stage 1 (Coal) Operations – Predicted Incremental HF 90-Day Average Concentrations (µg/m³) (Criteria: 0.5 µg/m³)

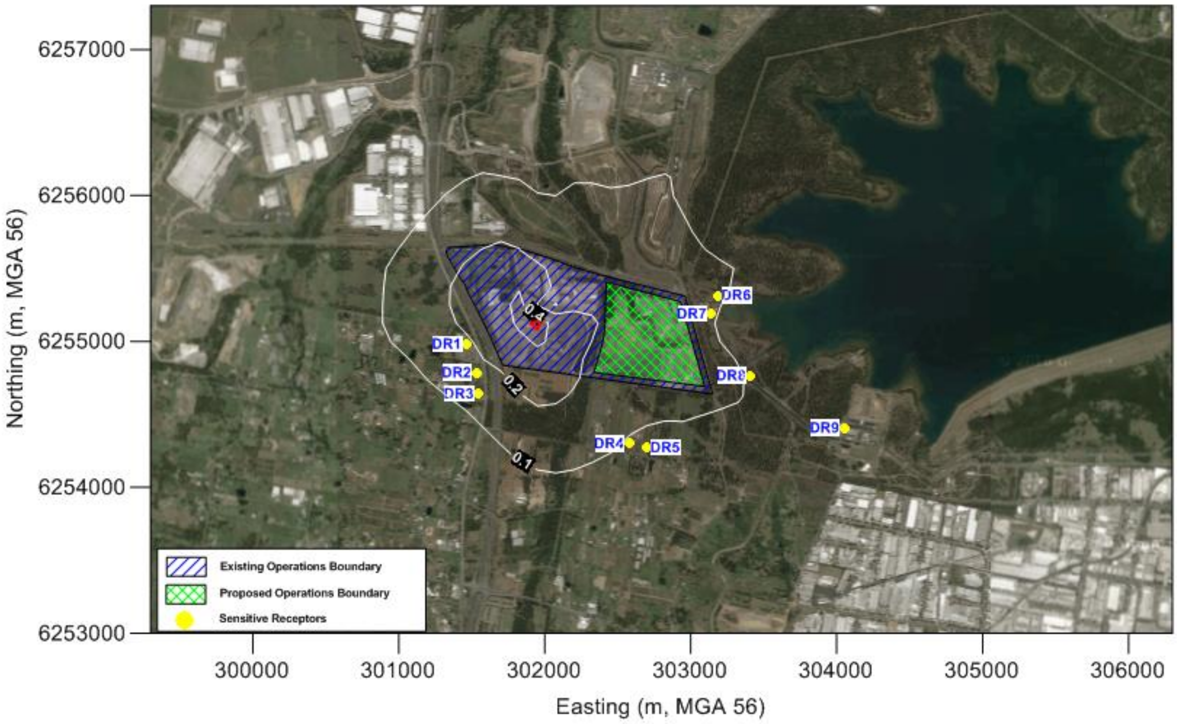

Figure A-4: LWA Stage 1 (Natural Gas) Operations – Predicted Incremental HF 90-Day Average Concentrations (µg/m³) (Criteria: 0.5 µg/m³)

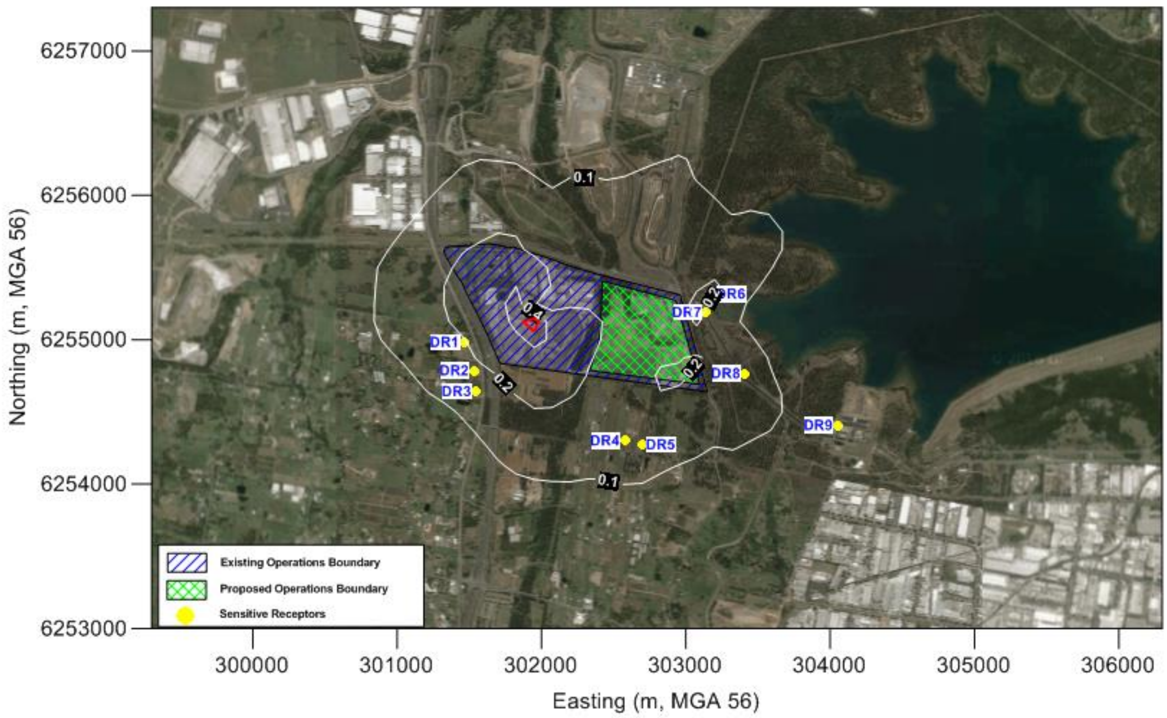

Figure A-5: LWA Stage 2 (Coal) Operations – Predicted Incremental HF 90-Day Average Concentrations (μg/m³) (Criteria: 0.5 μg/m³)

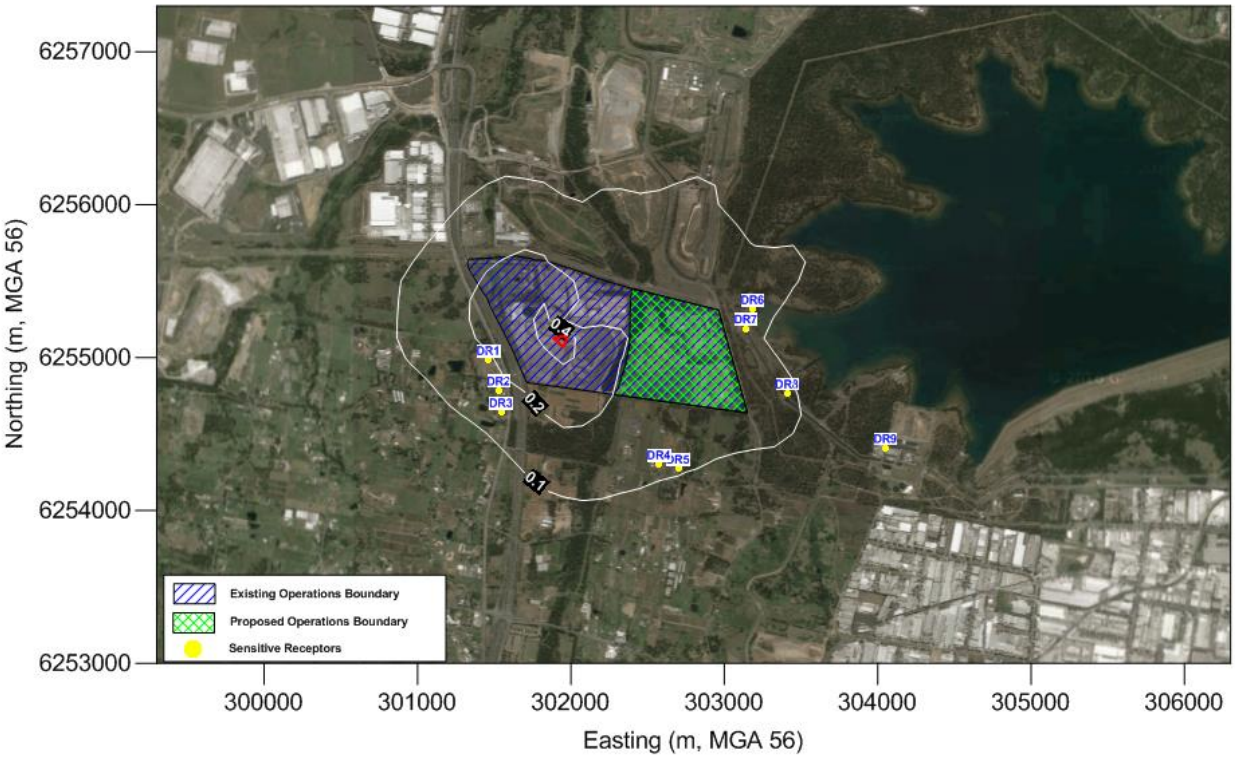

Figure A-6: LWA Stage 2 (Natural Gas) Operations – Predicted Incremental HF 90-Day Average Concentrations (μg/m³) (Criteria: 0.5 μg/m³)

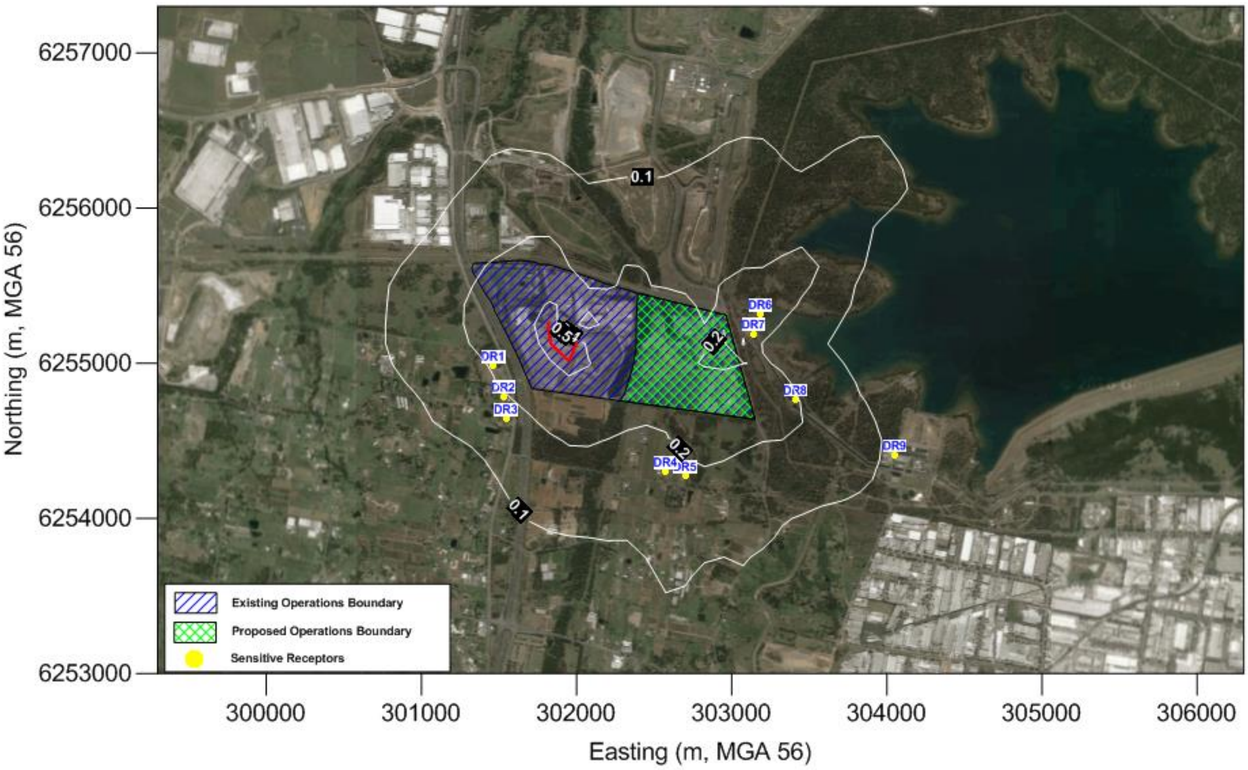

Figure A-7: Existing Operations (without Cascade Scrubber on Plant 2) – Predicted Incremental HF 24-Hour Average Concentrations (µg/m³) (Criteria: 2.9 µg/m³)

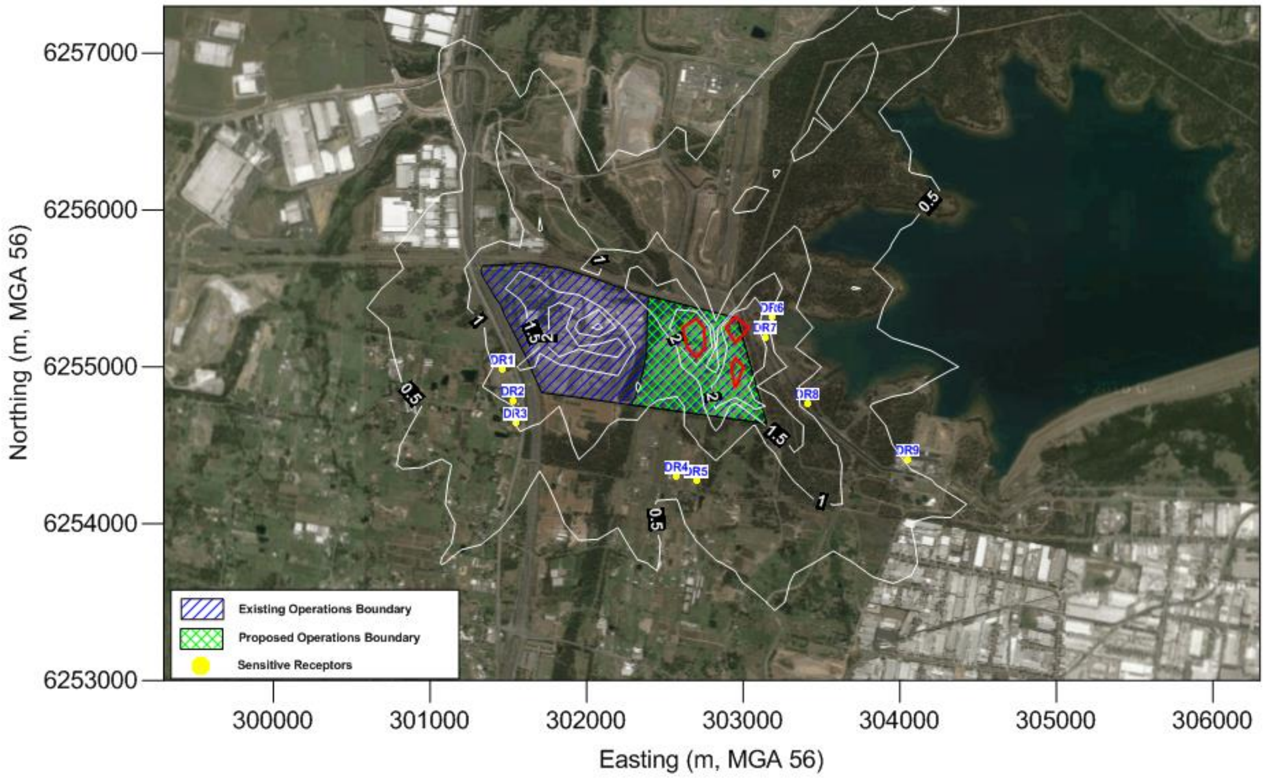

Figure A-8: Existing Operations (with Cascade Scrubber on Plant 2) – Predicted Incremental HF 24-Hour Average Concentrations (µg/m³) (Criteria: 2.9 µg/m³)

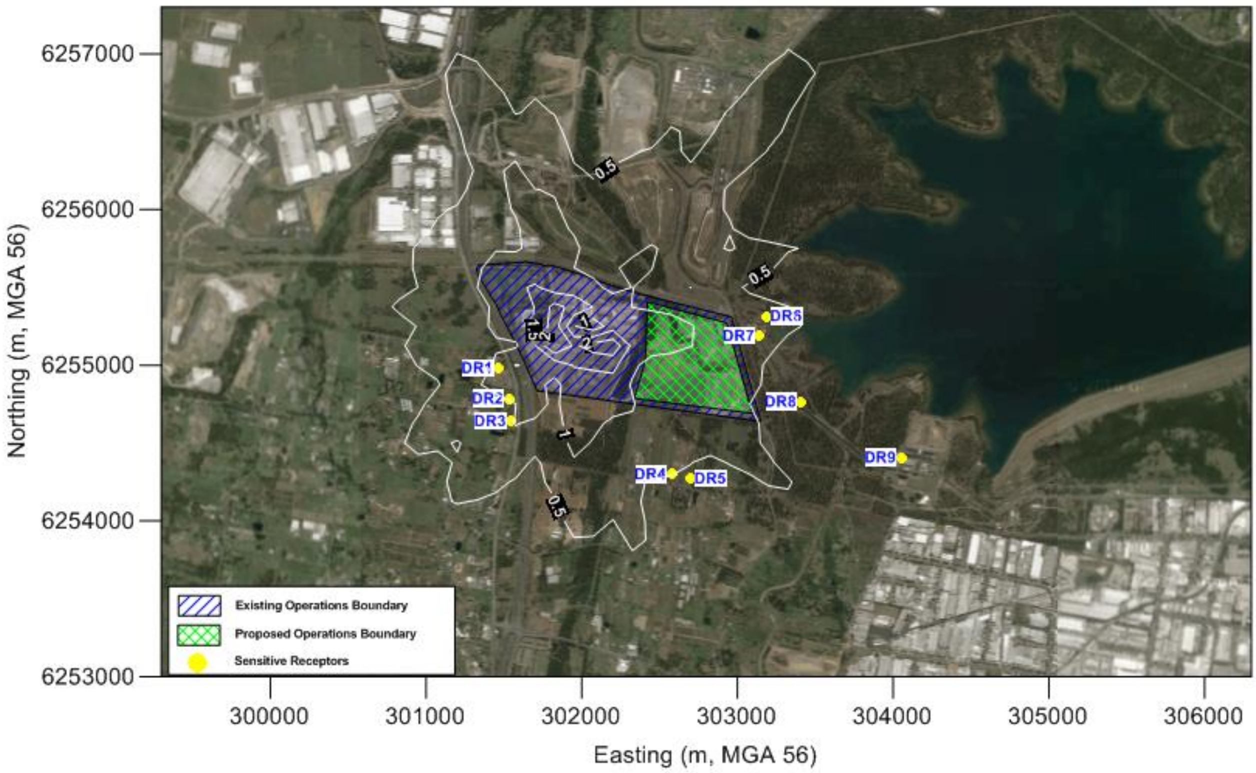

Figure A-9: LWA Stage 1 (Coal) Operations – Predicted Incremental HF 24-Hour Average Concentrations (µg/m³) (Criteria: 2.9 µg/m³)

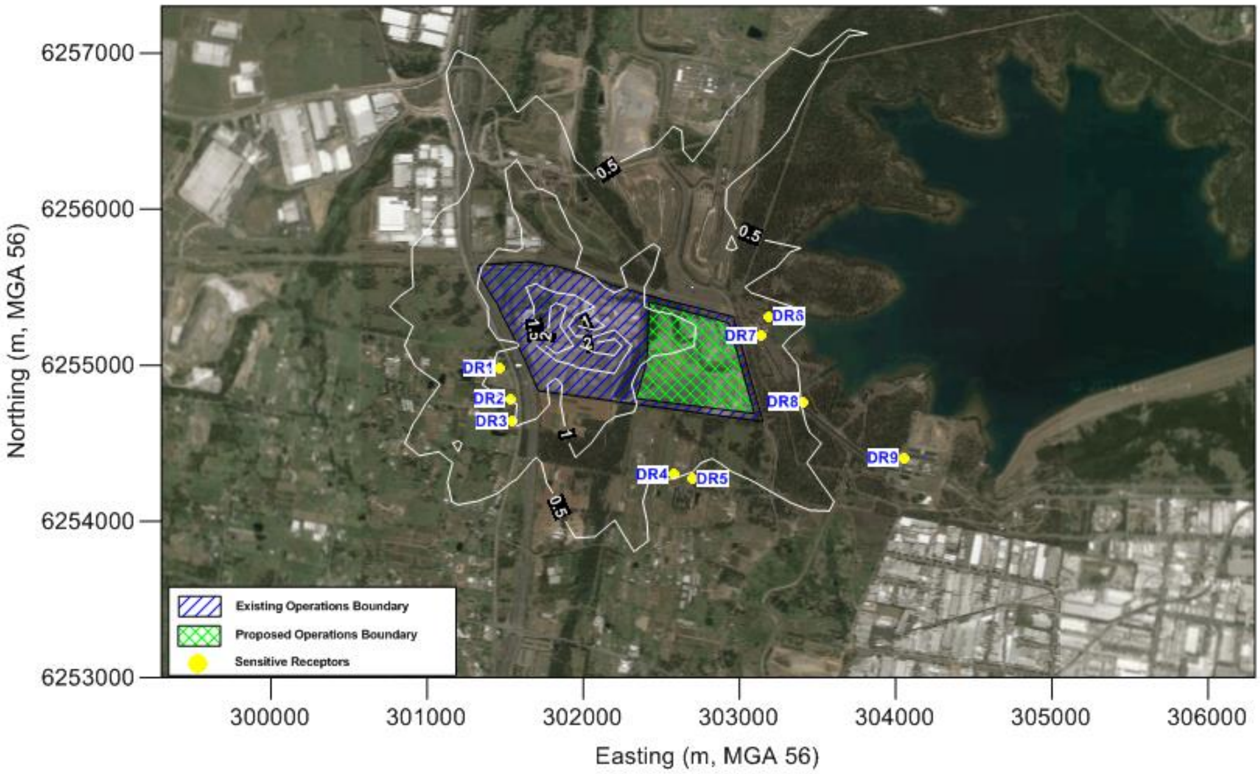

Figure A-10: LWA Stage 1 (Natural Gas) Operations – Predicted Incremental HF 24-Hour Average Concentrations (µg/m³) (Criteria: 2.9 µg/m³)

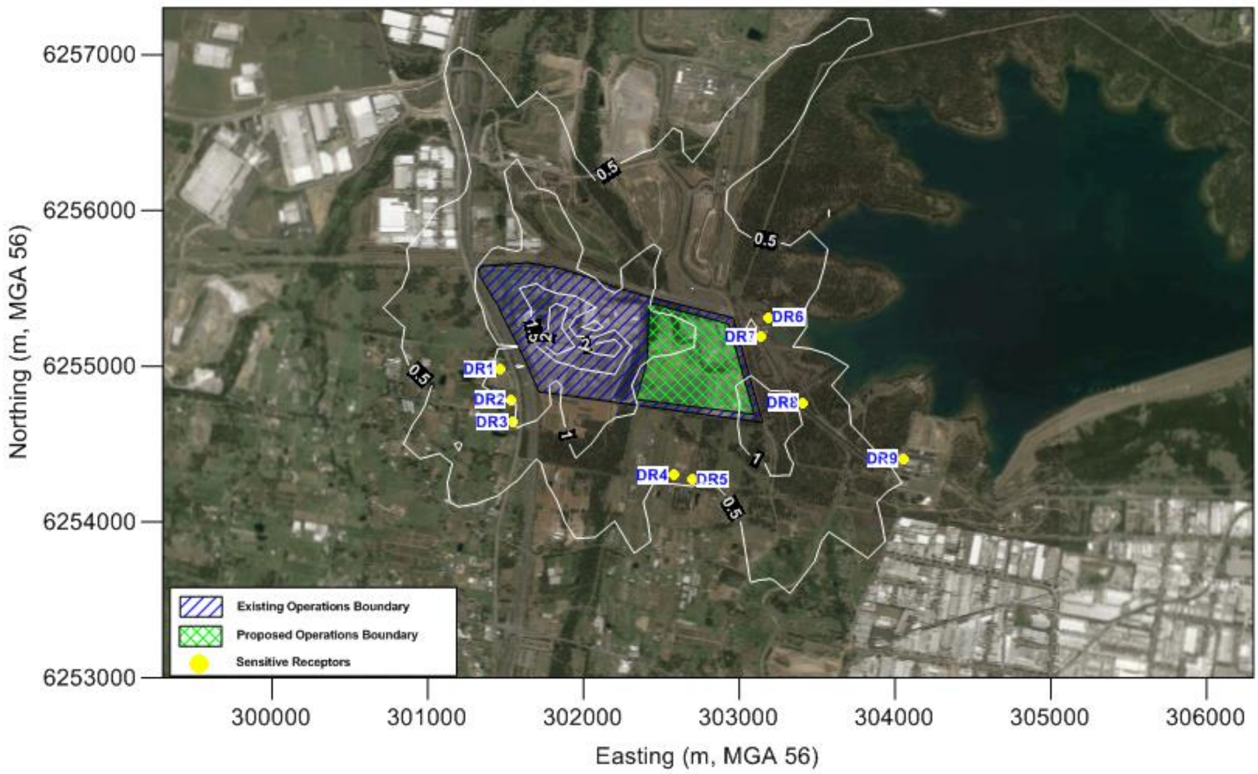

Figure A-11: LWA Stage 2 (Coal) Operations – Predicted Incremental HF 24-Hour Average Concentrations (µg/m³) (Criteria: 2.9 µg/m³)

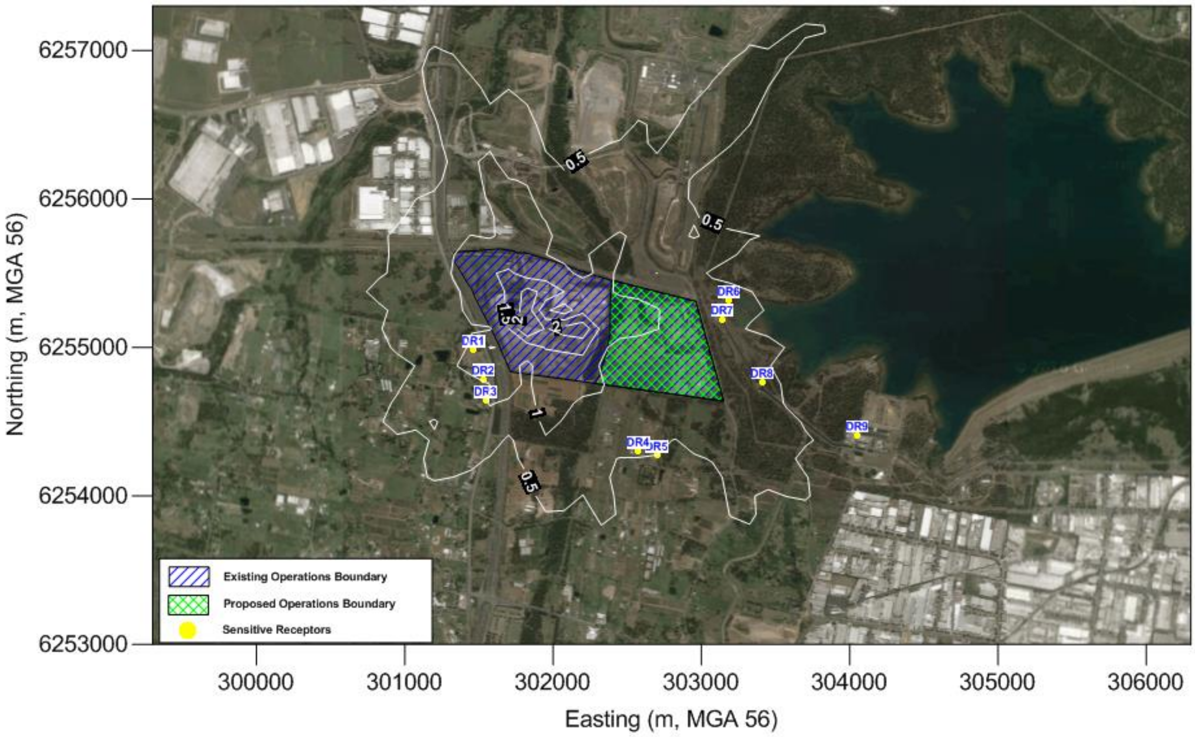

Figure A-12: LWA Stage 2 (Natural Gas) Operations – Predicted Incremental HF 24-Hour Average Concentrations (µg/m³) (Criteria: 2.9 µg/m³)

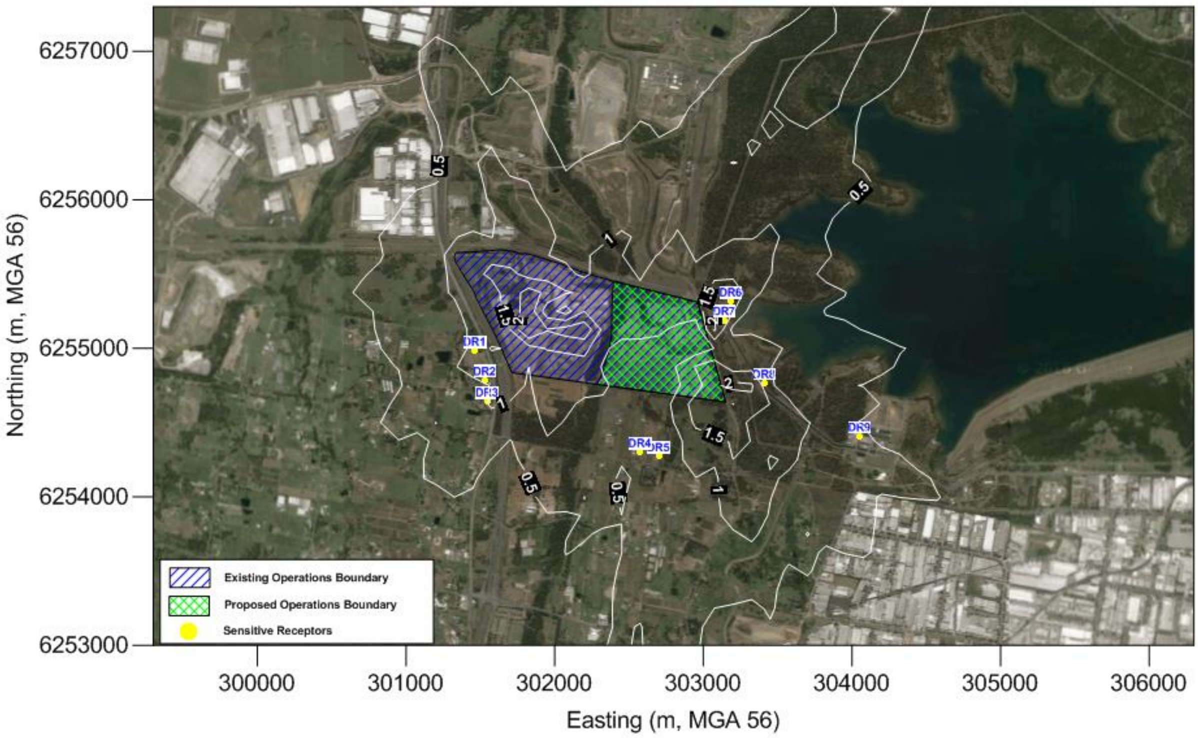

Figure A-13: Existing Operations – Predicted Cumulative NO_2 1-Hour Average Concentrations (µg/m³) (Criteria: 246 µg/m³)

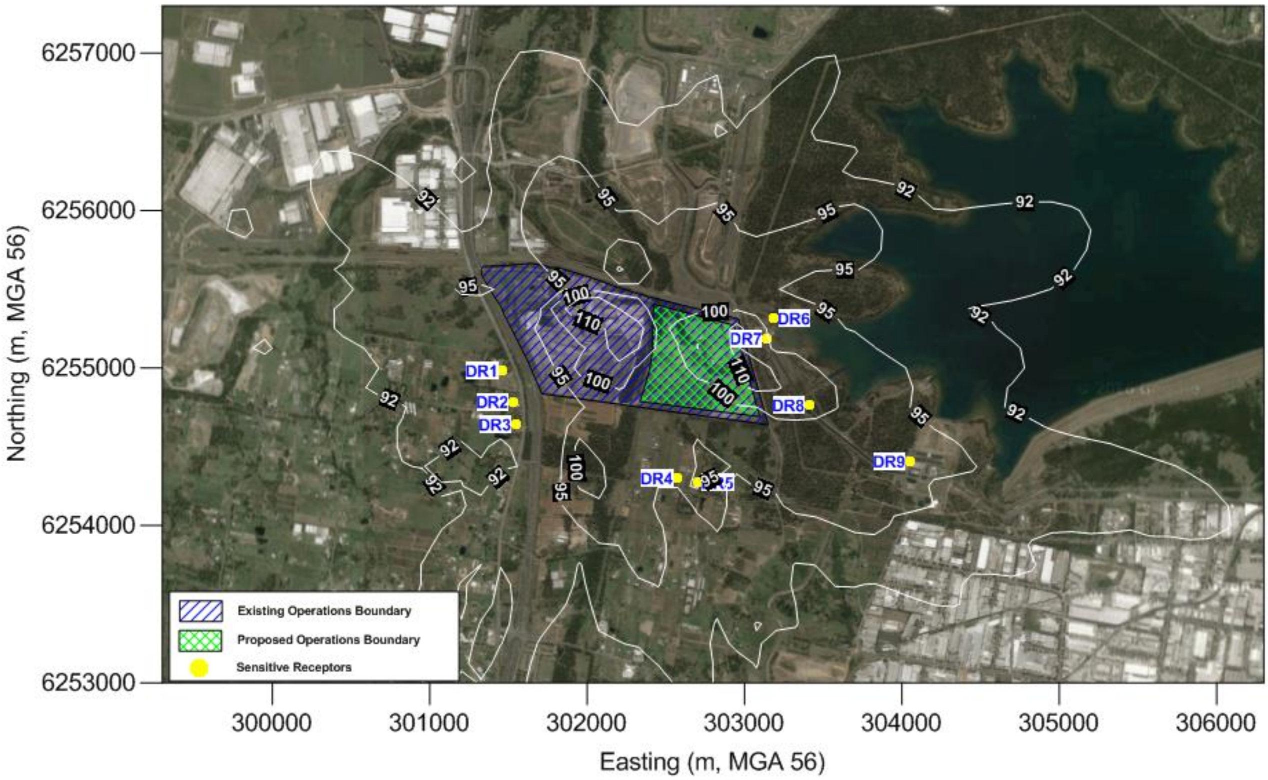

Figure A-14: LWA Stage 1 (Coal) Operations – Predicted Cumulative NO_2 1-Hour Average Concentrations (µg/m³) (Criteria: 246 µg/m³)

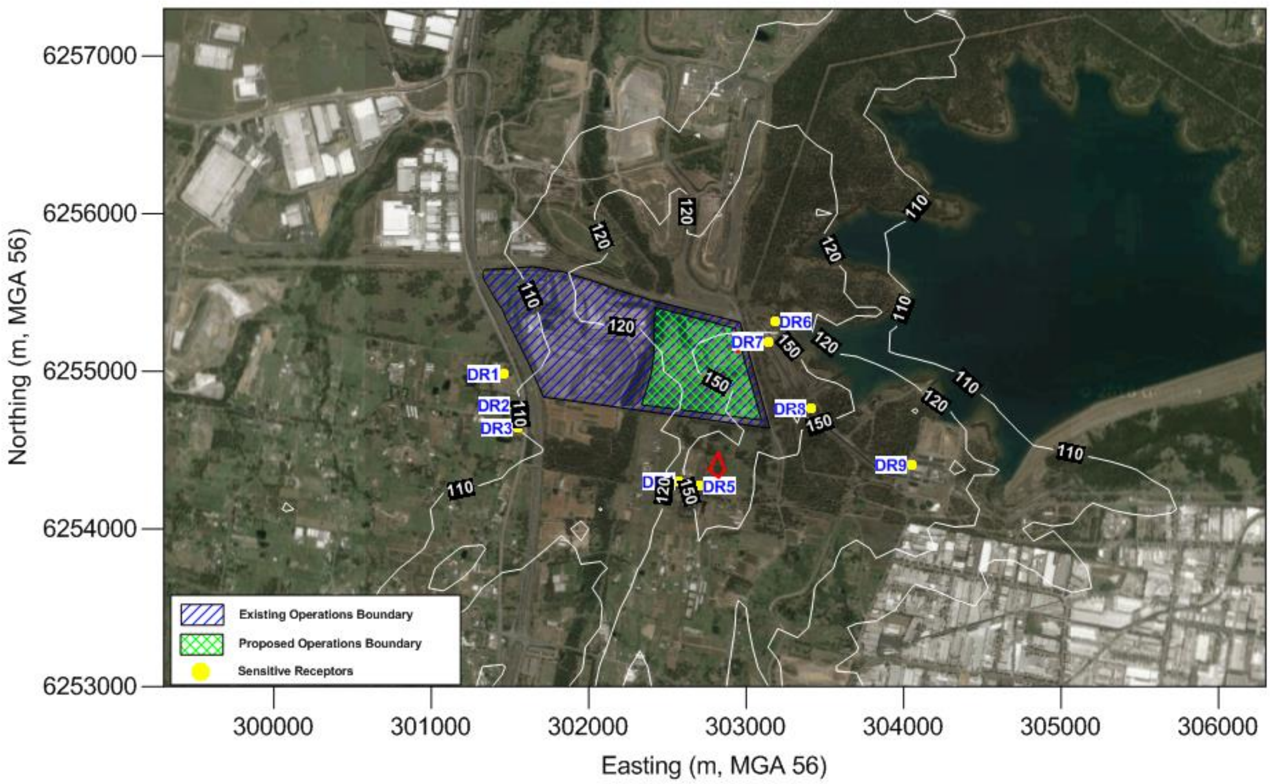

Figure A-15: LWA Stage 1 (Natural Gas) Operations – Predicted Cumulative NO_2 1-Hour Average Concentrations (µg/m³) (Criteria: 246 µg/m³)

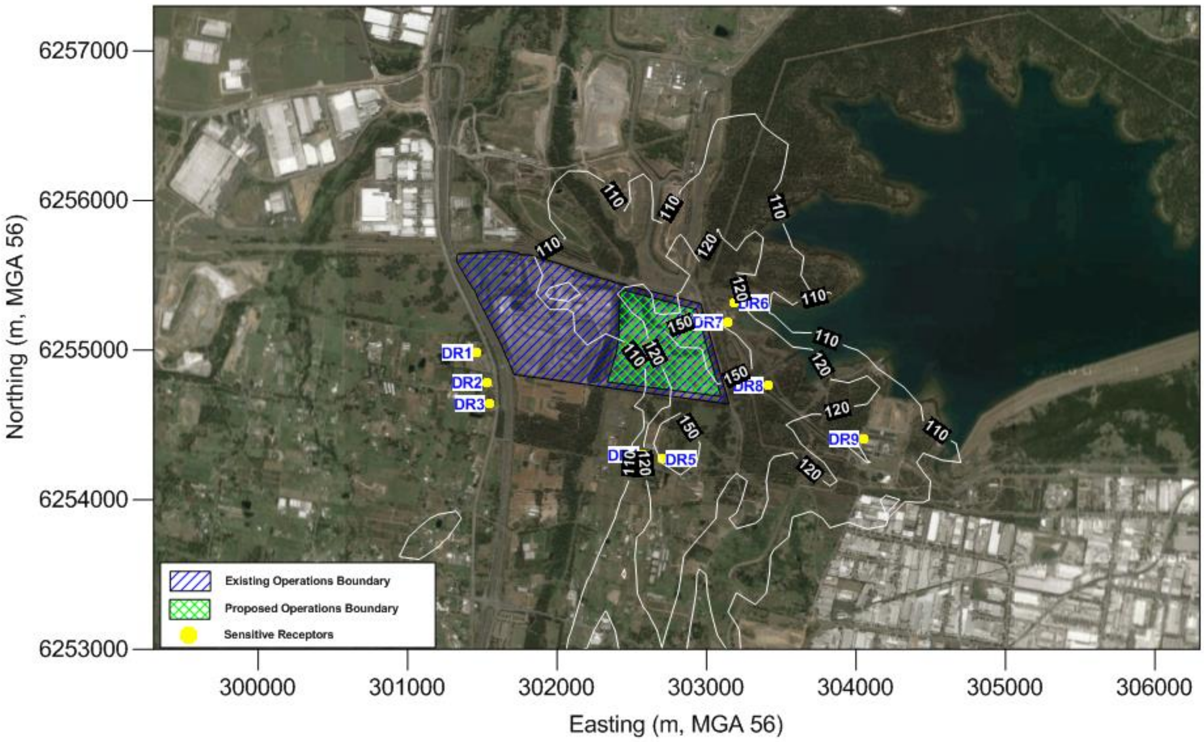

Figure A-16: LWA Stage 2 (Coal) Operations – Predicted Cumulative NO_2 1-Hour Average Concentrations (µg/m³) (Criteria: 246 µg/m³)

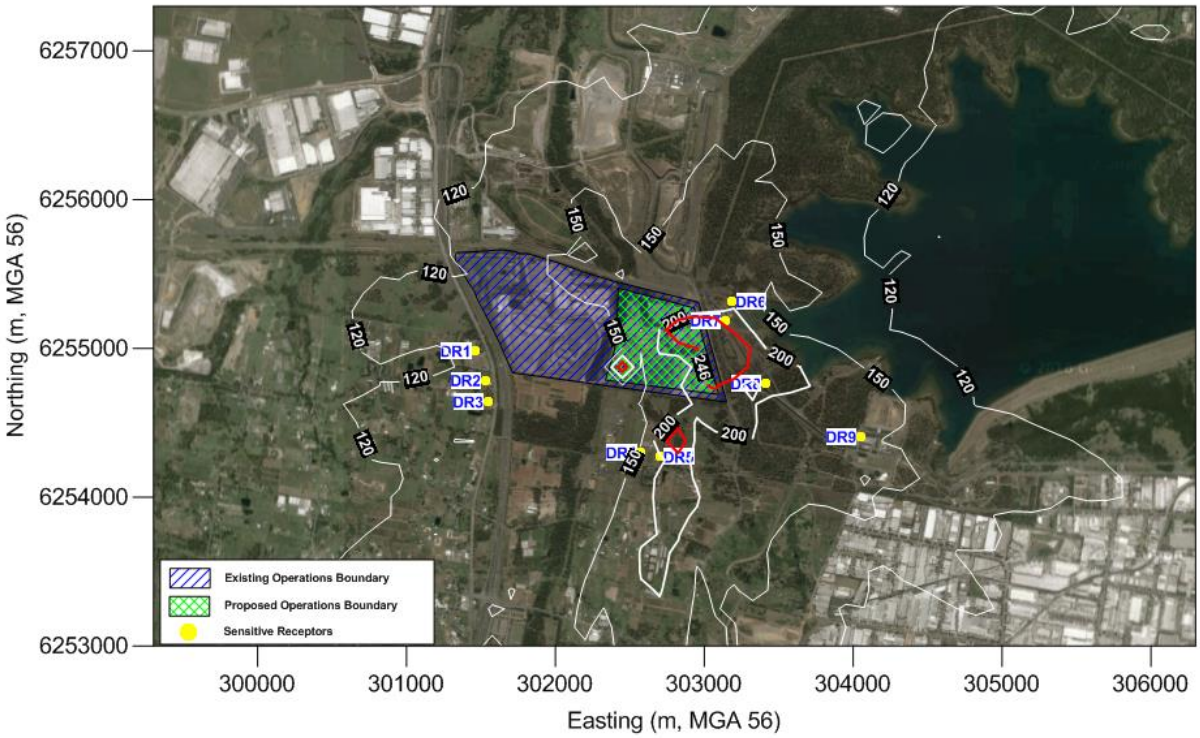

Figure A-17: LWA Stage 2 (Natural Gas) Operations – Predicted Cumulative NO_2 1-Hour Average Concentrations (µg/m³) (Criteria: 246 µg/m³)