November 2021

Air Dispersion Modelling Report

William Connolly & Sons Unlimited Company

Grange Lower, Goresbridge, Co. Kilkenny

MALONE O'REGAN

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Grange Lower, Goresbridge, Co. Kilkenny

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1 INTRODUCTION

Malone O'Regan Environmental (MOR) was commissioned by William Connolly & Sons Unlimited Company (herein referred to as Red Mills) to undertake an Air Dispersion Modelling study of emissions to air from their facility located at Goresbridge, Co. Kilkenny (the Site), shown in Figure 1-1. This study has been prepared in support of the Request for Further Information (RFI) issued by the EPA dated the 20th November 2018 with respect to the Industrial Emission (IE) Licence Application, Reference No. P1069-01.

Figure 1-1: Site Location

This report presents the findings of this Air Dispersion Modelling Study and has been prepared in accordance with the Environmental Protection Agency's (EPA) updated "Air Dispersion Modelling from Industrial Installations Guidance Note (AG4)", issued in December 2019 (EPA, 2019).

1.1 Overview

The primary objective of this study was to evaluate the impact of emissions to air arising from major emission point sources, from the Site to the surrounding environment and to propose mitigation measures if and where applicable.

There are 41 major emission point sources existing at the Site, as of November 2021, with additional 11 major emission points proposed to be installed between December 2021 and June 2023. These dates depend on multiple factors including business conditions, potential supply chain issues, etc.

There is a significant business requirement for the installation of these new emission points, 10No. of which will be new dryers:

- The grain arriving on site at the Site during the harvest season fluctuates in both volume and moisture content depending on the soil conditions and importantly changing weather conditions (temperature, rainfall, sun hours). With climate change, extreme and unusual weather is occurring more frequently. For example, 2021 was the largest harvest in Ireland for over 50 years.
- Due to technological advances, farm machinery can now harvest much more grain over a shorter duration.
- The throughput of the dryers depends on the amount of moisture in the grain, which needs to be evaporated. There is a very short window to dry grain before it starts deteriorating and turns to a waste; therefore with relatively wet crops and short window to harvest sufficient drying capacity is required to avoid significant losses of the harvested grain.
- In practice this means that Red Mills needs more drying capacity to avoid degradation of the incoming grain supply that is arriving over a shorter duration.

There are significant environmental benefits associated with increased drying capacity:

- Avoiding grain turning to a waste.
- Shortening the drying period will reduce period where potential nuisance issues could arise with dust and noise emissions from the temporary storage of grain onsite.
- Removing the need for off-site storage and associated truck movements to move this grain to and from off-site storage facilities will greatly reduce traffic movement with the associated benefits of reduction in air quality impacts and GHG emissions.

It is important to note that there are three distinct operations at the Site:

- Feed Mill – produces feed for various animals (horses, sheep, chicken), both in bulk and bagged. Feed Mill operates 24/5, year round. The Feed Mill does not operate at the weekends most of the time; however, there are occasions when it is required to operate the Feed Mill at weekends. Therefore, as a worst-case scenario it was assumed that this process operates 24/7, 356 days a year.
- Dryers – this is a grain drying process which only happens during the harvest season. Drying operates season is typically mid-July to mid-September; however, this depends on the weather and success of the harvest (i.e. amount of grain harvested), and is typically 6 - 8 weeks. However, as the start and end date vary from year to year; in this study and again to take a very precautionary approach it was assumed that all dryers are continuously operating 1 July to 30 September every year.
    - Dryers 2, 4A and 4B are specialist seed dryers, that produces seed for planting. Separate dryers must be used for seed and grain, in order to avoid the potential for cross-contamination.
    - Dryer 5, replacement Dryer 6, and replacement Dryers 1 and 3 are intended to dry grain for production of animal feed.
- Seed Plant – this is also a seasonal process, with 2 major emission points; and only operates approximately 6 months a year. As a worst-case scenario, it was assumed that these emission point operate year-round.

Except for boilers, which emit NOx, the only pollutant emitted into air from the Site is dust arising from various processes at the Site.

All major emission points will be further examined in Section 4 of this report.

1.2 Aims of the Study

The aim of this study was to assess the following:

- The existing emissions to air at the Site;
- Proposed emissions to air at the Site;

- The effectiveness of proposed mitigation measures; and
- To recommend proposed Emission Limit Values as part of the Industrial Emissions Licence Application for the Facility.

1.3 Air Dispersion Model Used for the Study

AERMOD View software was used for this study. AERMOD View is a user interface for AERMOD, Gaussian Plume Air Dispersion Model, created and distributed by Lakes Environmental (www.weblakes.com). The AERMOD model was developed by the American Meteorological Society (AMS) and United States Environmental Protection Agency (US EPA). AERMOD is the next generation air dispersion model based on planetary boundary layer theory. It is a steady-state Gaussian plume model used to assess pollutant concentrations from a wide variety of sources associated with an industrial complex. It fully incorporates building downwash algorithms, advanced depositional parameters, local terrain effects, and advanced meteorological turbulence calculations.

Key feature includes:

- Settling and dry deposition of particles.
- Building downwash.
- Point, area, line, open pit, flare, and volume sources.
- Flat and complex terrain.

AERMOD has enhanced plume dispersion coefficients due to the building turbulent wake. It incorporates reduced plume rise caused by a combination of descending streamlines in the lee of the building and the increased entrainment in its wake.

AERMOD is recommended for use in the Irish EPA's AG4 as well as by the US EPA and is commonly used in Ireland for air dispersion modelling of point source emissions from licenced facilities.

Further information related to AERMOD is provided in Appendix E.

2 EMISSION POINTS AT RED MILLS

2.1 Determination of Major Emission Points

MOR has undertaken a review of Major Emission Points list which was previously submitted with the IEL application for the Site. In addition, two subsequent site visits were carried out with the Operations and Maintenance Managers, and other staff who are familiar with the operations at the site. Based on the existing list, site visits and several meetings with the Site staff, a more accurate list of emission points for the facility was prepared – refer to section 10 below and Appendix A.

Locations of these emission points were then confirmed determined based on two drone surveys, observations during site visits and discussions with site staff. Refer to Appendix B for maps showing locations of emission points.

In order to determine both volumetric flow and emission rates, a monitoring programme was planned for the harvest season 2021. As part of the preparatory works for this monitoring programme, it was established that many emission points did not have monitoring ports or access platforms. These works were commissioned immediately, and the following was completed:

- All major emission points were labelled;
- High access platform and permanent stairs were installed for Dryer 5 (5 emission points);
- Ports and access were installed for Dryer 2 (3 points) and Dryers 4A and 4B (4 points in total);
- Ports and access were installed where possible throughout the Feed Mill building.

Monitoring of emission points, where possible, was completed in August 2021, during the harvest season (see results in Appendix A). Volumetric flows and Total Particulate Matter (TPM) as monitored, as the ELVs for other Feed Mills are set for TPM.

However, it was not practicable for health and safety reasons to provide access or install ports for a total of 11 major emission points. Therefore, these were not monitored, and volumetric flows and emission rates were estimated. The emission points that were not monitored due to lack of ports or access or both include:

- A2-12 - Cyclone GVRSA and GVRSB
- A2-13 - Fines
- A2-17 - Soya Cyclone - Bin Filling
- A2-21 - Main Intake Grain
- A2-26 - Flaker Clean 1
- A2-32 - Dryer 5 Pre-Cleaner
- A2-40 - Dryer 4 Pre-Cleaner
- A2-49 - Seed Plant Pre-Cleaner
- A2-48 - Seed Plant - Screening and Dressing Seeds

In addition, two emission points were not monitored as these were not operational at the time of monitoring. As these have largely similar characteristics to the adjacent emission points in the same process line, these volumetric flows and the emission rates were estimated:

- A2-4 Cuber 4; and
- A2-19 Grinder 3.

2.2 Boilers

There are two diesel (MGO – marked gas oil) boilers at the Site. However, Red Mills management committed that these diesel boilers would be converted to LPG (liquid petroleum gas), which has already been installed at the Site to fuel burners on the dryers. During 2021, burners for Dryers 4A, 4B and 5 were already converted to LPG.

This conversion will be completed by end of May 2022. Therefore, the only relevant pollutant from these boilers will be NOx.

These boilers run as duty and stand-by:

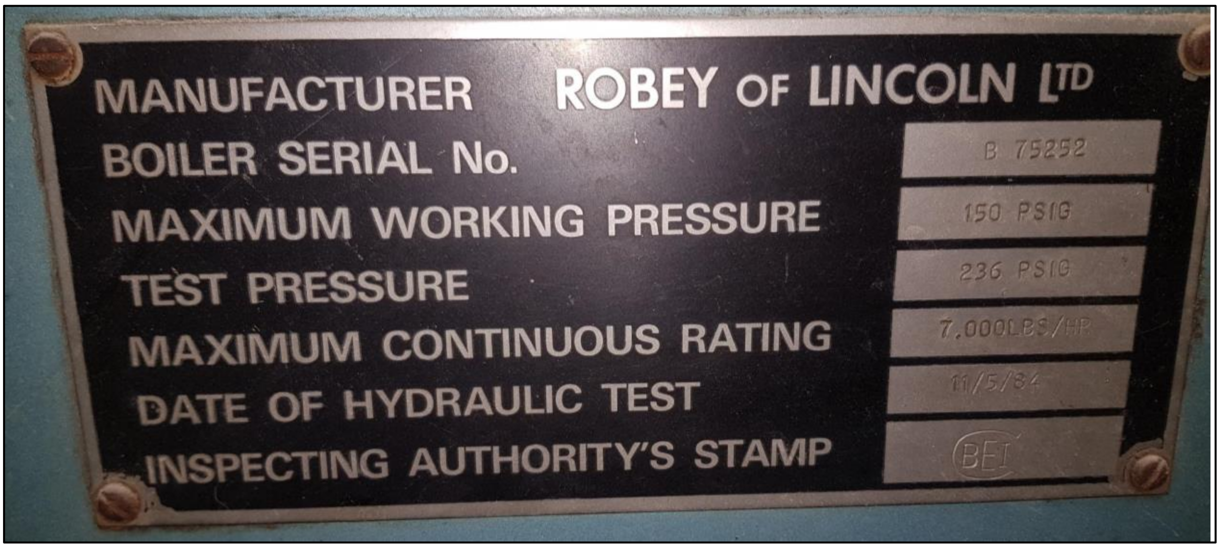
- Duty boiler – Danstoker, 6,000kg/steam per hour. This boiler runs 24/7/365, except for maintenance, and typically runs at 70-80% of load.
- Standby boiler – Robey of Lincoln, 3,175 kg/steam per hour. This boiler runs only during maintenance of duty boiler, and for about 5-6 hours per week.

Currently, neither thermal input nor volumetric flow is available for these boilers. In addition, the monitoring ports in accordance with AG1 were not available and only NOx was monitored (169.85 mg/Nm3).

The only available information is what is provided on the labels on the boilers, refer to Figures 2-1 and 2-2. MOR did contact the manufacturer to obtain volumetric flow data, and although the manufacturer provided some information, volumetric flows or emission data was not available.

Figure 2-1: Duty boiler label

Figure 2-2: Stand-by boiler label



2.2.1 Modelling Approach for Boilers

As these boilers will be converted to LPG, requiring new burners, the volumetric flow is currently unknown.

A NOx limit of 200mg/Nm3 in proposed, as the current monitoring data for NOx (169.85 mg/Nm3) indicates that boilers perform below this limit. Once converted to LPG, it is expected that NOx emissions will decrease.

Approach to volumetric flow estimation was to review volumetric flow for other industrial boilers at similar facilities, and to include the highest possible volumetric flow that does not breach 75% of applicable AQS, as per AG4 Guidance. Both boilers were run in the model at 100% load, 24/7/365, which is a significant overestimate.

Following LPG conversion and installation of appropriate ports and access, monitoring will be completed to confirm both NOx emissions and volumetric flow. At that point validation modelling can be carried out.

2.3 Dryer 6

2.3.1 Flat-bed Dryer

During harvest season 2021, a flat-bed dryer was in use. This dryer has been on site since the 2000's and does not have a stack or a vent. Instead, along its side there are slats, and dust is emitted through these slats (refer to Figure 2-3). Given how this dryer works, it is a source of fugitive emissions rather than a point source. As such, it was not included in the air dispersion model.

Figure 2-3: Flat-bed Dryer 6

However, during harvest season 2021, an ambient PM10 monitor was positioned in front of this dryer, at the Site boundary, to assess the fugitive emissions arising at this location. Although this monitoring was limited in duration – 5 days, no significant impact was detected – refer to Appendix C where details of the monitoring and the results are presented. The average monitored PM10 concentration was slightly lower than average Zone D background PM10 concentrations.

Flatbed Dreyer 6 in currently in the process of decommissioning.

2.3.2 Replacement Dyer 6

As the flat-bed Dryer 6 in not only old but also inefficient, with a low throughput, resulting in delays in drying process and associated difficulties (unless grain is died as soon as possible, it rots and becomes waste; refer to section 1.1 above). Therefore, the Red Mills management decided to replace it with a new dryer 6 that will be installed as soon as possible as it has already been purchased, and it will be in operation for Harvest season 2022. This dryer will have a total of 5 emission points, one of which will be a pre-cleaner.

Replacement Dryer 6 will be brand new, efficient dryer with high throughput to shorten the drying season. It will include 5 stacks i.e. point sources – major emission points.

Schematic, elevation and description of New Dryer 6 provided by the manufacturer, is presented in Appendix D of this report.

It is important to note that in terms of emissions to air, this type of dryer will emit dust for a period of 10 seconds every 3 to 5 minutes. This means that in space of an hour, this dryer will emit for a total of 200 seconds or 3 minutes and 20 seconds. The dryer design will include a fabric filter to reduce emissions during these 10 seconds (refer to Appendix D).

Although volumetric flow is known for all 5 emission points, as this dryer has not been installed or operated at Red Mills yet, it is unknown what the actual emission rate will be during these 10 seconds of dust emission or during the rest of the operation, if any.

Currently, it is planned to carry out monitoring at the same type of dryer at another installation mid-December 2021. However, the results of this monitoring will not be available prior to January 2022, and therefore cannot be included in this assessment at this stage.

Given the variable emission rate from this type of dryer, it is proposed that the ELV for this dryer is set as a mass emission in kg/hr for Total Particulate Matter, rather than as mg/Nm3. Please refer to Table 2-1 below.

Emissions rate of 1.36 kg/hr of dust is equivalent to constant emission rate of 10mg/Nm3 over 1 hour x specified volumetric flow. However, as the emission rate in mg/Nm3 (i.e. as concentration) is not constant, but in 10 second pulses every 5 minutes, it is considered appropriate to apply emission rate of 1.36kg/hr for each stack (and 0.2 kg/hr for pre-cleaner).

Table 2-1: Proposed ELVs for replacement Dryer 6

Emission Point Ref	Emission Point Name	Volume Flow - proposed ELV (Nm3/hr)	Emission rate (g/s)	Emission rate – proposed ELV (kg/hr)
A2-45A	Replacement Dryer 6	136,000	0.378	1.36
A2-45B	Replacement Dryer 6	136,000	0.378	1.36
A2-46A	Replacement Dryer 6	136,000	0.378	1.36
A2-46B	Replacement Dryer 6	136,000	0.378	1.36
A2-46C	Replacement Dryer 6 – pre-cleaner	20,000	0.056	0.2

2.4 Replacement Dryers 1 and 3

Dryers 1 and 3 were previously present onsite for grain drying but were decommissioned in the past. It is required to replace these dryers, for reasons outlined in section 1.1 above. Currently, it is planned to have these dryers in operation for Harvest 2023. For more detail refer to Non-Technical Summary and cover letter provided by MOR in response to the EPA's RFI.

Please note that emissions from old Dryers 1 and 3 could not be modelled, as these dryers were decommissioned, and no information on emission rates or volumetric flows is available.

This assessment is based on two replacement dryers being of the same type and characteristics as the Replacement Dryer 6 (see above), and would result in 5 new emission points:

- Replacement Dryer 1 – 2 emissions points;
- Replacement Dryer 3 – 2 emission points;
- One pre-cleaner serving these dryers.

These emissions were included in this study in Scenario 4. In analogy for replacement Dryer 6, it is proposed that the ELVs for replacement Dryers 1 and 3 is set as a mass emission in kg/hr for Total Particulate Matter, rather than as mg/Nm3. Refer to Table 2-2 below.

Table 2-2: Proposed ELVs for replacement Dryers 1 and 3

Emission Point Ref	Emission Point Name	Volume Flow - proposed ELV (Nm3/hr)	Emission rate (g/s)	Emission rate – proposed ELV (kg/hr)
A2-50A	Replacement Dryer 1	136,000	0.378	1.36
A2-50B	Replacement Dryer 1	136,000	0.378	1.36
A2-51A	Replacement Dryer 2	136,000	0.378	1.36

A2-51B	Replacement Dryer 2	136,000	0.378	1.36
A2-52	Dryer 1/2 pre-cleaner	20,000	0.056	0.2

2.5 Oat Cleaner

Oat cleaner (A2-53) is a new process planned for the Feed Mill to be installed by the end of 2022. As all equipment will be located internally, this emission point and associated process or equipment does not require planning permission. In addition, the proposed volumetric flow will be a relatively small proportion of the total Feed Mill Volumetric flow (ca. 8%) and even smaller proportion of mass emissions (6%).

3 SCENARIOS IN THIS ASSESSMENT

For the purposes of this technical response to the EPA as part of the IE Licence application, a total of 4 scenarios were run:

1) **Scenario 1**
   - This Scenario was based on the major emissions points to air that were present at the Site during harvest season 2021. Where available, actual monitoring data was used in this scenario, as opposed to proposed ELVs.
   - Where no monitored data was available, emission rates were based on proposed ELVs and volumetric flows were estimated.
   - Flat-bed Dryer 6 was not included, as this was deemed to be a fugitive emission.
2) **Scenario 2**
   - This scenario modelled emission points in Scenario 1, with some significant improvements (abatement for Dryers 4A and 4B, increase in stack heights/ removal of caps for pre-cleaners Dryer 4A/B and 5, A2-48 and A2-49 (Seed Plant)).
   - This scenario also included replacement Dryer 6 with 5 emission points.
3) **Scenario 3**
   - In this Scenario, Scenario 2 emission points with mitigation measures, i.e. stack heights/configuration at Feed Mill were adjusted to maximise dust dispersion.
4) **Scenario 4**
   - This scenario is based on Scenario 3 plus additional emission points planned to be operational by Harvest 2023:
     i. Two dryers (replacing historic Dryers 1 and 3, plus pre-cleaner) – 5 additional emission points; and,
     ii. Oat Mill Cleaner emission point.

4 RELEVANT AMBIENT AIR QUALITY STANDARDS

Assessment of the significance of a particular level of pollution is made with reference to limit values established in the latest EU legislation, the Clean Air for Europe (CAFE) Directive (2008/50/EC) (European Parliament, 2008) which was transposed into Irish law as S.I. 180 of 2011. (ISB, 2011).

Air Quality Standards (AQSs) are usually based on the effects of pollutants on human health, although other factors such as effects on vegetation are sometimes taken into account.

The relevant limit values for air quality standards as set by SI 180 of 2011 are presented in Table 4-1.

Table 4-1: EU and Irish Air Quality Standards

Pollutant	**Objective**			
	Concentration	**Maximum No. of Exceedances permitted**	**Exceedance Expressed as** Percentile	**Measured as**
PM10	50 µg/m^3	35 times per year	90.4th percentile	24 hours
PM10	40 µg/m^3	-	-	Annual mean (calendar year)
Nitrogen Dioxide	200 µg/m^3 as NO_2	18 times per year	99.79th percentile	1 hour mean
	40 µg/m^3 as NO_2	~	~	Annual mean
Nitrogen Dioxide	30 µg/m^3 as NO_2	~	~	Annual mean (protection of ecosystems)

5 MODEL INPUTS

5.1 Background Concentration of Relevant Pollutants

As recommended in the AG4 Guidance document, background concentration available from the representative monitoring stations operated by the EPA is used in this study. The selected background concentrations are based on the average of the appropriate zonal concentrations – Zone D, Rural Ireland, in this case.

The current trends in air quality in Ireland are reported in the EPA publication 'Air Quality in Ireland (Key Indicators of Ambient Air Quality) – Annual Report 2019' (EPA, 2019) which is currently the most up to date analysis of air quality data for Ireland. AG4 recommends that average of 2 to 3 years of data is used. Table 5-1 shows the baseline air quality data for Zone D for PM10, taken from the past four years of EPA Air Quality reports.

Table 5-1: Background value Zones D EPA 2016-2019 PM_{10} – Annual Mean

Monitoring Stations	Total Particulates PM_{10} Annual Mean (µg/m³)			
	EPA Report 2016	EPA Report 2017	EPA Report 2018	EPA Report 2019
Castlebar	11.9	11.2	11	16
Kilkitt	8.1	7.8	9	7
Claremorris	10.1	10.8	12	11
Enniscorthy	17.3	-	-	18
Roscommon town	-	-	12	12
Cobh	-	-	15	13
Tipperary Town	-	-	-	9
Macroom				28
Average	**11.85**	**9.93**	**11.8**	**14.25**

The overall average annual mean concentration of PM_{10} for the Zone D monitoring locations from 2016-2019 is 11.96 µg/m^3. The most recent annual mean across all Zone D monitoring locations was 14.25 µg/m^3 (2019) and included more monitoring stations. Macroom has an elevated PM_{10} annual mean for 2019 in comparison to other years. Due to this elevated reading this study will use the overall annual mean from 2016 – 2019 as the background PM_{10} value for Zone D and for the Site.

Table 5-2 shows the baseline air quality data for Zone D for NOx, taken from the past four years of EPA Air Quality reports.

Table 5-2: Background value Zones D EPA 2016-2019 NO_2 – Annual Mean and hourly max

Monitoring Station	NO_2 Annual Mean (µg/m³)			
	2016	2017	2018	2019
Castlebar	8.5	7.4	8	8
Kilkitt	3.0	2.3	3	5
Emo Court	4.1	3.4	3	4

Monitoring Station	NO_2 Annual Mean (µg/m³)			
	2016	2017	2018	2019
Average Zone D	4.98 µg/m³			

The average background annual mean NO_2 value for Zone D from 2016-2019 was 4.98 µg/m³. In accordance with the methods outlined in “Combining Short-Term Process Contribution With Background Concentration” of Appendix D of the EPA’s AG4 Guidance (EPA, 2019a), the *“99.8th%ile process contribution NOX + 2 x (annual mean background NO_2)”* was utilised for the purposes of estimating the 1-hr 99.79%ile Predicted Environmental Concentration (PEC) throughout this report. As per the above method, double the average annual mean NO_2 for Zone D is 9.96 µg/m³.

5.2 Ambient PM monitoring data

PM10 ambient monitoring was carried out at two suitable locations during harvest 2021 to assess overall ambient concentrations of PM10 at the Site. Monitoring was carried out for a period of 5 days at each location.

For details of monitoring, wind direction and results please refer to Appendix C.

This monitoring data included PM10 concentrations arising from:

- Background concentration in the area;
- PM10 emissions form all point sources operating during the monitoring (Feed Mill, Dryers including Dryer 6 and Seed Plant);
- Fugitive emissions arising from grain delivered and temporarily stored at the Site (in open air) during the harvest;
- Fugitive emissions arising from traffic generated by normal site operations, as well as grain deliveries for drying.

Results show no exceedance of 24-hr AQS, moreover, are slightly lower than average Zone D PM10 concentration (presented in section 5.1 above).

5.3 Meteorology

Detailed meteorological data was required for the model to construct realistic planetary boundary layer (PBL) similarity profiles and adequately characterise the dispersive capacity of the atmosphere.

In this study, five consecutive years of hourly meteorological data was used for all Scenarios as per AG4. This data was obtained from Met Éireann. The nearest synoptic station that provides hourly historical data is Oak Park, Co. Carlow, ca. 26 km north east of the Site.

Table 5-3 below provides summary of met data for Oak Park.

Table 5-3: Oak Park Meteorological Data 2016-2020.

Year	Average wind speed (m/s)	Maximum wind speed (m/s)	Average temperature (°C)	No. of calm hours
2016	3.69	14.9	10	7
2017	3.81	19	10.5	4
2018	3.83	16.9	10.5	2
2019	3.85	13.9	10.2	1
2020	4.15	15.9	10.2	0

A wind rose for each of the 5 modelled years (2016-2020 is shown in Figures 5-1 to 5-5).

Figure 5-1: Wind rose for Oak Park 2016

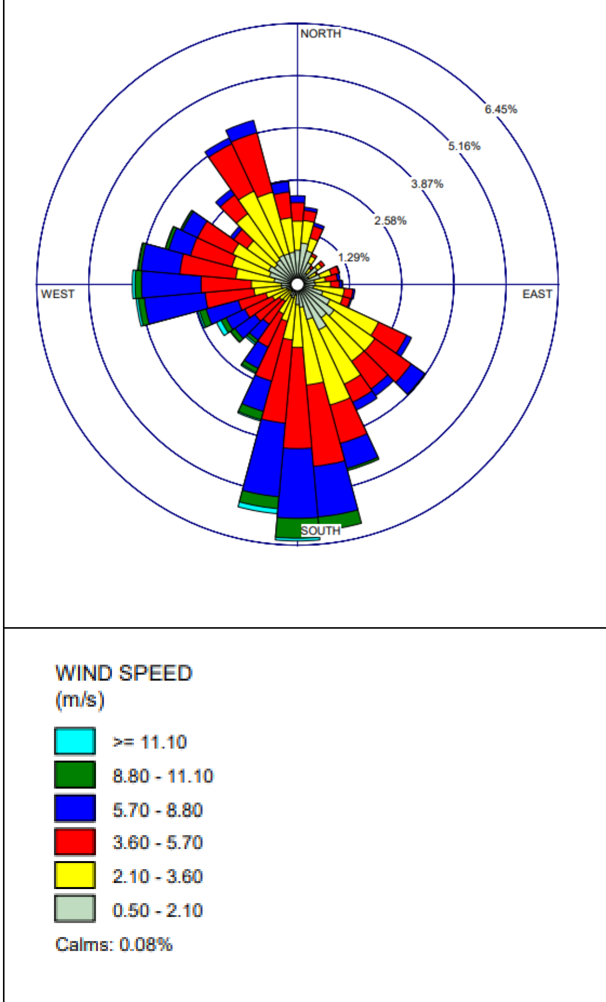


Figure 5-2: Wind rose for Oak Park 2017

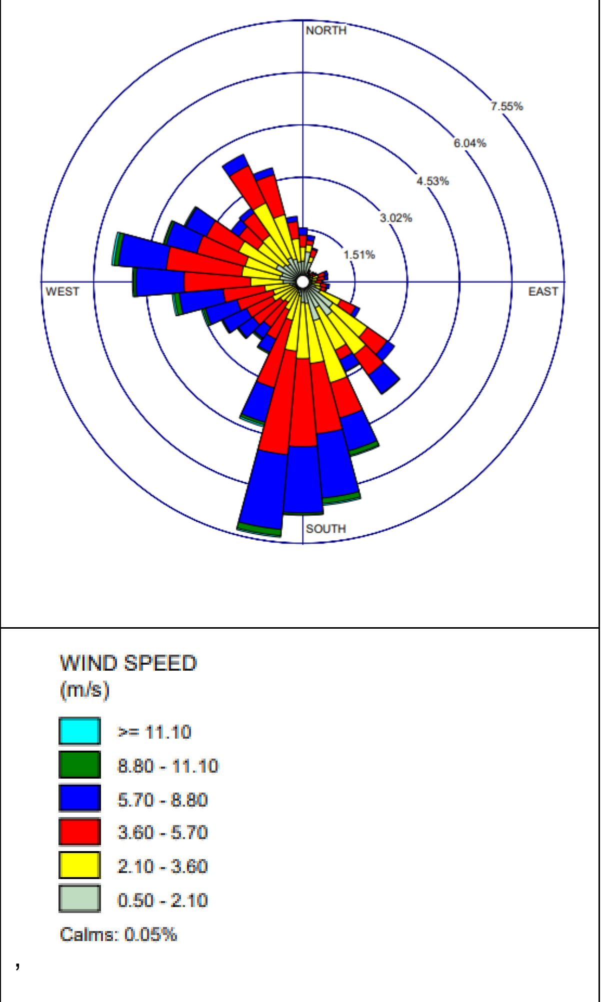
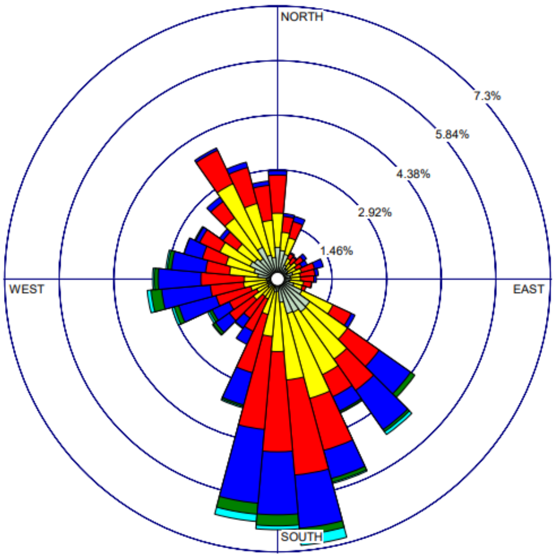


Figure 5-3: Wind rose for Oak Park 2018

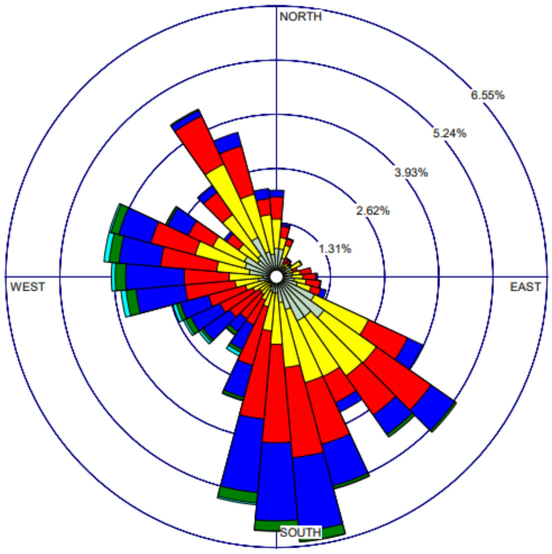


WIND SPEED
(m/s)

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10

Calms: 0.02%

Figure 5-4: Wind rose for Oak Park 2019



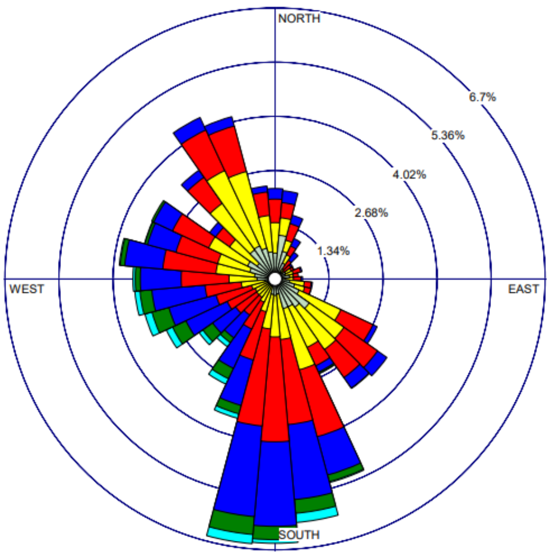
WIND SPEED
(m/s)

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10

,

Calms: 0.01%

Figure 5-5: Wind rose for Oak Park 2020



WIND SPEED
(m/s)

- >= 11.10
- 8.80 - 11.10
- 5.70 - 8.80
- 3.60 - 5.70
- 2.10 - 3.60
- 0.50 - 2.10

Calms: 0.00%

5.4 Geophysical Considerations

AERMOD incorporates a meteorological pre-processor AERMET(24). The AERMET meteorological pre-processor requires the input of surface characteristics, including surface roughness (z0), Bowen Ratio and albedo by sector and season, as well as hourly observations of wind speed, wind direction, cloud cover, and temperature. The values of albedo, Bowen Ratio and surface roughness depend on land-use type (e.g., urban, cultivated land etc.) and vary with seasons and wind direction.

The assessment of appropriate land-use type was carried out to 10km from the meteorological station for Bowen Ratio and albedo and to a distance of 1km for surface roughness in line with USEPA recommendations.

The surface roughness length is related to the height of obstacles to the wind flow and is, in principle, the height at which the mean horizontal wind speed is zero based on a logarithmic profile. The surface roughness length influences the surface shear stress and is an important factor in determining the magnitude of mechanical turbulence and the stability of the boundary layer.

Detailed terrain features that exceed a 10% elevation slope from any given receptor must be included in the model. Given that the site location, terrain data was obtained from Ordnance Survey Ireland and included in the model.

5.5 Designated Areas

One Natura 2000 designated site was identified within 5km of the Site (Table 5-4). This is an aquatic habitats – estuaries.

Table 5-4: Natura 2000 designated sites within 5km

Site Name	Code	Distance (km)	Direction from the Site
Special Areas of Conservation (SAC)			
River Barrow and River Nore SAC	002162	Ca. 0.1km	E

5.6 Sensitive Receptors

Sensitive receptors and their distance to the Site are detailed in Table 5-5 below and shown in Figure 5-6. The nearest sensitive receptor is located ca. 6 metres to the east, in between the road and the Site's boundaries.

Figure 5-6: Sensitive Receptors

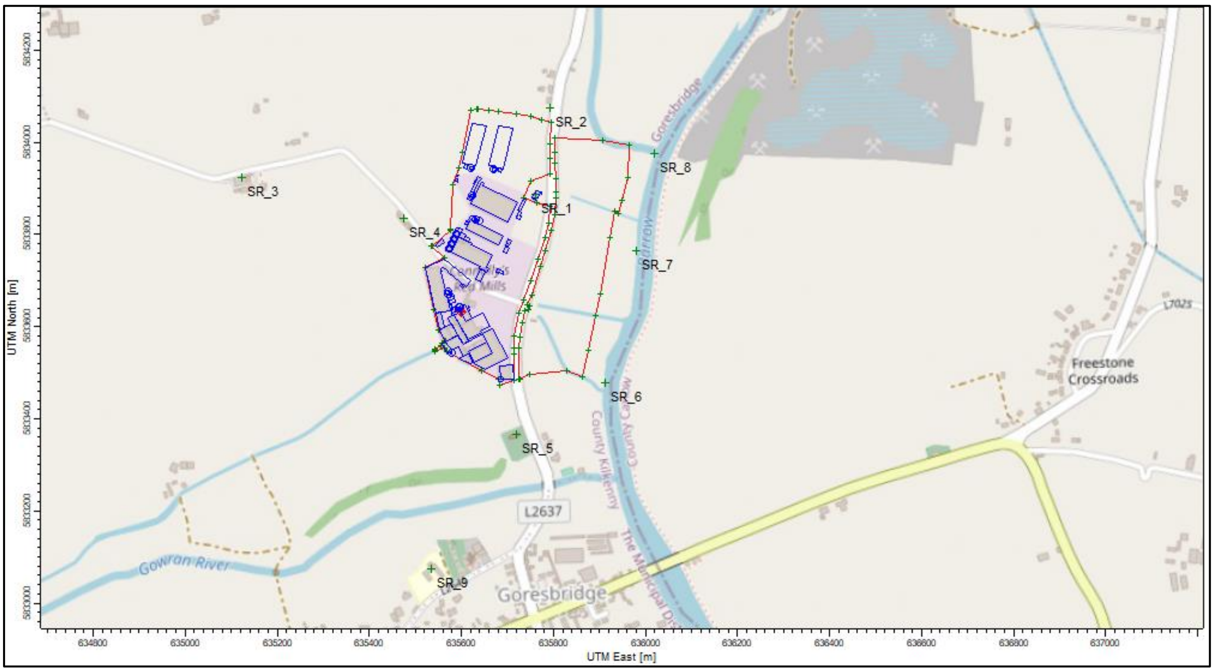


Table 5-5: Identification of Sensitive Receptors

ID	Location Relevant to Site	Distance to Site Boundary (m)	Note
SR 1	Dwelling on road between Site boundary	ca.6	Residential property
SR 2	Dwellings to the north of the Site	ca.40	Residential properties
SR 3	Dwelling to the west of the Site	ca.350	Residential property
SR 4	Dwelling to the west of the Site.	ca.759	Residential property
SR 5	Church to south of the Site	ca.110	Church/ community amenity
SR 6	River Barrow SAC	ca.93	SAC
SR7	River Barrow SAC	ca.52	SAC
SR8	River Barrow SAC	ca.56	SAC
SR9	School to south of the Site	c.430	School

5.7 Modelling Assumptions

In this model the following assumptions were made:

- All point sources associated with dryers (Dryer 2, 4A, 4B, 6, replacement Dryer 6, 1 and 3 dryers) will run at full load 24/7, for 3 months of the year to simulate the drying season – July, August and September. This is maximum/worst-case scenario. The drying season is typically 6 to 8 weeks.

- Remaining point sources will run at full load 24/7, 365 days a year; which is also a maximum/worst-case scenario as Feed Mill typically operates 5 days a week/year round, and Seed Plan operates approximately 6 months a year.
- Terrain data (SRTM1 Global ~30m) was included in the model.
- Five consecutive years of Oak Park synoptic station met data was used.
- Mass emissions were calculated based on normalised volumetric flow and normalised concentration emission rate.

5.7.1 Assumptions due to Data Gaps

- Volumetric flow for boilers is a rough estimate, as no monitoring data or manufacturer specification was available.
- Mass emissions for replacement dryers (Dryer 6, 1 and 3) are estimated. Given the design that includes fabric filters, it is expected that this is an over-estimate; however, this will be confirmed via monitoring to be carried out in December 2021.
- Emission rates and volumetric flows for non-monitored emission points (refer to section 2.1 above) were estimated based on the emission points within the same processes.

5.8 Emissions and Stack Data

Due to there being 49 dust emission points it was considered that the data set was too large to include in the main body of the report. The raw emissions and stack data that was input into the model for these points is available in Appendix A – separate table is provided for each modelled scenario.

Boilers input data is presented in section 5.8.1. below.

5.8.1 Boilers

The following parameters were used in the model for assessing NOx emissions (Table 5-6).

Table 5-6: Input Parameters for NOx emissions to air from the two boilers at Red Mills

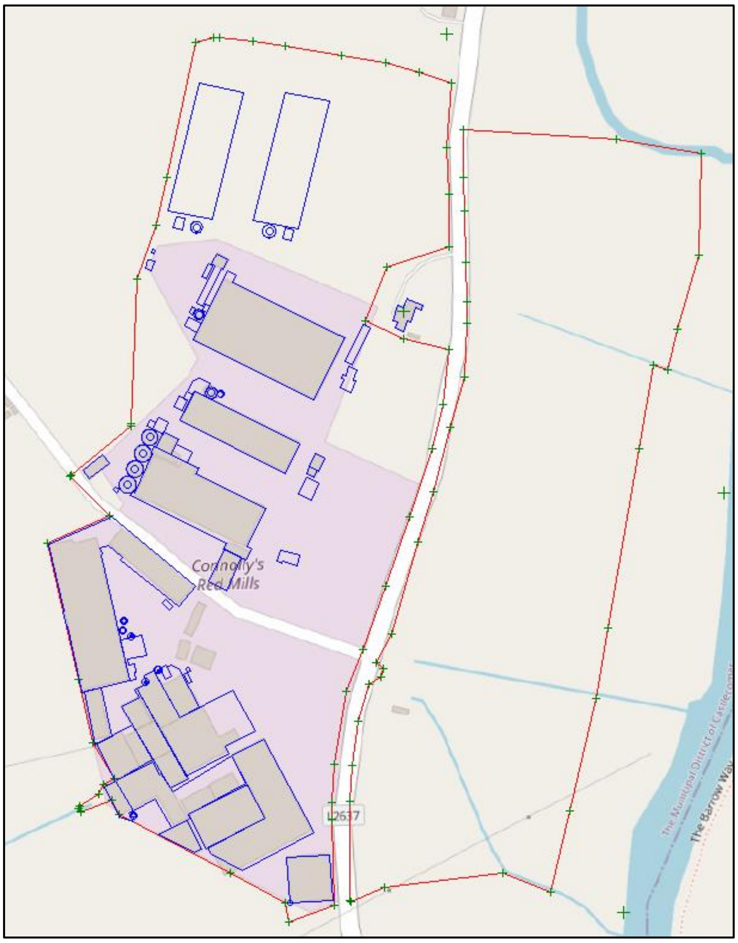
Emission Point	A1-1	A1-2
Description	Existing boiler	Existing boiler
Release Height (m)	18	18
ELV (mg/Nm3) *	200	200
Volumetric Flow (Nm3/hr)*	10,000	5,000
Emission Rate (g/s)	0.556	0.2778
Exit Temperature (C)	165.7	165.7
Stack Diameter (m)	0.59	0.59
Actual Exit Flow Rate (m3/s)	2.78	1.39

5.9 Buildings

All on-site buildings and significant process structures were mapped into the model to create a three-dimensional visualisation of the Site and its emission points. Buildings and process structures can influence the passage of airflow over the emission stacks and draw plumes down towards the ground (termed building downwash).

Figure 5-7 shows the Site layout with building locations.

Figure 5-7: Site layout with buildings



5.10 Receptor Grid

In the model, a receptor grid was created and for each grid point, a ground level concentration of pollutants was modelled. Receptors were mapped with sufficient resolution to ensure all localised "hot-spots" were identified without adding unduly to processing time. The receptor grid was based on Cartesian grid with the Site at the centre.

As per AG4, a uniform cartesian receptor grid was utilised measuring 2.45km x 2.45km, with 50m between the points.

In addition, 9 sensitive receptors, i.e., residential houses, specified in section 2.5 respectively, were also set up in the model as receptors.

5.11 NO_2/NOx Conversion

NOx emissions resulting from the combustion process are comprised of both NO and NO_2. Once in the atmosphere, through complex reactions with ozone and sunlight, eventually most of NO is converted to NO_2. However, the relevant AQS are expressed as NO_2 (see section 2 above).

There are various approaches suggested by different agencies (the US EPA and the UK EA); however, for annual average it is commonly taken that full conversion takes place; i.e., all emitted NOx converts to NO_2. This approach is taken in this study.

For short term (1-hr average) emissions, the UK EA (H1 Annex F Air Emissions, 2011) recommends conversion factor of 0.5, i.e., NO_2/NOx = 0.5. (This method is also referred to in the EPA's AG4 Guidance.) This approach is taken in this study.

6 RESULTS - NOX

The results of the modelling emissions from the two boilers plant at the site locations are presented in Tables 6-1 to 6-5 below.

6.1 Predicted Environmental Concentrations – Annual Mean NO_2

Table 6-1 details the results of the air dispersion modelling for NO_2 annual mean, showing maximum process contribution at ground level (emissions to air from the stacks) and maximum predicted environmental concentration (process contribution plus background contribution) outside the Site boundary at ground level. These concentrations represent the worst-case scenario - maximum concentrations in a very limited area near the Site boundary, that only occur rarely under specific weather conditions.

Table 6-1: Maximum Predicted Environmental Concentration of Pollutants - Annual Mean NO_2 in µg/Nm^3

NO_2 (annual mean) (µg/Nm^3)	**2016**	**2017**	**2018**	**2019**	**2020**
Maximum Process Contribution (PC)	11.08	**13.13**	11.40	11.37	11.47
Background Concentration	4.98	**4.98**	4.98	4.98	4.98
Predicted environmental concentration (PEC)	16.06	**18.11**	16.38	16.45	16.45
Air Quality Standard (AQS)	40	**40**	40	40	40
PEC as percentage of AQS	40.2%	**45.3%**	40.9%	41.1%	41.1%

Table 6-2 provides the NO_2 (Annual Mean) Maximum Process Contribution (PC) and the Predicted Environmental Concentrations (PEC) at sensitive receptors for each of the individual modelling years (2016 to 2020).

Table 6-2: Predicted Environmental Concentrations of Pollutants at SRs (NO_2 Annual Mean at Sensitive Receptors)

Year	**Receptor**	**Result (PC) µg/Nm^3**	**Background Concentration µg/Nm^3**	**Result + Background (PEC)**	**AQS**	**%AQS (PEC)**
2016	SR1	1.69	4.98	6.67	40.00	0.17%
	SR2	1.30	4.98	6.28	40.00	0.16%
	SR3	1.49	4.98	6.47	40.00	0.16%
	SR4	3.85	4.98	8.83	40.00	0.22%
	SR5	4.21	4.98	9.19	40.00	0.23%
	SR6	2.56	4.98	7.54	40.00	0.19%
	SR7	1.38	4.98	6.36	40.00	0.16%
	SR8	0.66	4.98	5.64	40.00	0.14%
	SR9	1.31	4.98	6.29	40.00	0.16%
2017	SR1	1.82	4.98	6.80	40.00	0.17%
	SR2	1.50	4.98	6.48	40.00	0.16%
	SR3	1.00	4.98	5.98	40.00	0.15%

Year	Receptor	Result (PC) µg/Nm³	Background Concentration µg/Nm³	Result + Background (PEC)	AQS	%AQS (PEC)
	SR4	3.68	4.98	8.66	40.00	0.22%
	SR5	3.76	4.98	8.74	40.00	0.22%
	SR6	2.85	4.98	7.83	40.00	0.20%
	SR7	1.48	4.98	6.46	40.00	0.16%
	SR8	0.79	4.98	5.77	40.00	0.14%
	SR9	0.89	4.98	5.87	40.00	0.15%
2018	SR1	1.51	4.98	6.49	40.00	0.16%
	SR2	1.21	4.98	6.19	40.00	0.15%
	SR3	1.19	4.98	6.17	40.00	0.15%
	SR4	4.42	4.98	9.40	40.00	0.23%
	SR5	4.05	4.98	9.03	40.00	0.23%
	SR6	2.16	4.98	7.14	40.00	0.18%
	SR7	1.26	4.98	6.24	40.00	0.16%
	SR8	0.70	4.98	5.68	40.00	0.14%
	SR9	1.05	4.98	6.03	40.00	0.15%
2019	SR1	1.47	4.98	6.45	40.00	0.16%
	SR2	1.17	4.98	6.15	40.00	0.15%
	SR3	1.82	4.98	6.80	40.00	0.17%
	SR4	4.47	4.98	9.45	40.00	0.24%
	SR5	4.08	4.98	9.06	40.00	0.23%
	SR6	2.70	4.98	7.68	40.00	0.19%
	SR7	1.35	4.98	6.33	40.00	0.16%
	SR8	0.64	4.98	5.62	40.00	0.14%
	SR9	0.78	4.98	5.76	40.00	0.14%
2020	SR1	1.69	4.98	6.67	40.00	0.17%
	SR2	1.27	4.98	6.25	40.00	0.16%
	SR3	1.17	4.98	6.15	40.00	0.15%
	SR4	3.61	4.98	8.59	40.00	0.21%
	SR5	4.49	4.98	9.47	40.00	0.24%
	SR6	2.45	4.98	7.43	40.00	0.19%
	SR7	1.33	4.98	6.31	40.00	0.16%
	SR8	0.64	4.98	5.62	40.00	0.14%
	SR9	0.64	4.98	5.62	40.00	0.14%

6.2 Predicted Environmental Concentrations – Short-term 1-hour NO_2

Table 6-3 details the results of the air dispersion modelling for the short-term 1-hour NO_2 concentration, showing maximum process contribution at ground level (emissions to air from the stacks) and maximum predicted environmental concentration (process contribution plus background contribution) outside the Site boundary at ground level. These concentrations represent the worst-case scenario - maximum concentrations in a very limited area near the Site boundary, that only occur rarely under specific weather conditions.

To assess the worst-case scenario for short-term events, annual mean background concentration was doubled, as recommended in the EPA's AG4 Guidance, Appendix D.

Table 6-3: Maximum Predicted Environmental Concentration of Pollutants - NO_2 (1-hr 99.79%ile) (µg/Nm³)

NO_2 (hourly mean) (µg/Nm³)	**2016**	**2017**	**2018**	**2019**	**2020**
Maximum Process Contribution (PC)	130.76	119	117.13	104.65	**138.37**
Background Concentration	9.96	9.96	9.96	9.96	**9.96**
Predicted environmental concentration (PEC)	140.72	128.96	127.10	114.61	**148.33**
Air Quality Standard (AQS)	200	200	200	200	**200**
PEC as percentage of AQS	70.4%	64.5%	63.5%	57.3%	**74.2%**

Table 6-4 provides the NO_2 (1-hr 99.79%ile) Maximum Process Contribution (PC) and the Predicted Environmental Concentrations (PEC) at sensitive receptors for each of the individual modelling years (2016 to 2020).

Table 6-4: Predicted Environmental Concentrations of Pollutants at SRs (1-hr NO_2 99.79%ile)

Year	Receptor	Result (PC) µg/Nm³	Background Concentration µg/Nm³	Result + Background (PEC)	AQS	%AQS (PEC)
2016	SR1	1.69	4.98	6.67	40.00	0.17%
	SR2	1.30	4.98	6.28	40.00	0.16%
	SR3	1.49	4.98	6.47	40.00	0.16%
	SR4	3.85	4.98	8.83	40.00	0.22%
	SR5	4.21	4.98	9.19	40.00	0.23%
	SR6	2.56	4.98	7.54	40.00	0.19%
	SR7	1.38	4.98	6.36	40.00	0.16%
	SR8	0.66	4.98	5.64	40.00	0.14%
	SR9	1.31	4.98	6.29	40.00	0.16%
2017	SR1	1.82	4.98	6.80	40.00	0.17%
	SR2	1.50	4.98	6.48	40.00	0.16%
	SR3	1.00	4.98	5.98	40.00	0.15%
	SR4	3.68	4.98	8.66	40.00	0.22%
	SR5	3.76	4.98	8.74	40.00	0.22%
	SR6	2.85	4.98	7.83	40.00	0.20%
	SR7	1.48	4.98	6.46	40.00	0.16%
	SR8	0.79	4.98	5.77	40.00	0.14%
	SR9	0.89	4.98	5.87	40.00	0.15%
2018	SR1	1.51	4.98	6.49	40.00	0.16%
	SR2	1.21	4.98	6.19	40.00	0.15%

Year	Receptor	Result (PC) µg/Nm³	Background Concentration µg/Nm³	Result + Background (PEC)	AQS	%AQS (PEC)
	SR3	1.19	4.98	6.17	40.00	0.15%
	SR4	4.42	4.98	9.40	40.00	0.23%
	SR5	4.05	4.98	9.03	40.00	0.23%
	SR6	2.16	4.98	7.14	40.00	0.18%
	SR7	1.26	4.98	6.24	40.00	0.16%
	SR8	0.70	4.98	5.68	40.00	0.14%
	SR9	1.05	4.98	6.03	40.00	0.15%
2019	SR1	1.47	4.98	6.45	40.00	0.16%
	SR2	1.17	4.98	6.15	40.00	0.15%
	SR3	1.82	4.98	6.80	40.00	0.17%
	SR4	4.47	4.98	9.45	40.00	0.24%
	SR5	4.08	4.98	9.06	40.00	0.23%
	SR6	2.70	4.98	7.68	40.00	0.19%
	SR7	1.35	4.98	6.33	40.00	0.16%
	SR8	0.64	4.98	5.62	40.00	0.14%
	SR9	0.78	4.98	5.76	40.00	0.14%
2020	SR1	1.69	4.98	6.67	40.00	0.17%
	SR2	1.27	4.98	6.25	40.00	0.16%
	SR3	1.17	4.98	6.15	40.00	0.15%
	SR4	3.61	4.98	8.59	40.00	0.21%
	SR5	4.49	4.98	9.47	40.00	0.24%
	SR6	2.45	4.98	7.43	40.00	0.19%
	SR7	1.33	4.98	6.31	40.00	0.16%
	SR8	0.64	4.98	5.62	40.00	0.14%
	SR9	0.64	4.98	5.62	40.00	0.14%

6.3 Contour Plots

Figures 6-1 and Figure 6-2 shows the contour plots for the air dispersion of NO_2 for both boilers at the Red Mills facility. Background concentrations are not shown in contour plots. As per AG4 guidance, the years which contributed the highest PC for both short term (1hr, 99.8th percentile) and long-term (annual), were shown. For short-term, 2020 showed the highest PC and thus the contour plots for 2020 are displayed in Figure 6-1. For annual emissions, 2017 showed the highest PC and thus the contours are displayed in Figure 6-2.

Figure 6-1: Short Term Process Contribution (99th percentile) for NO_2 concentrations at Red Mills (Year 2020)

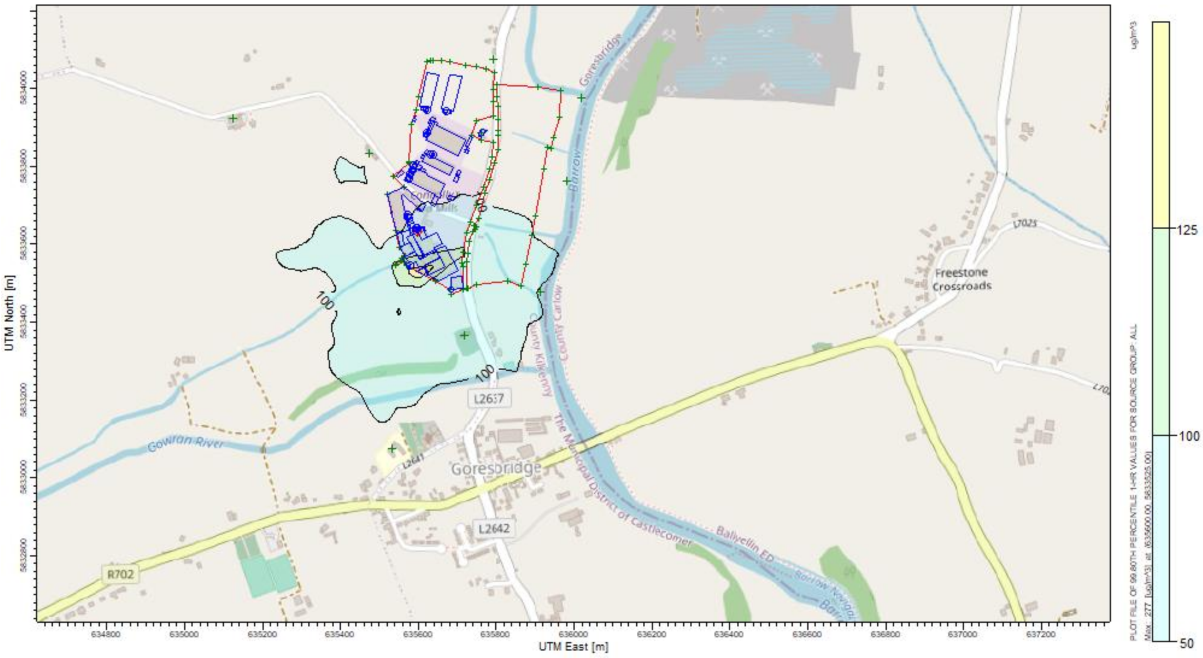
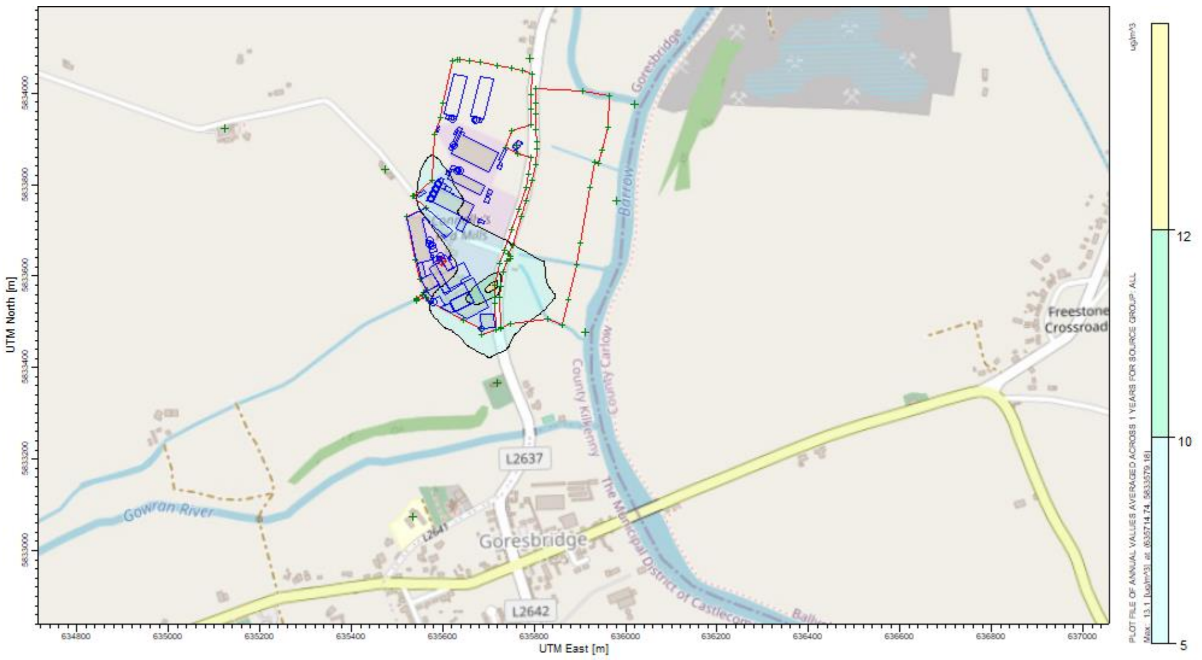


Figure 6-2: Long Term (Annual) Process Contribution for NO_2 concentrations at Red Mills (Year 2017)



6.4 Designated Areas

A guide to the assessment of air quality impacts on designated nature conservation sites – version 1.1, Institute of Air Quality Management (IAQM), London (Holman et al, 2014) lists NOx as one of the gaseous pollutant which is subject to Air Quality Assessment for designated sites. In addition to AQS (see below and section 5.1 above), IAQM sets critical level for 24-hr mean of 200 µg/Nm^3.[1]

The only applicable AQS at the nearest designated areas is for NO_2 annual mean at 30 µg/Nm^3, which is applicable for protection of vegetation. However, this SAC is designated for the aquatic habitat – River Barrow, and only small part of this SAC is terrestrial – along the river banks. Nonetheless, process contribution (PC) at these locations was predicted – at SR 6, 7 and 8 (refer to section 5.6).

Process Contribution for Long-Term (Annual) NO_2 concentrations for the sensitive receptors assigned to the designated areas along the River Barrow (SR6, SR7, SR8) for the worst met year – 2017, is presented in Table 6-5 below[2].

Table 6-5: Process Contribution for Long-Term (Annual) NO_2 concentrations for the sensitive receptors assigned to the designated areas along the River Barrow (SR6, SR7, SR8)

Year	Receptor ID	PC Annual Mean (NO_2) µg/Nm^3	PEC (PC + Background)	AQS	AQS %
2017	SR6	2.85	7.83	30	26.10%
2017	SR7	1.48	6.46	30	21.53%
2017	SR8	0.79	5.77	30	19.23%

As per the IAQM guidance, 24-hr critical levels for NOx are presented for the worst-case met year – 2020 in Table 6-6 below. As background levels for 24-hr NO_x are not available, annual background of 4.98 µg/m^3 was used to calculate PEC.

Table 6-6: Process Contribution of NO_2 for 24hr averages of designated sites

Year	Receptor ID	PC 24hr Mean (NOx) µg/Nm^3	PEC (PC + Background)	Critical Level	PEC as %tage of AQS
2020	SR6	21.52	26.5	200	13.25%
2020	SR7	9.42	14.4	200	7.20%
2020	SR8	6.34	11.32	200	5.66%

Notes: No NOx conversion was applied.

Results in Tables 6-5 and 6-6 above show that NOx concentrations at River Barrow, which is an SAC, are significantly below relevant AQS and significantly below critical level, therefore no impact on this designated site was predicted from NOx emissions from onsite boilers.

[1] The critical level of 75 µg/m3 only applies where there are high concentrations of SO_2 and ozone, which is not case with Zone D in Ireland, where the site is located.
[2] PEC for all other modelled years for SR 6, 7 and 8 are available in section 6.1 above.

7 RESULTS – PM10

7.1 Scenario 1 – Baseline

Scenario 1 represents baseline emissions to air that were operating on the Site during harvest season 2021, i.e. July through September 2021.

Scenario 1 modelling data includes the 2021 monitoring results carried out by Trim Environmental Services at the Site. Input data for emission points that were not monitored due to no access/ports being present were estimated, based on the associated processes and other emission points associated with the same processes.

Scenario 1 includes:

- Emission points in operation during harvest 2021;
- Flat-bed dryer which is a fugitive emission (refer to section 2.3.1 above) was excluded;
- Boilers were excluded, as no monitoring data available on TPM or volumetric flow, and these will be converted to natural gas;
- Stacks parameters in their current configuration;
- Any new or non-operational emission points were excluded A2-4 (Cuber 4), Oat Mill Cleaner (A2-52), Dryer 6 replacement (A2-45A, A2-45B, A2-46A, A2-46B, A2-47C) or dryers 1 and 3 (A2-50A, A2-50B, A2-51A, A2-51B, A2-52), as these were not operational or not in existence during harvest season 2021.

All model input for Scenario 1 is shown in Appendix A.

7.1.1 Predicted Environmental Concentrations – Annual Mean PM10

Table 7-1 details the results of the air dispersion modelling for PM10 annual mean, showing maximum process contribution at ground level (emissions to air from the stacks) and maximum predicted environmental concentration (process contribution plus background contribution) outside the Site boundary at ground level.

Table 7-1: Annual Mean PM10 in µg/Nm3 Scenario 1

PM10 (annual mean) (µg/Nm^3)	**2016**	**2017**	**2018**	**2019**	**2020**
Maximum Process Contribution (PC)	15.38	12.82	15.31	16.32	15.66
Background Concentration	11.96	11.96	11.96	11.96	11.96
Predicted environmental concentration (PEC)	27.34	24.78	27.28	28.28	27.62
Air Quality Standard (AQS)	40	40	40	40	40
PEC as percentage of AQS	**68%**	**62%**	**68%**	**71%**	**69%**

Table 7-2 provides the PM10 (Annual Mean) Maximum Process Contribution (PC) and the Predicted Environmental Concentrations (PEC) at sensitive receptors for each of the individual modelling years (2016 to 2020).

Table 7-2: Predicted Environmental Concentrations of Pollutants at SRs (PM10 Annual Mean at Sensitive Receptors) Scenario 1

Year	**Receptor**	**Result (PC)** µg/Nm^3	**Background Concentration** µg/Nm^3	**Result + Background (PEC)**	**AQS**	**%AQS (PEC)**
2016	SR1	2.84	11.96	14.80	40	37%
	SR2	1.70	11.96	13.66	40	34%

Year	Receptor	Result (PC) µg/Nm^3	Background Concentration µg/Nm^3	Result + Background (PEC)	AQS	%AQS (PEC)
	SR3	1.41	11.96	13.37	40	33%
	SR4	4.46	11.96	16.42	40	41%
	SR5	4.07	11.96	16.03	40	40%
	SR6	2.55	11.96	14.51	40	36%
	SR7	1.96	11.96	13.92	40	35%
	SR8	1.02	11.96	12.98	40	32%
	SR9	1.29	11.96	13.25	40	33%
2017	SR1	2.94	11.96	14.90	40	37%
	SR2	1.86	11.96	13.82	40	35%
	SR3	1.10	11.96	13.05	40	33%
	SR4	4.30	11.96	16.26	40	41%
	SR5	3.83	11.96	15.79	40	39%
	SR6	2.90	11.96	14.86	40	37%
	SR7	1.94	11.96	13.90	40	35%
	SR8	1.12	11.96	13.08	40	33%
	SR9	1.01	11.96	12.97	40	32%
2018	SR1	2.60	11.96	14.56	40	36%
	SR2	1.65	11.96	13.61	40	34%
	SR3	1.18	11.96	13.14	40	33%
	SR4	4.69	11.96	16.65	40	42%
	SR5	4.31	11.96	16.27	40	41%
	SR6	2.25	11.96	14.21	40	36%
	SR7	1.65	11.96	13.61	40	34%
	SR8	1.05	11.96	13.01	40	33%
	SR9	1.23	11.96	13.19	40	33%
2019	SR1	2.47	11.96	14.43	40	36%
	SR2	1.57	11.96	13.53	40	34%
	SR3	1.82	11.96	13.78	40	34%
	SR4	4.86	11.96	16.82	40	42%
	SR5	4.09	11.96	16.05	40	40%
	SR6	2.81	11.96	14.77	40	37%
	SR7	1.62	11.96	13.58	40	34%
	SR8	0.95	11.96	12.91	40	32%
	SR9	0.86	11.96	12.82	40	32%
2020	SR1	2.49	11.96	14.45	40	36%
	SR2	1.45	11.96	13.41	40	34%
	SR3	1.21	11.96	13.17	40	33%
	SR4	4.04	11.96	16.00	40	40%
	SR5	4.74	11.96	16.70	40	42%
	SR6	2.64	11.96	14.60	40	37%

Year	Receptor	Result (PC) µg/Nm³	Background Concentration µg/Nm³	Result + Background (PEC)	AQS	%AQS (PEC)
	SR7	1.77	11.96	13.73	40	34%
	SR8	0.90	11.96	12.86	40	32%
	SR9	1.41	11.96	13.37	40	33%

7.1.2 Predicted Environmental Concentrations – Short-term 24hr PM10

Table 7-3 details the results of the air dispersion modelling for PM10 24-hr mean, showing maximum process contribution at ground level (emissions to air from the stacks) and maximum predicted environmental concentration (process contribution plus background contribution) outside the Site boundary at ground level.

Table 7-3: PM10 (24-hr 90.4%ile) (µg/Nm3) Scenario 1

PM10 (24-hr 90.4%ile) (µg/Nm³)	2016	2017	2018	2019	2020
Maximum Process Contribution (PC)	43.61	37.31	45.83	44.35	48.53
Background Concentration	11.96	11.96	11.96	11.96	11.96
Predicted environmental concentration (PEC)	55.57	49.27	57.78	56.31	60.49
Air Quality Standard (AQS)	50	50	50	50	50
PEC as percentage of AQS	111%	99%	116%	113%	121%

Table 7-4 provides the PM10 (24-hr Mean) Maximum Process Contribution (PC) and the Predicted Environmental Concentrations (PEC) at sensitive receptors for each of the individual modelling years (2016 to 2020).

Table 7-4: Predicted Environmental Concentrations of Pollutants at SRs (PM10 24hr Mean at Sensitive Receptors) Scenario 1

Year	Receptor	Result (PC) µg/Nm³	Background Concentration µg/Nm³	Result + Background (PEC)	AQS	%AQS (PEC)
2016	SR1	8.90	11.96	20.86	50	42%
	SR2	6.13	11.96	18.09	50	36%
	SR3	4.77	11.96	16.73	50	33%
	SR4	11.96	11.96	23.92	50	48%
	SR5	13.25	11.96	25.21	50	50%
	SR6	7.67	11.96	19.63	50	39%
	SR7	6.87	11.96	18.83	50	38%
	SR8	3.35	11.96	15.31	50	31%
	SR9	4.77	11.96	16.73	50	33%
2017	SR1	9.19	11.96	21.15	50	42%
	SR2	4.85	11.96	16.81	50	34%
	SR3	3.70	11.96	15.66	50	31%
	SR4	11.65	11.96	23.61	50	47%
	SR5	12.58	11.96	24.54	50	49%
	SR6	7.90	11.96	19.86	50	40%

Year	Receptor	Result (PC) µg/Nm³	Background Concentration µg/Nm³	Result + Background (PEC)	AQS	%AQS (PEC)
	SR7	6.14	11.96	18.10	50	36%
	SR8	3.82	11.96	15.78	50	32%
	SR9	3.50	11.96	15.46	50	31%
2018	SR1	8.19	11.96	20.15	50	40%
	SR2	4.40	11.96	16.36	50	33%
	SR3	3.52	11.96	15.48	50	31%
	SR4	12.38	11.96	24.34	50	49%
	SR5	14.55	11.96	26.51	50	53%
	SR6	6.74	11.96	18.70	50	37%
	SR7	4.72	11.96	16.68	50	33%
	SR8	3.15	11.96	15.11	50	30%
	SR9	3.97	11.96	15.93	50	32%
2019	SR1	7.33	11.96	19.29	50	39%
	SR2	4.10	11.96	16.06	50	32%
	SR3	5.89	11.96	17.85	50	36%
	SR4	12.07	11.96	24.03	50	48%
	SR5	14.73	11.96	26.69	50	53%
	SR6	8.23	11.96	20.19	50	40%
	SR7	4.54	11.96	16.50	50	33%
	SR8	2.96	11.96	14.92	50	30%
	SR9	2.57	11.96	14.53	50	29%
2020	SR1	6.29	11.96	18.25	50	37%
	SR2	3.80	11.96	15.76	50	32%
	SR3	4.58	11.96	16.54	50	33%
	SR4	10.47	11.96	22.43	50	45%
	SR5	15.82	11.96	27.78	50	56%
	SR6	8.51	11.96	20.47	50	41%
	SR7	5.41	11.96	17.37	50	35%
	SR8	2.50	11.96	14.46	50	29%
	SR9	4.62	11.96	16.58	50	33%

7.1.3 Contour Plots

Figures 7-1 and Figure 7-2 shows the contour plots for the air dispersion of all major emission points at the Red Mills facility (excluding Boilers). Background concentrations are not shown in contour plots. As per AG4 guidance, the years which contributed the highest PC for both short term (24hr, 90.4th percentile) and long-term (annual), were shown. For short-term and long term, 2020 showed the highest PC and thus the contour plots 2020 are displayed.

Figure 7-1: Results Annual Scenario 1 2020 – Process Contribution Annual Mean (no background)

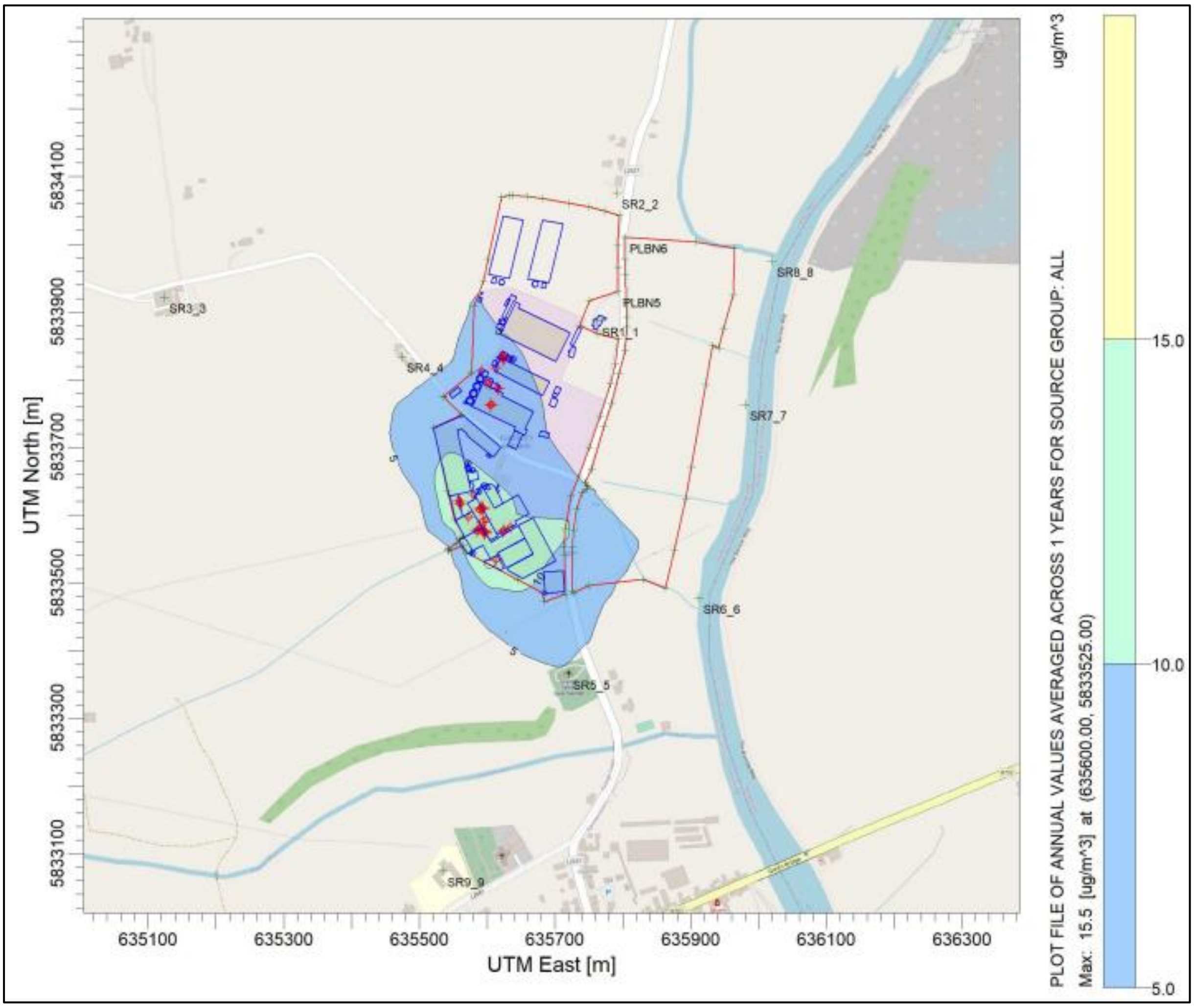
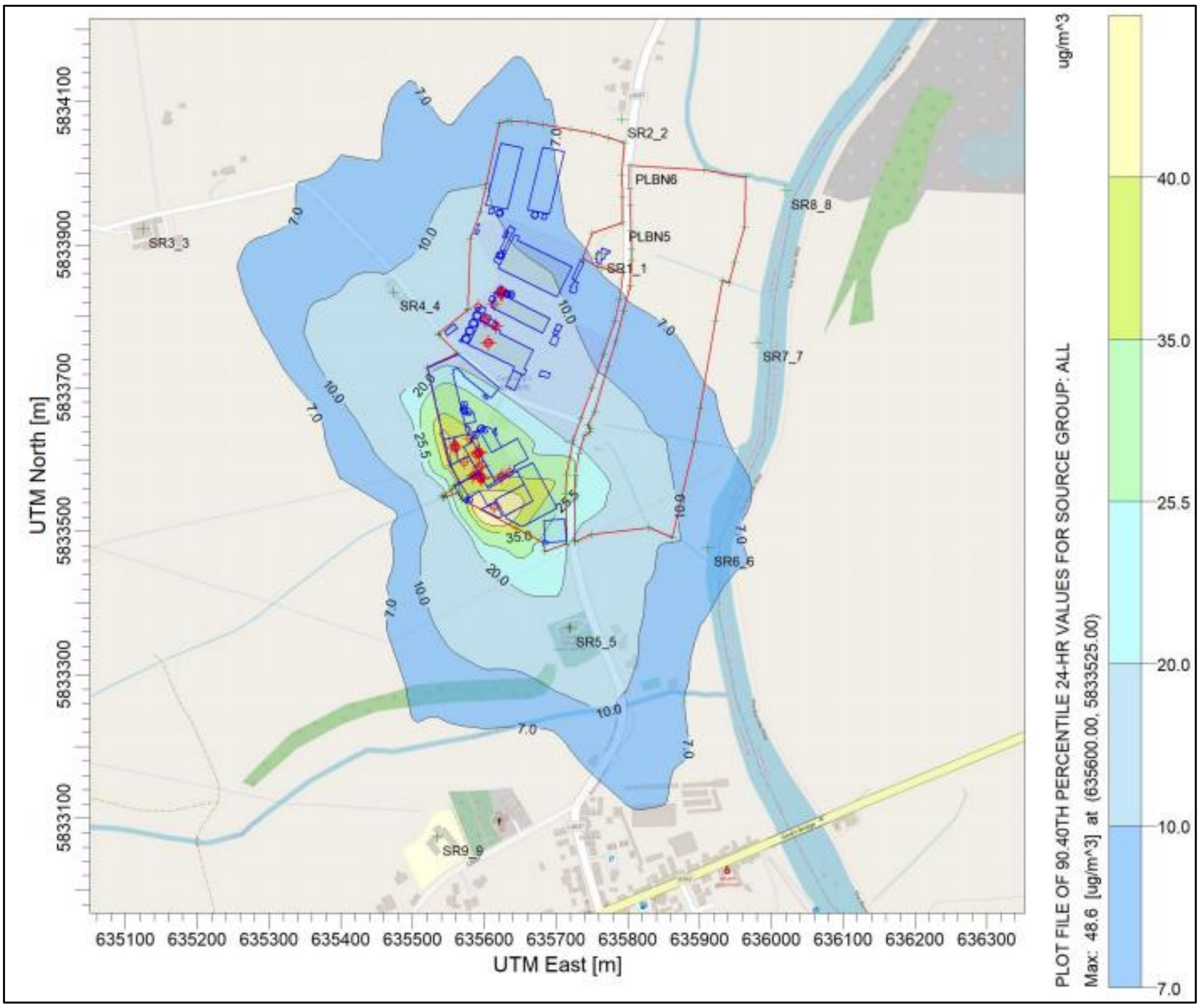


Figure 7-2: Results Scenario 1 2020 - 24hr Averaging Process Contribution (no background)



7.2 Scenario 2 – Harvest 2022

This scenario presents all emission points from Scenario 1 with proposed ELVs (refer to section 10 below and Appendix A - Scenario 2), as well as replacement Dryer 6 emission points.

In addition, this scenario includes:

- A total of 5 replacement Dryer 6 emission points A2-45A, A2-45B, A2-46A, A2-46B, A2-46C);
- Cuber 4 – emission point A2-4;
- Stack improvements – increased height and vertical dispersion – for emission points A2-32 and A2-40 (Dryer 4 and 5 pre-cleaners) and A2-48 and A2-49 (Seed Plant).
- Abatement for Dryer 4A and 4B (cyclones similar to Dryer 5).

7.2.1 Predicted Environmental Concentrations – Annual Mean PM10

Table 7-5 details the results of the air dispersion modelling for PM10 annual mean, showing maximum process contribution at ground level (emissions to air from the stacks) and maximum predicted environmental concentration (process contribution plus background contribution) outside the Site boundary at ground level.

Table 7-5: Annual Mean PM10 in µg/Nm3 Scenario 2

PM10 (annual mean) (µg/Nm³)	**2016**	**2017**	**2018**	**2019**	**2020**
Maximum Process Contribution (PC)	17.43	13.92	16.74	18.74	15.78
Background Concentration	11.96	11.96	11.96	11.96	11.96
Predicted environmental concentration (PEC)	29.39	25.88	28.70	30.70	27.74
Air Quality Standard (AQS)	40	40	40	40	40
PEC as percentage of AQS	**73%**	**65%**	**72%**	**77%**	**69%**

Table 7-6 provides the PM10 (Annual Mean) Maximum Process Contribution (PC) and the Predicted Environmental Concentrations (PEC) at sensitive receptors for each of the individual modelling years (2016 to 2020).

Table 7-6: Predicted Environmental Concentrations of Pollutants at SRs (PM10 Annual Mean at Sensitive Receptors) Scenario 2

Year	**Receptor**	**Result (PC) µg/Nm³**	**Background Concentration µg/Nm³**	**Result + Background (PEC)**	**AQS**	**%AQS (PEC)**
2016	SR1	7.32	11.96	19.28	40	48%
	SR2	2.40	11.96	14.36	40	36%
	SR3	1.61	11.96	13.57	40	34%
	SR4	4.79	11.96	16.75	40	42%
	SR5	4.20	11.96	16.16	40	40%
	SR6	2.86	11.96	14.82	40	37%
	SR7	2.34	11.96	14.30	40	36%
	SR8	1.71	11.96	13.67	40	34%
	SR9	1.37	11.96	13.33	40	33%
	SR10	7.32	11.96	19.28	40	48%
2017	SR1	7.00	11.96	18.96	40	**47%**
	SR2	2.61	11.96	14.57	40	**36%**
	SR3	1.22	11.96	13.18	40	**33%**
	SR4	4.66	11.96	16.62	40	**42%**
	SR5	3.96	11.96	15.92	40	**40%**
	SR6	3.31	11.96	15.27	40	**38%**
	SR7	2.39	11.96	14.35	40	**36%**
	SR8	1.85	11.96	13.81	40	**35%**
	SR9	1.05	11.96	13.01	40	**33%**
	SR10	7.00	11.96	18.96	40	**47%**
2018	SR1	6.10	11.96	18.06	40	45%
	SR2	2.34	11.96	14.30	40	36%
	SR3	1.37	11.96	13.33	40	33%
	SR4	5.09	11.96	17.05	40	43%
	SR5	4.54	11.96	16.50	40	41%

Year	Receptor	Result (PC) µg/Nm³	Background Concentration µg/Nm³	Result + Background (PEC)	AQS	%AQS (PEC)
	SR6	2.68	11.96	14.64	40	37%
	SR7	2.10	11.96	14.06	40	35%
	SR8	1.63	11.96	13.59	40	34%
	SR9	1.31	11.96	13.27	40	33%
	SR10	6.10	11.96	18.06	40	45%
2019	SR1	5.68	11.96	17.64	40	44%
	SR2	2.16	11.96	14.12	40	35%
	SR3	2.15	11.96	14.11	40	35%
	SR4	5.13	11.96	17.09	40	43%
	SR5	4.28	11.96	16.24	40	41%
	SR6	3.26	11.96	15.22	40	38%
	SR7	2.19	11.96	14.15	40	35%
	SR8	1.52	11.96	13.48	40	34%
	SR9	0.92	11.96	12.88	40	32%
	SR10	5.68	11.96	17.64	40	44%
2020	SR1	6.22	11.96	18.18	40	45%
	SR2	1.99	11.96	13.95	40	35%
	SR3	1.37	11.96	13.33	40	33%
	SR4	4.34	11.96	16.30	40	41%
	SR5	4.97	11.96	16.93	40	42%
	SR6	3.13	11.96	15.09	40	38%
	SR7	2.38	11.96	14.34	40	36%
	SR8	1.45	11.96	13.41	40	34%
	SR9	1.49	11.96	13.45	40	34%
	SR10	6.22	11.96	18.18	40	45%

7.2.2 Predicted Environmental Concentrations – Short-term 24hr PM10

Table 7-7 details the results of the air dispersion modelling for PM10 24-hr mean, showing maximum process contribution at ground level (emissions to air from the stacks) and maximum predicted environmental concentration (process contribution plus background contribution) outside the Site boundary at ground level.

Table 7-7: PM10 (24-hr 90.4%ile) (µg/Nm3) Scenario 2

PM10 (24-hr 90.4%ile) (µg/Nm³)	2016	2017	2018	2019	2020
Maximum Process Contribution (PC)	46.41	40.12	44.85	49.38	48.53
Background Concentration	11.96	11.96	11.96	11.96	11.96
Predicted environmental concentration (PEC)	58.37	52.08	56.81	61.34	60.49
Air Quality Standard (AQS)	50	50	50	50	50

PM10 (24-hr 90.4%ile) (μg/Nm³)	**2016**	**2017**	**2018**	**2019**	**2020**
PEC as percentage of AQS	**117%**	**104%**	**114%**	**123%**	**121%**

Table 7-8 provides the PM10 (Annual Mean) Maximum Process Contribution (PC) and the Predicted Environmental Concentrations (PEC) at sensitive receptors for each of the individual modelling years (2016 to 2020).

Table 7-8: Predicted Environmental Concentrations of Pollutants at SRs (PM10 24hr Mean at Sensitive Receptors) Scenario 2

Year	Receptor	Result (PC) μg/Nm³	Background Concentration μg/Nm³	Result + Background (PEC)	AQS	%AQS (PEC)
2016	SR1	24.57	11.96	36.53	50	73%
	SR2	7.31	11.96	19.27	50	39%
	SR3	5.50	11.96	17.46	50	35%
	SR4	13.30	11.96	25.26	50	51%
	SR5	13.41	11.96	25.37	50	51%
	SR6	8.89	11.96	20.85	50	42%
	SR7	7.81	11.96	19.77	50	40%
	SR8	5.24	11.96	17.20	50	34%
	SR9	4.86	11.96	16.82	50	34%
2017	SR1	25.44	11.96	37.40	50	75%
	SR2	7.42	11.96	19.38	50	39%
	SR3	4.11	11.96	16.07	50	32%
	SR4	13.09	11.96	25.05	50	50%
	SR5	13.02	11.96	24.98	50	50%
	SR6	9.38	11.96	21.34	50	43%
	SR7	7.21	11.96	19.17	50	38%
	SR8	6.21	11.96	18.17	50	36%
	SR9	4.04	11.96	16.00	50	32%
2018	SR1	17.70	11.96	29.66	50	59%
	SR2	6.57	11.96	18.53	50	37%
	SR3	4.24	11.96	16.20	50	32%
	SR4	13.15	11.96	25.11	50	50%
	SR5	15.49	11.96	27.45	50	55%
	SR6	7.78	11.96	19.74	50	39%
	SR7	6.42	11.96	18.38	50	37%
	SR8	4.92	11.96	16.88	50	34%
	SR9	4.37	11.96	16.33	50	33%
2019	SR1	18.68	11.96	30.64	50	61%
	SR2	6.17	11.96	18.13	50	36%
	SR3	6.53	11.96	18.49	50	37%
	SR4	13.08	11.96	25.04	50	50%
	SR5	14.97	11.96	26.93	50	54%

Year	Receptor	Result (PC) µg/Nm^3	Background Concentration µg/Nm^3	Result + Background (PEC)	AQS	%AQS (PEC)
	SR6	9.90	11.96	21.86	50	44%
	SR7	7.39	11.96	19.35	50	39%
	SR8	4.67	11.96	16.63	50	33%
	SR9	2.83	11.96	14.79	50	30%
2020	SR1	20.00	11.96	31.96	50	64%
	SR2	4.72	11.96	16.68	50	33%
	SR3	4.91	11.96	16.87	50	34%
	SR4	11.07	11.96	23.03	50	46%
	SR5	16.49	11.96	28.45	50	57%
	SR6	9.92	11.96	21.88	50	44%
	SR7	7.00	11.96	18.96	50	38%
	SR8	4.24	11.96	16.20	50	32%
	SR9	4.95	11.96	16.91	50	34%

7.2.3 Contour Plots

Figures 7-3 and Figure 7-4 shows the contour plots for the air dispersion of all major emission points at Red Mills facility (excluding Boilers). Background concentrations are not shown in contour plots. As per AG4 guidance, the years which contributed the highest PC for both short term (24hr, 90.4th percentile) and long-term (annual), were shown. For short-term and long term, 2019 showed the highest PC and thus the contour plots 2019 are displayed.

Figure 7-3: Results Annual Scenario 2 2019 – Process Contribution Annual Mean (no background)

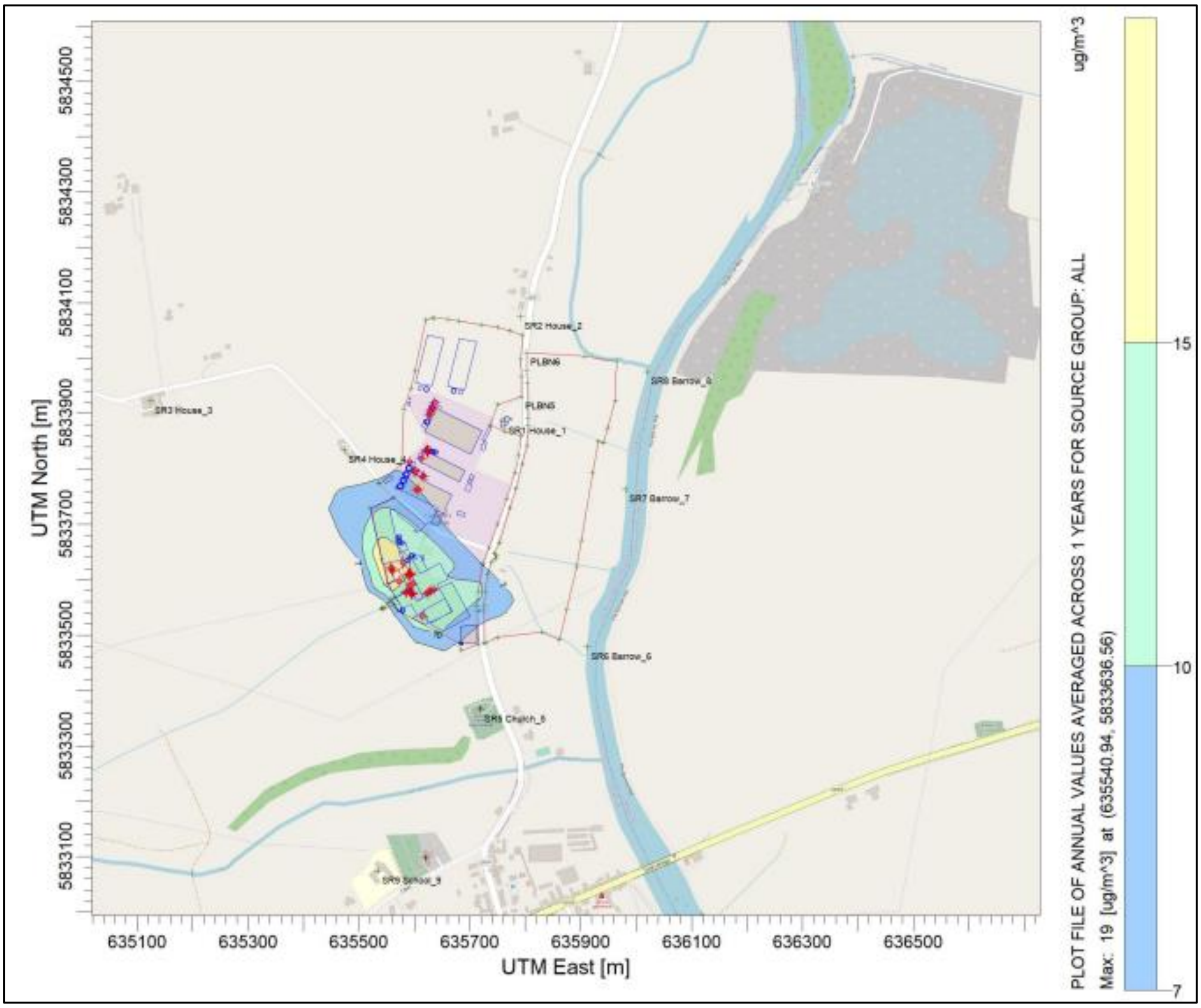
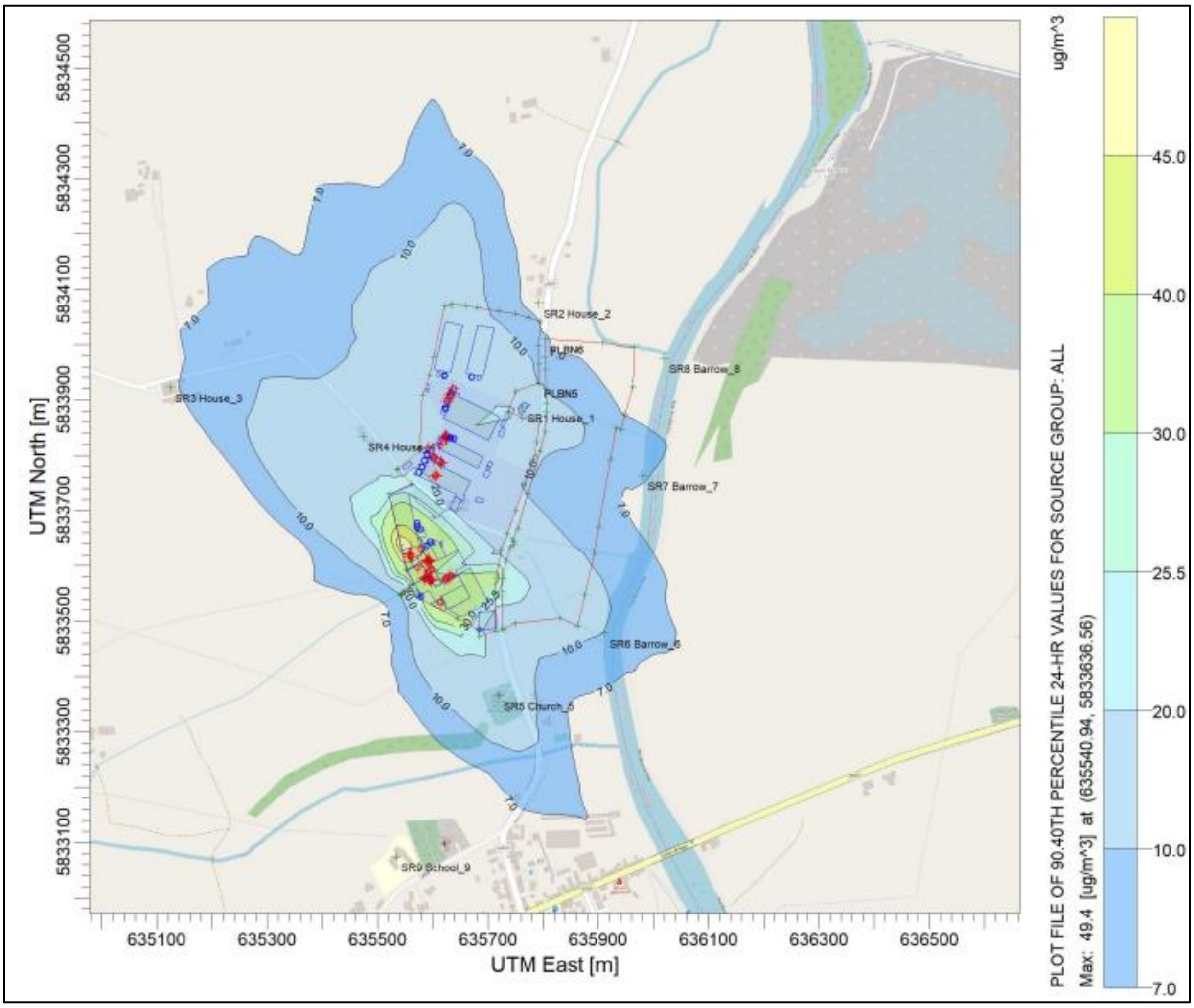


Figure 7-4: Results Scenario 2 2019 - 24hr Averaging Process Contribution (no background)



7.3 Scenario 3 – Mitigation Measures

In order to mitigate potential impacts at the Site boundaries, predicted in Scenario 2, which largely occur due to building downdrafts and current stack configurations, many of which are on sides of buildings turned downwards, it is proposed to maximise dispersion of dust by increasing the height of these stacks with vertical orientation:

- A2-12 (Cyclone GVRSA and GVRSB) is a vertical stack located on top of a 25m building in the southern portion of the site. It is proposed to increase the stack height to +5.5m above the building height.
- A2-21 (main intake) is a vertical stack, located on a 14.5m building at the main grain intake area. Due to the large height variation between this stack (ca. 0.5m above building height) and the surrounding buildings it is subject to building downwash dynamics and a stack height increase of +10m is proposed (to bring it above adjacent building, which is much higher).
- A2-1, A2-2, A2-3, A2-4 (Cubers1-4) are four emission points located on the side of a 25m building in the southern portion of the site, all facing downwards. It is proposed to bring all of these emission points to the roof and all stacks to be +5m above roof.
- A2-6, A2-7, A2-9 (flakers 1-3) are three emission points located on a 22m building in the southern portion of the site. These emission points are all horizontal and are ca. 20m above ground height. It is proposed to bring these emission points to the roof and all stacks to be 3m above roof.

- A2-10 (flaker cyclone) is a vertical stack, located on a 15m building in the southern portion of the site. The stack is currently ca. 5m above the building height. It is proposed to bring it to +11m above building height (to bring it above adjacent building, which is much higher).
- A2-18, A2-19, A2-20 (grinders) are located on the side of a building in the southern portion of the site. These emission points are ca. 3m above ground height. It is proposed to bring these emission points to the roof of the building (15m) and all stacks to be 10m above building height (as the adjacent building is much higher);
- A2-26 (flaker clean) is a vertical stack located on a 22m building. This stack is currently ca. 1m above building height. It is proposed to bring this stack height to +4m above building height.

For the exact locations of emission points please refer to Appendix B. All building heights referenced in Model are from building eves height.

7.3.1 Predicted Environmental Concentrations – Annual Mean PM10

Table 7-9 details the results of the air dispersion modelling for PM10 annual mean, showing maximum process contribution at ground level (emissions to air from the stacks) and maximum predicted environmental concentration (process contribution plus background contribution) outside the Site boundary at ground level.

Table 7-9: Annual Mean PM10 in µg/Nm3 Scenario 3

PM10 (annual mean) (µg/Nm^3)	**2016**	**2017**	**2018**	**2019**	**2020**
Maximum Process Contribution (PC)	11.22	10.80	10.10	12.71	10.17
Background Concentration	11.96	11.96	11.96	11.96	11.96
Predicted environmental concentration (PEC)	23.18	22.76	22.06	24.67	22.13
Air Quality Standard (AQS)	40	40	40	40	40
PEC as percentage of AQS	**58%**	**57%**	**55%**	**62%**	**55%**

Table 7-10: Predicted Environmental Concentrations of Pollutants at SRs (PM10 Annual Mean at Sensitive Receptors) Scenario 3

Year	**Receptor**	**Result (PC)** µg/Nm^3	**Background Concentration** µg/Nm^3	**Result + Background (PEC)**	**AQS**	**%AQS (PEC)**
2016	SR1	7.11	11.96	19.07	40	37%
	SR2	2.30	11.96	14.26	40	16%
	SR3	1.41	11.96	13.37	40	11%
	SR4	3.97	11.96	15.93	40	25%
	SR5	3.28	11.96	15.24	40	22%
	SR6	2.48	11.96	14.44	40	17%
	SR7	2.22	11.96	14.18	40	16%
	SR8	1.66	11.96	13.62	40	12%
	SR9	1.17	11.96	13.13	40	9%
2017	SR1	6.80	11.96	18.76	40	47%
	SR2	2.50	11.96	14.46	40	36%

Year	Receptor	Result (PC) µg/Nm^3	Background Concentration µg/Nm^3	Result + Background (PEC)	AQS	%AQS (PEC)
	SR3	1.07	11.96	13.03	40	33%
	SR4	3.90	11.96	15.86	40	40%
	SR5	3.14	11.96	15.10	40	38%
	SR6	2.89	11.96	14.85	40	37%
	SR7	2.26	11.96	14.22	40	36%
	SR8	1.78	11.96	13.74	40	34%
	SR9	0.91	11.96	12.87	40	32%
2018	SR1	5.94	11.96	17.90	40	45%
	SR2	2.25	11.96	14.21	40	36%
	SR3	1.21	11.96	13.17	40	33%
	SR4	4.26	11.96	16.22	40	41%
	SR5	3.63	11.96	15.59	40	39%
	SR6	2.35	11.96	14.31	40	36%
	SR7	1.99	11.96	13.95	40	35%
	SR8	1.57	11.96	13.53	40	34%
	SR9	1.20	11.96	13.16	40	33%
2019	SR1	5.50	11.96	17.46	40	44%
	SR2	2.05	11.96	14.01	40	35%
	SR3	1.90	11.96	13.86	40	35%
	SR4	4.26	11.96	16.22	40	41%
	SR5	3.39	11.96	15.35	40	38%
	SR6	2.84	11.96	14.80	40	37%
	SR7	2.08	11.96	14.04	40	35%
	SR8	1.47	11.96	13.43	40	34%
	SR9	0.82	11.96	12.78	40	32%
2020	SR1	6.05	11.96	18.01	40	45%
	SR2	1.91	11.96	13.87	40	35%
	SR3	1.21	11.96	13.17	40	33%
	SR4	3.63	11.96	15.59	40	39%
	SR5	3.97	11.96	15.93	40	40%
	SR6	2.77	11.96	14.73	40	37%
	SR7	2.27	11.96	14.23	40	36%
	SR8	1.40	11.96	13.36	40	33%
	SR9	1.31	11.96	13.27	40	33%

7.3.2 Predicted Environmental Concentrations – Short-term 24hr PM10

Table 7-11 details the results of the air dispersion modelling for PM10 24-hr mean, showing maximum process contribution at ground level (emissions to air from the stacks) and maximum predicted environmental concentration (process contribution plus background contribution) outside the Site boundary at ground level.

Table 7-11: PM10 (24-hr 90.4%ile) (µg/Nm3) Scenario 3

PM10 (24-hr 90.4%ile) (µg/Nm^3)	2016	2017	2018	2019	2020
Maximum Process Contribution (PC)	31.38	27.86	26.51	34.76	28.77
Background Concentration	11.96	11.96	11.96	11.96	11.96
Predicted environmental concentration (PEC)	43.34	39.82	38.47	46.72	40.73
Air Quality Standard (AQS)	50	50	50	50	50
PEC as percentage of AQS	87%	80%	77%	93%	81%

Table 7-12 provides the PM10 (Annual Mean) Maximum Process Contribution (PC) and the Predicted Environmental Concentrations (PEC) at sensitive receptors for each of the individual modelling years (2016 to 2020).

Table 7-12: Predicted Environmental Concentrations of Pollutants at SRs (PM10 24hr Mean at Sensitive Receptors) Scenario 3

Year	Receptor	Result (PC) µg/Nm^3	Background Concentration µg/Nm^3	Result + Background (PEC)	AQS	%AQS (PEC)
2016	SR1	24.34	11.96	36.30	50	67%
	SR2	6.87	11.96	18.83	50	36%
	SR3	4.85	11.96	16.81	50	29%
	SR4	11.47	11.96	23.43	50	49%
	SR5	10.12	11.96	22.08	50	46%
	SR6	7.55	11.96	19.51	50	39%
	SR7	7.54	11.96	19.50	50	39%
	SR8	5.23	11.96	17.19	50	30%
	SR9	4.48	11.96	16.44	50	27%
	SR10	24.34	11.96	36.30	50	67%
2017	SR1	25.11	11.96	37.07	50	74%
	SR2	7.23	11.96	19.19	50	38%
	SR3	3.78	11.96	15.74	50	31%
	SR4	10.71	11.96	22.67	50	45%
	SR5	10.33	11.96	22.29	50	45%
	SR6	8.56	11.96	20.52	50	41%
	SR7	6.99	11.96	18.95	50	38%
	SR8	6.21	11.96	18.17	50	36%
	SR9	3.78	11.96	15.74	50	31%
2018	SR1	16.85	11.96	28.81	50	58%
	SR2	6.53	11.96	18.49	50	37%
	SR3	3.83	11.96	15.79	50	32%
	SR4	10.79	11.96	22.75	50	45%
	SR5	11.67	11.96	23.63	50	47%
	SR6	7.39	11.96	19.35	50	39%

Year	Receptor	Result (PC) µg/Nm^3	Background Concentration µg/Nm^3	Result + Background (PEC)	AQS	%AQS (PEC)
	SR7	6.34	11.96	18.30	50	37%
	SR8	4.54	11.96	16.50	50	33%
	SR9	4.01	11.96	15.97	50	32%
2019	SR1	18.23	11.96	30.19	50	60%
	SR2	6.16	11.96	18.12	50	36%
	SR3	5.76	11.96	17.72	50	35%
	SR4	10.68	11.96	22.64	50	45%
	SR5	11.74	11.96	23.70	50	47%
	SR6	8.50	11.96	20.46	50	41%
	SR7	7.32	11.96	19.28	50	39%
	SR8	4.46	11.96	16.42	50	33%
	SR9	2.36	11.96	14.32	50	29%
2020	SR1	19.97	11.96	31.93	50	**64%**
	SR2	4.53	11.96	16.49	50	**33%**
	SR3	4.26	11.96	16.22	50	**32%**
	SR4	9.26	11.96	21.22	50	**42%**
	SR5	13.04	11.96	25.00	50	**50%**
	SR6	8.31	11.96	20.27	50	**41%**
	SR7	6.60	11.96	18.56	50	**37%**
	SR8	3.80	11.96	15.76	50	**32%**
	SR9	4.40	11.96	16.36	50	**33%**

7.3.3 Contour Plots

Figures 7-5 and Figure 7-6 shows the contour plots for the air dispersion of all major emission points at Red Mills facility (excluding Boilers). Background concentrations are not shown in contour plots. As per AG4 guidance, the years which contributed the highest PC for both short term (24hr, 90.4th percentile) and long-term (annual), were shown. For short-term and long term, 2019 showed the highest PC and thus the contour plots 2019 are displayed.

Figure 7-5: Results Annual Scenario 3 2019 – Process Contribution Annual Mean (no background)

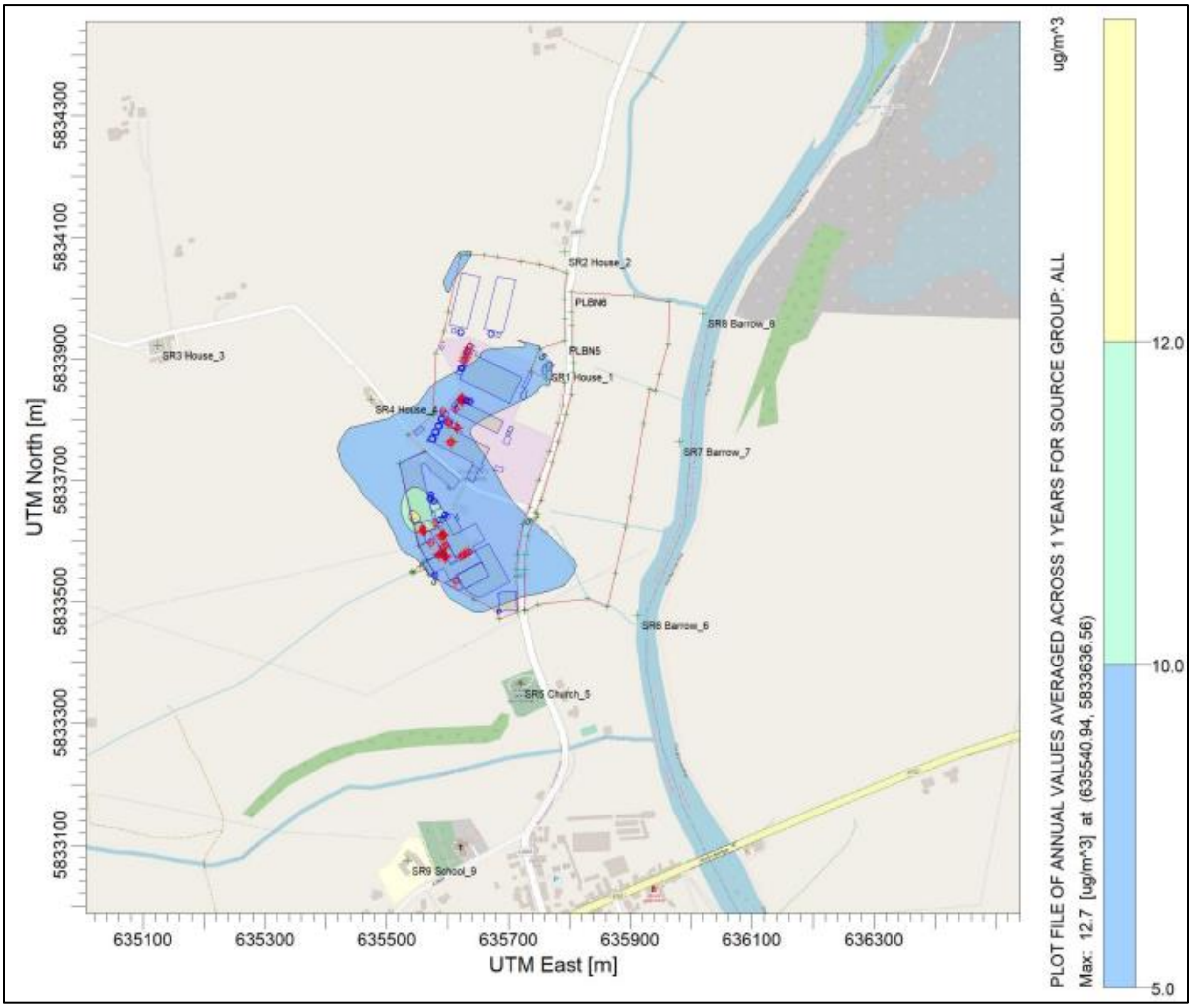
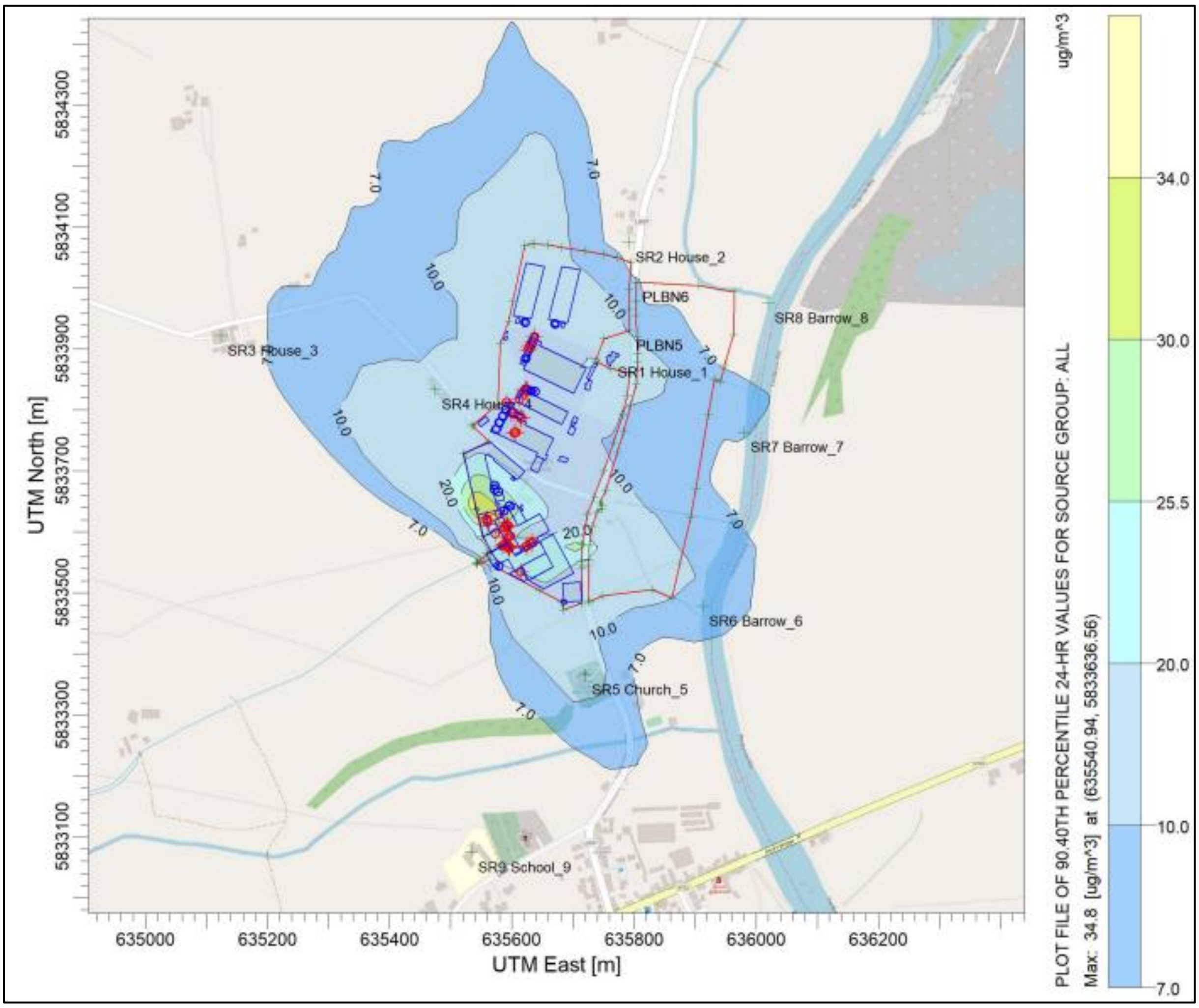


Figure 7-6: Results Scenario 3 2019 - 24hr Averaging Process Contribution (no background)



7.4 Scenario 4 – Future with Mitigation

This scenario will include all emission points as per Scenario 3 (mitigation measures - stack improvements listed in Scenario 3 also included) and emissions points to be installed by Harvest 2023:

- Replacement Dryer 1 (A2-50A, A2-50B);
- Replacement Dryer 3 (A2-51A, A2-51B);
- Pre-cleaner for replacement Dryers 1 and 2 (A2-52); and
- Oat Mill cleaner (A2-53).

7.4.1 Predicted Environmental Concentrations – Annual Mean PM10

Table 7-13 details the results of the air dispersion modelling for PM10 annual mean, showing maximum process contribution at ground level (emissions to air from the stacks) and maximum predicted environmental concentration (process contribution plus background contribution) outside the Site boundary at ground level.

Table 7-13: Annual Mean PM10 in µg/Nm3 Scenario 4

PM10 (annual mean) (µg/Nm^3)	**2016**	**2017**	**2018**	**2019**	**2020**
Maximum Process Contribution (PC)	11.57	11.54	10.59	13.18	10.65
Background Concentration	11.96	11.96	11.96	11.96	11.96
Predicted environmental concentration (PEC)	23.53	23.50	22.55	25.14	22.61
Air Quality Standard (AQS)	40	40	40	40	40
PEC as percentage of AQS	59%	59%	56%	63%	57%

Table 7-14 provides the PM10 (Annual Mean) Maximum Process Contribution (PC) and the Predicted Environmental Concentrations (PEC) at sensitive receptors for each of the individual modelling years (2016 to 2020).

Table 7-14: Predicted Environmental Concentrations of Pollutants at SRs (PM10 Annual Mean at Sensitive Receptors) Scenario 4

Year	**Receptor**	**Result (PC)** µg/Nm^3	**Background Concentration µg/Nm^3**	**Result + Background (PEC)**	**AQS**	**%AQS (PEC)**
2016	SR1	8.16	11.96	20.12	40	50%
	SR2	3.59	11.96	15.55	40	39%
	SR3	1.58	11.96	13.54	40	34%
	SR4	4.20	11.96	16.16	40	40%
	SR5	3.53	11.96	15.49	40	39%
	SR6	2.88	11.96	14.84	40	37%
	SR7	2.88	11.96	14.84	40	37%
	SR8	2.74	11.96	14.70	40	37%
	SR9	1.25	11.96	13.21	40	33%
2017	SR1	7.89	11.96	19.85	40	50%
	SR2	3.82	11.96	15.78	40	39%
	SR3	1.18	11.96	13.14	40	33%
	SR4	4.15	11.96	16.11	40	40%
	SR5	3.42	11.96	15.38	40	38%
	SR6	3.44	11.96	15.40	40	38%
	SR7	2.99	11.96	14.95	40	37%
	SR8	2.83	11.96	14.79	40	37%
	SR9	1.00	11.96	12.96	40	32%
2018	SR1	6.94	11.96	18.90	40	47%
	SR2	3.51	11.96	15.47	40	39%
	SR3	1.35	11.96	13.31	40	33%
	SR4	4.55	11.96	16.51	40	41%
	SR5	4.07	11.96	16.03	40	40%
	SR6	2.99	11.96	14.95	40	37%
	SR7	2.71	11.96	14.67	40	37%

Year	Receptor	Result (PC) µg/Nm^3	Background Concentration µg/Nm^3	Result + Background (PEC)	AQS	%AQS (PEC)
	SR8	2.38	11.96	14.34	40	36%
	SR9	1.34	11.96	13.30	40	33%
2019	SR1	6.54	11.96	18.50	40	46%
	SR2	3.18	11.96	15.14	40	38%
	SR3	2.10	11.96	14.06	40	35%
	SR4	4.56	11.96	16.52	40	41%
	SR5	3.68	11.96	15.64	40	39%
	SR6	3.42	11.96	15.38	40	38%
	SR7	2.85	11.96	14.81	40	37%
	SR8	2.26	11.96	14.22	40	36%
	SR9	0.90	11.96	12.86	40	32%
2020	SR1	7.28	11.96	19.24	40	18%
	SR2	2.93	11.96	14.89	40	7%
	SR3	1.35	11.96	13.31	40	3%
	SR4	3.89	11.96	15.85	40	10%
	SR5	4.38	11.96	16.34	40	11%
	SR6	3.52	11.96	15.48	40	9%
	SR7	3.14	11.96	15.10	40	8%
	SR8	2.28	11.96	14.24	40	6%
	SR9	1.46	11.96	13.42	40	4%

7.4.2 Predicted Environmental Concentrations – Short-term 24hr PM10

Table 7-15 details the results of the air dispersion modelling for PM10 24-hr mean, showing maximum process contribution at ground level (emissions to air from the stacks) and maximum predicted environmental concentration (process contribution plus background contribution) outside the Site boundary at ground level.

Table 7-15: PM10 (24-hr 90.4%ile) (µg/Nm3) Scenario 4

PM10 (24-hr 90.4%ile) (µg/Nm^3)	2016	2017	2018	2019	2020
Maximum Process Contribution (PC)	34.24	35.09	27.83	36.45	30.16
Background Concentration	11.96	11.96	11.96	11.96	11.96
Predicted environmental concentration (PEC)	46.20	47.05	39.79	48.41	42.12
Air Quality Standard (AQS)	50	50	50	50	50
PEC as percentage of AQS	92%	94%	80%	97%	84%

Table 7-16 provides the PM10 (Annual Mean) Maximum Process Contribution (PC) and the Predicted Environmental Concentrations (PEC) at sensitive receptors for each of the individual modelling years (2016 to 2020).

Table 7-16: Predicted Environmental Concentrations of Pollutants at SRs (PM10 24hr Mean at Sensitive Receptors) Scenario 4

Year	Receptor	Result (PC) µg/Nm^3	Background Concentration µg/Nm^3	Result + Background (PEC)	AQS	%AQS (PEC)
2016	SR1	30.10	11.96	42.06	50	84%
	SR2	10.43	11.96	22.39	50	45%
	SR3	5.25	11.96	17.21	50	34%
	SR4	12.20	11.96	24.16	50	48%
	SR5	10.88	11.96	22.84	50	46%
	SR6	8.76	11.96	20.72	50	41%
	SR7	8.72	11.96	20.68	50	41%
	SR8	10.11	11.96	22.07	50	44%
	SR9	5.02	11.96	16.98	50	34%
	SR10	30.10	11.96	42.06	50	84%
2017	SR1	30.64	11.96	42.60	50	85%
	SR2	12.72	11.96	24.68	50	49%
	SR3	4.12	11.96	16.08	50	32%
	SR4	11.32	11.96	23.28	50	47%
	SR5	11.06	11.96	23.02	50	46%
	SR6	9.86	11.96	21.82	50	44%
	SR7	9.23	11.96	21.19	50	42%
	SR8	10.22	11.96	22.18	50	44%
	SR9	3.97	11.96	15.93	50	32%
2018	SR1	22.56	11.96	34.52	50	69%
	SR2	10.54	11.96	22.50	50	45%
	SR3	4.33	11.96	16.29	50	33%
	SR4	11.37	11.96	23.33	50	47%
	SR5	12.91	11.96	24.87	50	50%
	SR6	9.50	11.96	21.46	50	43%
	SR7	7.75	11.96	19.71	50	39%
	SR8	7.71	11.96	19.67	50	39%
	SR9	4.26	11.96	16.22	50	32%
2019	SR1	23.83	11.96	35.79	50	72%
	SR2	10.36	11.96	22.32	50	45%
	SR3	6.29	11.96	18.25	50	36%
	SR4	11.98	11.96	23.94	50	48%
	SR5	12.96	11.96	24.92	50	50%
	SR6	9.91	11.96	21.87	50	44%
	SR7	9.16	11.96	21.12	50	42%
	SR8	6.44	11.96	18.40	50	37%
	SR9	2.77	11.96	14.73	50	29%
2020	SR1	22.12	11.96	34.08	50	44%

Year	Receptor	Result (PC) µg/Nm³	Background Concentration µg/Nm³	Result + Background (PEC)	AQS	%AQS (PEC)
	SR2	7.30	11.96	19.26	50	15%
	SR3	4.56	11.96	16.52	50	9%
	SR4	10.13	11.96	22.09	50	20%
	SR5	13.77	11.96	25.73	50	28%
	SR6	11.19	11.96	23.15	50	22%
	SR7	10.41	11.96	22.37	50	21%
	SR8	7.51	11.96	19.47	50	15%
	SR9	5.05	11.96	17.01	50	10%

7.4.3 Contour Plots

Figures 7-7 and Figure 7-8 shows the contour plots for the air dispersion of all major emission points at Red Mills facility (excluding Boilers). Background concentrations are not shown in contour plots. As per AG4 guidance, the years which contributed the highest PC for both short term (24hr, 90.4th percentile) and long-term (annual), were shown. For short-term and long term, 2019 showed the highest PC and thus the contour plots 2019 are displayed.

Figure 7-7: Results Annual Scenario 4 2019 – Process Contribution Annual Mean (no background)

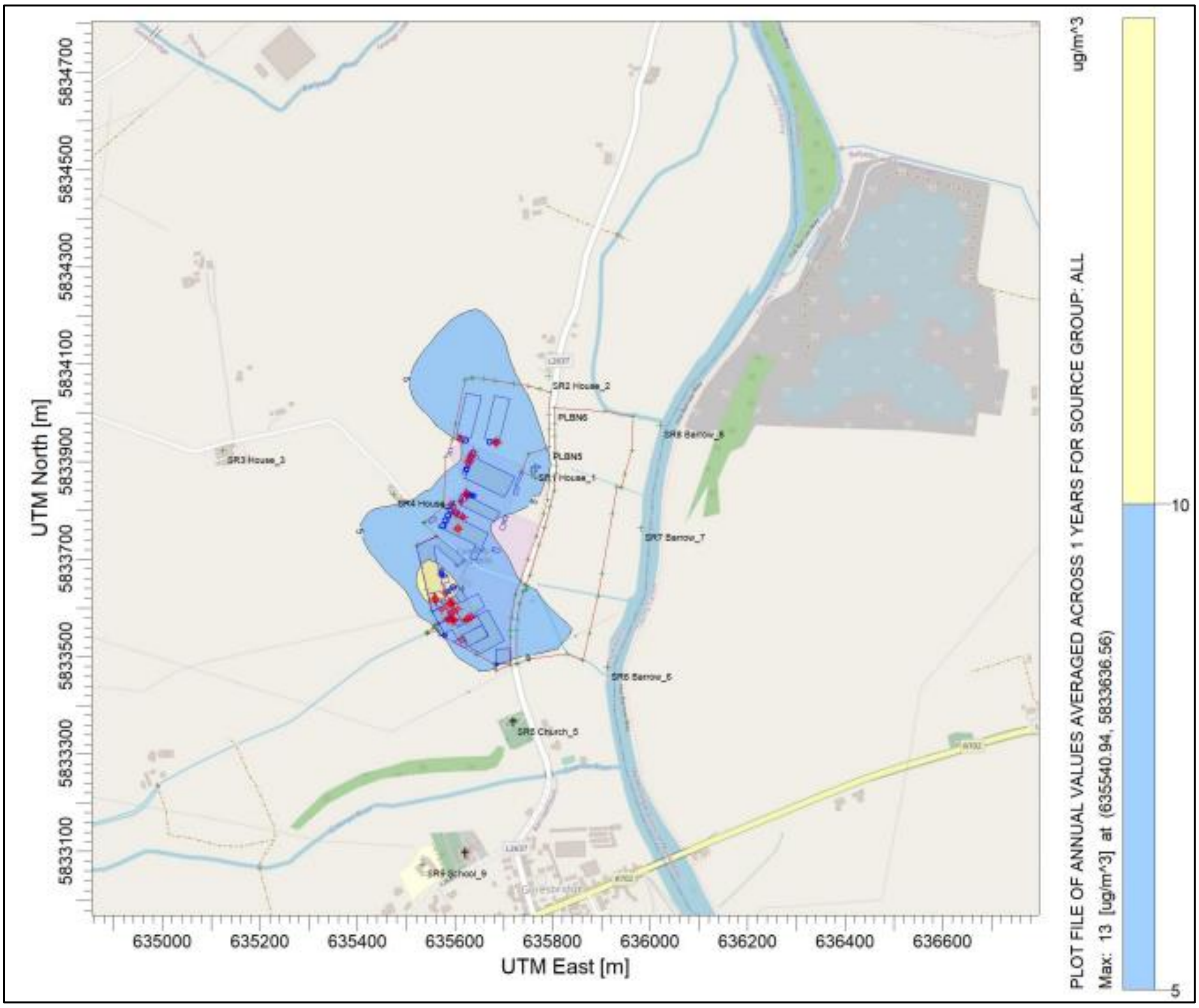
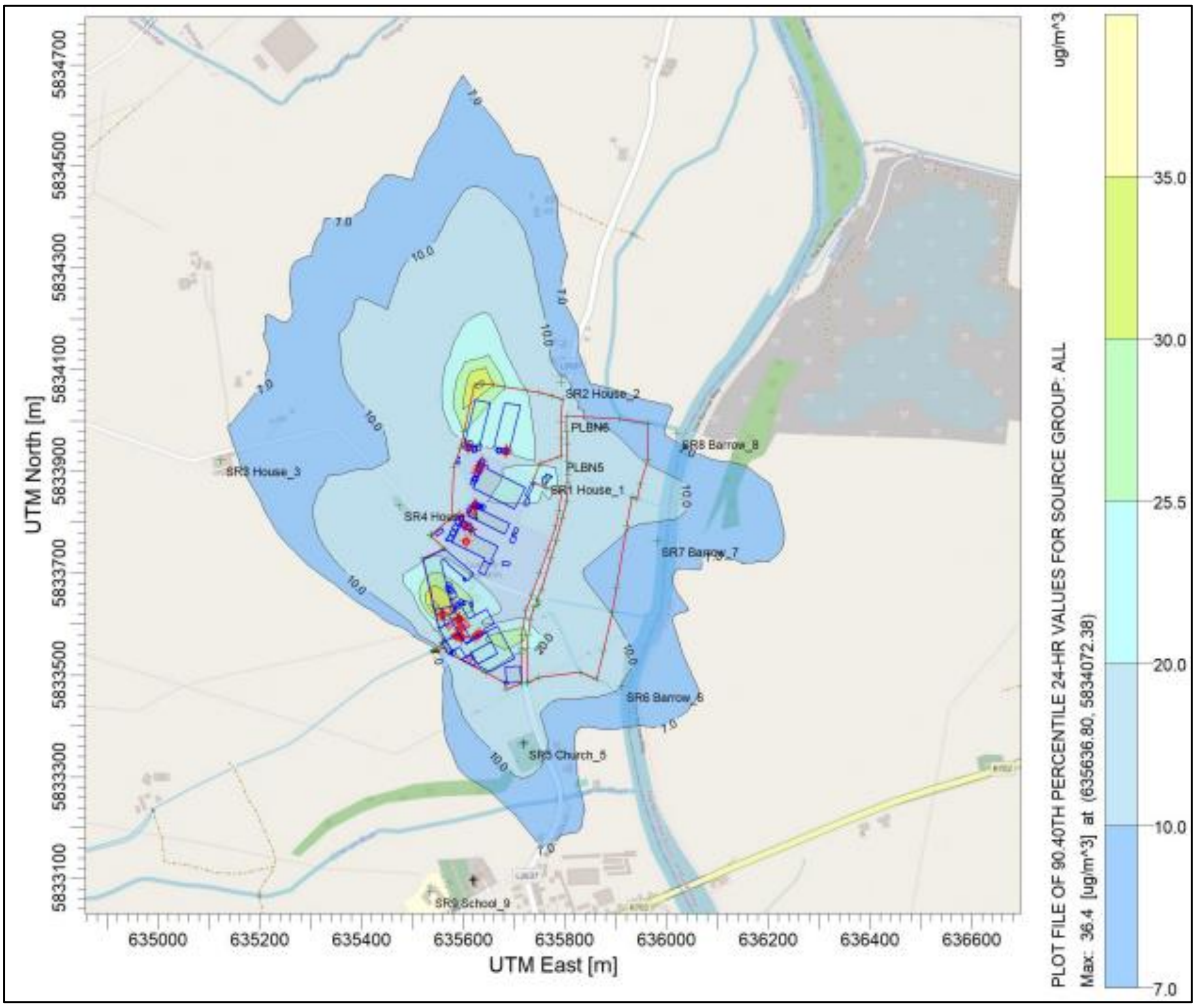


Figure 7-8: Results Scenario 4 2019 - 24hr Averaging Process Contribution (no background)



7.5 Designated Areas

PM10 AQS are set for protection of human health and not applicable to species / habitats. Moreover, SAC adjacent to the Site is designated for the aquatic habitat – River Barrow, and only small part of this SAC is terrestrial – along the river banks. Aquatic habitats are in general not sensitive to ambient air pollutants (Holman et al, 2014). Nonetheless, process contribution (PC) at these locations was calculated for the worst met year, 2019[3]. PC is not significant compared to the background concentration, therefore there will be no impact on air quality from the Site at the nearest designated site, as shown in Table 7-17 below which displays the annual and 24hr PM10 concentrations for Scenario 4 and the worst case met conditions (2019). For contour plots, refer to Figures 7-7 and 7-8 above.

[3] Sections 7.1 to 7.4 contain results at SR 6, 7 and 8 for other met years modelled and other Scenarios, and demonstrate no impact at these SRs.

Table 7-17: PM10 concentrations for Scenario 4 at designated site (SR6, SR7, SR8) – Scenario 4, year 2019

2019	Receptor	Result (PC) µg/Nm^3	Background Concentration µg/Nm^3	Result + Background (PEC)	AQS	%AQS (PEC)
Annual	SR6	3.42	11.96	15.38	40	38%
Annual	SR7	2.85	11.96	14.81	40	37%
Annual	SR8	2.26	11.96	14.22	40	36%
24hr (90.4th)	SR6	9.91	11.96	21.87	50	44%
24hr (90.4th)	SR7	9.16	11.96	21.12	50	42%
24hr (90.4th)	SR8	6.44	11.96	18.40	50	37%

8 DISCUSSION

8.1 NOx

Modelling of NOx emission from the boiler was carried out based on estimates of volumetric flow, with the objective of determining highest ELVs for both emission rate and volumetric flow that will not have an impact on the environment, i.e. breach 75% of NOx annual and hourly AQS. This is a significant overestimate, as the stand-by boiler was run 24/7/365, whereas in reality this boiler runs 5-6 hours per week, and annually one week when the duty boiler is being maintained.

Once conversion of boilers from diesel to LPG is completed, these ELVs will be validated.

8.2 Dust

All results present unlikely worst-case scenarios due to the following:

- In the model, all emission points running at maximum ELVs simultaneously. In reality, both volumetric flows and emission rates will be lower than ELVs.
- In the model all Feed Mill points running 24/7, 365 days a year. Some of the emission points will not be running 24 hours per day. Most importantly, the Feed Mill in general operates 5 days a week; however, on some occasions there are operations on Saturdays and/or Sundays, so the modelling was carried out with worst-case operating time – 24/7/365.
- All dryers running 24/7, for 3 months a year. In reality, drying season will more likely be 6 - 8 weeks; and once Dryer 1 and 3 replacements installed, possibly even less than 6 weeks. However, running time and start date will always vary from year to year, depending on weather, amount of grain harvested and multiple other factors. Therefore, a worst-case scenario where all dryers were operating for 3 months was modelled.
- The results presented are for the worst-case metrological conditions.

8.2.1 Scenario 1

The highest off-site annual mean Predicted Environmental Concentration (PEC) was 28.28 μg/Nm3 or 71% of the annual AQS of 40 μg/Nm3, which occurred for met year 2019. At sensitive receptors, the maximum annual mean PEC was 16.70 μg/Nm3 or 42% of annual AQS. This occurred at SR5 for met year 2020. Therefore, model predicts that annual mean PEC outside the site boundary and at sensitive receptors would have been significantly below AQS.

The highest predicted off-site ground level PEC was 56.31 μg/Nm3, or 121% of 24-hr AQS of 50 μg/Nm3 (calculated as 90.4%tile), which occurred for met year 2020. This occurs at the south-western and western site boundary, and falls below 75% of 24-hr AQS within ca. 31 metres of the site boundary. Adjoining this boundary is an agricultural field with a wayleave / right or way allowing Red Mills access which runs parallel to the south-western boundary. See Section 7.1 Figure 7-2.

At the sensitive receptors, the maximum 24-hr PEC was 27.78μg/Nm3 or 56% of annual AQS. This occurred at SR5 for met year 2020. Therefore, it can be concluded that 24-hr PEC at sensitive receptors was significantly below AQS.

8.2.2 Scenario 2

The highest off-site annual mean predicted environmental concentration (PEC) was 30.70 μg/Nm3 or 77% of the annual AQS of 40 μg/Nm3, which occurred for met year 2019. At sensitive receptors, the maximum annual mean PEC was 7.32 μg/Nm3 or 48% of annual AQS. This occurred at SR5 for met year 2016. Therefore, it can be concluded that annual mean PEC outside the site boundary and at sensitive receptors was significantly below AQS.

The highest off-site ground level PEC was 61.34 μg/Nm3, or 123% of 24-hr AQS of 50 μg/Nm3 (calculated as 90.4%tile), which occurred for met year 2019. This occurred at the western site boundary and fell below 75% of 24-hr AQS within ca. 43 metres of the site boundary. In this area there is an agricultural field. See Section 7.2, Figure 7-4.

Scenario 3 mitigation measures were specifically designed to mitigate this impact. Sensitivity studies, where results for each individual emission point were analysed, concluded that the key issue is contribution form Feed Mill emission points. Incrementally increasing stack heights, resulted in mitigation measures proposed in Scenario 3, which are predicted to address concentration at the western site boundary.

At sensitive receptors, the maximum 24-hr mean PEC was 37.40 μg/Nm3 or 75% of annual AQS. This occurred at SR1 for met year 2017. Therefore, it can be concluded that 24-hr PEC at sensitive receptors was well below AQS.

8.2.3 Scenario 3

The highest off-site annual mean predicted environmental concentration (PEC) was 24.67 μg/Nm3 or 62% of the annual AQS of 40 μg/Nm3, which occurred for met year 2019. At sensitive receptors, the maximum annual mean PEC was 18.76 μg/Nm3 or 47% of annual AQS. This occurred at SR1 for met year 2017. Therefore, it can be concluded that annual mean outside the site boundary and at sensitive receptors was well below AQS.

The highest off-site ground level PEC was 46.72 μg/Nm3, or 93% of 24-hr AQS of 50 μg/Nm3 (calculated as 90.4%tile), which occurred for met year 2019. This occurred at the western site boundary, and fell below 75% of 24-hr AQS within 19.5 metres of the site boundary. In this area there is an agricultural field. See 7.3, Figure 7-6.

At sensitive receptors, the maximum 24-hr mean PEC was 37.07 μg/Nm3 or 74% of annual AQS. This occurred at SR1 for met year 2017. Therefore, it can be concluded that 24-hr PEC at sensitive receptors was well below AQS.

Mitigation measures (Feed Mill Stack height increases) proposed for this scenario are based on increasing each individual stack. At this stage, this proposal is based solely on improving dispersion, and no engineering feasibility study has been carried out. It is proposed that an initial study of processes related to the emission points that are major contributors to ambient concentrations will be carried out in January 2022, to assess which emission points could be merged and how to redesign ducting to bring these points to the sufficient height.

Once this has been completed, engineering plans will be prepared and validated via air dispersion modelling.

8.2.4 Scenario 4

The highest predicted off-site annual mean predicted environmental concentration (PEC) was 25.14 μg/Nm3 or 63% of the annual AQS of 40 μg/Nm3, which occurred for met year 2019. At sensitive receptors, the maximum annual mean PEC was 20.12 μg/Nm3 or 50% of annual AQS. This occurred at SR1 for met year 2019. Therefore, it can be concluded that annual mean PEC outside the site boundary and at sensitive receptors was well below AQS.

The highest predicted off-site ground level concentration was 48.41 μg/Nm3, or 97% of 24-hr AQS of 50 μg/Nm3 (calculated as 90.4%tile), which occurred for met year 2019. This occurred at the north-western site boundary, and fell below 75% of 24-hr AQS within ca. 58 metres of the site boundary. In this area is an agricultural field. Planning permission for a public road in this area has been granted. See Section 7.4, Figure 7-8.

At sensitive receptors, the maximum 24-hr mean PEC was 42.60 μg/Nm3 or 85% of annual AQS. This occurred at SR1 for met year 2017. For other met years, at SR1 24-hr mean PEC was 84% (2016), 69% (2018), 72% (2019) and 44% (2020). At all other SRs, for all met years, maximum 24-hr mean PEC was less or equal to 50% of AQS. Therefore, it can be concluded that 24-hr PEC at sensitive receptors was below well below AQS.

In comparison to Scenario 3, increases in process contribution at Site boundaries and SRs is attributed to replacement Dryers 1 and 3. The main site boundary impact appears to be due to building downdraft (new grain stores); therefore, tweaks in stack heights and potentially locations[4], would lead to improvements. Once the exact emission rates have been determined by monitoring of this type of dryer (in December 2021); validation can be carried out to optimise stack parameters.

These emission points should be contained within the licence and will be validated via updated Air Dispersion Modelling following monitoring in December 2021.

[4] Changing stack locations is limited to couple of meters, within the general area where replacement Dryers 1 and 3 are currently proposed to be located, however, given the building downdraft it may be beneficial, therefore, validation of that approach is proposed.

9 PROGRAMME OF IMPROVEMENTS

9.1 Immediate Improvements

Based on the site visit and monitoring carried out during 2021, Red Mills management has committed to the following immediate improvements at the site:

- Replacement of old flat-bed dryer 6, which results in uncontrolled fugitive emissions, which were very difficult to quantify, and therefore were not included in Scenario 1, with new highly-efficient, high throughput dryer.
  - This new dryer will have controlled, low emissions, as it will use fabric filters and have monitoring ports.
  - Monitoring of a dryer equivalent to replacement Dryer 6 will be carried out in December 2021, and therefore the results of this assessment will be validated in January 2022.
- Conversion of two diesel boilers to LPG, to be completed by the end of May 2022.
  - At that juncture ports will be installed to carry out monitoring and confirm volumetric flows.
- Installation of ports and access at all emission points where these are not currently in place:
  - A2-12 (Cyclone GVRSA and GVRSB);
  - A2-21 (main grain intake);
  - A2-13 (fines);
  - A2-26 (Flaker Clean 1); and,
  - A2-17 (Soya Cyclone – Bin Filling).
- New abatement to be installed at Dryers 4A and 4B, as these dryers do not currently have dust abatement equipment. It is proposed to install a similar type of cyclone that are currently installed on Dryer 5. With such abatement, it is expected that very low emissions will be achieved, similar to Dryer 5.
- Cyclone and stack improvements, as well as installation of monitoring ports and access at:
  - A2-32 (Dryer 5, Pre-Cleaner)
  - A2-40 (Dryer 4, Pre-Cleaner)
  - A2-49 (Seed Plant, Pre-Cleaner)
  - A2-48 (Seed Plant, Screening and Dressing Seeds)

The above immediate improvements will be fully implemented before the start of Harvest 2022, or sooner.

9.2 Mitigation Measures proposed in Scenario 3

Given the very low emission rates proposed for most of the Feed Mill emission sources in Scenario 2 and limitations in reducing these any further due to the configuration of the building, available space, type of process and most importantly type of dust (which in some cases has a high moisture content), the most efficient way to reduce impact on the environment will be to improve dispersion by increasing stack heights.

Sensitivity analysis was carried out, and stacks with highest contributions to maximum off-site PEC were selected. The following changes are proposed:

- A2-12 (Cyclone GVRSA and GVRSB) is a vertical stack located on top of a 25m building in the southern portion of the site. It is proposed to increase the stack height to +5.5m above the building height.
- A2-21 (main intake) is a vertical stack, located on a 14.5m building at the main grain intake area. Due to the large height variation between this stack (~0.5m above building height) and the surrounding buildings it is subject to building downwash

dynamics and a stack height increase of +10m is proposed (to bring it above adjacent building, which is much higher).

- A2-1, A2-2, A2-3, A2-4 (Cubers1-4) are four emission points located on the side of a 25m building in the southern portion of the site, all facing downwards. It is proposed to bring all of these emission points to the roof and all stacks to be +5m above roof.
- A2-6, A2-7, A2-9 (flakers 1-3) are three emission points located on a 22m building in the southern portion of the site. These emission points are all horizontal and are ~ 20m above ground height. It is proposed to bring these emission points to the roof and all stacks to be 3m above roof.
- A2-10 (flaker cyclone) is a vertical stack, located on a 15m building in the southern portion of the site. The stack is currently ~5m above the building height. It is proposed to bring it to +11m above building height (to bring it above adjacent building, which is much higher).
- A2-18, A2-19, A2-20 (grinders) are located on the side of a building in the southern portion of the site. These emission points are ca. 3m above ground height. It is proposed to bring these emission points to the roof of the building (15m) and all stacks to be 10m above building height (as the adjacent building is much higher);
- A2-26 (flaker clean) is a vertical stack located on a 22m building. This stack is currently ~1mabove building height. It is proposed to bring this stack height to +4m above building height.

However, it should be noted that it will take approximately 18 months for these measures to be completed, as it is required to review feasibility of this proposal from an engineering perspective, prepare engineering design, validate this design and carry out the actual works. In addition, at this stage, it makes sense to connect ducting from related emission points from the same processes into single stacks that then could be routed to the top of the highest building. This makes sense for e.g. cubers and flakers. However, a detailed engineering analysis will need to be carried out from both a process perspective as well as structural perspective.

As these stacks are close together already, these multiple plumes could be considered as a single plume (Lakes Environmental, 2003), by adjusting volumetric flows. Therefore, the modelling results in Scenario 3 are not expected to change significantly in cases where nearby stacks are merged into a single stack. Moreover, it is expected that plume buoyancy would improve, thereby improving dispersion. Nonetheless, once engineering designs have been prepared, it is proposed to validate the designs via updated Air Dispersion Modelling.

9.3 Programme

Programme of improvements outlined in sections 9.1 and 9.2 is summarised in Table 9-1 below.

Table 9-1: Programme of Improvements in relation to Emissions to Air

No.	Action	To be completed by
1.	Monitoring of a dryer that is equivalent to replacement Dryer 6 to obtain exact emission rates.	December 2021
2.	Installation of monitoring ports / access on all points in Feed Mill where this is missing	Q1 2022
3.	Boilers conversion to LPG and installation of monitoring ports / access and monitoring to validate volumetric flows / NOx emissions	May 2022
4.	Dryer 4 and dryer 5 pre-cleaners – improvements to cyclones, installation of stacks above the roof of nearest building with vertical dispersion	June 2022

No.	Action	To be completed by
5.	Installation of abatement on Dryers 4A and 4B (cyclone similar to Dryer 5 cyclones)	June 2022
6.	Seed Plant emission points – reconfiguration of cyclones and ducting to allow installation of monitoring ports and access	June 2022
7.	Feed Mill Stack increases: 7.1 Review of processes and ducting to assess the most efficient way to increase stacks to required height, including merging several emission points into one stack 7.2 Engineering design 7.3 Validation of stack height increase / location and engineering design impact via air dispersion modelling 7.4 Prepare implementation plan, which must accommodate ongoing operations, i.e. minimum disruption to production 7.5 Carry out the stack changes	18 months (June 2023)

10 CONCLUSIONS

There are two relevant air pollutants emitted from point sources at the Red Mills Site in Goresbridge - NOx and dust (TPM). Both were assessed by means of detailed air dispersion modelling. The assessment included baseline (2021), baseline with mitigation measures, and future emissions (2022 and 2023).

NOx is emitted from two boilers currently running on diesel. Volumetric flow for either boiler could not be determined through monitoring or through manufacturer's documentation. Further, these boilers will be converted to LPG by the end of May 2022, requiring new burners. Therefore, proposed ELVs are based on standard NOx emission rate of 200 mg/Nm3 and volumetric flows that would not breach 75% of relevant AQS (annual and 1-hr averaging) at the Site boundaries.

MOR propose that Table 10-1 below be incorporated into Schedule B: Emission Limits of the IEL for boilers.

Table 10-1: Proposed B. Emission Limits for Boilers

Ref. No.	Irish Grid Reference E, N	Minimum Discharge Height (m)	Volumetric Flow (Nm3/hr)	NOx Emission Rate (mg/Nm3)
A1-1	268010, 154262	18	10,000	200
A1-2	268009, 154263	18	5,000	200

** Volumetric flows must be validated via monitoring.*

Dust (total particulates) is emitted from a total of 49 (current and proposed) major emission points at the Site. These include Feed Mill processes, Seed Plant and Dryers. Scenario 1 and Scenario 2 show exceedance of 24hr AQS at the Site boundary. Therefore, Mitigation Measures are proposed in Scenario 3; however, it will take ca. 18 months to fully implement all of these measures. In addition to stack height increases, the locations of these stacks are likely to change slightly.

A review undertaken of individual process contribution for each emission point, and process contribution for groups of emission points (Feed Mill vs. Dryers) and the contour plots, shows that the plume lands at different parts of the Site boundary; therefore the inclusion of replacement Dryers 1, 3 and 6 will not significantly impact on the Site boundaries impacted in Scenario 1 and 2.

For all proposed emission points (replacement Dryers 1, 3 and 6) emission rates, stack heights and co-ordinates must be validated through monitoring and air dispersion modelling. As the emission rate form these dryers will not be constant, but in short pulses (emitting for 10sec every 3-5min), an ELV in mg/m3 is not applicable; it is proposed to set ELV in kg/hr.

MOR propose that Table 10-2 below be incorporated into Schedule Proposed Schedule B: Emission Limits of the IEL for Feed Mill.

Table 10-2: Proposed B. Emission Limits for Feed Mill & Seed Plant

Emission Point Ref	Emission Point Name	Volumetric Flow (Nm3/hr)	Total Particulates Emission Rate (mg/m3)
A2-1	Cuber 1	26,000	5
A2-2	Cuber 2	24,000	5
A2-3	Cuber 3	28,000	5
A2-4	Cuber 4	28,000	5
A2-6	Flaker 1	18,000	5
A2-7	Flaker 1	12,000	20
A2-8	Flaker 2	15,000	5
A2-9	Flaker 2	3,000	5

Emission Point Ref	Emission Point Name	Volumetric Flow (Nm3/hr)	Total Particulates Emission Rate (mg/m3)
A2-10	Flaker Cyclone	30,000	20
A2-11	Flaker Cyclone	10,000	5
A2-12	Cyclone GVRSA and GVRSB	26,000	10
A2-13	Na	12,000	10
A2-15	Soya Grinder	5,000	5
A2-16	Soya Extruder	6,000	5
A2-17	Soya Cyclone - Bin Filling	3,000	10
A2-18	Grinder 1	7,000	5
A2-19	Grinder 3	6,500	5
A2-20	Grinder 4 - Dust Extraction	8,000	5
A2-21	Main Intake Grain	6,500	5
A2-22	Extruder Vent	14,000	5
A2-23	Extruder Dryer/ Cooler Vent	28,000	5
A2-26	Flaker Clean 1	15,000	5
A2-53	OatMill Cleaner	27,000	5
A2-48	Seed Plant	20,000	10
A2-49	Seed Plant	10,000	10

** Grid-reference and stack heights to be confirmed once mitigation measures designed and validated. For current grid-reference and stack height, used in this assessment, refer to Appendix A.*

MOR propose that Table 10-3 below be incorporated into Schedule Proposed Schedule B: Emission Limits of the IEL for current Dryers.

Table 10-3: Proposed Schedule B. Emission Limits for Current Dryers

Emission Point Ref	Emission Point Name	Irish Grid Reference E, N	Minimum Discharge Height (m)	Volumetric Flow (Nm3/hr)	Total Particulates Emission Rate
A2-30A	Dryer 2	267972,154247	8	59,000	5 mg/m3
A2-30B	Dryer 2	267972,154246	8	59,000	5 mg/m3
A2-31	Dryer 2	267971,154252	14.5	2,000	10 mg/m3
A2-32	Dryer 5	268028,154447	13	10,000	5 mg/m3
A2-33	Dryer 5	268042,154460	22	42,000	5 mg/m3
A2-34	Dryer 5	268040,154461	22	39,000	5 mg/m3
A2-35	Dryer 5	268038,154459	22	32,000	5 mg/m3
A2-36	Dryer 5	268038,154462	22	39,000	5 mg/m3
A2-37	Dryer 5	268037,154463	22	39,000	5 mg/m3
A2-38	Dryer 4A2	268029,154417	12	53,000	5 mg/m3
A2-39	Dryer 4A1	268030,154418	12	83,000	5 mg/m3
A2-40	Dryer 4	268005,154443	14.3	10,000	5 mg/m3
A2-41	Dryer 4B	268013,154424	22.1	59,000	5 mg/m3
A2-42	Dryer 4B	268016,154422	22.1	78,000	5 mg/m3

MOR propose that Table 10-4 below be incorporated into Schedule Proposed Schedule B: Emission Limits of the IEL replacement dryers.

Table 10-4: Proposed Schedule B. Emission Limits for Replacement Dryers

Emission Point Ref	Emission Point Name	Minimum Discharge Height (m)	Volumetric Flow (Nm3/hr)	Total Particulates Mass Emissions
A2-45A	Replacement Dryer 6	24	136,000	1.36 kg/hr
A2-45B	Replacement Dryer 6	24	136,000	1.36 kg/hr
A2-46A	Replacement Dryer 6	24	136,000	1.36 kg/hr
A2-46B	Replacement Dryer 6	24	136,000	1.36 kg/hr
A2-46C	Replacement Dryer 6 Pre-cleaner	24	20,000	0.2 kg/hr
A2-50A	Replacement Dryer 1	24	136,000	1.36 kg/hr
A2-50A	Replacement Dryer 1	24	136,000	1.36 kg/hr
A2-51A	Replacement Dryer 3	24	136,000	1.36 kg/hr
A2-51B	Replacement Dryer 3	24	136,000	1.36 kg/hr
A2-52	Replacement Dryer 1/3 Pre-cleaner	24	20,000	0.2 kg/hr

** Grid-reference and stack heights to be confirmed once engineering designs validated. For current grid-reference and stack height, used in this assessment, refer to Appendix A.*

REFERENCES

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Lakes Environmental. (2003). *Proposed Guideline for Air Dispersion Modelilng for Ontario Ministry of Environment.*

APPENDICES

APPENDIX A

Scenario 1 Baseline (Harvest 2021) - TPM

Emission Point Ref	Emission Point Name	Stack height GL in model (m)	Stack Inside Diameter (m)	Type of Stack	Gas Stack Temp (K)	Monitored TPM (mg/Nm3)	Monitored Volume Flow (Nm3/hr)	Model Input Emission rate (g/s)	Molde Input Gas Exit Flow Rate (m3/s)	Monitored or estimated
Feed Mill										
A2-1	Cuber 1	23	0.71	Downward (Horizontal in Model)	324.55	1.27	23,201	0.008	6.445	monitored
A2-2	Cuber 2	23	1.13	Downward Master plan (Horizontal in Model)	329.05	4.59	21,440	0.027	5.956	monitored
A2-3	Cuber 3	23	0.80	Downward Master plan (Horizontal in Model)	313.65	2.24	24,674	0.015	6.854	monitored
A2-4	Cuber 4	NA	NA	NA		NA	NA	NA	NA	new emission in place but process not operational in 2021
A2-6	Flaker 1	22	0.91	Horizontal	300.50	20	15,595	0.087	4.332	monitored
A2-7	Flaker 1	20	0.62	Horizontal	298.25	22.57	10,579	0.066	2.939	monitored
A2-8	Flaker 2	23.5	0.78	Vertical	297.95	4.63	12,919	0.017	3.589	monitored
A2-9	Flaker 2	20	0.27	Horizontal	299.55	0.61	2,567	0.00043	0.713	monitored
A2-10	Flaker Cyclone	20	1.69	Vertical	298.25	20.71	26,955	0.155	7.488	monitored
A2-11	Flaker Cyclone	16.5	0.41	Vertical	333.25	2.65	8,772	0.006	2.437	monitored
A2-12	Cyclone GVRSA and GVRSB	25.5	0.50	Vertical	333.25	10	26,000	0.072	7.222	not moitored as ports and access not in place; modelled with proposed ELVs
A2-13	fines	25	0.50	Horizontal	298.25	10	12,000	0.033	3.333	not moitored as ports and access not in place; modelled with proposed ELVs
A2-15	Soya Grinder	3	0.23	Horizontal	300.15	1.2	4,001	0.001	1.111	monitored
A2-16	Soya Extruder	15.5	0.65	Vertical	304.25	1.13	4,777	0.001	1.327	monitored
A2-17	Soya Cyclone - Bin Filling	14.5	0.50	Vertical	289.15	10	3,000	0.008	0.833	not moitored as ports and access not in place;
A2-18	Grinder 1	3	0.85	Horizontal	301.15	6	6060	0.010	1.683	monitored
A2-19	Grinder 3	3	0.50	Horizontal	306.15	5	6,500	0.009	1.806	not moitored as it was not operational; modelled with proposed ELVs
A2-20	Grinder 4 - Dust Extraction	3	0.34	Horizontal	306.15	12.61	6,756	0.024	1.877	monitored
A2-21	Main Intake Grain	15.9	0.50	Vertical	301.15	5	6,500	0.009	1.806	not moitored as ports and access not in place;
A2-22	Extruder Vent	15.5	0.40	Vertical	295.65	5.66	12,625	0.020	3.507	monitored
A2-23	Extruder Dryer/ Cooler Ve	15.5	0.65	Vertical	316.25	2.72	25,100	0.019	6.972	monitored
A2-26	Flaker Clean 1	23	0.50	Vertical	289.15	5	15,000	0.021	4.167	not moitored as ports and access not in place;
Dryers										
A2-30A	Dryer 2	8	1.65	Horizontal	299.15	2.12	52,824	0.031	14.673	monitored
A2-30B	Dryer 2	8	1.65	Horizontal	299.15	1.79	53,061	0.026	14.739	monitored
A2-31	Dryer 2	14.5	0.23	Horizontal	291.45	20.08	1,397	0.008	0.388	monitored
A2-32	Dryer 5	9	0.50	Capped	289.15	5	10,000	0.014	2.778	not moitored as ports and access not in place;
A2-33	Dryer 5	22	1.13	Vertical	293.55	1.22	37,401	0.013	10.389	monitored
A2-34	Dryer 5	22	1.13	Vertical	293.75	1.12	35,241	0.011	9.789	monitored
A2-35	Dryer 5	22	1.00	Vertical	300.15	2.52	28,205	0.020	7.835	monitored
A2-36	Dryer 5	22	1.13	Vertical	299.85	2.34	35,134	0.023	9.759	monitored
A2-37	Dryer 5	22	1.13	Vertical	303.55	6.24	35,234	0.061	9.787	monitored
A2-38	Dryer 4A2	12	0.95	Vertical	311.45	14.95	47,395	0.197	13.165	monitored
A2-39	Dryer 4A1	12	0.97	Vertical	310.25	36.25	74,999	0.755	20.833	monitored
A2-40	Dryer 4	10.3	0.50	Capped	289.15	5	10,000	0.014	2.778	not moitored as ports and access not in place; modelled with proposed ELVs
A2-41	Dryer 4B	22.1	1.35	Vertical	307.85	5.44	53,070	0.080	14.742	monitored
A2-42	Dryer 4B	22.1	1.35	Vertical	306.85	13.72	70,162	0.267	19.489	monitored
Seed Plant										
A2-48	Seed Plant	13.35	0.50	Capped	289.15	10	20,000	0.056	5.556	not moitored as ports and access not in place; modelled with proposed ELVs
A2-49	Seed Plant	13.35	0.50	Capped	289.15	10	10,000	0.028	2.778	not moitored as ports and access not in place; modelled with proposed ELVs

Note: Dryer 6 not included as a point source in Scenario 1, as this was flat-bed horizontal dryer with no point sources, i.e. a source of fugitive emission.

Scenario 2 (Harvest 2022) - TPM

Emission Point Ref	Emission Point Name	Abatement	Building Height (m)	Actual height above GL in model (m)	Type of Stack	Stack Inside Diameter (m)	Gas Stack Temp (K)	Proposed ELV for TPM (mg/Nm3)	Proposed ELV for Volumetric Flow (Nm3/hr)	Model Input - Emission rate (g/s)	Model Input - Gas Exit Flow Rate (m3/s)	Proposed Changes to Scenario 1
Feed Mill												
A2-1	Cuber 1	Cyclone	25	23	Downward Master plan (Horizontal in Model)	0.71	324.55	5	26,000	0.036	7.222	none
A2-2	Cuber 2	Cyclone	25	23	Downward Master plan (Horizontal in Model)	1.13	329.05	5	24,000	0.033	6.667	none
A2-3	Cuber 3	Cyclone	25	23	Downward Master plan (Horizontal in Model)	0.80	313.65	5	28,000	0.039	7.778	none
A2-4	Cuber 4	Cyclone	25	23	Horizontal	0.50	329.05	5	28,000	0.039	7.778	none
A2-6	Flaker 1	Cyclone and Sock filter	22	22	Horizontal	0.91	300.50	5	18,000	0.025	5.000	none
A2-7	Flaker 1	Cyclone and Sock filter	22	20	Horizontal	0.62	298.25	20	12,000	0.067	3.333	none
A2-8	Flaker 2	Cyclone and Sock filter	22	23.5	Vertical	0.78	297.95	5	15,000	0.021	4.167	none
A2-9	Flaker 2	Cyclone and Sock filter	22	20	Horizontal	0.27	299.55	5	3,000	0.004	0.833	none
A2-10	Flaker Cyclone	Cyclone	15	20	Vertical	1.69	298.25	20	30,000	0.167	8.333	none
A2-11	Flaker Cyclone	Cyclone	15	16.5	Vertical	0.41	333.25	5	10,000	0.014	2.778	none
A2-12	Cyclone GVRSA and GVRSB	Cyclone	25	25.5	Vertical	0.50	333.25	10	26,000	0.072	7.222	none
A2-13	Fines	None	25	25	Horizontal	0.50	298.25	10	12,000	0.033	3.333	none
A2-15	Soya Grinder	Cyclone	15	3	Horizontal	0.23	300.15	5	5,000	0.007	1.389	none
A2-17	Soya Cyclone - Bin Filling	Cyclone	15	14.5	Vertical	0.50	289.15	10	3,000	0.008	0.833	none
A2-16	Soya Extruder	Cyclone	15	15.5	Vertical	0.65	304.25	5	6,000	0.008	1.667	none
A2-18	Grinder 1	Sock Filter	15	3	Horizontal	0.85	301.15	5	7,000	0.010	1.944	none
A2-19	Grinder 3	Sock Filter	15	3	Horizontal	0.50	306.15	5	6,500	0.009	1.806	none
A2-20	Grinder 4 - Dust Extraction	Sock Filter	15	3	Horizontal	0.34	306.15	5	8,000	0.011	2.222	none
A2-21	Main Intake Grain	Sock Filter	14.5	15.9	Vertical	0.50	301.15	5	6,500	0.009	1.806	none
A2-22	Extruder Vent	Cyclone	15	15.5	Vertical	0.40	295.65	5	14,000	0.019	3.889	none
A2-23	Extruder Dryer/ Cooler Vent	None	15	15.5	Vertical	0.65	316.25	5	28,000	0.039	7.778	none
A2-26	Flaker Clean 1	Cyclone	22	23	Vertical	0.50	289.15	5	15,000	0.021	4.167	none
Dryers												
A2-30A	Dryer 2	None	14	8	Horizontal	1.65	299.15	5	59,000	0.082	16.389	none
A2-30B	Dryer 2	None	14	8	Horizontal	1.65	299.15	5	59,000	0.082	16.389	none
A2-31	Dryer 2	None	14	14.5	Horizontal	0.23	291.45	10	2,000	0.006	0.556	none
A2-32	Dryer 5	Cyclone	11	**13**	**Vertical**	0.50	289.15	5	10,000	0.014	2.778	Increased stack height, cap removed
A2-33	Dryer 5	Cyclone	20	22	Vertical	1.13	293.55	5	42,000	0.058	11.667	
A2-34	Dryer 5	Cyclone	20	22	Vertical	1.13	293.75	5	39,000	0.054	10.833	
A2-35	Dryer 5	Cyclone	20	22	Vertical	1.00	300.15	5	32,000	0.044	8.889	
A2-36	Dryer 5	Cyclone	20	22	Vertical	1.13	299.85	5	39,000	0.054	10.833	
A2-37	Dryer 5	Cyclone	20	22	Vertical	1.13	303.55	5	39,000	0.054	10.833	
A2-38	Dryer 4A2	**Cyclone**	10	12	Vertical	0.95	311.45	5	53,000	0.074	14.722	Abatement unit installed
A2-39	Dryer 4A1	**Cyclone**	10	12	Vertical	0.97	310.25	5	83,000	0.115	23.056	Abatement unit installed
A2-40	Dryer 4	Cyclone	12.3	**14.3**	**Vertical**	0.50	289.15	5	10,000	0.014	2.778	Increased stack height, cap removed
A2-41	Dryer 4B	**Cyclone**	20.3	22.1	Vertical	1.35	307.85	5	59,000	0.082	16.389	Abatement unit installed
A2-42	Dryer 4B	**Cyclone**	20.3	22.1	Vertical	1.35	306.85	**5**	78,000	0.108	21.667	Abatement unit installed
A2-45A	**Replacement Dryer 6**	**Fabric filter**	11.2	24	Vertical	1.86	299.85	1.36 kg/hr	136,000	0.378	37.778	New modern dryer, replacing flat bed Dryer 6
A2-45B	**Replacement Dryer 6**	**Fabric filter**	11.2	24	Vertical	1.86	299.85	1.36 kg/hr	136,000	0.378	37.778	New modern dryer, replacing flat bed Dryer 6
A2-46A	**Replacement Dryer 6**	**Fabric filter**	11.2	24	Vertical	1.86	299.85	1.36 kg/hr	136,000	0.378	37.778	New modern dryer, replacing flat bed Dryer 6
A2-46B	**Replacement Dryer 6**	**Fabric filter**	11.2	24	Vertical	1.86	299.85	1.36 kg/hr	136,000	0.378	37.778	New modern dryer, replacing flat bed Dryer 6
A2-46C	**Replacement Dryer 6**	**Cyclone**	11.2	24	Vertical	0.50	289.15	0.2 kg/hr	20,000	0.056	5.556	New modern dryer, replacing flat bed Dryer 6
Seed Plant												
A2-48	Seed Plant	Screening and Dressing Seeds	12.45	**14.45**	**Vertical**	0.50	289.15	10	20,000	0.056	5.556	Increased stack height, cap removed
A2-49	Seed Plant	Cyclone	12.45	**14.45**	**Vertical**	0.50	289.15	10	10,000	0.028	2.778	Increased stack height, cap removed

*** Changes to Scenario are indicated in blue bold.**

Scenario 3 (including Mitigation Measures) - TPM

Emission Point Ref	Emission Point Name	Abatement	Building Height (m)	Actual height above GL in model (m)	Type of Stack	Gas Stack Temp (K)	Stack Inside Diameter (m)	Proposed ELV for TPM (mg/Nm3)	Proposed ELV for Volumetric Flow (Nm3/hr)	Model Input - Emission rate (g/s)	Model Input - Gas Exit Flow Rate (m3/s)	Proposed Changes to Scenario 2
Feed Mill												
A2-1	Cuber 1	Cyclone	25	**30**	**Vertical**	324.55	0.71	5	26,000	0.036	7.222	Increase stack height, with vertical orientation
A2-2	Cuber 2	Cyclone	25	**30**	**Vertical**	329.05	1.13	5	24,000	0.033	6.667	Increase stack height, with vertical orientation
A2-3	Cuber 3	Cyclone	25	**30**	**Vertical**	313.65	0.80	5	28,000	0.039	7.778	Increase stack height, with vertical orientation
A2-4	Cuber 4	Cyclone	25	**30**	Vertical	329.05	0.50	5	28,000	0.039	7.778	Increase stack height
A2-6	Flaker 1	Cyclone and Sock filter	22	**25**	**Vertical**	300.50	0.91	5	18,000	0.025	5.000	Increase stack height, with vertical orientation
A2-7	Flaker 1	Cyclone and Sock filter	22	**25**	**Vertical**	298.25	0.62	20	12,000	0.067	3.333	Increase stack height, with vertical orientation
A2-8	Flaker 2	Cyclone and Sock filter	22	23.5	Vertical	297.95	0.78	5	15,000	0.021	4.167	none
A2-9	Flaker 2	Cyclone and Sock filter	22	**25**	**Vertical**	299.55	0.27	5	3,000	0.004	0.833	Increase stack height, with vertical orientation
A2-10	Flaker Cyclone	Cyclone	15	**26**	Vertical	298.25	1.69	20	30,000	0.167	8.333	Increase stack height
A2-11	Flaker Cyclone	Cyclone	15	16.5	Vertical	333.25	0.41	5	10,000	0.014	2.778	none
A2-12	Cyclone GVRSA and GVRSB	Cyclone	25	**30.5**	Vertical	333.25	0.50	10	26,000	0.072	7.222	Increase stack height
A2-13	Fines	None	25	25	Horizontal	298.25	0.50	10	12,000	0.033	3.333	none
A2-15	Soya Grinder	Cyclone	15	3	Horizontal	300.15	0.23	5	5,000	0.007	1.389	none
A2-16	Soya Extruder	Cyclone	15	15.5	Vertical	304.25	0.65	5	6,000	0.008	1.667	none
A2-17	Soya Cyclone - Bin Filling	Cyclone	15	14.5	Vertical	289.15	0.50	10	3,000	0.008	0.833	none
A2-18	Grinder 1	Sock Filter	15	**25**	**Vertical**	301.15	0.85	5	7,000	0.010	1.944	Increase stack height, with vertical orientation
A2-19	Grinder 3	Sock Filter	15	**25**	**Vertical**	306.15	0.50	5	6,500	0.009	1.806	Increase stack height, with vertical orientation
A2-20	Grinder 4 - Dust Extraction	Sock Filter	15	**25**	**Vertical**	306.15	0.34	5	8,000	0.011	2.222	Increase stack height, with vertical orientation
A2-21	Main Intake Grain	Sock Filter	14.5	**25**	Vertical	301.15	0.50	5	6,500	0.009	1.806	Increase stack height
A2-22	Extruder Vent	Cyclone	15	15.5	Vertical	295.65	0.40	5	14,000	0.019	3.889	none
A2-23	Extruder Dryer/ Cooler Vent	None	15	15.5	Vertical	316.25	0.65	5	28,000	0.039	7.778	none
A2-26	Flaker Clean 1	Cyclone	22	**26**	Vertical	289.15	0.50	5	15,000	0.021	4.167	Increase stack height
Dryer												
A2-30A	Dryer 2	None	14	8	Horizontal	299.15	1.65	5	59,000	0.082	16.389	none
A2-30B	Dryer 2	None	14	8	Horizontal	299.15	1.65	5	59,000	0.082	16.389	none
A2-31	Dryer 2	None	14	14.5	Horizontal	291.45	0.23	10	2,000	0.006	0.556	none
A2-32	Dryer 5	Cyclone	11	13	Vertical	289.15	0.50	5	10,000	0.014	2.778	none
A2-33	Dryer 5	Cyclone	20	22	Vertical	293.55	1.13	5	42,000	0.058	11.667	none
A2-34	Dryer 5	Cyclone	20	22	Vertical	293.75	1.13	5	39,000	0.054	10.833	none
A2-35	Dryer 5	Cyclone	20	22	Vertical	300.15	1.00	5	32,000	0.044	8.889	none
A2-36	Dryer 5	Cyclone	20	22	Vertical	299.85	1.13	5	39,000	0.054	10.833	none
A2-37	Dryer 5	Cyclone	20	22	Vertical	303.55	1.13	5	39,000	0.054	10.833	none
A2-38	Dryer 4A2	Cyclone	10	12	Vertical	311.45	0.95	5	53,000	0.074	14.722	none
A2-39	Dryer 4A1	Cyclone	10	12	Vertical	310.25	0.97	5	83,000	0.115	23.056	none
A2-40	Dryer 4	Cyclone	12.3	14.3	Vertical	289.15	0.50	5	10,000	0.014	2.778	none
A2-41	Dryer 4B	Cyclone	20.3	22.1	Vertical	307.85	1.35	5	59,000	0.082	16.389	none
A2-42	Dryer 4B	Cyclone	20.3	22.1	Vertical	306.85	1.35	5	78,000	0.108	21.667	none
A2-45A	Replacement Dryer 6	Fabric filter	11.2	24	Vertical	299.85	1.86	1.36 kg/hr	136,000	0.378	37.778	none
A2-45B	Replacement Dryer 6	Fabric filter	11.2	24	Vertical	299.85	1.86	1.36 kg/hr	136,000	0.378	37.778	none
A2-46A	Replacement Dryer 6	Fabric filter	11.2	24	Vertical	299.85	1.86	1.36 kg/hr	136,000	0.378	37.778	none
A2-46B	Replacement Dryer 6	Fabric filter	11.2	24	Vertical	299.85	1.86	1.36 kg/hr	136,000	0.378	37.778	none
A2-46C	Replacement Dryer 6	Cyclone	11.2	24	Vertical	289.15	0.50	0.2 kg/hr	20,000	0.056	5.556	none
Seed Plant												
A2-48	Seed Plant	Screening and Dressing Seeds	12.45	14.45	Vertical	289.15	0.50	10	20,000	0.056	5.556	none
A2-49	Seed Plant	Cyclone	12.45	14.45	Vertical	289.15	0.50	10	10,000	0.028	2.778	none

*** Changes to Scenario are indicated in blue bold.**

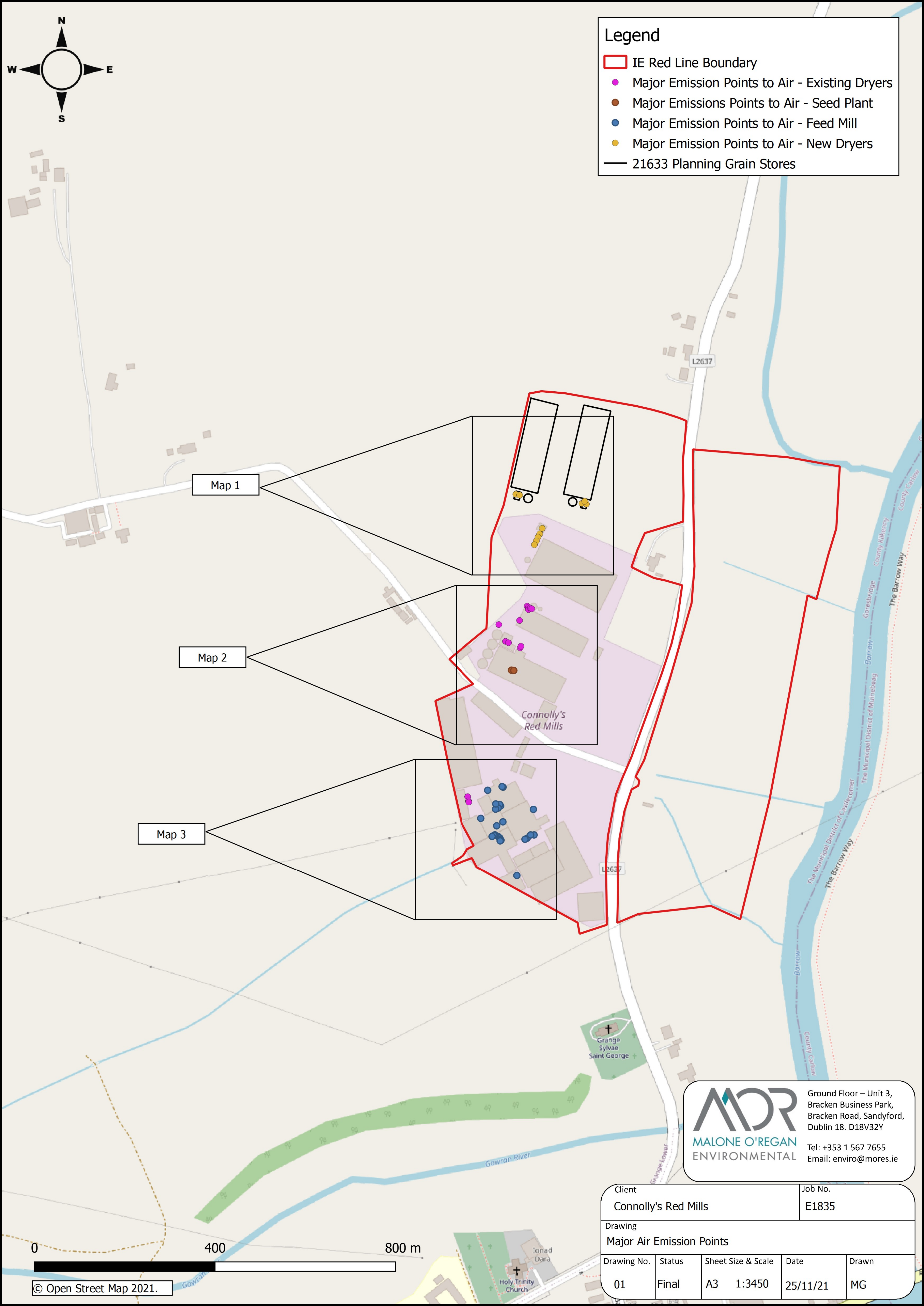
Scenario 4 - including additional emission points (2023) - TPM

Emission Point Ref	Emission Point Name	Abatement	Building Height (m)	Actual height above GL in model (m)	Stack Inside Diameter (m)	Type of Stack	Gas Stack Temp (K)	Result/proposed mg/Nm3 dust	Volume Flow - proposed ELV (Nm3/hr)	Emission rate (g/s)	Gas Exit Flow Rate (m3/s)	Proposed Changes to Scenario 3
						Feed Mill						
A2-1	Cuber 1	Cyclone	25	30	0.71	Vertical	324.55	5	26,000	0.036	7.222	None
A2-2	Cuber 2	Cyclone	25	30	1.13	Vertical	329.05	5	24,000	0.033	6.667	None
A2-3	Cuber 3	Cyclone	25	30	0.80	Vertical	313.65	5	28,000	0.039	7.778	None
A2-4	Cuber 4	Cyclone	25	30	0.50	Vertical	329.05	5	28,000	0.039	7.778	None
A2-6	Flaker 1	Cyclone and Sock filter	22	25	0.91	Vertical	300.50	5	18,000	0.025	5.000	None
A2-7	Flaker 1	Cyclone and Sock filter	22	25	0.62	Vertical	298.25	20	12,000	0.067	3.333	None
A2-8	Flaker 2	Cyclone and Sock filter	22	23.5	0.78	Vertical	297.95	5	15,000	0.021	4.167	None
A2-9	Flaker 2	Cyclone and Sock filter	22	25	0.27	Vertical	299.55	5	3,000	0.004	0.833	None
A2-10	Flaker Cyclone	Cyclone	15	26	1.69	Vertical	298.25	20	30,000	0.167	8.333	None
A2-11	Flaker Cyclone	Cyclone	15	16.5	0.41	Vertical	333.25	5	10,000	0.014	2.778	None
A2-12	Cyclone GVRSA and GVRSB	Cyclone	25	30.5	0.50	Vertical	333.25	10	26,000	0.072	7.222	None
A2-13	na	None	25	25	0.50	Horizontal	298.25	10	12,000	0.033	3.333	None
A2-15	Soya Grinder	Cyclone	15	3	0.23	Horizontal	300.15	5	5,000	0.007	1.389	None
A2-16	Soya Extruder	Cyclone	15	15.5	0.65	Vertical	304.25	5	6,000	0.008	1.667	None
A2-17	Soya Cyclone - Bin Filling	Cyclone	15	14.5	0.50	Vertical	289.15	10	3,000	0.008	0.833	None
A2-18	Grinder 1	Sock Filter	15	25	0.85	Vertical	301.15	5	7,000	0.010	1.944	None
A2-19	Grinder 3	Sock Filter	15	25	0.50	Vertical	306.15	5	6,500	0.009	1.806	None
A2-20	Grinder 4 - Dust Extraction	Sock Filter	15	25	0.34	Vertical	306.15	5	8,000	0.011	2.222	None
A2-21	Main Intake Grain	Sock Filter	14.5	25	0.50	Vertical	301.15	5	6,500	0.009	1.806	None
A2-22	Extruder Vent	Cyclone	15	15.5	0.40	Vertical	295.65	5	14,000	0.019	3.889	None
A2-23	Extruder Dryer/ Cooler Vent	None	15	15.5	0.65	Vertical	316.25	5	28,000	0.039	7.778	None
A2-26	Flaker Clean 1	Cyclone	22	26	0.50	Vertical	289.15	5	15,000	0.021	4.167	None
A2-53	**OatMill Cleaner**	Bag filter	25	**30**	**1**	Vertical	299.85	5	27,000	0.04	7.50	New Emission Point
						Dryers						
A2-30A	Dryer 2	None	14	8	1.65	Horizontal	299.15	5	59,000	0.082	16.389	None
A2-30B	Dryer 2	None	14	8	1.65	Horizontal	299.15	5	59,000	0.082	16.389	None
A2-31	Dryer 2	None	14	14.5	0.23	Horizontal	291.45	10	2,000	0.006	0.556	None
A2-32	Dryer 5	Cyclone	11	13	0.50	Vertical	289.15	5	10,000	0.014	2.778	None
A2-33	Dryer 5	Cyclone	20	22	1.13	Vertical	293.55	5	42,000	0.058	11.667	None
A2-34	Dryer 5	Cyclone	20	22	1.13	Vertical	293.75	5	39,000	0.054	10.833	None
A2-35	Dryer 5	Cyclone	20	22	1.00	Vertical	300.15	5	32,000	0.044	8.889	None
A2-36	Dryer 5	Cyclone	20	22	1.13	Vertical	299.85	5	39,000	0.054	10.833	None
A2-37	Dryer 5	Cyclone	20	22	1.13	Vertical	303.55	5	39,000	0.054	10.833	None
A2-38	Dryer 4A2	Cyclone	10	12	0.95	Vertical	311.45	5	53,000	0.074	14.722	None
A2-39	Dryer 4A1	Cyclone	10	12	0.97	Vertical	310.25	5	83,000	0.115	23.056	None
A2-40	Dryer 4	Cyclone	12.3	14.3	0.50	Vertical	289.15	5	10,000	0.014	2.778	None
A2-41	Dryer 4B	Cyclone	20.3	22.1	1.35	Vertical	307.85	5	59,000	0.082	16.389	None
A2-42	Dryer 4B	Cyclone	20.3	22.1	1.35	Vertical	306.85	5	78,000	0.108	21.667	None
A2-45A	Replacement Dryer 6	Fabric filter	11.2	24	1.86	Vertical	299.85	1.36 kg/hr	136,000	0.378	37.778	None
A2-45B	Replacement Dryer 6	Fabric filter	11.2	24	1.86	Vertical	299.85	1.36 kg/hr	136,000	0.378	37.778	None
A2-46A	Replacement Dryer 6	Fabric filter	11.2	24	1.86	Vertical	299.85	1.36 kg/hr	136,000	0.378	37.778	None
A2-46B	Replacement Dryer 6	Fabric filter	11.2	24	1.86	Vertical	299.85	1.36 kg/hr	136,000	0.378	37.778	None
A2-46C	Replacement Dryer 6 Pre-cleaner	Cyclone	11.2	24	0.50	Vertical	289.15	0.2 kg/hr	20,000	0.056	5.556	None
A2-50A	**Replacement Dryer 1**	Fabric filter	18	24	1.86	Vertical	299.85	1.36 kg/hr	136,000	0.378	37.778	New Emission Points to be installed in 2023. All ELVs and licenced parameters are subject to validation of the final engineering plans.
A2-50A	**Replacement Dryer 1**	Fabric filter	18	24	1.86	Vertical	299.85	1.36 kg/hr	136,000	0.378	37.778	
A2-51A	**Replacement Dryer 3**	Fabric filter	18	24	1.86	Vertical	299.85	1.36 kg/hr	136,000	0.378	37.778	
A2-51B	**Replacement Dryer 3**	Fabric filter	18	24	1.86	Vertical	299.85	1.36 kg/hr	136,000	0.378	37.778	
A2-52	**Replacement Dryer 1/3 Pre-cleaner**	Cyclone	18	24	0.5	Vertical	289.15	0.2 kg/hr	20,000	0.056	5.556	
						Seed Plant						
A2-48	Seed Plant	Screening and Dressing Seeds	12.45	14.45	0.50	Vertical	289.15	10	20,000	0.056	5.556	None
A2-49	Seed Plant	Cyclone	12.45	14.45	0.50	Vertical	289.15	10	10,000	0.028	2.778	None

*** Changes to Scenario are indicated in blue bold.**

Emission Point Ref	Eastings	Northings
Feed Mill		
A2-1	268010	154262
A2-2	268009	154263
A2-3	268034	154204
A2-4	268041	154209
A2-6	268001	154209
A2-7	268000	154209
A2-8	268005	154207
A2-9	267998	154208
A2-10	268003	154219
A2-11	268010	154224
A2-12	268007	154241
A2-13	268006	154243
A2-15	267993	154259
A2-16	268005	154239
A2-17	267985	154228
A2-18	268008	154203
A2-19	268007	154205
A2-20	268006	154206
A2-21	268025	154164
A2-22	268002	154238
A2-23	268002	154244
A2-26	268007	154203
A2-53 (Oat Cleaner)	268043	154236
Dryers		
A2-30A	267972	154247
A2-30B	267972	154246
A2-31	267971	154252
A2-32	268028	154447
A2-33	268042	154460
A2-34	268040	154461
A2-35	268038	154459
A2-36	268038	154462
A2-37	268037	154463
A2-38	268029	154417
A2-39	268030	154418
A2-40	268005	154443
A2-41	268013	154424
A2-42	268016	154422
A2-45A	268045	154531
A2-45B	268047	154535
A2-46A	268049	154539
A2-46B	268051	154543
A2-46C	268053	154549
A2-50A	268025	154587
A2-50B	268028	154587
A2-51A	268098	154577
A2-51B	268100	154579
A2-52	268102	154576
Seed Plant		
A2-48	268022	154392
A2-49	268019	154392
Boilers		
A1-1	268010	154262
A1-2	268009	154263

APPENDIX B


N
W
E
S
Legend
IE Red Line Boundary
Major Emission Points to Air - Existing Dryers
Major Emissions Points to Air - Seed Plant
Major Emission Points to Air - Feed Mill
Major Emission Points to Air - New Dryers
21633 Planning Grain Stores
L2637
Map 1
Map 2
Map 3
Connolly's Red Mills
Grange Sylvae Saint George
Gowran River
Holy Trinity Church
Ionad Dara
The Barrow Way
0
400
800 m
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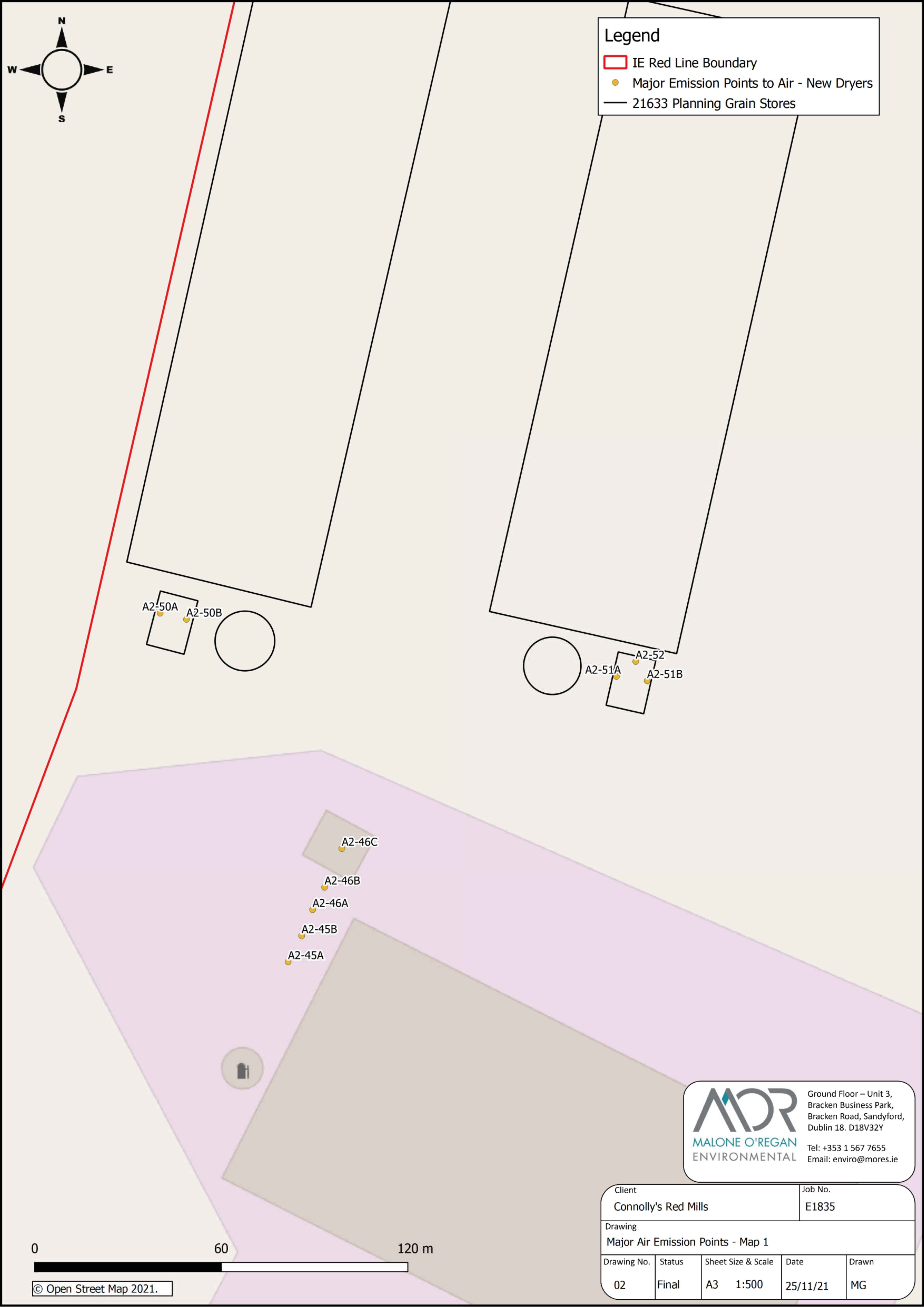
MALONE O'REGAN ENVIRONMENTAL
Ground Floor – Unit 3, Bracken Business Park, Bracken Road, Sandyford, Dublin 18. D18V32Y
Tel: +353 1 567 7655
Email: enviro@mores.ie
Client
Connolly's Red Mills
Job No.
E1835
Drawing
Major Air Emission Points
Drawing No.
01
Status
Final
Sheet Size & Scale
A3 1:3450
Date
25/11/21
Drawn
MG

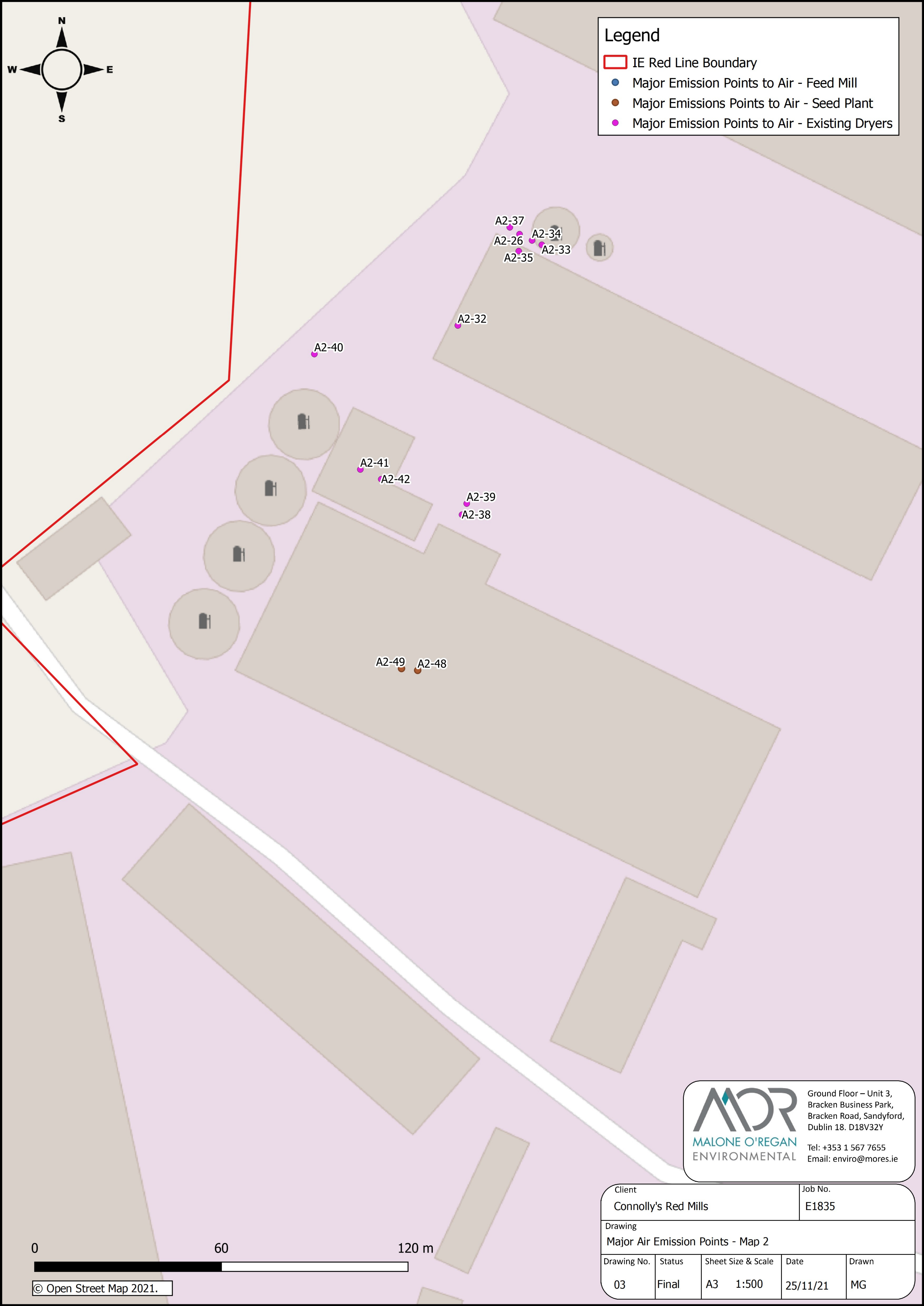


MALONE O'REGAN ENVIRONMENTAL
Ground Floor – Unit 3, Bracken Business Park, Bracken Road, Sandyford, Dublin 18. D18V32Y
Tel: +353 1 567 7655
Email: enviro@mores.ie

Client	Job No.
Connolly's Red Mills	E1835

Drawing: Major Air Emission Points - Map 1

Drawing No.	Status	Sheet Size & Scale	Date	Drawn
02	Final	A3 1:500	25/11/21	MG


N
S
E
W
Legend
IE Red Line Boundary
Major Emission Points to Air - Feed Mill
Major Emissions Points to Air - Seed Plant
Major Emission Points to Air - Existing Dryers
A2-37
A2-34
A2-26
A2-33
A2-35
A2-32
A2-40
A2-41
A2-42
A2-39
A2-38
A2-49
A2-48
0
60
120 m
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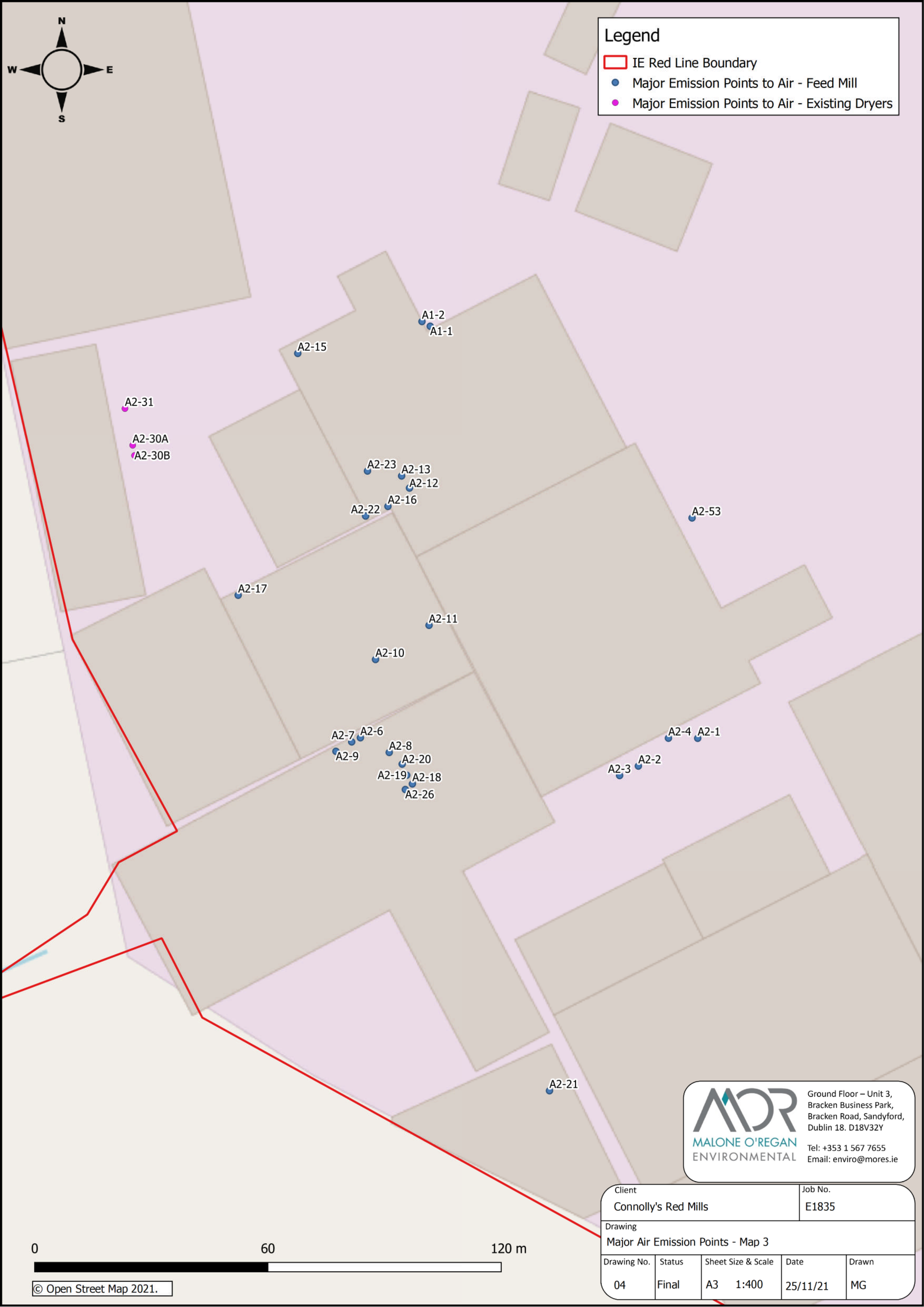
MALONE O'REGAN ENVIRONMENTAL
Ground Floor – Unit 3, Bracken Business Park, Bracken Road, Sandyford, Dublin 18. D18V32Y
Tel: +353 1 567 7655
Email: enviro@mores.ie
Client
Connolly's Red Mills
Job No.
E1835
Drawing
Major Air Emission Points - Map 2
Drawing No.
03
Status
Final
Sheet Size & Scale
A3 1:500
Date
25/11/21
Drawn
MG


N
S
E
W
Legend
IE Red Line Boundary
Major Emission Points to Air - Feed Mill
Major Emission Points to Air - Existing Dryers
A1-2
A1-1
A2-15
A2-31
A2-30A
A2-30B
A2-23
A2-13
A2-12
A2-16
A2-22
A2-53
A2-17
A2-11
A2-10
A2-7
A2-6
A2-9
A2-8
A2-20
A2-19
A2-18
A2-26
A2-4
A2-1
A2-3
A2-2
A2-21
0
60
120 m
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MALONE O'REGAN ENVIRONMENTAL
Ground Floor – Unit 3, Bracken Business Park, Bracken Road, Sandyford, Dublin 18. D18V32Y
Tel: +353 1 567 7655
Email: enviro@mores.ie
Client
Connolly's Red Mills
Job No.
E1835
Drawing
Major Air Emission Points - Map 3
Drawing No.
04
Status
Final
Sheet Size & Scale
A3 1:400
Date
25/11/21
Drawn
MG

APPENDIX C

TECHNICAL NOTE

E1835, Red Mills PM Monitoring

Re: Monitoring of Ambient Particulate Matter (PM) at Red Mills Factory, Goresbridge, Co. Kilkenny

1 INTRODUCTION

Malone O'Regan Environmental (MOR) was commissioned by William Connolly & Sons Unlimited Company herein referred to as 'Red Mills' to undertake ambient particulate monitoring on their site in Goresbridge, Co. Kilkenny (the Site).

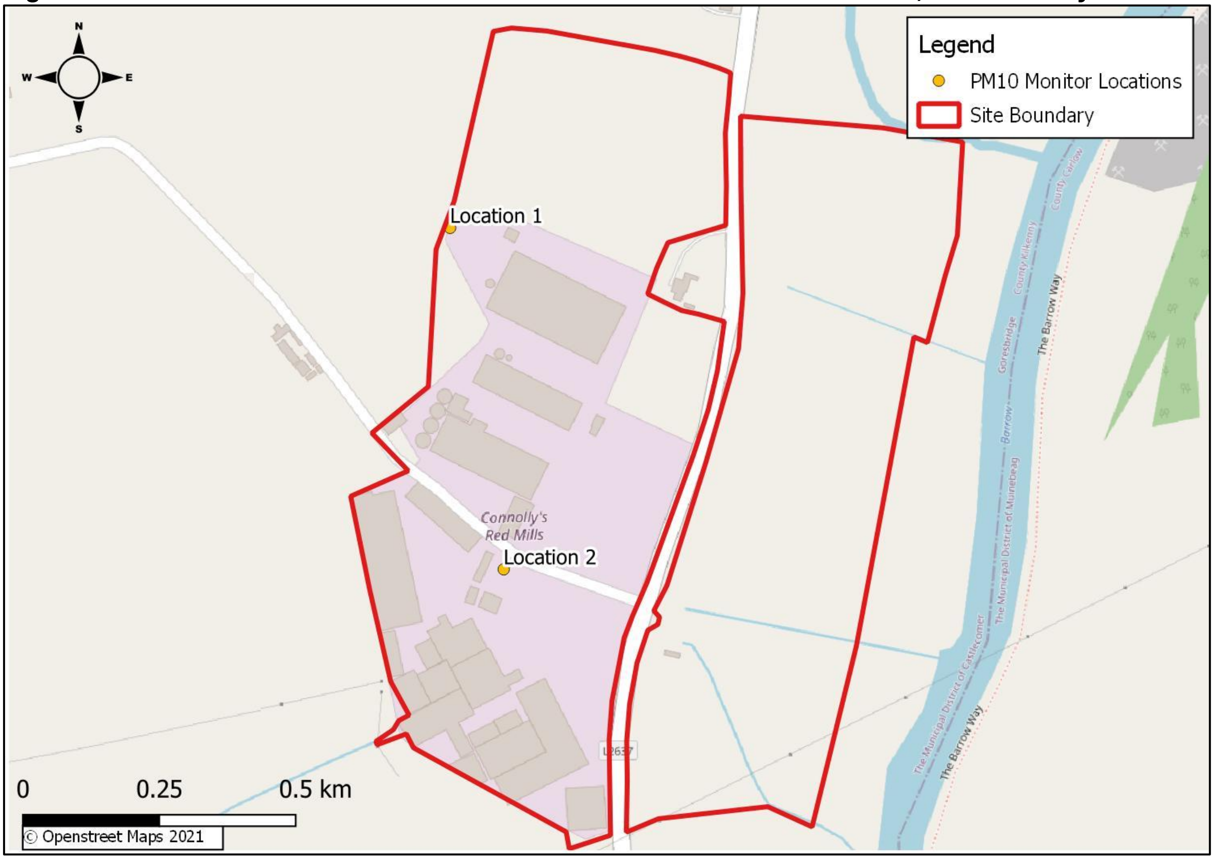
Using the TOPAS OSIIRS (TNO04361) (hereafter referred as the MOR particulate monitor) at two locations:

- **Location 1**: 17th to 21st of August 2021; and
- **Location 2:** 23rd to 28th of August 2021.

Real-time recordings of air quality have been obtained.

The MOR particulate monitor was installed by experienced MOR staff and is calibrated as per the manufacturer's instructions and industry standards. The two locations of the MOR particulate monitor and associated weather station are shown in Figure 1-1 below.

Figure 1-1: MOR Particulate Monitors Locations 1 and 2 at Red Mills Site, Co. Kilkenny



The monitoring results show ambient PM_{10} concentrations. The results include:

- Background concentrations of particulate matter (PM_{10}) derived from a nearby EPA official station; and
- Concentrations of PM_{10} recorded from the MOR particulate monitor, mostly attributed to the activity at the Red Mills Factory.

Operations associated with grain processing on the site, which are linked to increases in PM_{10} concentrations include emissions from dryers, coolers, flakers, grinders and cubers. Other fugitive sources of PM_{10} include delivery of the grain by trucks, and the associated traffic and offloads, stockpiles and general dust from the Red Mills Factory.

2 WEATHER STATION DATA

Meteorological data was obtained from the David Vantage Vue weather station throughout the monitoring period (17th August - 28th August 2021). Wind rose data was prepared to show the dominant wind direction at the two (2 No) monitoring locations (Figure 2-1 to Fig 2-2). Daily Average rainfall data was also calculated (Table 2-1 and Table 2-2 below).

Figure 2-1: Wind rose from the 17th – 21st August at Location 1

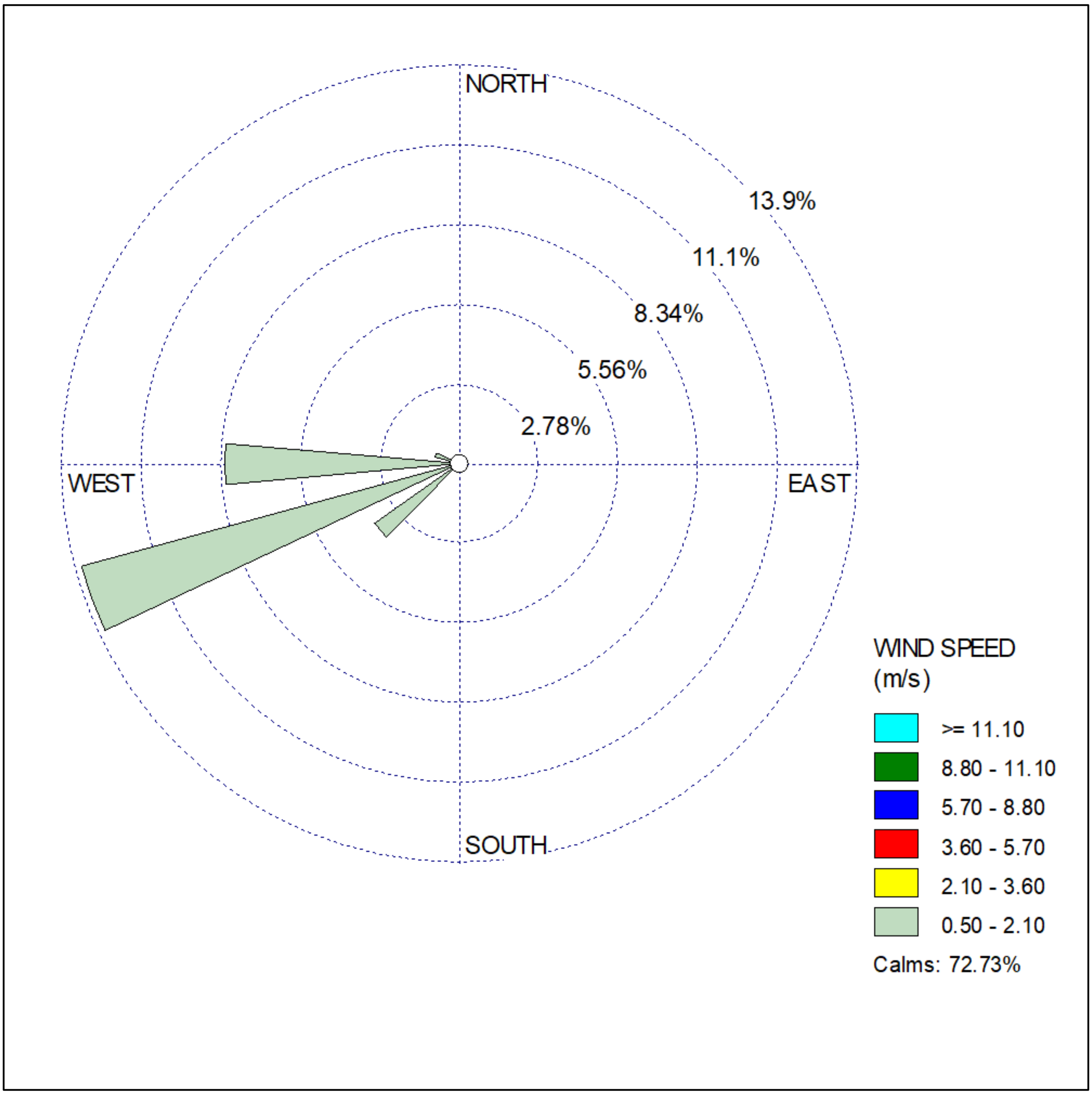


Table 2-1 Daily Average Rainfall and Wind Speed data obtained from Location 1 (17th August - 21st August 2021)

Date	Mean wind speed (m/s)	Rainfall (mm)
17/08/2021	0.29	0.05
18/08/2021	0.12	0
19/08/2021	0.23	0
20/08/2021	1.17	0.43
21/08/2021	0.48	0.47

Figure 2-3 Wind rose from Location 2 monitored between the 23rd - 28th of August 2021

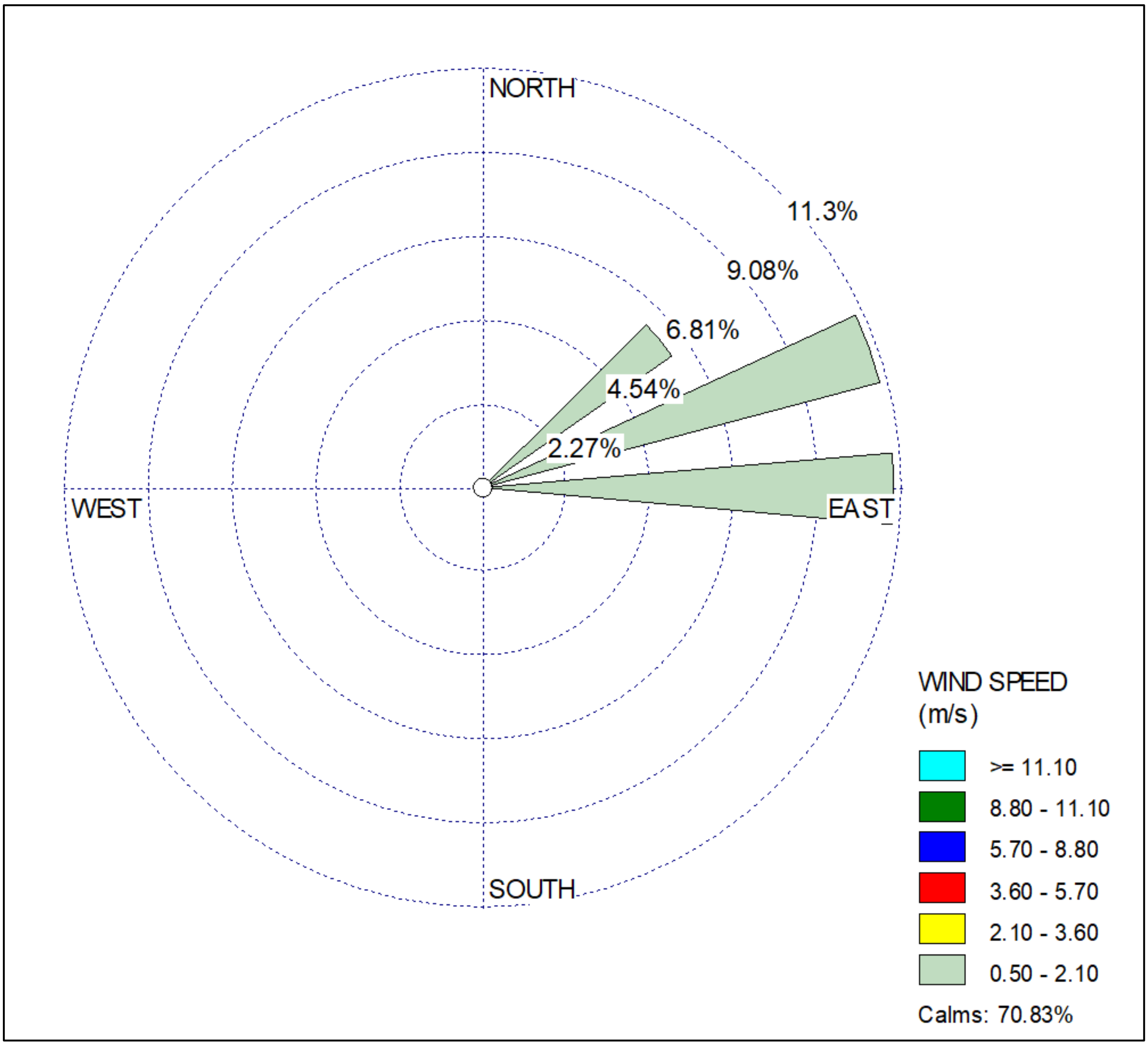


Table 2-1 Daily Average Rainfall and Wind Speed data obtained from Location 2 (23rd- 28th of August 2021)

Date	Mean wind speed (m/s)	Rainfall (mm)
23/08/2021	0.31	0.01
24/08/2021	0.71	0
25/08/2021	0.54	0
26/08/2021	0.39	0
27/08/2021	0.42	0
28/08/2021	0.28	0

3 AIR QUALITY STANDARDS

Table 3-1 below lists the applicable air quality standards (AQS) for PM_{10}, as set out in the Air Quality Directive (2008/50/EC) and S.I. No. 180 of 2011.

Table 3-1: Air Quality Standards (AQS) for PM_{10}

Pollutant	Concentration	Maximum No. of Exceedances permitted	Exceedance Expressed as Percentile	Measured as
Particulates (PM_{10})	50 µg/m^3	35 times in a year	90.40th percentile	24-hour mean
	40 µg/m^3	None	-	Annual mean

4 BACKGROUND AIR QUALITY

EU legislation on air quality requires that all Member States divide their territory into zones for the assessment and management of air quality. The current trends in air quality in Ireland are reported in the EPA publication Air Quality in Ireland (Key Indicators of Ambient Air Quality) – Annual Report 2016- 2020, which is the most up to date report on air quality in Ireland.

For ambient air quality management and monitoring in Ireland, four zones, A, B, C and D are described in the Air Quality Standards (AQS) Regulations (S.I. No. 180 of 2011) and are defined as follows:

- **Zone A:** Dublin Conurbation;
- **Zone B:** Cork Conurbation;
- **Zone C:** 24 cities and large towns. Includes Galway, Limerick, Waterford, Clonmel, Kilkenny, Sligo, Drogheda, Wexford, Athlone, Ennis, Bray, Naas, Carlow, Tralee, Dundalk, Navan, Newbridge, Mullingar, Letterkenny, Celbridge and Balbriggan, Portlaoise, Greystones and Leixlip; and
- **Zone D:** Rural Ireland, i.e., the remainder of the State excluding Zones A, B & C.

According to the EPA Air Quality Mapping site (EPA Maps), Red Mills Factory is located in Zone D of the Air Quality Map of Ireland. Located North-West of Red Mills is EPA Station 36, Callan Road.

Particulate monitors located in Zone D are deemed to be representative of background concentrations of PM, due to their location in rural settings. To contextualise background concentrations of PM_{10} for the Red Mills Factory, annual averages from these rural monitors are defined in Table 4-1.

Table 4-1: Annual Mean Concentrations of Pollutants Measured in Zone D

Monitoring Station	Total Particulates PM_{10} Annual Mean (µg/m³)				
	2016	2017	2018	2019	2020
Castlebar	11.9	11.2	11	16	14
Cobh	-	-	15	13	13
Claremorris	10.1	10.8	12	11	10
Kilkitt	8.1	7.8	9	7	8
Roscommon Town	-	-	12	12	11
Enniscorthy	17.3	-	-	18	15

Monitoring Station	Total Particulates PM_{10} Annual Mean (µg/m³)				
	2016	2017	2018	2019	2020
Macroom	-	-	-	28	15
Tipperary Town	-	-	-	9	12
Carrick-on-Shannon	-	-	-	-	10
Birr	-	-	-	-	10
Askeaton	-	-	-	-	7
Cavan	-	-	-	-	9
Average Zone D	**11.9**	**9.9**	**11.8**	**14.3**	**11.16**

5 MONITORING RESULTS

Tables 5-1 and 5-2 below details PM_{10} monitoring results collated for Locations 1 and 2 respectively for each monitoring period. Figures 5-1 and 5-2 shows daily PM_{10} from the MOR Particulate monitor against PM_{10} data from Callan Road for Locations 1 and 2. Figures 5-1 and 5-2 below also show reference to the EPA's AQH limit value (50ug/m^3).

5.1 Location 1

During the monitoring at Location 1, Daily Averages of PM_{10} were well below the Daily AQS limit (50 µg/m^3). Maximum daily concentrations recorded on the 19/08/2021 constituted only 31% of the total allowance for the AQS limit (15 µg/m^3).

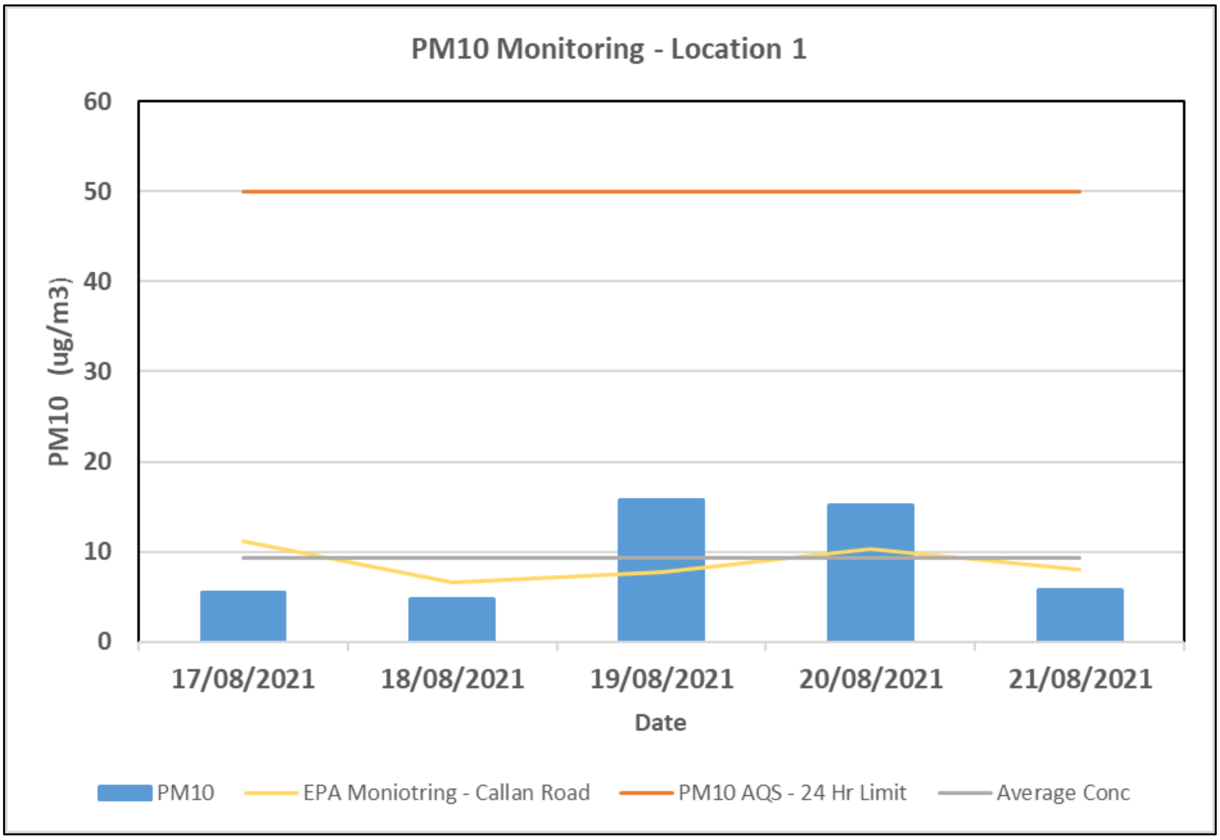
Average concentrations over the monitoring period was 9.37 µg/m^3, below the AQS annual limit of 40 µg/m^3.These concentrations also fall below the annual limit values set by WHO guidelines of 15 µg/m^3.

All values recorded throughout monitoring at Location 1, fell within the '1-good' AQS rating system provided by the EPA (0-16 µg/m^3) for PM_{10} concentrations.

Table 5-1 PM10 Monitoring Results from Location 1, Red Mills, Co. Kilkenny

Monitoring period	Monitored PM_{10} µg/m^3 24 hour mean	% of 24 hour mean AQS
17/08/2021 (10:45am -23:45pm)	5.52	11.04
18/08/2021 (00:00am -23:45pm	4.71	9.42
19/08/2021 (00:00am – 23:45pm)	15.75	31.50
20/08/2021 (00:00am-23:45pm)	15.14	30.2
21/08/2021 (00:00am-23:45pm)	5.73	11.46
Average for the monitoring period (17/08/2021 to 21/08/2021).	**9.37**	18

Figure 5-1: PM10 Monitoring Data at Location 1 Red Mills, August 17th -21st August 2021



5.2 Location 2

During the monitoring at Location 2, Daily Averages of PM_{10} were well below the Daily AQS limit (50 µg/m^3).

Average concentrations over the monitoring period was 7.43 µg/m^3, below the AQS annual limit of 40 µg/m^3.These concentrations also fall below the annual limit values set by WHO guidelines of 15 µg/m^3.

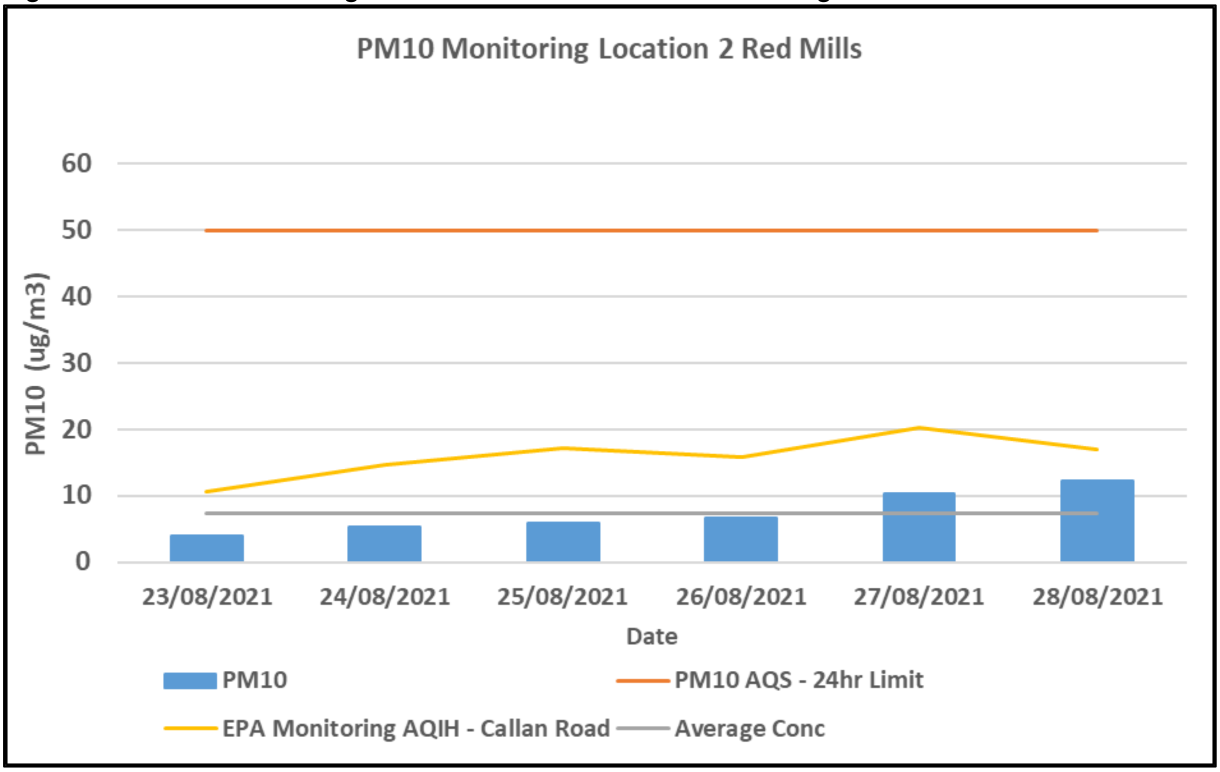
All values recorded throughout monitoring at Location 2, fell within the '1-good' AQS rating system provided by the EPA (0-16 µg/m^3) for PM_{10} concentrations.

Throughout the monitoring period at Location 2, PM10 values were continuously lower than the EPA station at Callan Road.

Table 5-2: PM10 Monitoring Results from Location 2, Red Mills, Co. Kilkenny

Monitoring period	Monitored PM_{10} µg/m^3 24 hour mean	% of 24 hour mean AQS
23/08/2021(11:30am – 23:45pm)	4.04	8.08
24/08/2021(00:00am-23:45pm)	5.26	10.52
25/08/2021 (00:00am-23:45pm)	5.95	11.9
26/08/2021 (00:00am-23:45pm)	6.74	13.48
27/08/2021 (00:00am-23:45pm)	10.23	20.68
28/08/2021 (00:00am – 23:45pm)	12.3	24.6
Average for the monitoring period (23/08/2021 to 28/08/2021).	**7.43**	14.87

Figure 5-2: PM10 Monitoring at Location 2 Red Mills 23rd -28th August 2021



For context for on site concentrations, the highest concentrations recorded in Zone D (from 2020) are shown in Table 5-3 below.

Table 5-3: Comparisons of highest Zone D annual concentrations with total mean concentrations recorded from Location 1 and Location 2 at Red Mills, Co. Kilkenny

Monitoring Station	**Zone Affiliated**	**2020**
Enniscorthy	D	15
Macroom	D	15
Castlebar	D	14
Monitoring Sites		**Monitoring Mean**
Location 1 (Red Mills)	D	9.37
Location 2 (Red Mills)	D	7.43

6 CONCLUSIONS

Based on the PM_{10} recorded at Location 1 and Location 2 the following can be concluded:

- The daily concentrations reflect those seen in the Zone D Air Quality(rural) settings.
- Daily PM_{10} concentrations recorded on site at both locations never exceed the EPA's limit values (50 µg/m^3), or WHO Guidelines values (25 µg/m^3).
- All values recorded during the monitoring season would have received a '1-Good' Rating by EPA AQH standards.
- At Location 1, the max % of daily concentrations against EPA AQH limit values was 31%.
- At Location 2, the max % of daily concentrations against AQH limits was 25%.
- Air Quality at the Red Mills factory, throughout the monitoring period, was below national averages regarding background concentration.
- Air Quality at the Red Mills site was lower than every annual average of the stations located in Zone D and therefore can be representative of normal background concentrations of PM_{10}.

APPENDIX D

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PARKWAY BUILDING, WHITESTOWN INDUSTRIAL ESTATE, TALLAGHT, DUBLIN 24

20 November 2021

Klara Kovacic

Malone O'Regan Environmental

Ground Floor - Unit 3

Bracken Business Park

Bracken Road, Sandyford

Dublin 18, D18 V32Y

Klara,

Please find below a brief description in relation to the dryer operation.

1. The dryer is initially filled with grain. It is the centre column of the dryer as shown in the attached schematic, and it is filled to the top.
2. The dryers fans are then switched on, and subsequently the gas burners are switched on.
3. Hot air from the burner side of the dryer is drawn across the column of the grain and is exhausted on the opposite side via the fans. Note that the grain is not moving and is static.
4. At intervals which can vary from 3minutes to 5 minutes, a series of slides open at the bottom discharge section of the dryer.
5. When this occurs grain flows out of the bottom of the dryer, and the column of grain within the dryer moved down over a 10 second period.
6. During this 10 seconds discharge period (as the grain is in motion) a fine dust will be emitted from the fan exhaust.

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7. To significantly reduce this, during this 10 seconds discharge period, a damper positioned on the stack, above the fan outlet is closed, which stops the airflow.
8. However, a small quantity of air (approximately 10%) is still drawn through the dryer, and this 10% volume is diverted into a reverse air fabric filter.
9. The exhaust air (which will be dust free) is redirected into the 22m stack.
10. After the 10 second period the grain have setting in the dryer and is static again.
11. The fan damper opens up again and full drying resumes.
12. This cycle continuously repeats during the drying process.
13. Note that when the fan damper closes and the airflow is reduced to 10% volume, the firing rate of the gas burners are set reduce so as not to have excessive heat during the discharge period.

I hope that you find this quotation of interest and if you have any questions please do not hesitate to contact me.

Yours sincerely,

Fergus O'Brien.

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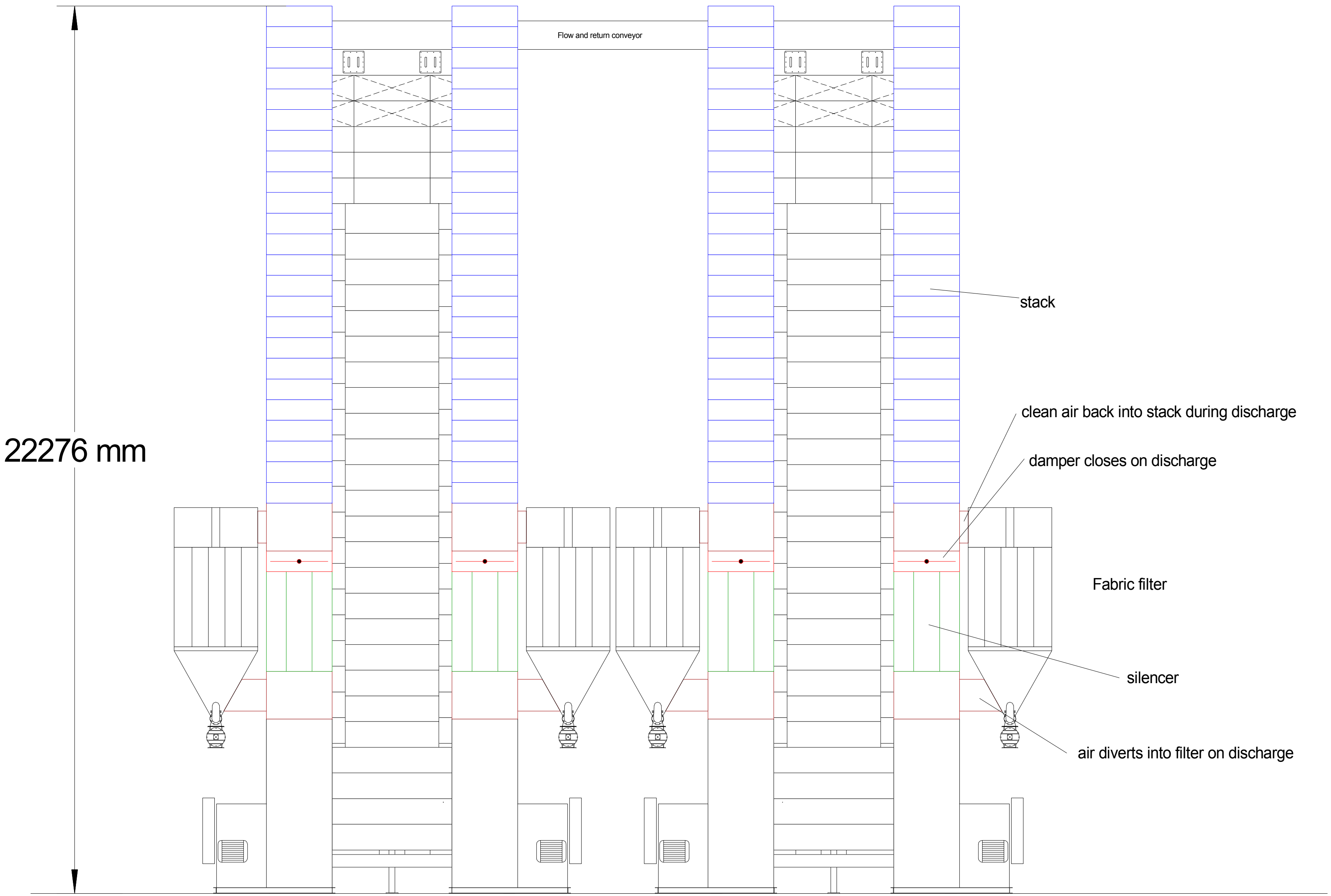

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Proposal For: Connolly Redmills

Project: Elevation schematic

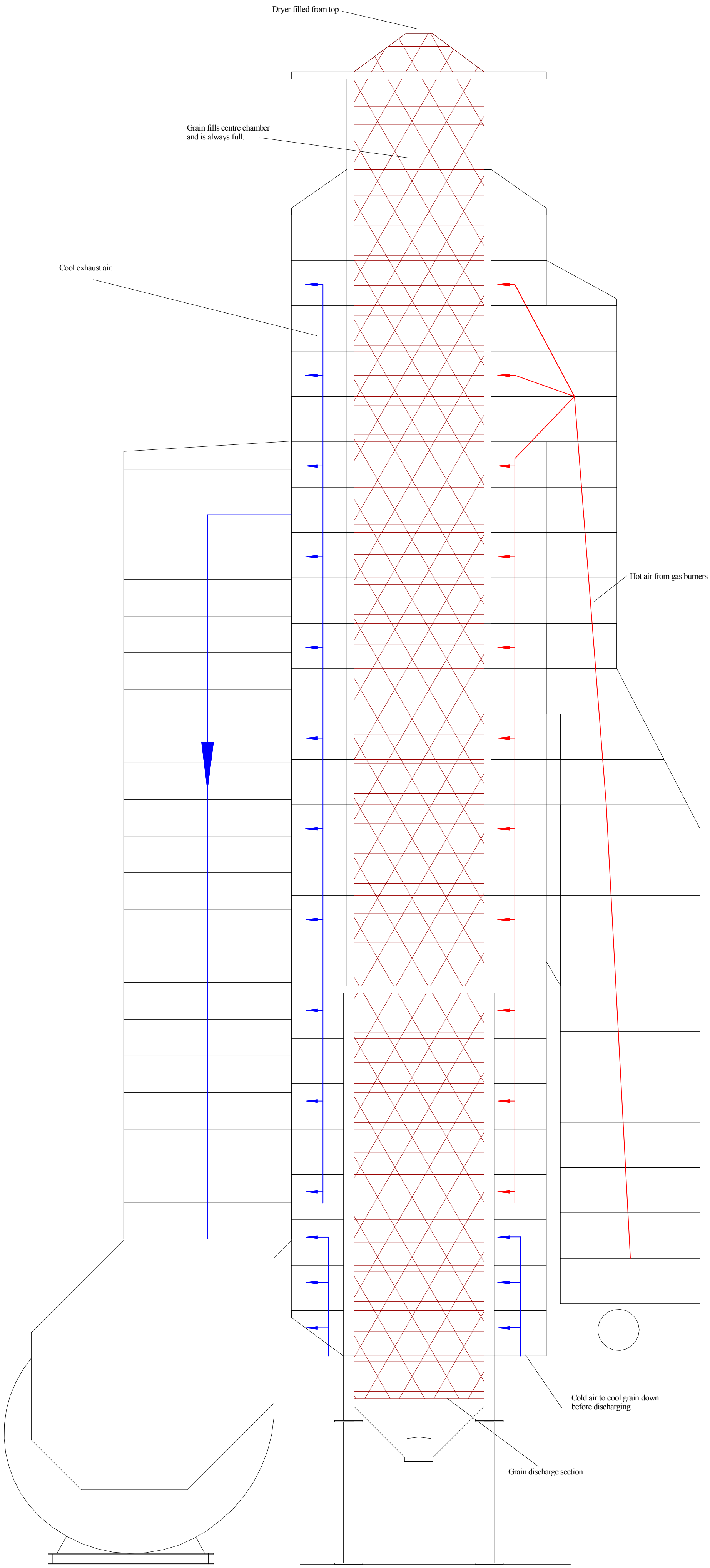
Drawn By: Fergus O'Brien

Date: 20-11-21

Scale: Not to scale

Reference: CR211121E1

Elevation schematic



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Tel: 01-4596756; Fax: 01-4610452

Proposal For: Connelly's Redmills

Project: Grain Dryer elevation view

Drawn By: Fergus O'Brien

Date: 21-11-21

Scale: Not to scale

Reference: CR211121P1

Grain Dryer

APPENDIX E

MODEL OVERVIEW

AERMOD is applicable to rural and urban areas, flat and complex terrain, surface and elevated releases, and multiple sources (including, point, area and volume sources). Every effort has been made to avoid model formulation discontinuities wherein large changes in calculated concentrations result from small changes in input parameters.

AERMOD is a steady-state plume model. In the stable boundary layer (SBL), the concentration distribution is assumed to be Gaussian in both the vertical and horizontal. In the convective boundary layer (CBL), the horizontal distribution is assumed to be Gaussian, but the vertical distribution is described with a bi-Gaussian probability density function (p.d.f.). Additionally, in the CBL, AERMOD treats "plume lofting," whereby a portion of plume mass, released from a buoyant source, rises to and remains near the top of the boundary layer before becoming mixed into the CBL. AERMOD also tracks any plume mass that penetrates into elevated stable layer, and then allows it to re-enter the boundary layer when and if appropriate.

AERMOD incorporates, with a new simple approach, current concepts about flow and dispersion in complex terrain. Where appropriate the plume is modelled as either impacting and/or following the terrain. This approach has been designed to be physically realistic and simple to implement while avoiding the need to distinguish among simple, intermediate and complex terrain, as is required by present regulatory models. As a result, AERMOD removes the need for defining complex terrain regimes; all terrain is handled in a consistent, and continuous manner that is simple while still considering the dividing streamline concept (Snyder, et al., 1985) in stably-stratified conditions.

One of the major improvements that AERMOD brings to applied dispersion modelling is its ability to characterize the PBL through both surface and mixed layer scaling. AERMOD constructs vertical profiles of required meteorological variables based on measurements and extrapolations of those measurements using similarity (scaling) relationships. Vertical profiles of wind speed, wind direction, turbulence, temperature, and temperature gradient are estimated using all available meteorological observations. AERMOD was designed to run with a minimum of observed meteorological parameters. AERMOD can operate using data of a type that is readily available from an NWS station. AERMOD requires only a single surface (generally, 10m) measurement of wind speed (reference wind speed (between 7 z0 and 100m)), direction and ambient temperature (reference temperature). AERMOD also needs observed cloud cover and requires the full morning upper air sounding (RAWINSONDE). In addition to the morning and afternoon mixing heights derived form that sounding, AERMOD needs surface characteristics (surface roughness, Bowen ratio, and albedo) in order to construct its PBL profiles.

AERMOD accounts for the vertical inhomogeneity of the PBL. This is accomplished by "averaging " the parameters of the actual PBL into "effective" parameters of an equivalent homogenous PBL.

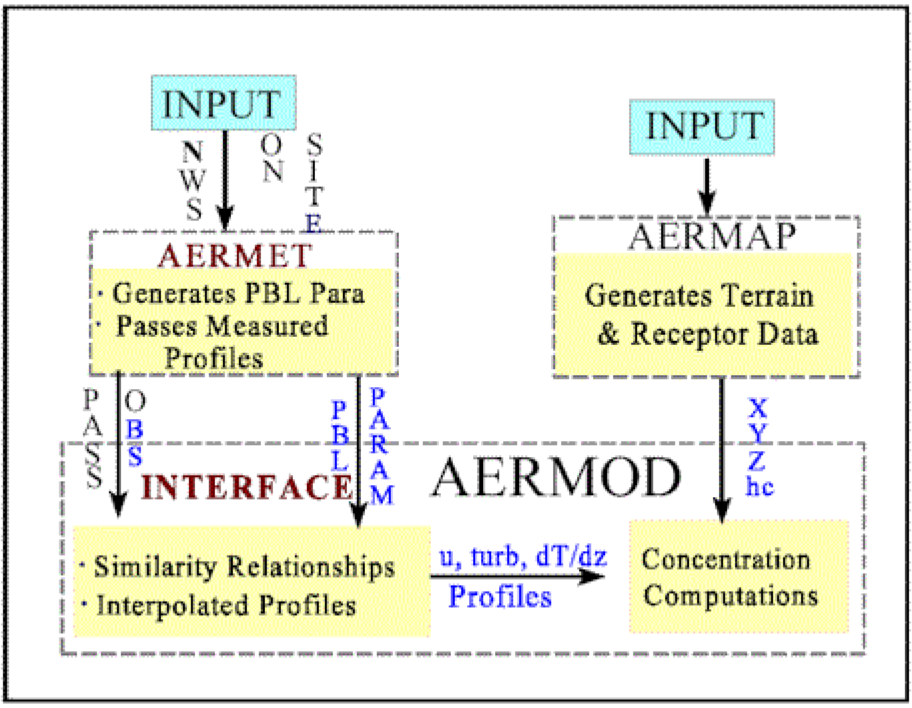

Figure 1: Data Flow in the AERMOD Modelling System

Figure 1 shows the flow and processing of information in AERMOD. The modelling system consists of one main program (AERMOD) and two pre-processors (AERMET and AERMAP). The major purpose of AERMET is to calculate boundary layer parameters for use by AERMOD. The meteorological INTERFACE, internal to AERMOD, uses these parameters to generate profiles of the needed meteorological variables. In addition, AERMET passes all meteorological observations to AERMOD.

Surface characteristics in the form of albedo, surface roughness and Bowen ratio, plus standard meteorological observations (wind speed, wind direction, temperature, and cloud cover), are input to AERMET. AERMET then calculates the PBL parameters: friction velocity (u*), Monin-Obukhov length (L), convective velocity scale (w*), temperature scale (*), mixing height (z i), and surface heat flux (H). These parameters are then passed to the INTERFACE (which is within AERMOD) where similarity expressions (in conjunction with measurements) are used to calculate vertical profiles of wind speed (u), lateral and vertical turbulent fluctuations (v , w), potential temperature gradient (d/dz), potential temperature , and the horizontal Lagrangian time scale (TLy).

The AERMOD terrain pre-processor AERMAP uses gridded terrain data to calculate a representative terrain-influence height (hc), also referred to as the terrain height scale. The terrain c height scale h , which is uniquely defined for each receptor location, is used to calculate the c dividing streamline height. The gridded data needed by AERMAP is selected from Digital Elevation Mapping (DEM) data. AERMAP is also used to create receptor grids. The elevation for each specified receptor is automatically assigned through AERMAP. For each receptor, AERMAP passes the following information to AERMOD: the receptor's location (xr , yr), its height above mean sea level (zr), and the receptor specific terrain height scale (hc).

Further detailed information about AERMOD can be found at https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models