Dust Assessment Addendum

Greetham Quarry

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Executive Summary

Redmore Environmental Ltd was commissioned by Mick George Ltd to undertake a Dust Assessment Addendum in support of the extension of Greetham Quarry, Rutland.

A Dust Assessment was previously submitted in support of the proposals and a number of comments received from the environmental health department at Rutland County Council and local residents. Subsequently, the applicant instructed a further assessment using dispersion modelling in order to consider potential changes in particulate concentrations as a result of emissions from the site in more detail.

It is acknowledged that without appropriate mitigation the proposals have the potential to cause adverse impacts on existing air quality as a result of fugitive dust emissions associated with operations at the quarry. A detailed assessment was therefore undertaken to quantify changes in pollutant levels at sensitive receptor locations and determine the potential for exceedence of the relevant air quality standards. This included the use of multiple annual meteorological data sets to account for inter year variability within observed weather patterns, as well as representation of emissions through the different extraction phases and consideration of potential uncertainty in local baseline pollution level predictions.

The results of the assessment indicated fugitive dust releases from the proposed development are not predicted to result in exceedences of the relevant air quality objectives at any sensitive location within the vicinity of the site. Additionally, impacts were classified as not significant at all receptors, in accordance with the relevant best practice guidance.

Based on the results of the assessment, air quality factors are not considered a constraint to planning consent for the proposals.

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Appendix 1 - Dispersion Modelling Results

1.0 INTRODUCTION

1.1 Background

1.1.1 Redmore Environmental Ltd was commissioned by Mick George Ltd to undertake a Dust Assessment Addendum in support of the extension to Greetham Quarry, Rutland.

1.1.2 A Dust Assessment[1] was undertaken by Redmore Environmental in June 2020 in support of the scheme. This considered potential impacts as a result of fugitive dust emissions associated with operations at the quarry using a qualitative approach in line with the Institute of Air Quality Management (IAQM) guidance[2]. Comments were subsequently received from Rutland County Council (RCC)[3] and local residents.

1.1.3 In order to address concerns raised within the comments as contained within the formal Regulation 25 Request (of the EIA Regulations), the applicant instructed a detailed Dust Assessment Addendum utilising dispersion modelling in order to consider potential changes in particulate matter (PM) concentrations at human receptors in more detail. The results are provided in the following report.

1.2 Aim and Scope of Assessment

1.2.1 The following report develops the analysis provided within the previous Dust Assessment[4] in relation to changes in ambient PM concentrations at human receptors. Comments provided by RCC indicated concerns over the use of a screening assessment within the Dust Assessment as predicted local background concentrations were within 10% of the relevant criteria. As such, a detailed dispersion modelling assessment was undertaken to determine potential increases in pollutant concentrations as a result of fugitive dust emissions from the quarry. The criteria outlined within the Institute of Air Quality Management (IAQM) guidance document 'Land-Use Planning & Development Control: Planning for Air Quality'[5] was then utilised to determine the significance of the change in

1 Dust Assessment, Greetham Quarry, Redmore Environmental Ltd, 2020.

2 Guidance on the Assessment of Mineral Dust Impacts for Planning V1.1, IAQM, 2016.

3 Consultee Comments for Planning Application 2020/0297/MIN, RCC, 2020.

4 Dust Assessment, Greetham Quarry, Redmore Environmental Ltd, 2020.

5 Land-Use Planning & Development Control: Planning for Air Quality, IAQM, 2017.

air quality at receptors. The use of a quantitative assessment method allowed further consideration of uncertainty associated with baseline conditions in the context of potential exceedences of the relevant Air Quality Objectives (AQOs) and accorded with the methodology outlined within The IAQM 'Guidance on the Assessment of Mineral Dust Impacts for Planning V1.1'[6] for when impacts cannot be screened from an assessment.

1.2.2 It should be noted that this assessment does not include further consideration of disamenity impacts associated with dust deposition as this has not been requested. Reference should be made to the original Dust Assessment[7] for the associated assessment of these effects.

6 Guidance on the Assessment of Mineral Dust Impacts for Planning V1.1, IAQM, 2016.

7 Dust Assessment, Greetham Quarry, Redmore Environmental Ltd, 2020.

2.0 LEGISLATION

2.1.1 The Air Quality Standards Regulations (2010) came into force on 11th June 2010 and include Air Quality Limit Values (AQLVs) for 7 pollutants. Those of relevance to this assessment include:

- Particulate matter with an aerodynamic diameter of less than 10μm (PM_{10}); and,
- Particulate matter with an aerodynamic diameter of less than 2.5μm ($PM_{2.5}$).

2.1.2 Part IV of the Environment Act (1995) requires UK government to produce a national Air Quality Strategy (AQS) which contains standards, objectives and measures for improving ambient air quality. The most recent AQS was produced by the Department for Environment, Food and Rural Affairs (DEFRA) and published in July 2007[8]. The AQS sets out Air Quality Objectives (AQOs) that are maximum ambient pollutant concentrations that are not to be exceeded either without exception or with a permitted number of exceedences over a specified timescale. These are generally in line with the AQLVs, although the requirements for the determination of compliance vary.

2.1.3 Table 1 presents the AQOs and AQLV for pollutants considered within this assessment.

Table 1 Air Quality Objectives/Air Quality Limit Value

Pollutant	Air Quality Objective/Limit Value	
	Concentration (μg/m³)	Averaging Period
PM_{10}	40	Annual mean
	50	24-hour mean, not to be exceeded on more than 35 occasions per annum
$PM_{2.5}$	25	Annual mean

2.1.4 Table 2 summarises the advice provided in DEFRA guidance[9] on where the AQOs for pollutants considered within this report apply.

8 The AQS for England, Scotland, Wales and Northern Ireland, DEFRA, 2007.

9 Local Air Quality Management Technical Guidance (TG16), DEFRA, 2018.

Table 2 Examples of Where the Air Quality Objectives Apply

Averaging Period	Objective Should Apply At	Objective Should Not Apply At
Annual mean	All locations where members of the public might be regularly exposed Building façades of residential properties, schools, hospitals, care homes etc.	Building façades of offices or other places of work where members of the public do not have regular access Hotels, unless people live there as their permanent residence Gardens of residential properties Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term
24-hour mean	All locations where the annual mean objective would apply, together with hotels Gardens of residential properties	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term

3.0 BASELINE

3.1 Introduction

3.1.1 Existing air quality conditions in the vicinity of the site were identified in order to provide a baseline for assessment. These are detailed in the following Sections.

3.2 Background Concentrations

3.2.1 Predictions of background PM_{10} and $PM_{2.5}$ concentrations on a 1km by 1km grid basis have been produced by DEFRA for the entire of the UK to assist local authorities in their Review and Assessment of air quality. These are based on the 2018 reference year and consider emissions, monitoring and meteorological data for this year in order to provide the most up to date information.

3.2.2 It is noted that the values are an average over the grid square and actual concentrations may vary due to the presence of specific sources such as roads or industrial premises. This may lead to uncertainty when considering pollutant levels at a local level. The assessment results were therefore considered in the context of a potential underestimation of baseline concentrations at sensitive receptor locations to determine the risk of AQO exceedence. The highest predicted level for the area surrounding the scheme was also used in the analysis as a worst-case.

3.2.3 The proposed site is located in four grid squares. Data for these locations was downloaded from the DEFRA website[10] for the base year of 2020 and the future year of 2030 and is summarised in Table 3. It is noted that the quarry will potentially be operational until 2040. However, DEFRA does not currently provide background data further than 2030.

10 https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018.

Table 3 Background Particulate Matter Concentration Predictions

National Grid Reference (NGR)	2020 Predicted Background Pollutant Concentration (µg/m³)		2030 Predicted Background Pollutant Concentration (µg/m³)	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
492500, 315500	15.56	8.60	14.76	7.96
492500, 314500	14.46	8.43	13.64	7.77
493500, 315500	14.59	8.38	14.48	7.74
493500, 314500	15.30	8.56	13.28	7.89

3.2.4 As shown in Table 3, predicted background PM_{10} and $PM_{2.5}$ concentrations are below the relevant AQO and AQLV at the development site. Additionally, concentrations are predicted to decrease between 2020 and 2030. As such, an assessment year of 2020 was considered throughout this report as this represents the maximum predicted level throughout the life of the project.

3.3 Sensitive Receptors

3.3.1 Human receptors potentially sensitive to changes in baseline air quality conditions were identified within the vicinity of the site. In order to provide a comprehensive assessment, the closest sensitive location in each direction from the development boundary was included in the dispersion modelling. These are situated between 20m and 340m from the proposed site boundary and are summarised in Table 4. These are the same locations identified in the original Dust Assessment[11] to provide continuity between both analyses.

Table 4 Sensitive Receptor Locations

Receptor		NGR (m)		Distance from Boundary (m)
		X	Y	
R1	48 Great Lane	492746.5	314708.0	90
R2	Greetham Community Centre	492759.7	314748.5	45
R3	Sports Pitches, Great Lane	492763.4	314811.3	20
R4	Rutland Caravan and Camping	492490.0	314965.8	300

11 Dust Assessment, Greetham Quarry, Redmore Environmental Ltd, 2020.

Receptor		NGR (m)		Distance from Boundary (m)
		X	Y	
R5	White House, Thistleton Lane	493225.3	315147.9	40
R6	24 Stretton Road	493114.9	314444.6	180
R7	Fir Tree Cottage, Stretton Road	493016.8	314448.4	330
R8	56 - 58 Main Street	492912.7	314418.0	340
R9	Manor Farm Poultry Units	492891.4	314691.2	75
R10	Holly Cottage Farm	492834.6	314566.1	205
R11	Shepherds Cottage	492514.4	314778.1	270

3.3.2 Reference should be made to Figure 1 for a graphical representation of the sensitive receptor locations.

4.0 DISPERSION MODELLING METHODOLOGY

4.1 Introduction

4.1.1 Fugitive dust released as a result of the extraction, transfer and processing of materials on site has the potential to affect local air quality. Changes in atmospheric pollutant concentrations at sensitive locations were therefore quantified in accordance with the following stages:

- Identification of potential dust sources on site;
- Identification of PM emission rates to represent dust releases from the relevant sources;
- Dispersion modelling of source emissions to quantify PM_{10} and $PM_{2.5}$ concentrations at the sensitive receptor locations;
- Comparison of PM_{10} and $PM_{2.5}$ concentrations with the relevant AQOs and AQLV; and,
- Determination of the significance of impact on baseline air quality conditions in accordance with the Institute of Air Quality Management (IAQM) guidance[12].

4.1.2 The methodology is summarised in the following Sections. This was discussed with Andrew Woodhouse, Environmental Protection Officer at RCC, in September 2020[13] through provision of a letter outlining the proposed approach. Comments[14] were subsequently received requesting further details on the use of the chosen modelling software and meteorological considerations. These comments were addressed via email[15] with no further response from RCC at the time of reporting.

4.2 Dispersion Model

4.2.1 Dispersion modelling was undertaken using ADMS-5.2 (v5.2.4.0), which is developed by Cambridge Environmental Research Consultants (CERC) Ltd. ADMS-5 is a short-range dispersion modelling software package that simulates a wide range of buoyant and

12 Land-Use Planning & Development Control: Planning for Air Quality, IAQM, 2017.

13 Letter to Andrew Woodhouse at RCC, 3682-1c1, Redmore Environmental Ltd, 2020.

14 Email correspondence between Andrew Woodhouse and Redmore Environmental, September 2020.

15 Email correspondence between Redmore Environmental and Andrew Woodhouse, September 2020.

passive releases to atmosphere. It is a new generation model utilising boundary layer height and Monin-Obukhov length to describe the atmospheric boundary layer and a skewed Gaussian concentration distribution to calculate dispersion under convective conditions.

4.2.2 The model utilises hourly meteorological data to define conditions for plume rise, transport and diffusion. It estimates the concentration for each source and receptor combination for each hour of input meteorology and calculates user-selected long-term and short-term averages.

4.2.3 Although it is not common practice to model emissions from mineral extraction, several assessments were identified that use ADMS-5 to determine potential impacts associated with PM_{10} and $PM_{2.5}$ emissions. These include a Detailed Assessment of Mountsorrel Quarry by WYG Environment Planning Transport Ltd[16] as part of Charnwood Borough Council's Local Air Quality Management (LAQM) responsibilities, an Air Quality Impact Assessment for the proposed extension to Bryn Quarry undertaken by Airshed[17] and modelling of emissions at Womersley Quarry also carried out by Airshed[18]. The use of dispersion modelling is therefore considered a suitable assessment method for a project of this nature in lieu of other quantitative methods.

4.3 Scenarios

4.3.1 Potential impacts have been defined by predicting annual mean PM_{10} and $PM_{2.5}$ and 24-hour mean PM_{10} concentrations at sensitive locations for the following scenarios:

- Operational year Do-Minimum (DM) (predicted concentrations should the quarry not be operational); and,
- Operational year Do-Something (DS) (predicted concentrations should the quarry be operational).

16 Detailed Assessment of Respirable Particulate PM_{10}, Mountsorrel, WYG, 2011.

17 Air Quality Impact Assessment for Proposed Extension to Quarry at Bryn Quarry, Gelliargwellt Uchaf Farm, The Airshed, 2011.

18 Amendment & Extension of Womersley Quarry Spoil Disposal Scheme, Environmental Statement, The Airshed, 2012.

4.3.2 As discussed previously, an assessment year of 2020 was utilised as predicted concentrations in future years would be lower.

4.4 Sources

4.4.1 There will be five phases of extraction during the operation of the project. Emissions during each were modelled using area sources within ADMS-5. These were positioned over the closest extraction and processing areas to the identified sensitive receptors, taking into account any operational buffer zones, to ensure maximum pollutant concentrations were predicted. The five modelling scenarios can be summarised as follows:

- Phase 1 Extraction and Processing Areas;
- Phase 2 Extraction and Processing Areas;
- Phase 3 Extraction and Processing Areas;
- Phase 4 Extraction and Processing Areas; and,
- Phase 5 Extraction and Processing Areas.

4.4.2 It should be noted that extraction and processing will not be undertaken within 150m and 350m of any residential property within Greetham Village, respectively. These stand off distances were therefore represented within the model as necessary.

4.4.3 Reference should be made to Figure 1 for a graphical representation of the source locations.

4.5 Emissions

4.5.1 Emission rates were obtained from the Coordinated European Particulate Matter Emission Inventory Program (CEPMEIP)[19]. This provides activity rate based emission data for a wide range of sources, including mineral extraction sites, and is used by the European Environment Agency (EEA) in the preparation of national emission inventories.

4.5.2 The emission rates are provided for 'low to medium' and 'medium high to high' emission level sources. These are defined as follows:

19 CEPMEIP, Visschedijk et al, 2004. In: Proceedings of the PM Emission Inventories Scientific Workshop, EUR 21302 EN, JRC, pp.163–174, 2004,

- Low - Modern facility, well maintained, Best Available Technology (BAT);
- Medium - Average age, well maintained;
- Medium high - Older equipment, well maintained; and,
- High - Old facility, poor maintenance.

4.5.3 As the proposed development will be a new modern facility employing BAT, the 'low to medium' emission rates were considered most appropriate for use in the assessment. These are summarised in Table 5.

Table 5 On-site Activity Emission Rates

Pollutant	Emission Rate for Mineral Output (g/tonne)
PM_{10}	25.0
$PM_{2.5}$	3.8

4.5.4 The proposed production rate for each phase is 150,000 tonnes per annum (tpa). This was used to calculate annual emissions. These are summarised in Table 6.

Table 6 Annual Emission Rates

Pollutant	Emission Rate (g/yr)
PM_{10}	3,750,000
$PM_{2.5}$	570,000

4.5.5 The annual emission rate was divided by the operational extents of the relevant phase to provide an area based emission rate as required by ADMS-5. The relevant information is summarised in Table 7.

Table 7 Modelled Emission Rates

Pollutant	Operational Area (m^2)	Emission Rate ($g/m^2/s$)	
		PM_{10}	$PM_{2.5}$
Phase 1	5,444	0.00002184	0.00000332
Phase 2	6,083	0.00001955	0.00000297
Phase 3.1	5,336	0.00001112	0.00000169

Pollutant	Operational Area (m^2)	Emission Rate ($g/m^2/s$)	
		PM_{10}	$PM_{2.5}$
Phase 3.2	5,353	0.00001112	0.00000169
Phase 4.1	7,462	0.00000928	0.00000141
Phase 4.2	5,353	0.00000928	0.00000141
Phase 5	5,445	0.00002184	0.00000332

4.5.6 Phases 3 and 4 were apportioned into two operational areas to account for extraction and processing activities, the latter of which will not take place within 350m of Greetham village, as outlined previously, and confirmed in the DMP[20] for the scheme.

4.6 Meteorological Data

4.6.1 Meteorological data used in the assessment was taken from RAF Wittering meteorological station over the period 1st January 2015 to 31st December 2019 (inclusive). RAF Wittering meteorological station is located at NGR: 503490, 302412, which is approximately 16.6km south-east of the development. The use of this data was discussed and agreed with Andrew Woodhouse, Environmental Protection Officer at RCC, in June 2020[21]. Reference should be made to the original Dust Assessment[22] for further discussion of meteorological data source.

4.6.2 The use of 5-years of hourly sequential meteorological data resulted in the prediction of 43,800 individual pollutant concentrations at each modelled receptor. This ensured consideration of emission dispersion through a wide range of conditions and that worst-case wind speed and directions were included in the results.

4.6.3 All meteorological files used in the assessment were provided by Atmospheric Dispersion Modelling Ltd, which is an established distributor of data within the UK. Reference should be made to Figure 2 for wind roses of the utilised meteorological records.

20 Dust Management Plan, Greetham Quarry, Redmore Environmental Ltd, 2020

21 Email correspondence with Andrew Woodhouse at RCC, 2020.

22 Dust Assessment, Greetham Quarry, Redmore Environmental Ltd, 2020.

4.7 Roughness Length

4.7.1 The roughness length (z_0) is a modelling parameter applied to allow consideration of surface height roughness elements. A z_0 of 0.5m was used to describe the dispersion extents, suggested within ADMS-Roads as being suitable for 'parkland, open suburbia'. This is considered appropriate for the morphology of the area due to the presence of the existing quarry and Greetham village, as well as large areas of flat agricultural land and woodland, that contribute to varying topography and associated surface inducing turbulence throughout the modelling extents.

4.7.2 A z_0 of 0.3m was used to describe the meteorological site. This value of z_0 is considered appropriate for the morphology of the area and is suggested within ADMS-Roads as being suitable for 'agricultural areas (max)'.

4.8 Monin-Obukhov Length

4.8.1 The Monin-Obukhov length provides a measure of the stability of the atmosphere. A minimum Monin-Obukhov length of 10m was used to describe the dispersion extents and meteorological site. This value is considered appropriate for the nature of both areas and is suggested within ADMS-5 as being suitable for 'small towns $< 50,000$'.

4.9 Terrain Data

4.9.1 Ordnance Survey OS Terrain 50 data was included in the model for the site and surrounding area in order to take account of the specific flow field produced by variations in ground height throughout the assessment extents. This was pre-processed using the method suggested by CERC.

4.10 Prediction of 24-hour PM10 Concentrations

4.10.1 Predicted annual mean PM_{10} concentrations were converted to the number of days with PM_{10} concentrations above 50μg/m^3 using the equation outlined in DEFRA guidance[23].

23 Local Air Quality Management Technical Guidance (TG16), DEFRA, 2018.

4.11 Background Concentrations

4.11.1 Background concentrations of PM_{10} and $PM_{2.5}$ were obtained from the DEFRA mapping study for 2020, as shown in Table 3, and use to represent existing baseline levels throughout the assessment. As discussed previously, there is the potential for the background maps to underestimate concentrations in close proximity to local sources. As such, the model predictions were considered in the context of the potential underestimation and the risk of AQO exceedence.

4.11.2 It is noted that the quarry will be operational until 2040. Comments provided by RCC requested consideration of pollutant concentrations over the lifetime of the scheme. However, as discussed previously, predicted background levels are not available from DEFRA after 2030. As such, concentrations for 2020 were included within the assessment as they are higher than those indicated for 2030 and therefore provide worst-case predictions.

4.12 Assessment of Impact Significance

4.12.1 The significance of predicted impacts on PM_{10} and $PM_{2.5}$ concentrations as a result of emissions from site activities was determined in accordance with the guidance provided within the IAQM document 'Land-Use Planning & Development Control: Planning for Air Quality'[24]. Using this methodology impacts were defined based on the interaction between the predicted pollutant concentration from the DS scenario and the magnitude of change between the DM and DS scenarios, as outlined in Table 8.

Table 8 Significance of Impact

Concentration at Receptor in Assessment Year	Predicted Concentration Change as Proportion of AQO/AQLV (%)			
	1	2 - 5	6 - 10	> 10
75% or less of AQO/AQLV	Negligible	Negligible	Slight	Moderate
76 - 94% of AQO/AQLV	Negligible	Slight	Moderate	Moderate
95 - 102% of AQO/AQLV	Slight	Moderate	Moderate	Substantial
103 - 109% of AQO/AQLV	Moderate	Moderate	Substantial	Substantial

24 Land-Use Planning & Development Control: Planning for Air Quality, IAQM, 2017.

Concentration at Receptor in Assessment Year	Predicted Concentration Change as Proportion of AQO/AQLV (%)			
	1	2 - 5	6 - 10	> 10
110% or more of AQO/AQLV	Moderate	Substantial	Substantial	Substantial

4.12.2 The matrix shown in Table 8 is intended to be used by rounding the change in percentage pollutant concentration to whole numbers, which makes it clearer which cell the impact falls within. It should be noted that changes of 0%, i.e. less than 0.5%, are described as **negligible**.

4.12.3 Following the prediction of impacts at discrete receptor locations, the IAQM document[25] provides guidance on determining the overall air quality impact significance of the operation of a development and states that an assessment must reach a conclusion on the likely significance of the predicted impact. It should be noted that this is a binary judgement of either it is **significant** or it is **not significant**. The document indicates that it is likely that a **moderate** or **substantial** impact will give rise to a **significant** effect and a **negligible** or **slight** impact will have a **not significant** effect, but such judgements are always more likely to be valid at the two extremes of impact severity.

4.12.4 The determination of significance relies on professional judgement and reasoning should be provided as far as practicable. This has been considered throughout the assessment when defining predicted impacts. The IAQM guidance[26] suggests the provision of details of the assessor's qualifications and experience. These are provided in Appendix 2.

4.12.5 It should be noted the above methodology is only suitable for predicting impacts at locations sensitive to changes in long term pollution levels. As such, the significance of changes in 24-hour mean PM_{10} concentrations has been considered based on the magnitude of results and likelihood of AQO exceedence.

25 Land-Use Planning & Development Control: Planning for Air Quality, IAQM, 2017.

26 Land-Use Planning & Development Control: Planning for Air Quality, IAQM, 2017.

4.13 Modelling Uncertainty

4.13.1 Uncertainty in dispersion modelling predictions can be associated with a variety of factors, including:

- Model uncertainty - due to model limitations;
- Data uncertainty - due to errors in input data, including emission estimates, operational procedures, land use characteristics and meteorology; and,
- Variability - randomness of measurements used.

4.13.2 Potential uncertainties in the model results were minimised as far as practicable and worst-case inputs used in order to provide a robust assessment. This included the following:

- Choice of model - ADMS-5 is a commonly used atmospheric dispersion model and results have been verified through a number of studies to ensure predictions are as accurate as possible. As outlined previously, the software has been used for a number of similar projects, with results accepted by DEFRA in support of LAQM requirements;
- Meteorological data - Modelling was undertaken using five annual meteorological data sets from an observation station local to the site to account for inter-year variability. The assessment was based on the worst-case year to ensure maximum concentrations were considered;
- Pollutant dispersion - Rainfall inhibits the raising of dust at the source. Reduced dispersion due to precipitation was not considered in the dispersion modelling. This is likely to have overestimated pollutant concentration predictions;
- Surface characteristics - The z_0 and Monin-Obukhov length were determined for both the dispersion and meteorological sites based on the surrounding land uses and guidance provided by CERC;
- Terrain data - Ordnance Survey OS Terrain 50 data was included in the model for the site and surrounding area in order to take account of the specific flow field produced by variations in ground height throughout the assessment extents. This was pre-processed using the method suggested by CERC;
- Emission rates - Emission rates were identified from the CEPMEIP, which provides activity rate based emission data for a wide range of sources, including mineral extraction sites, and is used by the EEA in the preparation of national emission

inventories. As such, the data was considered a representative source for use in the assessment. A sensitivity analysis was also undertaken using higher emission factors to consider potential impacts associated with adverse conditions;

- Background concentrations - Background pollutant levels for 2020 were obtained from DEFRA. The model predictions were considered in the context of potential underestimation of actual concentrations at sensitive receptors;
- Receptor locations - Discrete receptor points were included at sensitive locations in every direction from the site boundary to ensure maximum impacts were considered; and,
- Variability - All model inputs were as accurate as possible and worst-case conditions were considered as necessary in order to ensure a robust assessment of potential pollutant concentrations.

4.13.3 Results were considered in the context of the relevant AQOs and IAQM significance criteria. It is considered that the use of the stated measures to reduce uncertainty and the use of robust assumptions when necessary has resulted in model accuracy of an acceptable level.

5.0 DISPERSION MODELLING RESULTS

5.1 Introduction

5.1.1 Dispersion modelling was undertaken with the inputs described in Section 4.0. The results are outlined in the following Sections.

5.1.2 The dispersion modelling resulted in 25 separate pollutant concentration predictions at each receptor location. As such, the assessment was based on the meteorological data set that resulted in the highest output during each phase in order to ensure consideration of the worst case impacts. The maximum results are therefore summarised in the following Sections. Reference should be made to Appendix 1 for full results.

Predicted Concentrations

5.1.3 Annual mean PM_{10} concentrations were predicted at the sensitive receptor locations during each extraction phase. The maximum change in annual mean PM_{10} concentration at each receptor and the associated phase and meteorological data set for which this was predicted is summarised in Table 9.

Table 9 Predicted Annual Mean PM_{10} Concentrations

Receptor		Predicted Annual Mean PM_{10} Concentration (µg/m³)			Met. Data Set and Extraction Phase
		DM	DS	Change	
R1	48 Great Lane	15.56	16.89	1.33	2016 – Phase 4
R2	Greetham Community Centre	15.56	17.42	1.86	2016 – Phase 4
R3	Sports Pitches, Great Lane	15.56	18.37	2.81	2016 – Phase 4
R4	Rutland Caravan and Camping	15.56	15.84	0.28	2019 – Phase 4
R5	White House, Thistleton Lane	15.56	18.59	3.03	2017 – Phase 2
R6	24 Stretton Road	15.56	15.83	0.27	2016 – Phase 1
R7	Fir Tree Cottage, Stretton Road	15.56	15.91	0.35	2016 – Phase 4
R8	56 - 58 Main Street	15.56	15.88	0.32	2016 – Phase 4
R9	Manor Farm Poultry Units	15.56	16.76	1.20	2016 – Phase 4

Receptor		Predicted Annual Mean PM_{10} Concentration (μg/m³)			Met. Data Set and Extraction Phase
		DM	DS	Change	
R10	Holly Cottage Farm	15.56	16.16	0.60	2018 – Phase 4
R11	Shepherds Cottage	15.56	15.87	0.31	2016 – Phase 3

5.1.4 As indicated in Table 9, predicted annual mean PM_{10} concentrations were well below the relevant AQO of 40μg/m³ at all sensitive receptors during all extraction phases using all meteorological data sets.

5.1.5 Predicted annual mean $PM_{2.5}$ concentrations at the sensitive receptors are summarised in Table 10.

Table 10 Predicted Annual Mean $PM_{2.5}$ Concentrations

Receptor		Predicted Annual Mean $PM_{2.5}$ Concentration (μg/m³)			Met. Data Set and Extraction Phase
		DM	DS	Change	
R1	48 Great Lane	8.60	8.80	0.20	2016 - Phase 4
R2	Greetham Community Centre	8.60	8.88	0.28	2016 - Phase 4
R3	Sports Pitches, Great Lane	8.60	9.03	0.43	2016 - Phase 4
R4	Rutland Caravan and Camping	8.60	8.64	0.04	2016 - Phase 4
R5	White House, Thistleton Lane	8.60	9.06	0.46	2017 - Phase 2
R6	24 Stretton Road	8.60	8.64	0.04	2016 - Phase 1
R7	Fir Tree Cottage, Stretton Road	8.60	8.65	0.05	2016 - Phase 4
R8	56 - 58 Main Street	8.60	8.65	0.05	2016 - Phase 4
R9	Manor Farm Poultry Units	8.60	8.78	0.18	2016 - Phase 4
R10	Holly Cottage Farm	8.60	8.69	0.09	2018 - Phase 4
R11	Shepherds Cottage	8.60	8.65	0.05	2016 - Phase 3

5.1.6 As indicated in Table 10, predicted annual mean $PM_{2.5}$ concentrations were well below the relevant AQLV of 25μg/m³ at all sensitive receptors during all extraction phases using all meteorological data sets.

5.1.7 The number of days with PM_{10} concentrations above 50µg/m^3 at the sensitive receptors are summarised in Table 11.

Table 11 Number of Days with PM_{10} Concentrations above 50µg/m^3

Receptor		Number of Days with PM_{10} concentration above 50µg/m^3	Met. Data Set and Extraction Phase
R1	48 Great Lane	1	2016 - Phase 4
R2	Greetham Community Centre	1	2016 - Phase 4
R3	Sports Pitches, Great Lane	2	2016 - Phase 4
R4	Rutland Caravan and Camping	0	2016 - Phase 4
R5	White House, Thistleton Lane	3	2017 - Phase 2
R6	24 Stretton Road	0	2016 - Phase 1
R7	Fir Tree Cottage, Stretton Road	0	2016 - Phase 4
R8	56 - 58 Main Street	0	2016 - Phase 4
R9	Manor Farm Poultry Units	1	2016 - Phase 4
R10	Holly Cottage Farm	0	2018 - Phase 4
R11	Shepherds Cottage	0	2016 - Phase 3

5.1.8 As indicated in Table 11, the maximum number of days with PM_{10} concentrations above 50µg/m^3 was well below the permitted number of 35 at all sensitive receptor locations during all extraction phases using all meteorological data sets.

Predicted Impacts

5.1.9 Impacts on annual mean PM_{10} concentrations at the sensitive locations are summarised in Table 12. These are the maximum predicted at each receptor during all extraction phases for all meteorological data sets. As such, impacts will be lower for the majority of the quarry lifetime.

Table 12 Predicted Annual Mean PM_{10} Impacts

Receptor		Predicted Concentration	Predicted Concentration Change as Proportion of AQO (%)	Impact Significance
R1	48 Great Lane	Below 75% of AQO	2 - 5	Negligible
R2	Greetham Community Centre	Below 75% of AQO	2 - 5	Negligible
R3	Sports Pitches, Great Lane	Below 75% of AQO	6 - 10	Slight
R4	Rutland Caravan and Camping	Below 75% of AQO	1	Negligible
R5	White House, Thistleton Lane	Below 75% of AQO	6 - 10	Slight
R6	24 Stretton Road	Below 75% of AQO	1	Negligible
R7	Fir Tree Cottage, Stretton Road	Below 75% of AQO	1	Negligible
R8	56 - 58 Main Street	Below 75% of AQO	1	Negligible
R9	Manor Farm Poultry Units	Below 75% of AQO	2 - 5	Negligible
R10	Holly Cottage Farm	Below 75% of AQO	2 - 5	Negligible
R11	Shepherds Cottage	Below 75% of AQO	1	Negligible

5.1.10 As indicated in Table 12, impacts on annual mean PM_{10} concentrations as a result of the proposed scheme were predicted to be **slight** at two locations and **negligible** at the remaining nine receptors. It should be noted that the **slight** predictions relate to emissions during Phase 4 and Phase 2 at receptors R3 and R5, respectively, and impacts would be lower during all other phases.

5.1.11 Impacts on annual mean $PM_{2.5}$ concentrations at the sensitive locations are summarised in Table 13. These are the maximum predicted at each receptor during all extraction phases for all meteorological data sets. As such, impacts will be lower for the majority of the quarry lifetime.

Table 13 Predicted Annual Mean $PM_{2.5}$ Impacts

Receptor		Predicted Concentration	Predicted Concentration Change as Proportion of AQLV (%)	Impact Significance
R1	48 Great Lane	Below 75% of AQLV	1	Negligible
R2	Greetham Community Centre	Below 75% of AQLV	1	Negligible
R3	Sports Pitches, Great Lane	Below 75% of AQLV	2 - 5	Negligible
R4	Rutland Caravan and Camping	Below 75% of AQLV	0	Negligible
R5	White House, Thistleton Lane	Below 75% of AQLV	2 - 5	Negligible
R6	24 Stretton Road	Below 75% of AQLV	0	Negligible
R7	Fir Tree Cottage, Stretton Road	Below 75% of AQLV	0	Negligible
R8	56 - 58 Main Street	Below 75% of AQLV	0	Negligible
R9	Manor Farm Poultry Units	Below 75% of AQLV	1	Negligible
R10	Holly Cottage Farm	Below 75% of AQLV	0	Negligible
R11	Shepherds Cottage	Below 75% of AQLV	0	Negligible

5.1.12 As indicated in Table 13, impacts on annual mean $PM_{2.5}$ concentrations as a result of the proposed development were predicted to be **negligible** at all receptors during all extraction phases using all meteorological data sets.

5.1.13 As stated previously, the IAQM methodology provided in Section 4.12 is for the determination of the significance of annual mean impacts only. However, as there are no predicted 24-hour mean PM_{10} AQO exceedences at any receptor for any meteorological data set and the number of days with concentrations above 50µg/m^3 is well below the permitted number of 35 at all locations, impacts are considered to be **not significant**.

5.2 Sensitivity Analysis

Elevated Short Term Emissions

5.2.1 The use of the emission factors outlined in Table 5 provides an assessment based on average fugitive dust emissions across a year. As such, they present a suitable basis for the prediction of annual mean pollutant concentrations. However, site operations will vary, with certain activities having a greater dust generating potential than others. In order to consider potential impacts associated with these adverse conditions, a sensitivity analysis was undertaken to assess impacts on short-term concentrations at sensitive receptors.

5.2.2 The analysis considered impacts on 24-hour mean PM_{10} concentrations as this is the only short-term AQO for PM_{10} or $PM_{2.5}$.

5.2.3 The sensitivity analysis involved increasing the PM_{10} emission factor shown in Table 5 by a factor of 2. This revised value is indicated in the EEA guidebook[27] as the upper 95% confidence interval for PM_{10} emissions from mineral extraction and is therefore considered to represent elevated emissions for an assessment of this nature.

5.2.4 The number of days with PM_{10} concentrations above 50µg/m³ at the sensitive receptors using the higher emission rate are summarised in Table 14.

Table 14 Number of Days with PM_{10} Concentrations above 50µg/m³ - Sensitivity Analysis

Receptor		Number of Days with PM_{10} concentration above 50µg/m³	Met. Data Set and Extraction Phase
R1	48 Great Lane	2	2016 - Phase 4
R2	Greetham Community Centre	3	2016 - Phase 4
R3	Sports Pitches, Great Lane	5	2016 - Phase 4
R4	Rutland Caravan and Camping	0	2016 - Phase 4
R5	White House, Thistleton Lane	6	2017 - Phase 2
R6	24 Stretton Road	0	2016 - Phase 1
R7	Fir Tree Cottage, Stretton Road	0	2016 - Phase 4
R8	56 - 58 Main Street	0	2016 - Phase 4
R9	Manor Farm Poultry Units	1	2016 - Phase 4
R10	Holly Cottage Farm	1	2018 - Phase 4

27 EEA Air Pollutant Emission Inventory Guidebook 2016, EEA, 2017.

Receptor		Number of Days with PM_{10} concentration above 50µg/m^3	Met. Data Set and Extraction Phase
R11	Shepherds Cottage	0	2016 - Phase 3

5.2.5 As indicated in Table 14, the maximum number of days with PM_{10} concentrations above 50µg/m^3 was well below the permitted number of 35 at all sensitive receptor locations using the higher emission rate to represent periods of elevated releases.

5.2.6 As stated previously, the IAQM methodology provided in Section 4.12 is for the determination of the significance of annual mean impacts only. However, as there are no predicted 24-hour mean PM_{10} AQO exceedences at any receptor location for any meteorological data set, impacts are considered to be **not significant**.

Baseline Concentrations

5.2.7 As outlined previously, there is associated uncertainty with the DEFRA background concentrations utilised in the assessment to represent existing baseline conditions. However, review of the modelling results indicates a substantial level of headroom before exceedences of the relevant AQO would occur. This can be summarised as follows:

- The maximum predicted annual mean PM_{10} concentration at any receptor was 18.59µg/m^3;
- The predictions consisted of a baseline value of 15.56µg/m^3 and a quarry contribution of 3.03µg/m^3;
- The quarry contribution represents 7.6% of the AQO of 40µg/m^3;
- The baseline could therefore contribute 93.4% of the AQO, or 37.36µg/m^3, before an exceedence would occur; and,
- A baseline of this magnitude would necessitate an increase of 240% over the DEFRA background, which is considered extremely unlikely.

5.2.8 Additionally, if existing annual mean PM_{10} concentrations of 37.36µg/m^3 were occurring within Greetham then it would be a requirement for RCC to investigate the potential for

AQO exceedences as part of their LAQM requirements. However, as stated in the 2018 Annual Status Report produced by RCC[28]:

> "Previous rounds of the Air Quality Review and Assessment process have indicated that particulates (PM_{10}) aren't a significant problem in the county."

5.2.9 This would therefore indicate that baseline PM_{10} concentrations are well below the AQO in Greetham and the DEFRA background maps do not underestimate levels by a sufficient amount that exceedences would occur as a result of the proposals.

5.3 NPPG Compliance

5.3.1 The Ministry of Housing, Communities & Local Government have produced Planning Practice Guidance[29] which outlines how to assess environmental impacts associated with mineral extraction sites. This includes advice on how operators should seek to minimise dust emissions, outlining five key stages to a dust assessment study alongside the following Site Assessment flow chart in relation to PM_{10}.

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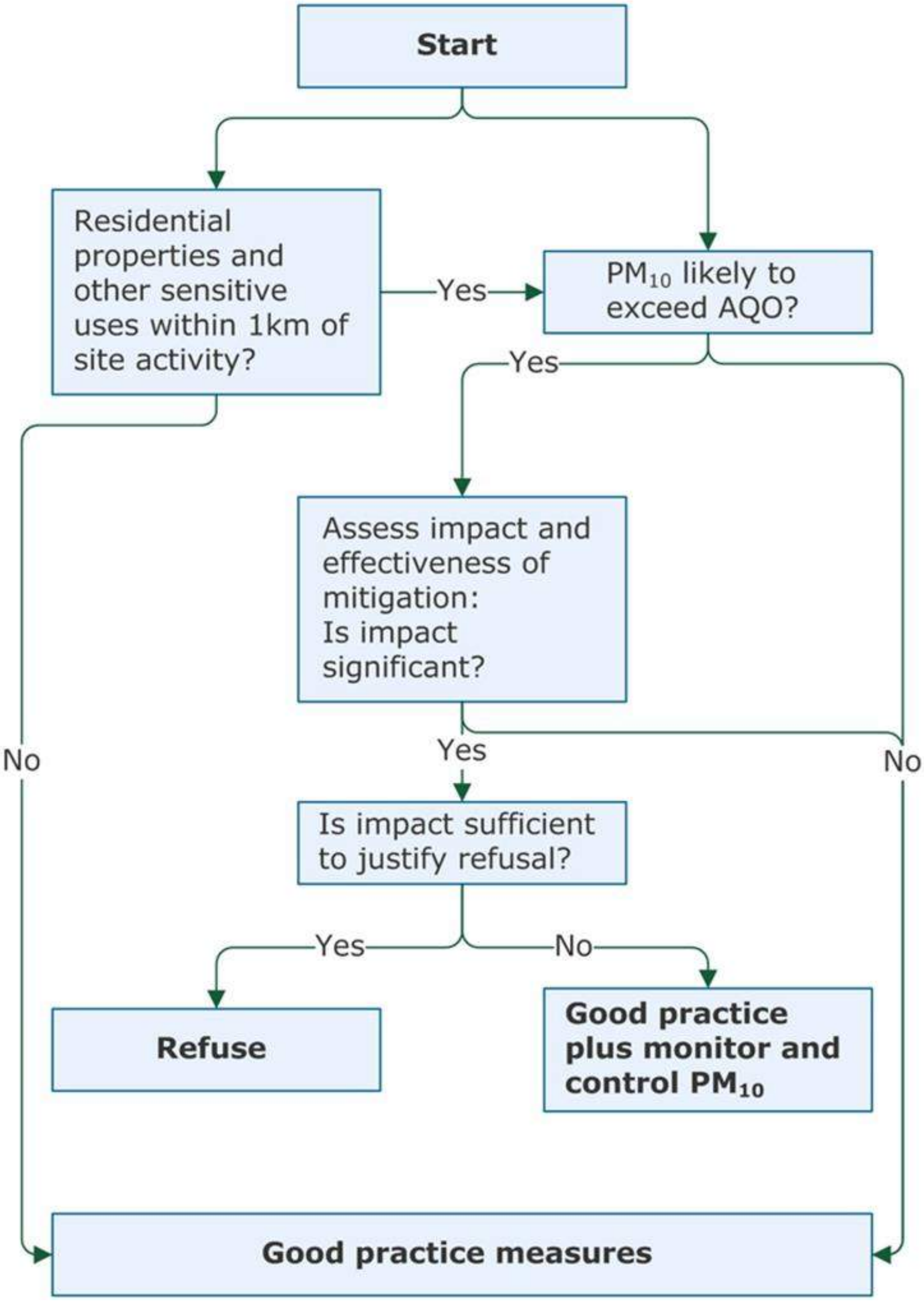
28 2018 Air Quality Annual Status Report (ASR), RCC, 2018.

29 https://www.gov.uk/guidance/minerals#Assessing-environmental-impacts-from-minerals-extraction.

Diagram 1 Site Assessment Flow Chart



5.3.2 The Site Assessment Flow Chart was utilised to determine an appropriate approach for mitigation techniques alongside the DMP. This is outlined below:

- Question 1 - Residential properties and other sensitive uses within 1km of site activity? Yes, as outlined in Table 4;
- Question 2 - PM_{10} likely to exceed AQO? As outlined in Section 5.3, annual mean and 24-hour mean PM_{10} concentrations are not predicted to exceed the relevant AQOs during any phase of the quarry at any receptor. As such, exceedences are not considered likely; and,
- Outcome - Implementation of Good Practice Measures.

5.3.3 Based on the outcome of the Site Assessment Flow Chart, the mitigation techniques outlined within the DMP, which take into account Good Practice Measures, are considered to provide sufficient control of fugitive dust emissions. As such, refusal would not be justified in accordance with the Ministry of Housing, Communities & Local Government Planning Practice Guidance[30].

5.4 Summary

5.4.1 The assessment results are summarised as follows:

- Maximum annual mean PM_{10} and $PM_{2.5}$ concentrations were predicted to be well below the relevant AQOs and AQLV of 40µg/m^3 and 25µg/m^3, respectively, at all sensitive receptor locations;
- The number of days with PM_{10} concentrations above 50µg/m^3 was not predicted to exceed the permitted number of 35 at any sensitive receptor location;
- Predicted impacts on annual mean PM_{10} concentrations were classified as **slight** at two receptors and **negligible** at nine locations;
- Predicted impacts on annual mean $PM_{2.5}$ concentrations were classified as **negligible** at all receptors locations;
- Predicted impacts on 24-hour mean PM_{10} concentrations were classified as **not significant** at all receptors locations;
- The number of days with PM_{10} concentrations above 50µg/m^3 during elevated emission events was not predicted to exceed 35 at any sensitive receptor locations;

30 https://www.gov.uk/guidance/minerals#Assessing-environmental-impacts-from-minerals-extraction.

- Consideration of the potential for underprediction of baseline concentrations to affect the results indicated significant headroom before AQO exceedences would occur. This is considered extremely unlikely. As such, the selection of baseline data has not affected the report conclusions; and,
- Refusal of the application in relation to PM_{10} would not be justified in accordance with the Ministry of Housing, Communities & Local Government Planning Practice Guidance[31].

5.4.2 The IAQM guidance[32] states that only if the impact is **moderate** or **substantial**, the effect is considered **significant**. As such, the overall effect of fugitive dust emissions from the proposals on PM_{10} and $PM_{2.5}$ concentrations is considered to be **not significant**.

5.4.3 It should be noted that emissions from on-site activities will be regulated under a DMP[33] that has been produced to control fugitive dust releases during operation. Measures outlined within the DMP have been developed based on the results of the Dust Assessment[34] as well as this Addendum. As such, there is considered to be a suitable method for controlling fugitive emissions throughout the lifetime of the scheme.

31 https://www.gov.uk/guidance/minerals#Assessing-environmental-impacts-from-minerals-extraction.

32 Guidance on the Assessment of Mineral Dust Impacts for Planning V1.1, IAQM, 2016.

33 Dust Management Plan, Greetham Quarry, Redmore Environmental Ltd, 2020.

34 Dust Assessment, Greetham Quarry, Redmore Environmental Ltd, 2020.

6.0 CONCLUSION

6.1.1 Redmore Environmental Ltd was commissioned by Mick George Ltd to produce a Dust Assessment Addendum in support of the extension to Greetham Quarry, Rutland.

6.1.2 A Dust Assessment[35] was undertaken by Redmore Environmental in June 2020 in support of the scheme. This considered potential impacts as a result of fugitive dust emissions associated with operations at the quarry using a qualitative approach in line with the IAQM guidance[36]. Comments were subsequently made by RCC and local residents.

6.1.3 Comments provided by RCC indicated concerns over the use of a screening assessment within the Dust Assessment as predicted local background concentrations were within 10% of the relevant screening criteria. As such, a detailed dispersion modelling assessment was undertaken to determine potential increases in PM_{10} and $PM_{2.5}$ concentrations as a result of fugitive dust emissions from the quarry. The criteria outlined within IAQM guidance[37] was then utilised to determine the significance of predicted impacts.

6.1.4 The results of the assessment indicated the following:

- Maximum annual mean PM_{10} and $PM_{2.5}$ concentrations were predicted to be well below the relevant AQOs and AQLV of 40µg/m^3 and 25µg/m^3, respectively, at all sensitive receptor locations;
- The number of days with PM_{10} concentrations above 50µg/m^3 was not predicted to exceed the permitted number of 35 at any sensitive receptor location;
- Predicted impacts on annual mean PM_{10} concentrations were classified as **slight** at two receptors and **negligible** at nine locations;
- Predicted impacts on annual mean $PM_{2.5}$ concentrations were classified as **negligible** at all receptors locations;
- Predicted impacts on 24-hour mean PM_{10} concentrations were classified as **not significant** at all receptors locations;
- The number of days with PM_{10} concentrations above 50µg/m^3 during elevated emission events was not predicted to exceed 35 at any sensitive receptor locations;

35 Dust Assessment, Greetham Quarry, Redmore Environmental Ltd, 2020.

36 Guidance on the Assessment of Mineral Dust Impacts for Planning V1.1, IAQM, 2016.

37 Land-Use Planning & Development Control: Planning for Air Quality, IAQM, 2017.

- Consideration of the potential for underprediction of baseline concentrations to affect the results indicated significant headroom before AQO exceedences would occur. This is considered extremely unlikely. As such, the selection of baseline data has not affected the report conclusions; and,
- Refusal of the application in relation to PM_{10} would not be justified in accordance with the Ministry of Housing, Communities & Local Government Planning Practice Guidance[38].

6.1.5 Based on the assessment results, the overall effect of fugitive dust emissions from the proposals on PM_{10} and $PM_{2.5}$ concentrations is considered to be **not significant**. Air quality factors are therefore not considered a constraint to planning consent for the proposals.

38 https://www.gov.uk/guidance/minerals#Assessing-environmental-impacts-from-minerals-extraction.

7.0 ABBREVIATIONS

AQLV	Air Quality Limit Value
AQO	Air Quality Objective
AQS	Air Quality Standard
BAT	Best Available Technology
CEPMEIP	Coordinated European Particulate Matter Emission Inventory Program
CERC	Cambridge Environmental Research Consultants
DEFRA	Department for Environment, Food and Rural Affairs
DM	Do-Minimum
DMP	Dust Management Plan
DS	So-Something
EEA	European Environment Agency
IAQM	Institute of Air Quality Management
NGR	National Grid Reference
PM	Particulate Matter
PM_{10}	Particulate matter with an aerodynamic diameter of less than 10µm
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of less than 2.5µm
RCC	Rutland County Council
tpa	Tonnes per annum
z_0	Roughness length

Figures

Legend

Site Boundary

Receptor

Emission Source

Title

Figure 1 - ADMS-5 Inputs

Project

Dust Assessment Addendum
Greetham Quarry

Project Reference

3682-3

Client

Mick George Ltd

Redmore environmental

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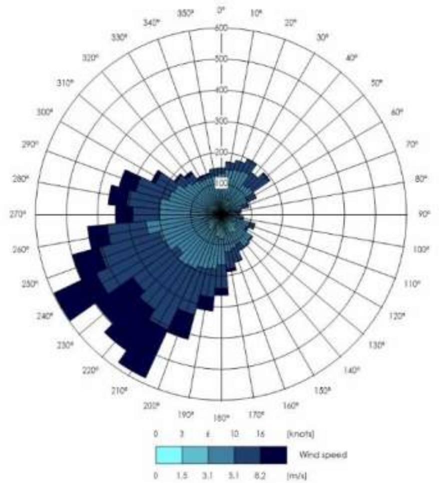
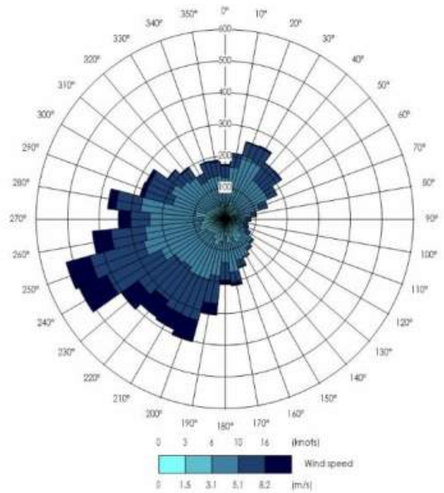
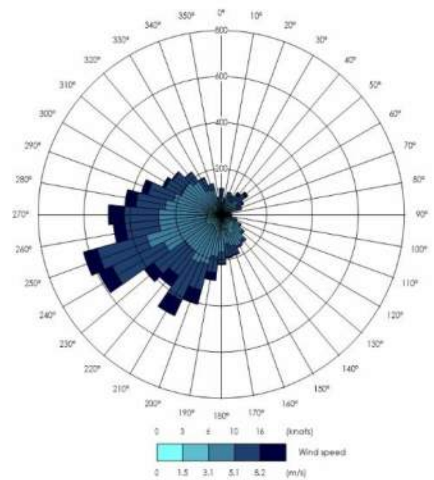


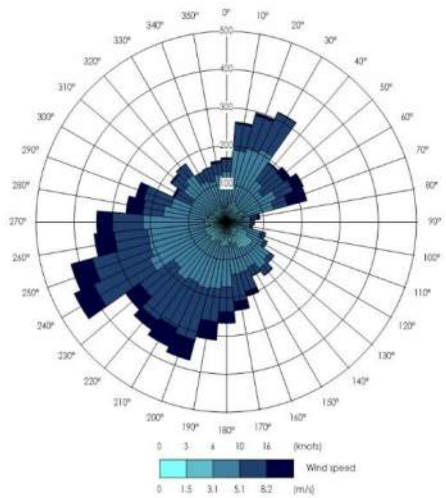
2015



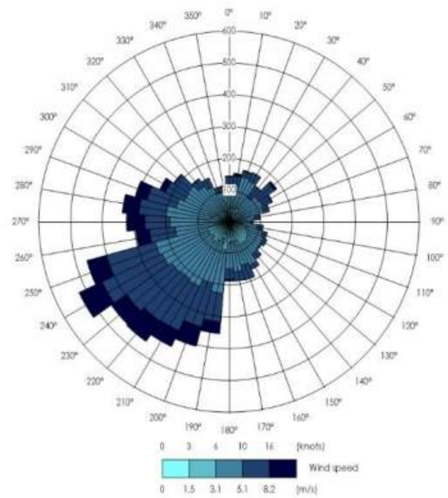
2016



2017



2018



2019

Legend

Title
Figure 2 - Wind Roses of 2015 to 2019 RAF Wittering Meteorological Data

Project
Dust Assessment Addendum
Greetham Quarry

Project Reference
3682-3

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Appendix 1 - Dispersion Modelling Results

Table A1 Predicted Annual Mean PM_{10} Concentrations – Phase 1

Receptor	Predicted Annual Mean PM_{10} Concentration (µg/m^3)														
	2015			2016			2017			2018			2019		
	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change
R1	15.56	15.99	0.43	15.56	16.15	0.59	15.56	15.88	0.32	15.56	16.09	0.53	15.56	16.03	0.47
R2	15.56	16.03	0.47	15.56	16.22	0.66	15.56	15.92	0.36	15.56	16.16	0.60	15.56	16.10	0.54
R3	15.56	16.05	0.49	15.56	16.26	0.70	15.56	15.96	0.40	15.56	16.19	0.63	15.56	16.18	0.62
R4	15.56	15.66	0.10	15.56	15.71	0.15	15.56	15.65	0.09	15.56	15.67	0.11	15.56	15.71	0.15
R5	15.56	17.57	2.01	15.56	17.74	2.18	15.56	18.04	2.48	15.56	17.38	1.82	15.56	17.70	2.14
R6	15.56	15.77	0.21	15.56	15.83	0.27	15.56	15.73	0.17	15.56	15.80	0.24	15.56	15.78	0.22
R7	15.56	15.83	0.27	15.56	15.90	0.34	15.56	15.72	0.16	15.56	15.88	0.32	15.56	15.83	0.27
R8	15.56	15.79	0.23	15.56	15.83	0.27	15.56	15.67	0.11	15.56	15.84	0.28	15.56	15.78	0.22
R9	15.56	16.41	0.85	15.56	16.54	0.98	15.56	15.97	0.41	15.56	16.55	0.99	15.56	16.35	0.79
R10	15.56	15.98	0.42	15.56	16.05	0.49	15.56	15.76	0.20	15.56	16.03	0.47	15.56	15.96	0.40
R11	15.56	15.66	0.10	15.56	15.71	0.15	15.56	15.64	0.08	15.56	15.70	0.14	15.56	15.69	0.13

Table A2 Predicted Annual Mean PM_{10} Concentrations – Phase 2

Receptor	Predicted Annual Mean PM_{10} Concentration (µg/m^3)														
	2015			2016			2017			2018			2019		
	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change
R1	15.56	15.78	0.22	15.56	15.85	0.29	15.56	15.71	0.15	15.56	15.80	0.24	15.56	15.79	0.23
R2	15.56	15.81	0.25	15.56	15.89	0.33	15.56	15.73	0.17	15.56	15.83	0.27	15.56	15.82	0.26
R3	15.56	15.86	0.30	15.56	15.96	0.40	15.56	15.78	0.22	15.56	15.89	0.33	15.56	15.87	0.31
R4	15.56	15.63	0.07	15.56	15.68	0.12	15.56	15.62	0.06	15.56	15.66	0.10	15.56	15.66	0.10
R5	15.56	17.80	2.24	15.56	18.26	2.70	15.56	18.59	3.03	15.56	17.67	2.11	15.56	18.01	2.45
R6	15.56	15.71	0.15	15.56	15.75	0.19	15.56	15.65	0.09	15.56	15.74	0.18	15.56	15.71	0.15
R7	15.56	15.73	0.17	15.56	15.77	0.21	15.56	15.64	0.08	15.56	15.77	0.21	15.56	15.73	0.17
R8	15.56	15.71	0.15	15.56	15.73	0.17	15.56	15.63	0.07	15.56	15.75	0.19	15.56	15.70	0.14
R9	15.56	15.84	0.28	15.56	15.87	0.31	15.56	15.68	0.12	15.56	15.88	0.32	15.56	15.82	0.26
R10	15.56	15.76	0.20	15.56	15.79	0.23	15.56	15.65	0.09	15.56	15.79	0.23	15.56	15.75	0.19
R11	15.56	15.65	0.09	15.56	15.69	0.13	15.56	15.64	0.08	15.56	15.69	0.13	15.56	15.67	0.11

Table A3 Predicted Annual Mean PM_{10} Concentrations – Phase 3

Receptor	Predicted Annual Mean PM_{10} Concentration ($\mu g/m^3$)														
	2015			2016			2017			2018			2019		
	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change
R1	15.56	15.99	0.43	15.56	16.06	0.50	15.56	15.76	0.20	15.56	16.07	0.51	15.56	15.97	0.41
R2	15.56	16.09	0.53	15.56	16.18	0.62	15.56	15.81	0.25	15.56	16.18	0.62	15.56	16.06	0.50
R3	15.56	16.37	0.81	15.56	16.52	0.96	15.56	15.97	0.41	15.56	16.49	0.93	15.56	16.33	0.77
R4	15.56	15.72	0.16	15.56	15.83	0.27	15.56	15.70	0.14	15.56	15.79	0.23	15.56	15.79	0.23
R5	15.56	16.11	0.55	15.56	16.20	0.64	15.56	16.29	0.73	15.56	16.08	0.52	15.56	16.17	0.61
R6	15.56	15.70	0.14	15.56	15.74	0.18	15.56	15.68	0.12	15.56	15.72	0.16	15.56	15.70	0.14
R7	15.56	15.73	0.17	15.56	15.78	0.22	15.56	15.68	0.12	15.56	15.76	0.20	15.56	15.73	0.17
R8	15.56	15.73	0.17	15.56	15.77	0.21	15.56	15.65	0.09	15.56	15.76	0.20	15.56	15.73	0.17
R9	15.56	15.88	0.32	15.56	15.94	0.38	15.56	15.73	0.17	15.56	15.94	0.38	15.56	15.87	0.31
R10	15.56	15.80	0.24	15.56	15.84	0.28	15.56	15.67	0.11	15.56	15.85	0.29	15.56	15.79	0.23
R11	15.56	15.79	0.23	15.56	15.87	0.31	15.56	15.74	0.18	15.56	15.85	0.29	15.56	15.82	0.26

Table A4 Predicted Annual Mean PM_{10} Concentrations – Phase 4

Receptor	Predicted Annual Mean PM_{10} Concentration (µg/m³)														
	2015			2016			2017			2018			2019		
	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change
R1	15.56	16.60	1.04	15.56	16.89	1.33	15.56	16.22	0.66	15.56	16.78	1.22	15.56	16.61	1.05
R2	15.56	16.99	1.43	15.56	17.42	1.86	15.56	16.49	0.93	15.56	17.28	1.72	15.56	17.03	1.47
R3	15.56	17.59	2.03	15.56	18.37	2.81	15.56	17.01	1.45	15.56	18.14	2.58	15.56	17.91	2.35
R4	15.56	15.76	0.20	15.56	15.84	0.28	15.56	15.75	0.19	15.56	15.79	0.23	15.56	15.84	0.28
R5	15.56	16.02	0.46	15.56	16.05	0.49	15.56	16.13	0.57	15.56	15.98	0.42	15.56	16.07	0.51
R6	15.56	15.75	0.19	15.56	15.81	0.25	15.56	15.76	0.20	15.56	15.78	0.22	15.56	15.76	0.20
R7	15.56	15.83	0.27	15.56	15.91	0.35	15.56	15.77	0.21	15.56	15.87	0.31	15.56	15.83	0.27
R8	15.56	15.82	0.26	15.56	15.88	0.32	15.56	15.71	0.15	15.56	15.87	0.31	15.56	15.82	0.26
R9	15.56	16.53	0.97	15.56	16.76	1.20	15.56	16.16	0.60	15.56	16.73	1.17	15.56	16.51	0.95
R10	15.56	16.06	0.50	15.56	16.14	0.58	15.56	15.80	0.24	15.56	16.16	0.60	15.56	16.04	0.48
R11	15.56	15.76	0.20	15.56	15.85	0.29	15.56	15.72	0.16	15.56	15.81	0.25	15.56	15.81	0.25

Table A5 Predicted Annual Mean PM_{10} Concentrations – Phase 5

Receptor	Predicted Annual Mean PM_{10} Concentration (μg/m³)														
	2015			2016			2017			2018			2019		
	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change
R1	15.56	15.99	0.43	15.56	16.15	0.59	15.56	15.88	0.32	15.56	16.09	0.53	15.56	16.03	0.47
R2	15.56	16.03	0.47	15.56	16.22	0.66	15.56	15.92	0.36	15.56	16.16	0.60	15.56	16.10	0.54
R3	15.56	16.05	0.49	15.56	16.26	0.70	15.56	15.96	0.40	15.56	16.19	0.63	15.56	16.18	0.62
R4	15.56	15.66	0.10	15.56	15.71	0.15	15.56	15.65	0.09	15.56	15.67	0.11	15.56	15.71	0.15
R5	15.56	17.57	2.01	15.56	17.74	2.18	15.56	18.04	2.48	15.56	17.38	1.82	15.56	17.70	2.14
R6	15.56	15.77	0.21	15.56	15.83	0.27	15.56	15.73	0.17	15.56	15.80	0.24	15.56	15.78	0.22
R7	15.56	15.83	0.27	15.56	15.90	0.34	15.56	15.72	0.16	15.56	15.88	0.32	15.56	15.83	0.27
R8	15.56	15.79	0.23	15.56	15.83	0.27	15.56	15.67	0.11	15.56	15.84	0.28	15.56	15.78	0.22
R9	15.56	16.41	0.85	15.56	16.54	0.98	15.56	15.97	0.41	15.56	16.55	0.99	15.56	16.35	0.79
R10	15.56	15.98	0.42	15.56	16.05	0.49	15.56	15.76	0.20	15.56	16.03	0.47	15.56	15.96	0.40
R11	15.56	15.66	0.10	15.56	15.71	0.15	15.56	15.64	0.08	15.56	15.70	0.14	15.56	15.69	0.13

Table A6 Predicted Annual Mean $PM_{2.5}$ Concentrations – Phase 1

Receptor	Predicted Annual Mean $PM_{2.5}$ Concentration (μg/m³)														
	2015			2016			2017			2018			2019		
	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change
R1	8.60	8.66	0.06	8.60	8.69	0.09	8.60	8.65	0.05	8.60	8.68	0.08	8.60	8.67	0.07
R2	8.60	8.67	0.07	8.60	8.70	0.10	8.60	8.66	0.06	8.60	8.69	0.09	8.60	8.68	0.08
R3	8.60	8.67	0.07	8.60	8.71	0.11	8.60	8.66	0.06	8.60	8.70	0.10	8.60	8.69	0.09
R4	8.60	8.62	0.02	8.60	8.62	0.02	8.60	8.61	0.01	8.60	8.62	0.02	8.60	8.62	0.02
R5	8.60	8.91	0.31	8.60	8.93	0.33	8.60	8.98	0.38	8.60	8.88	0.28	8.60	8.93	0.33
R6	8.60	8.63	0.03	8.60	8.64	0.04	8.60	8.63	0.03	8.60	8.64	0.04	8.60	8.63	0.03
R7	8.60	8.64	0.04	8.60	8.65	0.05	8.60	8.62	0.02	8.60	8.65	0.05	8.60	8.64	0.04
R8	8.60	8.63	0.03	8.60	8.64	0.04	8.60	8.62	0.02	8.60	8.64	0.04	8.60	8.63	0.03
R9	8.60	8.73	0.13	8.60	8.75	0.15	8.60	8.66	0.06	8.60	8.75	0.15	8.60	8.72	0.12
R10	8.60	8.66	0.06	8.60	8.67	0.07	8.60	8.63	0.03	8.60	8.67	0.07	8.60	8.66	0.06
R11	8.60	8.61	0.01	8.60	8.62	0.02	8.60	8.61	0.01	8.60	8.62	0.02	8.60	8.62	0.02

Table A7 Predicted Annual Mean $PM_{2.5}$ Concentrations – Phase 2

Receptor	Predicted Annual Mean $PM_{2.5}$ Concentration (µg/m³)														
	2015			2016			2017			2018			2019		
	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change
R1	8.60	8.63	0.03	8.60	8.64	0.04	8.60	8.62	0.02	8.60	8.64	0.04	8.60	8.63	0.03
R2	8.60	8.64	0.04	8.60	8.65	0.05	8.60	8.63	0.03	8.60	8.64	0.04	8.60	8.64	0.04
R3	8.60	8.64	0.04	8.60	8.66	0.06	8.60	8.63	0.03	8.60	8.65	0.05	8.60	8.65	0.05
R4	8.60	8.61	0.01	8.60	8.62	0.02	8.60	8.61	0.01	8.60	8.62	0.02	8.60	8.62	0.02
R5	8.60	8.94	0.34	8.60	9.01	0.41	8.60	9.06	0.46	8.60	8.92	0.32	8.60	8.97	0.37
R6	8.60	8.62	0.02	8.60	8.63	0.03	8.60	8.61	0.01	8.60	8.63	0.03	8.60	8.62	0.02
R7	8.60	8.63	0.03	8.60	8.63	0.03	8.60	8.61	0.01	8.60	8.63	0.03	8.60	8.63	0.03
R8	8.60	8.62	0.02	8.60	8.63	0.03	8.60	8.61	0.01	8.60	8.63	0.03	8.60	8.62	0.02
R9	8.60	8.64	0.04	8.60	8.65	0.05	8.60	8.62	0.02	8.60	8.65	0.05	8.60	8.64	0.04
R10	8.60	8.63	0.03	8.60	8.63	0.03	8.60	8.61	0.01	8.60	8.63	0.03	8.60	8.63	0.03
R11	8.60	8.61	0.01	8.60	8.62	0.02	8.60	8.61	0.01	8.60	8.62	0.02	8.60	8.62	0.02

Table A8 Predicted Annual Mean $PM_{2.5}$ Concentrations – Phase 3

Receptor	Predicted Annual Mean $PM_{2.5}$ Concentration (µg/m³)														
	2015			2016			2017			2018			2019		
	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change
R1	8.60	8.67	0.07	8.60	8.68	0.08	8.60	8.63	0.03	8.60	8.68	0.08	8.60	8.66	0.06
R2	8.60	8.68	0.08	8.60	8.69	0.09	8.60	8.64	0.04	8.60	8.69	0.09	8.60	8.68	0.08
R3	8.60	8.72	0.12	8.60	8.75	0.15	8.60	8.66	0.06	8.60	8.74	0.14	8.60	8.72	0.12
R4	8.60	8.62	0.02	8.60	8.64	0.04	8.60	8.62	0.02	8.60	8.63	0.03	8.60	8.64	0.04
R5	8.60	8.68	0.08	8.60	8.70	0.10	8.60	8.71	0.11	8.60	8.68	0.08	8.60	8.69	0.09
R6	8.60	8.62	0.02	8.60	8.63	0.03	8.60	8.62	0.02	8.60	8.62	0.02	8.60	8.62	0.02
R7	8.60	8.63	0.03	8.60	8.63	0.03	8.60	8.62	0.02	8.60	8.63	0.03	8.60	8.63	0.03
R8	8.60	8.63	0.03	8.60	8.63	0.03	8.60	8.61	0.01	8.60	8.63	0.03	8.60	8.63	0.03
R9	8.60	8.65	0.05	8.60	8.66	0.06	8.60	8.63	0.03	8.60	8.66	0.06	8.60	8.65	0.05
R10	8.60	8.64	0.04	8.60	8.64	0.04	8.60	8.62	0.02	8.60	8.64	0.04	8.60	8.64	0.04
R11	8.60	8.64	0.04	8.60	8.65	0.05	8.60	8.63	0.03	8.60	8.64	0.04	8.60	8.64	0.04

Table A9 Predicted Annual Mean $PM_{2.5}$ Concentrations – Phase 4

Receptor	Predicted Annual Mean $PM_{2.5}$ Concentration (µg/m³)														
	2015			2016			2017			2018			2019		
	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change
R1	8.60	8.76	0.16	8.60	8.80	0.20	8.60	8.70	0.10	8.60	8.79	0.19	8.60	8.76	0.16
R2	8.60	8.82	0.22	8.60	8.88	0.28	8.60	8.74	0.14	8.60	8.86	0.26	8.60	8.82	0.22
R3	8.60	8.91	0.31	8.60	9.03	0.43	8.60	8.82	0.22	8.60	8.99	0.39	8.60	8.96	0.36
R4	8.60	8.63	0.03	8.60	8.64	0.04	8.60	8.63	0.03	8.60	8.64	0.04	8.60	8.64	0.04
R5	8.60	8.67	0.07	8.60	8.67	0.07	8.60	8.69	0.09	8.60	8.66	0.06	8.60	8.68	0.08
R6	8.60	8.63	0.03	8.60	8.64	0.04	8.60	8.63	0.03	8.60	8.63	0.03	8.60	8.63	0.03
R7	8.60	8.64	0.04	8.60	8.65	0.05	8.60	8.63	0.03	8.60	8.65	0.05	8.60	8.64	0.04
R8	8.60	8.64	0.04	8.60	8.65	0.05	8.60	8.62	0.02	8.60	8.65	0.05	8.60	8.64	0.04
R9	8.60	8.75	0.15	8.60	8.78	0.18	8.60	8.69114	0.09	8.60	8.78	0.18	8.60	8.74	0.14
R10	8.60	8.68	0.08	8.60	8.69	0.09	8.60	8.64	0.04	8.60	8.69	0.09	8.60	8.67	0.07
R11	8.60	8.63	0.03	8.60	8.64	0.04	8.60	8.62	0.02	8.60	8.64	0.04	8.60	8.64	0.04

Table A10 Predicted Annual Mean $PM_{2.5}$ Concentrations – Phase 5

Receptor	Predicted Annual Mean $PM_{2.5}$ Concentration (μg/m^3)														
	2015			2016			2017			2018			2019		
	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change	DM	DS	Change
R1	8.60	8.66	0.06	8.60	8.69	0.09	8.60	8.65	0.05	8.60	8.68	0.08	8.60	8.67	0.07
R2	8.60	8.67	0.07	8.60	8.70	0.10	8.60	8.66	0.06	8.60	8.69	0.09	8.60	8.68	0.08
R3	8.60	8.67	0.07	8.60	8.71	0.11	8.60	8.66	0.06	8.60	8.70	0.10	8.60	8.69	0.09
R4	8.60	8.62	0.02	8.60	8.62	0.02	8.60	8.61	0.01	8.60	8.62	0.02	8.60	8.62	0.02
R5	8.60	8.91	0.31	8.60	8.93	0.33	8.60	8.98	0.38	8.60	8.88	0.28	8.60	8.93	0.33
R6	8.60	8.63	0.03	8.60	8.64	0.04	8.60	8.63	0.03	8.60	8.64	0.04	8.60	8.63	0.03
R7	8.60	8.64	0.04	8.60	8.65	0.05	8.60	8.62	0.02	8.60	8.65	0.05	8.60	8.64	0.04
R8	8.60	8.63	0.03	8.60	8.64	0.04	8.60	8.62	0.02	8.60	8.64	0.04	8.60	8.63	0.03
R9	8.60	8.73	0.13	8.60	8.75	0.15	8.60	8.66	0.06	8.60	8.75	0.15	8.60	8.72	0.12
R10	8.60	8.66	0.06	8.60	8.67	0.07	8.60	8.63	0.03	8.60	8.67	0.07	8.60	8.66	0.06
R11	8.60	8.61	0.01	8.60	8.62	0.02	8.60	8.61	0.01	8.60	8.62	0.02	8.60	8.62	0.02

Table A11 Number of Days with PM_{10} Concentrations above 50µg/m³ – Phase 1

Receptor	Number of Days with PM_{10} Concentrations above 50µg/m³				
	2015	2016	2017	2018	2019
R1	0	0	0	0	0
R2	0	0	0	0	0
R3	0	0	0	0	0
R4	0	0	0	0	0
R5	1	1	1	1	1
R6	0	0	0	0	0
R7	0	0	0	0	0
R8	0	0	0	0	0
R9	0	1	0	1	0
R10	0	0	0	0	0
R11	0	0	0	0	0

Table A12 Number of Days with PM_{10} Concentrations above 50µg/m^3 – Phase 2

Receptor	Number of Days with PM_{10} Concentrations above 50µg/m^3				
	2015	2016	2017	2018	2019
R1	0	0	0	0	0
R2	0	0	0	0	0
R3	0	0	0	0	0
R4	0	0	0	0	0
R5	1	2	2	1	1
R6	0	0	0	0	0
R7	0	0	0	0	0
R8	0	0	0	0	0
R9	0	0	0	0	0
R10	0	0	0	0	0
R11	0	0	0	0	0

Table A13 Number of Days with PM_{10} Concentrations above 50µg/m^3 – Phase 3

Receptor	Number of Days with PM_{10} Concentrations above 50µg/m^3				
	2015	2016	2017	2018	2019
R1	0	0	0	0	0
R2	0	0	0	0	0
R3	0	1	0	0	0
R4	0	0	0	0	0
R5	0	0	0	0	0
R6	0	0	0	0	0
R7	0	0	0	0	0
R8	0	0	0	0	0
R9	0	0	0	0	0
R10	0	0	0	0	0
R11	0	0	0	0	0

Table A14 Number of Days with PM_{10} Concentrations above 50µg/m^3 – Phase 4

Receptor	Number of Days with PM_{10} Concentrations above 50µg/m^3				
	2015	2016	2017	2018	2019
R1	1	1	0	1	1
R2	1	1	0	1	1
R3	1	2	1	2	1
R4	0	0	0	0	0
R5	0	0	0	0	0
R6	0	0	0	0	0
R7	0	0	0	0	0
R8	0	0	0	0	0
R9	1	1	0	1	1
R10	0	0	0	0	0
R11	0	0	0	0	0

Table A15 Number of Days with PM_{10} Concentrations above 50µg/m^3 – Phase 5

Receptor	Number of Days with PM_{10} Concentrations above 50µg/m^3				
	2015	2016	2017	2018	2019
R1	0	0	0	0	0
R2	0	0	0	0	0
R3	0	0	0	0	0
R4	0	0	0	0	0
R5	1	1	1	1	1
R6	0	0	0	0	0
R7	0	0	0	0	0
R8	0	0	0	0	0
R9	0	1	0	1	0
R10	0	0	0	0	0
R11	0	0	0	0	0

Table A16 Number of Days with PM_{10} Concentrations above 50μg/m^3 – Phase 1 Sensitivity Analysis

Receptor	Number of Days with PM_{10} Concentrations above 50μg/m^3				
	2015	2016	2017	2018	2019
R1	0	1	0	1	0
R2	0	1	0	1	1
R3	1	1	0	1	1
R4	0	0	0	0	0
R5	3	3	4	2	3
R6	0	0	0	0	0
R7	0	0	0	0	0
R8	0	0	0	0	0
R9	1	1	0	1	1
R10	0	1	0	1	0
R11	0	0	0	0	0

Table A17 Number of Days with PM_{10} Concentrations above 50µg/m³ – Phase 2 Sensitivity Analysis

Receptor	Number of Days with PM_{10} Concentrations above 50µg/m³				
	2015	2016	2017	2018	2019
R1	0	0	0	0	0
R2	0	0	0	0	0
R3	0	0	0	0	0
R4	0	0	0	0	0
R5	3	5	6	3	4
R6	0	0	0	0	0
R7	0	0	0	0	0
R8	0	0	0	0	0
R9	0	0	0	0	0
R10	0	0	0	0	0
R11	0	0	0	0	0

Table A18 Number of Days with PM_{10} Concentrations above 50µg/m³ – Phase 3 Sensitivity Analysis

Receptor	Number of Days with PM_{10} Concentrations above 50µg/m³				
	2015	2016	2017	2018	2019
R1	0	1	0	1	0
R2	1	1	0	1	1
R3	1	1	0	1	1
R4	0	0	0	0	0
R5	1	1	1	1	1
R6	0	0	0	0	0
R7	0	0	0	0	0
R8	0	0	0	0	0
R9	0	0	0	0	0
R10	0	0	0	0	0
R11	0	0	0	0	0

Table A19 Number of Days with PM_{10} Concentrations above 50µg/m^3 – Phase 4 Sensitivity Analysis

Receptor	Number of Days with PM_{10} Concentrations above 50µg/m^3				
	2015	2016	2017	2018	2019
R1	1	2	1	1	1
R2	2	3	1	2	2
R3	3	5	2	4	4
R4	0	0	0	0	0
R5	0	1	1	0	1
R6	0	0	0	0	0
R7	0	0	0	0	0
R8	0	0	0	0	0
R9	1	1	1	1	1
R10	1	1	0	1	1
R11	0	0	0	0	0

Table A20 Number of Days with PM_{10} Concentrations above 50µg/m³ – Phase 5 Sensitivity Analysis

Receptor	Number of Days with PM_{10} Concentrations above 50µg/m³				
	2015	2016	2017	2018	2019
R1	0	1	0	1	0
R2	0	1	0	1	1
R3	1	1	0	1	1
R4	0	0	0	0	0
R5	3	3	4	2	3
R6	0	0	0	0	0
R7	0	0	0	0	0
R8	0	0	0	0	0
R9	1	1	0	1	1
R10	0	1	0	1	0
R11	0	0	0	0	0