

# REPORT

## **Phase 4 - Woodsmith Mine Construction Vehicle and Plant Management Plan**

Woodsmith Mine Phase 4 - CVPMP

Client: Sirius Minerals PLC

Reference: 40-RHD-WS-70-CI-PL-0005 REV 0

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## 1 Introduction

1.1.1 In 2014 a planning application (reference NYM/2014/0676/MEIA) was submitted to North York Moors National Park Authority (NYMNPA) for permission to develop a polyhalite mine and underground Mineral Transport System (MTS). Planning consent was subsequently granted in 2015, subject to conditions.

1.1.2 This document has been prepared on behalf of Sirius Minerals plc (Sirius Minerals) and details the requirements with respect to construction vehicles and plant for Phase 4 of the development at Woodsmith Mine (see paragraph 1.1.5 below). This document is required to partially discharge condition 92 of the NYMNPA planning permission NYM/2014/0676/MEIA and has been prepared in accordance with current good practice. The planning condition states that:

*“Prior to the commencement of development at either Dove’s Nest Farm or Lady Cross Plantation, a Construction Vehicle and Plant Management Plan (CVPM) shall be submitted to and approved in writing by the MPA. The CVPM shall include details of monitoring locations and baseline particulate emissions; predicted traffic movements into/out of the sites including levels at the A171/Mayfield junction; predicted particulate emissions from plant and HGVs during the construction period; proposed particulate control levels; proposed avoidance or mitigation measures to comply with control levels, and arrangements for monitoring over the construction period. Development shall only occur in strict accordance with the measures set out in the CVMP [sic], unless otherwise agreed in writing with the MPA.”*

1.1.3 The specific requirements of the planning condition are detailed in **Table 1-1**.

Table 1-1 Condition NYMNPA-92 Construction Vehicle and Plant Management Plan

Condition NYMNPA-92	Compliance with Condition NYMNPA-92
Details of monitoring locations and baseline particulate emissions	Section 2
Predicted traffic movements into/out of the sites including levels at the A171/Mayfield junction	Section 3
Predicted particulate emissions from plant and Heavy Goods Vehicles (HGVs) during the construction period	Section 4
Proposed avoidance or mitigation measures to comply with control levels	Section 5
Proposed particulate control levels	Section 5
Arrangements for monitoring over the construction period	Section 2

1.1.4 This management plan details only the Phase 4 Works at Woodsmith Mine and does not include any activities at Lady Cross Plantation, as these works are deferred. Updates to this plan will be prepared for subsequent construction phases and following any design review or method change. The NYMNPA has confirmed that it supports this approach.

1.1.5 The activities required for the Phase 4 Works comprise the following:

- Operation of the concrete batch plant;

- Installation, commissioning and operation of the bentonite plant and associated temporary structures;
- Installation of concrete guide walls (excavate to -3.5m and concrete wall down to -1.5m to -1.75m);
- Mobilisation to site of diaphragm walling equipment (cutters, cranes, workshops etc.);
- Diaphragm wall construction to -60m below ground level at the Production, Service and Mineral Transport System shafts; and,
- Limited continuation of earthworks to create an area for future storage of spoil.

1.1.6 Meetings were held with the Environmental Health Officer (EHO) of Scarborough Borough Council (SBC) and NYMNPA on 17 March 2016 and 27 April 2016 respectively. At these meetings, the scope and content of the document to discharge planning condition NYMNPA-92 was agreed. The scope was re-confirmed with the EHO in a meeting on 1 December 2016.

1.1.7 The agreed approach was to consider the requirements of the Condition in four parts, as detailed in **Table 1-1**. The structure of this document follows the agreed approach, and the structure of the CVPMP previously submitted to partially discharge planning condition NYMNPA-92 in respect of the Phase 4 Works.

## 2 Baseline Conditions

### 2.1 Definitions of dust and fine particulate matter

2.1.1 Definitions of dust and fine particulate matter are provided in **Appendix A1**.

### 2.2 Site-specific dust deposition survey

2.2.1 Baseline dust deposition monitoring was undertaken at eight locations (M1-M8) around the boundary of the Woodsmith Mine site between February and August 2014 using frisbee dust gauges. The locations at which monitoring was undertaken are shown in **Figure 1**. Key results of the six month monitoring are detailed in **Table A1** in **Appendix A2**. These results informed the full air quality assessment presented in the Environmental Statement (ES) which supported the planning application.

2.2.2 The monitoring results show that dust deposition varies at locations around the boundary of Woodsmith Mine. Of the valid measurements recorded, the average dust deposition value was 42 mg/m<sup>2</sup>/day (range 14 – 94 mg/m<sup>2</sup>/day; average deviation 18 mg/m<sup>2</sup>/day; standard deviation 22 mg/m<sup>2</sup>/day). Slightly higher average deposition was measured at locations M5 and M7, located at the south-east of the site boundary, within wooded areas, where deposition rates are likely to be attributable to influences from vegetation and resuspension of material from the nearby road network. The lowest deposition rates were measured at locations M2 and M8, located to the west and north of the site respectively. These locations are surrounded by open fields. Results from the comparable location M1 are higher, and agricultural activity and distant road traffic are likely to have contributed to the measured values.

- 2.2.3 Wind roses of hourly sequential meteorological data from the Fylingdales recording station were provided in the ES<sup>1</sup>. The predominant wind direction is from the south-west, therefore locations downwind of particulate sources are likely to experience the greatest deposition, as indicated at locations M5 and M7.
- 2.2.4 Regulatory authorities conventionally consider a threshold of 200 mg/m<sup>2</sup>/day<sup>2,3</sup> to be the dust deposition rate, above which complaints are likely<sup>4</sup>. The measured dust deposition rates are all well below 200 mg/m<sup>2</sup>/day, as would be expected in a rural and relatively undeveloped location.

## 2.3 Background particulate matter concentrations

- 2.3.1 Background PM<sub>10</sub> and PM<sub>2.5</sub> concentrations were sourced from pollutant maps provided by Defra<sup>5</sup> for a 1km x 1km resolution of the UK. The relevant 2017 background pollutant concentrations at Woodsmith Mine were obtained for the grid squares covering the area, and are detailed in **Table A2** in **Appendix A3**.
- 2.3.2 Background PM<sub>10</sub> and PM<sub>2.5</sub> concentrations at Woodsmith Mine are well below the annual mean Air Quality Objectives (in England) of 40µg.m<sup>-3</sup> and 25µg.m<sup>-3</sup> respectively. The main contributor to PM<sub>10</sub> concentrations within the above grid squares is secondary PM<sub>10</sub> (aerosols formed in atmospheric condensation reactions), sea salt and calcium and iron rich dusts, reflecting the proximity of Woodsmith Mine to the coast.

## 2.4 Additional monitoring

- 2.4.1 It was agreed in the consultation meetings with SBC and the NYMNPA that the existing monitoring data, re-presented in **Appendix A2**, provide a suitable and sufficient characterisation of baseline particulate conditions at the site and that no additional monitoring would therefore be required. Further passive deposition sampling during construction activities would provide only retrospective data, and correlation of monitored particulate concentrations with construction phase activities and generated emissions would not provide a meaningful management and control technique.
- 2.4.2 Nevertheless, the construction activities will be subject to a range of dust and vehicle management measures, as set out in the Construction Environmental Management Plan (CEMP - *Phase 3 CEMP* (40-RHD-WS-70-EN-PL-0014), provides these management measures, which remain valid for Phase 4 Works), submitted to partially discharge planning condition NYMNPA-93. The measures detailed in the CEMP include regular visual site inspections to monitor compliance with dust control procedures set out within the document. The results of the inspections will be recorded within the site log book, and included in monthly reporting. A Dust Management Plan (DMP) for the Phase 4 Works is included as part of the *Phase 4 CEMP*(40-RHD-WS-70-EN-PL-0023).

<sup>1</sup> Royal HaskoningDHV (2014) York Potash Project Mine, MTS and MHF Environmental Statement: Part 2 Chapter 9 Air Quality

<sup>2</sup> Environment Agency (2013) Technical Guidance Note (Monitoring) M17 Monitoring Particulate Matter in Ambient Air around Waste Facilities

<sup>3</sup> Institute of Air Quality Management (2012) Guidance on Air Quality Monitoring in the Vicinity of Demolition and Construction Sites

<sup>4</sup> Vallack & Shillito (1998) Suggested guidelines for deposited ambient dust, *Atmospheric Environment* **16** (32), 2737-2744

<sup>5</sup> Defra (2014) 2011-based background maps <https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2011>

### 3 Predicted Traffic Movements Associated with Phase 4 Works

#### 3.1 Construction phase road traffic movements

3.1.1 The anticipated traffic movements associated with Phase 4 align with those presented in the Construction Traffic Management Plan (CTMP), submitted to partially discharge planning condition NYMNPA-34. The Phase 4 Works will be undertaken over period of approximately 40 weeks, between July 2017 and March 2018.

3.1.2 This approach was agreed with SBC and the NYMNPA during the respective meetings (as detailed in Section 1). The number of traffic movements generated during the Phase 4 Works is detailed in **Table 3-1**.

Table 3-1 Traffic Movements Generated During Phase 4 at Woodsmith Mine

Vehicle Type	Number of Vehicles During Phase 4 (Two-Way)*	Maximum Number of Vehicles per Day (Two-Way)
HGV	30,720	126
Light Goods Vehicles (LGVs)**	33,600	120

\*HGVs are restricted on Sundays and therefore the total number of HGVs during Phase 4 does not equate to the duration multiplied by the number of HGVs per day

\*\*Includes cars, minibuses and vans

3.1.3 All HGVs will travel through the A171/Mayfield junction, as the primary source of construction materials within the area will be from Teesside, using the A171 corridor to access Woodsmith Mine (via the B1416 south to avoid Ruswarp).

3.1.4 It is not possible to quantify exact total numbers of vehicles that will travel through the A171/Mayfield junction; however, to provide a conservative approach, if it were assumed that all LGVs and HGVs were to travel through the A171/Mayfield junction, this would result in a maximum increase in vehicles of 246 per day (64,320 vehicles over the duration of Phase 4).

#### 3.2 On-site plant

3.2.1 The number and types of plant that would be operating for the duration of Phase 4 at Woodsmith Mine are provided in **Table 3-2**.

Table 3-2 Plant Required During Phase 4

Plant Type	Number of Units	Duration of Phase 4 That Plant Will Be Used*
20T excavator	3	3%
Wacker plate	3	1%
Jet wash	3	1%
73t Truck Crane	2	1%
0.76m <sup>3</sup> Excavator	1	1%
18m Telescopic Boom Lift	1	3%



Plant Type	Number of Units	Duration of Phase 4 That Plant Will Be Used*
5m <sup>3</sup> front end loader	1	34%
6T telehandler	1	44%
8m <sup>3</sup> concrete trucks	4	44%
D-wall cutter base crane	1	70%
D-wall cutter base crane	2	34%
90t crawler crane	2	24%
160t crawler crane	2	24%
110t mobile crane	2	34%
MEWP	3	12%
0.76m <sup>3</sup> Excavator	1	10%
1MVA generator	1	50%
1MVA generator	1	100%
350kVA generator	1	100%
100kVA	1	50%
100kVA	1	100%
50kVA generator	1	100%
50kVA generator	10	50%
20kVA generator	1	100%
20kVA generator	1	50%
10kVA generator	1	50%

\*Note that the percentage of Phase 4 that the plant is used takes into account the on-time of plant

## 4 Predicted Particulate Emissions from Plant and HGVs during Phase 4

### 4.1 Methodology

4.1.1 Particulate matter will be generated by the combustion of fuel and brake and tyre wear associated with the following activities during Phase 4:

- Transportation of workforce to site;
- HGV deliveries and movements; and
- The operation of on-site plant (referred to as Non-Road Mobile Machinery (NRMM)) and generators.

4.1.2 Data on the above activities are provided where the required information is known. Where data were not available, information used in the assessments undertaken for the Environmental Statement are used, which included the average trip length and speeds. This is considered to be a reasonable worst case scenario.

- 4.1.3 The quantification of emissions from road traffic was undertaken using the Defra Emission Factor Toolkit (version 7.0). The Emission Factor Toolkit is regularly updated to reflect the latest vehicle technologies and fleet compositions, and is the primary method of deriving emissions from road transport in the UK. The standard UK fleet composition for 2017, built into the Emission Factor Toolkit, was utilised.
- 4.1.4 The Emission Factor Toolkit does not provide specific emission factors for NRMM. As such, emissions of NRMM were calculated using the methodology detailed in European Environment Agency (EEA) Guidance<sup>6</sup>. This document details specific emission factors for NRMM, based on the power rating of the plant and the various emission stages, which correspond to the emission standards set out in relevant EU Directives.
- 4.1.5 The guidance provides three tiers of emission factors; the appropriate tier for use is dependent on the level of information available on the types of plant. As specific information on the make and model of plant used at Woodsmith Mine were provided by the Contractors, Tier 3 emission factors were used.
- 4.1.6 Emissions associated with generators were derived using data provided by the manufacturer (for the 1MVA generators) or the Tier 1 approach in EEA Guidance<sup>7</sup>, where specific emission data were not available. Fuel consumption was derived using the electrical load of the plant, the electrical efficiency, and the anticipated utilisation rate as provided by the Contractors. Emission factors were obtained from the EEA Guidance.

## 4.2 Assumptions

- 4.2.1 The following assumptions were made in the assessment of particulate emissions from NRMM and vehicle movements:
- Phase 4 will take place in 2017 and 2018 – emission factors for 2017 were used for the full Phase 4 period assessment;
  - The concrete batching plant will operate during the daytime only, with the diaphragm walling taking place 24 hours a day;
  - Where load factors for generators were not provided by the Contractor, it was assumed that they would be operating at full power load;
  - For smaller generators where specific emissions data were not available, generators were assumed to operate at 40% efficiency;
  - The duration of Phase 4 will be approximately 40 weeks, with all Sundays worked; and
  - HGV deliveries are restricted to 10% of weekday volumes on Sundays (as per the CTMP). It was therefore assumed that, on Sundays, HGV deliveries would be 10% of weekday trips.
- 4.2.2 A sensitivity test was undertaken with regard to the load factor of the NRMM whilst in use. Load factors of 0.5 and 0.7 were used in the calculation of emissions from NRMM to represent 50% and 70% engine load.

<sup>6</sup> EMEP/EEA (2016) *Emission Inventory Guidebook – Non-Road Mobile Sources and Machinery*

<sup>7</sup> EMEP/EEA (2016) *Emission Inventory Guidebook – Small Combustion*

4.2.3 Average HGV speeds were obtained from GIS smartphone data<sup>8</sup> on the road links that comprise the haul route, and average speeds of vehicles from the park and ride locations and cars were obtained from route mapping and estimated distance over time.

### 4.3 Emissions from construction phase road traffic movements

4.3.1 The quantification of particulate emissions generated by construction-phase traffic movements was undertaken using the following input data:

- Number of daily HGV and car movements;
- Average trip lengths (km);
- Average speed vehicles will be travelling; and
- Emission factors for each vehicle type.

4.3.2 Input and output data from the Emission Factor Toolkit are detailed in **Table A3** and **Table A4** in **Appendix A4**.

### 4.4 Emissions from the operation of on-site NRMM and generators

4.4.1 The input data used to calculate particulate (PM<sub>10</sub>) emissions from NRMM and generators are detailed in **Appendix A5** and **Appendix A6**. The calculated particulate emissions from NRMM, using average load factors of 0.5 and 0.7, and generators are detailed in **Table 4-1**.

Table 4-1 Total PM<sub>10</sub> Emissions from NRMM during Phase 4

Plant	Number of Plant Items	Total PM <sub>10</sub> Emission (tonnes)	
		Load Factor = 0.5*	Load Factor = 0.7*
20T excavator	3	0.0009	0.0012
Wacker plate	3	0.0011	0.0015
Jet wash	3	0.0019	0.0026
73t Truck Crane	2	0.0013	0.0018
0.76m <sup>3</sup> Excavator	1	0.0001	0.0001
18m Telescopic Boom Lift	1	0.0001	0.0002
5m <sup>3</sup> front end loader	1	0.0029	0.0040
6T telehandler	1	0.0048	0.0067
8m <sup>3</sup> concrete trucks	4	0.0191	0.0267
D-wall cutter base crane	1	0.1078	0.1509
D-wall cutter base crane	2	0.0846	0.1185
90t crawler crane	2	0.0125	0.0176
160t crawler crane	2	0.0136	0.0190
110t mobile crane	2	0.0289	0.0404

<sup>8</sup> Journey times were extracted from [www.arcgis.com](http://www.arcgis.com). Arcgis uses historic smartphone data to inform live traffic route planner services such as 'Google traffic'. The average speeds were calculated by dividing the measured distance by the recorded journey time.

Plant	Number of Plant Items	Total PM <sub>10</sub> Emission (tonnes)	
		Load Factor = 0.5*	Load Factor = 0.7*
MEWP	3	0.0016	0.0022
0.76m <sup>3</sup> Excavator	1	0.0010	0.0015
1MVA generator	1	1.3440	1.3440
1MVA generator	1	2.7518	2.7518
350kVA generator	1	0.0958	0.0958
100kVA	1	0.0137	0.0137
100kVA	1	0.0274	0.0274
50kVA generator	1	0.0192	0.0192
50kVA generator	10	0.2736	0.2736
20kVA generator	1	0.0011	0.0011
20kVA generator	1	0.0109	0.0109
10kVA generator	1	0.0027	0.0027

\*Specific load factors were provided by the Contractor for the generator plant  $\geq$ 350kVA. Generators <350kVA were assumed to be operating at full load

## 4.5 Total particulate emissions generated during Phase 4

4.5.1 The total particulate predicted to be generated during Phase 4 as a result of emissions from construction-phase traffic, NRMM and generators is detailed in **Table 4-2**.

Table 4-2 Total PM Emissions from Construction Traffic, NRMM and Generators

Source	Total PM Emission (tonnes)	
	Load Factor = 0.5	Load Factor = 0.7
Construction Traffic	0.326	0.326
NRMM and Generators	4.576	4.689
<b>TOTAL</b>	<b>4.902</b>	<b>5.015</b>

4.5.2 The total PM<sub>10</sub> emission within the SBC area was derived from National Atmospheric Emission Inventory (NAEI) mapping<sup>9</sup>, as detailed in **Figure 2**.

4.5.3 The total PM<sub>10</sub> emission within the whole SBC area of jurisdiction was 404.96 tonnes in 2014. Particulate emissions generated during Phase 4 will therefore contribute 1.21% to 1.24% of the total emissions, (using a load factor range of 0.5 to 0.7 respectively).

<sup>9</sup> National Atmospheric Emission Inventory (2014) Emission Maps for the UK [http://naei.defra.gov.uk/data/map-uk-das?pollutant\\_id=24&emiss\\_maps\\_submit=naei-20160526090831](http://naei.defra.gov.uk/data/map-uk-das?pollutant_id=24&emiss_maps_submit=naei-20160526090831)

## 5 Mitigation Measures

### 5.1 Construction dust and NRMM mitigation measures

5.1.1 Details of mitigation measures to minimise construction phase dust emissions are included in the Phase 3 CEMP, which remains valid for the Phase 4 Works.

5.1.2 All NRMM and plant will be well maintained. If any emissions of dark smoke occur then the relevant machinery will stop immediately and any problem rectified. In addition, the following controls will apply to NRMM:

- All NRMM should use fuel equivalent to ultralow sulphur diesel (fuel meeting the specification within EN590:2004);
- As of 1st January 2017, all NRMM will comply with regulation (EU) 2016/1628<sup>10</sup> of the European Parliament and of the European Council. All NRMM will be fitted with Diesel Particulate Filters (DPF) conforming to defined and demonstrated filtration efficiency (load/duty cycle permitting);
- The ongoing conformity of plant retrofitted with DPF, to a defined performance standard, will be ensured through a programme of onsite checks; and,
- Fuel conservation measures will be implemented, including instructions to (i) throttle down or switch off idle construction equipment; (ii) switch off the engines of trucks while they are waiting to access the site and while they are being loaded or unloaded and (iii) ensure equipment is properly maintained to ensure efficient fuel consumption.

5.1.3 The vehicle fleet accessing Woodsmith Mine will be fitted with DPFs, which will control particle emissions<sup>11</sup>.

### 5.2 Junction and road improvements

5.2.1 Several junction and road improvements are part of the Sirius Minerals North Yorkshire Polyhalite Project. The improvements are being made primarily for transport or safety reasons; however there will be air quality benefits. The improvements are detailed below, to address the requirement of the planning condition to detail '*avoidance or mitigation measures*' implemented as part of the development.

### 5.3 Provision of right turn lane on the A171

5.3.1 The junction of the A171/B1416 is a T-junction with no dedicated right-turn lane. HGVs access Woodsmith Mine by turning right onto the B1416 from the A171. The works involved the provision of a right turn lane at the A171/B1416 junction for traffic turning right on to the B1416. The addition of the right-turn lane will reduce queuing on the A171 as HGVs turn. Vehicle exhaust emissions are lower in free-flowing traffic and are higher under stop-start

<sup>10</sup> Regulation (EU) 2016/1628 of the European Parliament and of the Council of 14 September 2016 on requirements relating to gaseous and particulate pollutant emission limits and type-approval for internal combustion engines for non-road mobile machinery, amending Regulations (EU) No 1024/2012 and (EU) No 167/2013, and amending and repealing Directive 97/68/EC

<sup>11</sup> DPFs are commonly fitted to cars and commercial vehicles to reduce particulate emissions and ensure compliance with the latest Euro standards. It is an offence under the Road Vehicles (Construction and Use) Regulations (1986) to use a vehicle that has had the DPF removed.

conditions, therefore this measure will reduce particulate emissions locally. These works were undertaken as part of Phase 1, and are complete.

## **5.4 Improvements to signals at the A171/Mayfield Junction**

5.4.1 Improvements were made to the A171/Mayfield Junction to upgrade the signalling system, improve the provision for pedestrians and improve junction capacity. The improvements to the traffic signals at this location, which is anticipated to experience an increase in vehicle flows as a result of Phase 4, will have benefits for air quality by encouraging the flow of traffic around the junction and reducing waiting times.

## **5.5 Widening of the Carriageway of the A171 at Normanby Bends**

5.5.1 There is a series of bends along the A171 at Normanby, which forms part of the primary HGV haul route. The road will be widened at this location to accommodate two HGVs passing each other safely, however this will not be undertaken before the commencement of Phase 4.



## Figures



Figure 1 – Baseline Dust Deposition Monitoring Locations (as presented in the ES)

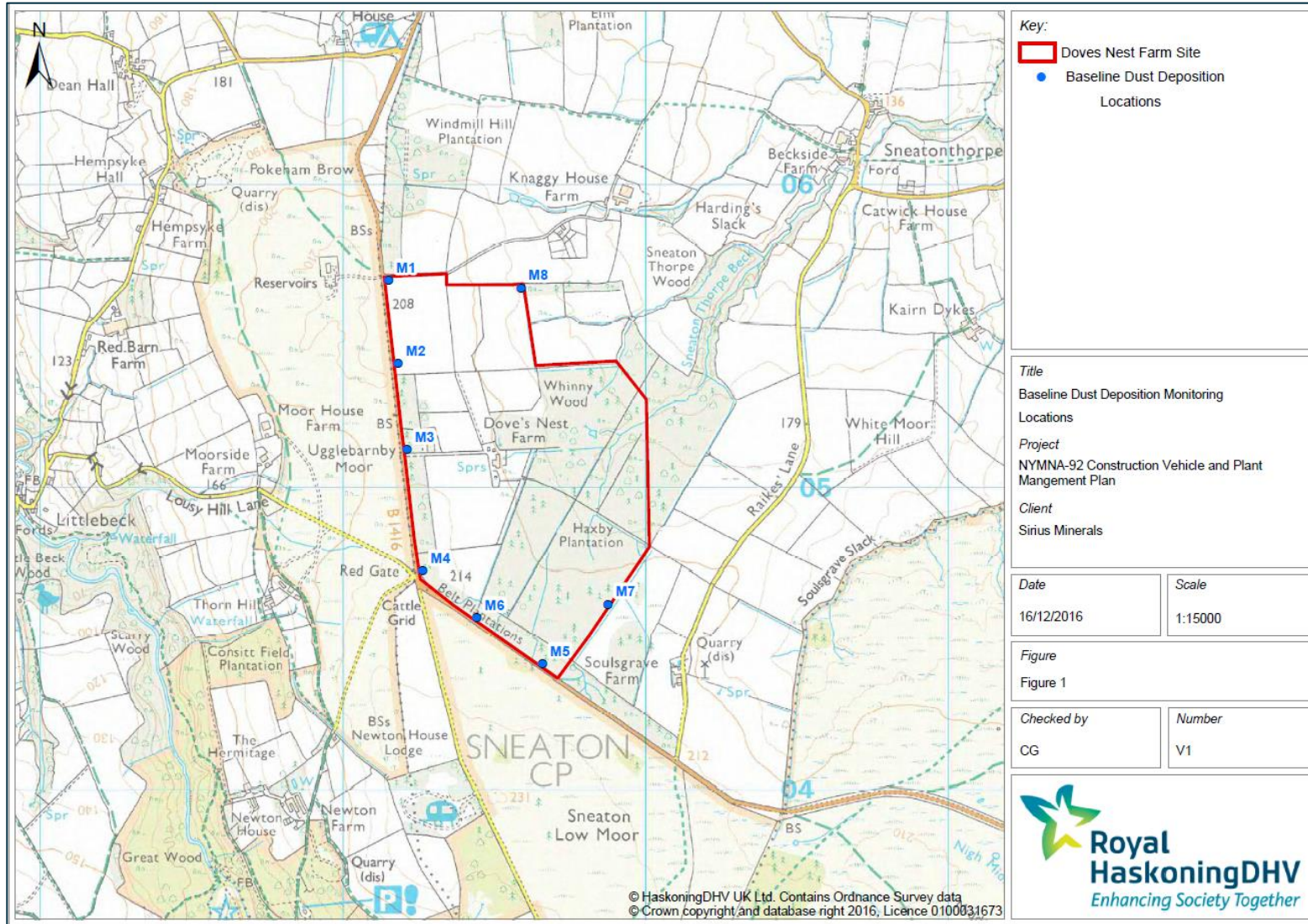
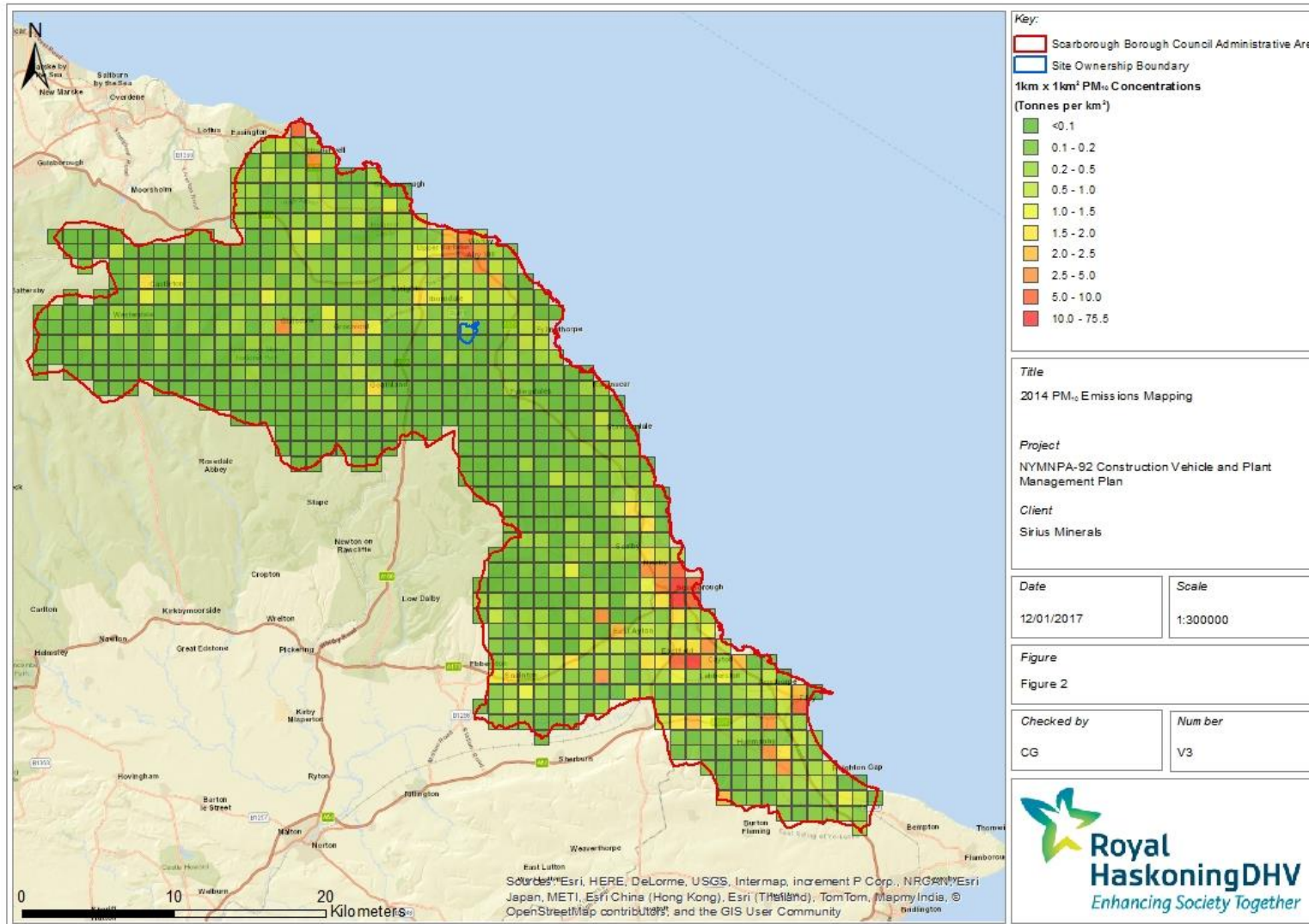




Figure 2 – 2014 PM<sub>10</sub> Emissions Mapping



## A1 Definitions of Dust and Fine Particulate Matter

Atmospheric particles are generally categorised by size fraction and by their source, and are usually measured by mass concentration (although particle number and 'black carbon' techniques are available). The generic term of 'dust' and the two size fractions most commonly used to consider human health environmental effects are defined below.

'Dust' is considered to be the mass of solid particles that are suspended in air, or have settled out onto a surface after having been suspended in air. In the Institute of Air Quality Management (IAQM) Guidance<sup>12</sup> and within this document, the term 'dust' has been used to include the particles that give rise to soiling, and to potential human health and ecological effects. BS 6069:1993 provides a definition of dust as particles up to 75µm in diameter.

The smaller size fractions considered in the UK Local Air Quality Management regime are defined in Regulations<sup>13</sup> as follows:

- "PM<sub>10</sub>" means particulate matter which passes through a size-selective inlet as defined in the reference method for the sampling and measurement of PM<sub>10</sub>, EN 12341, with a 50% efficiency cut-off at 10µm aerodynamic diameter; and,
- "PM<sub>2.5</sub>" means particulate matter which passes through a size-selective inlet as defined in the reference method for the sampling and measurement of PM<sub>2.5</sub>, EN 14907, with a 50% efficiency cut-off at 2.5µm aerodynamic diameter.

The term 'aerodynamic diameter' is a reference to the terminal velocity in air of a spherical particle of unit density, therefore this is a way of standardising the range of irregular airborne particle loading for measurement and standard-setting.

Particulate matter is generally described by source as being either 'primary' or 'secondary'. Primary particles such as carbon particles from fuel combustion, sea salt and mineral particles derived from construction activities are released directly into the air, whereas secondary particles are formed in the atmosphere by chemical reactions that lead to the formation of low volatility compounds that condense into particles.

The main sources of primary particulate are road transport (combustion emissions, brake and tyre wear and re-entrainment of dust from road surfaces); stationary combustion (such as domestic coal burning); and industrial processes (production of metals, cement, lime, coke and chemicals, bulk handling of dusty materials, construction, mining and quarrying).

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<sup>12</sup> Institute of Air Quality Management (2014). Guidance on the assessment of dust from demolition and construction.

<sup>13</sup> The Air Quality Standards Regulations 2010 (SI 2010 No.1001)

Secondary particles are less easy to ascribe to their original sources. They are comprised mainly of ammonium sulphate and nitrate, originating from the oxidation of sulphur and nitrogen oxides in the atmosphere to acids, which are then neutralised by atmospheric ammonia derived mainly from agricultural sources. The chemical processes involved in their formation are relatively slow and their persistence in the atmosphere is prolonged. Thus, secondary particles are distributed more evenly throughout the air with fewer differences between urban and rural areas. They can also travel large distances, resulting in the transport of particles across national boundaries (AQEG, 2005)<sup>14</sup>.

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<sup>14</sup> Air Quality Expert Group (AQEG), (2005). Particulate Matter in the United Kingdom. Defra, London

## A2 Dust Deposition Monitoring Results

Table A1 Dust Deposition Monitoring Results

Site ID	Site Description	Monthly Dust Deposition Rate (mg/m <sup>2</sup> /d)						
		Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Period Mean
M1	On open grassland on north-west corner of site	32	62	66	18	39	74	49
M2	On open grassland on western perimeter of site, adjacent to bund	19	30	37	17	19	22*	24
M3	Within woodland on western perimeter of site	21	68	44	17	34	56	40
M4	On open grassland, adjacent to light woodland on the south-west corner of the site	9*	18*	59	-	19	36	38
M5	Within light woodland on southern perimeter of site	22	42	86	44	32	87	52
M6	Within woodland on southern perimeter of site	21	55	84	48	27	47	47
M7	Within light woodland on eastern perimeter of site	46	46	94	66	34	76	60
M8	On open grassland on northern perimeter of site	14	-	25	-	30	42	28

\*foam particle trap taken from gauge during sample period. Therefore result does not include mass of material lost with trap, and these values have not been used to calculate the period mean deposition rate.

## A3 Background Particulate Matter Concentrations

**Table A2 2017 Background Particulate Matter Concentrations**

<b>Grid Square</b>	<b>PM<sub>10</sub> Background Concentration (<math>\mu\text{g}\cdot\text{m}^{-3}</math>)</b>	<b>PM<sub>2.5</sub> Background Concentration (<math>\mu\text{g}\cdot\text{m}^{-3}</math>)</b>
489500,504500	9.87	7.02
489500,505500	11.10	7.66
490500,504500	10.53	7.36
490500,505500	11.44	7.82

## A4 Inputs and Outputs of the Emission Factor Toolkit

**Table A3** Input Data into the Emission Factor Toolkit

Vehicle Type	Number of Vehicles During Phase 4	Number of Vehicles per Day (Averaged over Phase 4)	Speed (kph)	Trip Length (km)
HGV	30,720	110	69	64
Cars	33,600	120	60.4	50

**Table A4** Output from the Emission Factor Toolkit

Vehicle Type	Emissions of PM <sub>10</sub> over Phase 4 (kg)
HGV	353
Cars	72
<b>Total</b>	<b>425</b>

## A5 Calculation of Emissions from NRMM

The European Monitoring and Evaluation Programme (EMEP)/European Environment Agency (EEA) Emission Inventory Guidebook 2016<sup>15</sup> provides the following equation to calculate emissions from NRMM:

$$E = N \times \text{HRS} \times P \times (1 + \text{DFA}) \times \text{LFA} \times \text{EF}_{(\text{base})}$$

Where:

- E = mass of emissions generated
- N = source population
- HRS = hours of use over the period
- P = engine size (kW)
- DFA = deterioration factor adjustment
- LFA = load factor adjustment
- EF<sub>(base)</sub> = base emission factor (g/kWh).

The average kilowatt (kW) power ratings for the proposed NRMM are provided in **Table A5**.

**Table A5 Power Ratings of Required Plant During Phase 4 at Woodsmith Mine**

Plant	Power in kW
20T excavator	88
Wacker plate	40
Jet wash	35
73t Truck Crane	335
0.76m <sup>3</sup> Excavator	88
18m Telescopic Boom Lift	62
5m <sup>3</sup> front end loader	70
6T telehandler	90
8m <sup>3</sup> concrete trucks	90
D-wall cutter base crane	709
D-wall cutter base crane	570
90t crawler crane	213
160t crawler crane	230
110t mobile crane	350
MEWP	36
0.76m <sup>3</sup> Excavator	88
1MVA generator	800
1MVA generator	800

<sup>15</sup> EMEP/EEA (2016) *Emission Inventory Guidebook – Non-Road Mobile Sources and Machinery*

Plant	Power in kW
350kVA generator	280
100kVA	80
100kVA	80
50kVA generator	40
50kVA generator	40
20kVA generator	16
20kVA generator	16
10kVA generator	8

The input data used to calculate emissions from NRMM are detailed in **Table A6**.

**Table A6** Input Data Used to Calculate Particulate Emissions from NRMM

Plant	kW	Hours of Use During Phase 4	Number of Units	Load Factor		Emission Factor Stage	Emission Factor (g/kWh)
20T excavator	88	180	3	0.5	0.7	IV	0.025
Wacker plate	40	60	3	0.5	0.7	IIIA	0.200
Jet wash	35	60	3	0.5	0.7	IIIA	0.400
73t Truck Crane	335	26	2	0.5	0.7	IIIB	0.100
0.76m <sup>3</sup> Excavator	88	54	1	0.5	0.7	IV	0.025
18m Telescopic Boom Lift	62	106	1	0.5	0.7	IV	0.025
5m <sup>3</sup> front end loader	70	2,240	1	0.5	0.7	IV	0.025
6T telehandler	90	2,880	1	0.5	0.7	IV	0.025
8m <sup>3</sup> concrete trucks	90	2,880	4	0.5	0.7	IV	0.025
D-wall cutter base crane	709	4,586	1	0.5	0.7	II	0.045
D-wall cutter base crane	570	2,240	2	0.5	0.7	IV	0.045
90t crawler crane	213	1,600	2	0.5	0.7	IIIB	0.025
160t crawler crane	230	1,600	2	0.5	0.7	IV	0.025
110t mobile crane	350	2,240	2	0.5	0.7	IV	0.025
MEWP	36	800	3	0.5	0.7	IV	0.025
0.76m <sup>3</sup> Excavator	88	640	1	0.5	0.7	IV	0.025



## A6 Calculation of Emissions from Generators

For the largest (1 MegaVolt Ampere (MVA)) generators, the particulate concentration in the exhaust gas was provided by the generator manufacturer. The calculated particulate emission rate is presented in **Table A7**.

Table A7 Particulate emission rate from the Phase 4 1MVA Generators

Parameter	Values Used to Calculate Emission Rate
<b>Provided by Manufacturer</b>	
Stack diameter (m)	0.4
Volumetric flow rate (m <sup>3</sup> .s <sup>-1</sup> )	3.586
Efflux temperature (°C)	472
Oxygen (%) (assumed)	9
Particulate concentration (at Standard Temperature and Pressure (STP)) (mg.m <sup>-3</sup> )	130
<b>Calculated Particulate Emissions</b>	
Particulate emission rate (g/h)	420

For the smaller generators, emission rates were calculated using the following equation taken from the EMEP/EEA Emission Inventory Guidebook 2016<sup>16</sup> for combustion sources such as generators:

$$E_{\text{pollutant}} = AR_{\text{fuelconsumption}} \times EF_{\text{pollutant}}$$

Where:

$E_{\text{pollutant}}$  = the emission of the specified pollutant (g.h<sup>-1</sup>)

$AR_{\text{fuelconsumption}}$  = the activity rate for fuel consumption (GJ.h<sup>-1</sup>)

$EF_{\text{pollutant}}$  = the emission factor for the pollutant (g/GJ)

The fuel consumption (AR) of each generator was derived using the power rating of the generators, the load, the electrical efficiency and the utilisation percentage. The EF was taken from EMEP/EEA Guidance. The inputs are detailed in **Table A7**.

Table A8 Input Data Used to Calculate Particulate Emissions from Generators

Number of Generators	Power (kVA)	Power (kW*)	Power Load (%)	Utilisation (%)	Efficiency (%)	AR Fuel Consumption (GJ.h <sup>-1</sup> )	EF (Emission Factor) PM <sub>10</sub> (g/GJ)**
1	350 kVA	280	50	100	40	1.26	11.60
1	100 kVA	80	100	50	40	0.72	11.60
1	100 kVA	80	100	100	40	0.72	11.60
1	50 kVA	40	100	70	40	0.25	11.60
10	50 kVA	40	100	20	40	0.07	11.60

<sup>16</sup> EMEP/EEA (2016) *Emission Inventory Guidebook – Small Combustion*

Number of Generators	Power (kVA)	Power (kW*)	Power Load (%)	Utilisation (%)	Efficiency (%)	AR Fuel Consumption (GJ.h <sup>-1</sup> )	EF (Emission Factor) PM <sub>10</sub> (g/GJ)**
1	20 kVA	16	100	20	40	0.03	11.60
1	20 kVA	16	100	100	40	0.14	11.60
1	10 kVA	8	100	100	40	0.07	11.60

\*Based on kVA to kW conversion of 0.8

\*\* The Emission Factor for diesel oil was used