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Stopit2

Proposed Sand and Gravel Extraction, Haddiscoe, Norfolk

Review of Dust Assessment

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Consultants in air quality & odour assessment

Contents

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Executive Summary

Michael Bull and Associates Ltd (MBAL) was commissioned by Stopit2 to advise on air quality issues associated with a sand and gravel extraction proposal at Haddiscoe, Norfolk. MBAL has reviewed the air quality assessment provided in the Environmental Statement to consider whether this has used an adequate methodology to assess the potential impacts from the proposal. Some further assessment work has also been carried out to examine the use of potentially more appropriate meteorological data, consider how changes in terrain height may affect particulate dispersion and undertake some screening modelling to determine the possible scale of impact from the proposals.

The review shows that, while the assessment has followed expected guidance, it has not responded to the large changes in regulatory environment for fine particulate matter. The Environment Act 2021 clearly stated that a new $PM_{2.5}$ target value would be proposed for England and this proposed value was known at the time of the assessment and is now in place. In addition, the World Health Organisation (WHO) had also published updates to their air quality guidelines in 2021 which resulted in much more stringent PM_{10} and $PM_{2.5}$ guidelines. The assessment has not used these new guidelines and targets to determine the scale of impact from the proposals and therefore has underestimated its impact.

The assessment carried out has not examined the extraction activities on a phase by phase basis, this should have been carried out as the site boundary is within 50m of the closest housing, many of the properties in Haddiscoe are within 400m and the proposal is upwind of the prevailing wind direction. There are 106 properties and an estimated population of 205 people within 400m of the proposals which could be affected by particulate emissions from the proposal.

The assessment method used is the well known Source, Pathway, Receptor approach, while this is an accepted method, it is based on professional judgement. While an accepted method, this method provides no objective analysis of the likely scale of impact. The assessment could be usefully improved by estimation of the likely scale of emissions from each planned source on the site. Emission factors for each activity are readily available from European and US sources. These could then be used in dispersion modelling to determine the scale on impact at nearby receptors and to inform a health impact assessment.

When overall estimates for particulate emissions from sand and gravel extraction are placed into a screening model, this indicates the potential for significant adverse effects at nearby properties. Given the number of properties identified in this modelling as being potentially significantly affected by particulate matter, the applicant should be asked to produce more a more appropriate dust assessment and determine the impact using the revised $PM_{2.5}$ targets.

The impact of terrain height has not been considered, when examined in a wind field model these results in changes to wind speed in the area which impacts on dispersion of particulates. In addition, the applicant has used long term average wind frequency data that does not take into account the considerable variations in frequency on a year by year basis.

This information is available on a more local basis than that used by the applicant and its use would result in a more accurate assessment.

Although some dust mitigation measures are included in the Dust Management Plan there are no proposals for continuous monitoring during operation that would provide a valuable management tool for minimizing dust emissions.

1 Introduction

Michael Bull and Associates Ltd (MBAL) has been commissioned by Stopit2 to advise on air quality issues concerned with a proposed quarry at Haddiscoe, Norfolk. A planning application is being made for sand and gravel extraction for a period of seven years at a rate of up to 100,000 tonnes per annum.

MBAL has been commissioned to undertake three tasks as follows:

- to review the air quality assessment provided with the planning application;
- examine how the use of meteorological data more specific to the study area would affect the outcome of the assessment;
- examine how the consideration of changes in terrain height would affect the assessment;
- Undertake an indicative modelling assessment to determine the likely scale of impacts from particulate matter.

The author of this report is Dr Michael Bull who is an air quality and odour consultant with over 37 years of experience, has published and spoken widely on air quality and odour matters and was a contributing author to the book, Designing with Smells, published by Routledge in 2017. He is a former Vice Chair Institute of Air Quality Management (IAQM) and was the chair of group that produced the IAQM guidance on the assessment of odours for planning and was a member of the working group that produced the IAQM guidance on monitoring of dust near to construction sites.

2 Dust Assessment – Background, Guidance and Policy

2.1 Background – Dust/Particulate Matter

The assessment provided examines levels of disamenity dust and fine particulate matter. Disamenity dust is considered to be larger sized particles with a diameter above 10 microns although the size range is not considered in its measurement. The main observed adverse effect is soiling of surfaces with visible dust which can lead to annoyance (or at extreme levels, damage to property and vegetation). This can be measured in various ways, for instance by measurement of the rate of dust deposition, where the mass of dust falling into an instrument is determined over period of around a month – this is reported as $mg/m^2/day$.

There are no statutory standards for dust deposition although there is custom and practice standard of $200mg/m^2/day$ that is often applied to dust deposition levels.

Human health effects from dust are associated with suspended fine particulate matter with diameters below 10 microns. There are two types of fine particulate matter that have defined air quality standards, PM_{10} (i.e. with a diameter less than 10 microns) and $PM_{2.5}$ (with a diameter less than 2.5 microns). The Air Quality Standards Regulations 2010 and subsequent amendments define Limit Values and Objectives (which are numerically the same) for PM_{10} and $PM_{2.5}$ as shown in Table 1.

Pollutant	Averaging Period	Limit Value ($\mu g/m^3$)
PM_{10}	Annual mean	40
	24-Hour (35 exceedances allowed per year)	50
$PM_{2.5}$	Annual mean	20

Table 1 PM_{10} and $PM_{2.5}$ standards

However, a commitment was made in the Environment Act 2021 to introduce a new $PM_{2.5}$ target and this has been set in the Environmental Targets (Fine Particulate Matter) (England) Regulations 2023 which gives a target for annual mean $PM_{2.5}$ of $10\mu g/m^3$ to be met by the year 2040. An interim target is detailed in the Government's Environmental Improvement Plan 2023 of $12\mu g/m^3$ to be met by the end of January 2028. The focus of particulate matter regulation in England has therefore shifted from PM_{10} to $PM_{2.5}$ (no PM_{10} targets have been set) and as a minimum, the appropriate assessment criterion should be 12 $\mu g/m^3$ as an annual mean.

The World Health Organisation (WHO) also publishes air quality guidelines which were revised in 2021. These do not have any statutory authority in the UK but are based on observed health effects. The guidelines are 15 $\mu g/m^3$ for PM_{10} and $5\mu g/m^3$ for $PM_{2.5}$[1]. Note that both the new England $PM_{2.5}$ target and the WHO 2021 guideline represent substantial reductions compared with the standards in Table 1.

[1] https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health

2.2 Relevant Guidance

There is some very general guidance on assessment in the National Planning Policy Framework Planning Practice Guidance on minerals[2] which was produced in 2014. The approach is essentially to assess the risk that a development would result in a risk of exceeding a relevant air quality objective. The guidance provided relates to PM_{10} although could readily be applied to other pollutants.

The is also non-statutory assessment guidance[3] from the Institute of Air Quality Management (IAQM) that was produced in 2016. This provides a framework for assessing dust impacts and their significance. This approach has been used in the dust assessment for the project and is described in the dust assessment.

It should be noted that all of the available guidance predates more recent developments in air quality standards and targets and was based around compliance with the PM_{10} values in Table 1. Since these guidance documents were produced, the target values for $PM_{2.5}$ have reduced by 40% with a longer term aim to reduce by 50%. This is significant when the advice in the guidance is considered alongside these changes.

Also relevant is the EPUK/IAQM guidance on Land Use Planning and Development Control: Planning for Air Quality[4]. This provides a framework for determining the impact from predicted changes in pollutant concentrations as shown in Table 2.

[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/579117/minerals1_033.pdf accessed 26/4/23

[3] IAQM (2016) Guidance on the Assessment of Mineral Dust Impacts for Planning. Institute of Air Quality Management, London

[4] EPUK/IAQM, (2017) Land-Use Planning & Development Control: Planning for Air Quality.

Table 2 EPUK/IAQM Impact Descriptors

Long term average concentration at receptor	% Change in concentration relative to Air Quality Assessment Level (AQAL)			
	1	2-5	6-10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76-95% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

2.3 Relevant Policy

Specific Site Allocation Policy MIN25 in the Norfolk Minerals and Waste Local Plan May 2022 discusses this site. It notes that adverse dust impacts are uncommon 250m from dust generating activities and that the greatest impacts are within 100m, therefore operational areas would require at least a 100m set back (M25.1). The policy also requires that mitigation measures would deal appropriately with any amenity impacts.

3 The Proposed Development

The proposed development is on land known as Manor Farm Haddiscoe; the aerial plan provided in the Environmental Statement is shown in Figure 1. The site is currently agricultural land. There are residential properties north of the site on Church Road (within 40m), north east of the site (<80m) to the east of the site (~80m) on The Loke and south of the site on Loddon Road. There are 106 properties within 400m of the site boundary but this number would rise by approximately 35 houses if a proposed housing development for Haddiscoe is passed as part of the Norfolk Village Clusters Housing Plan.

The proposed development is to extract 1.3 million tonnes of sand and gravel from a 21.5 hectare extraction and processing area with a maximum extraction rate of 100,000 tonnes/year.

The site will be worked in seven phases as detailed in Figure 2. In each phase, topsoil and subsoil will be stripped and used for constructions of screening and storage bunds. This will then be used for restorations. Separation of sand and gravel will take place on site, the gravel to be transported offside for further processing. Extraction activities will take place at least 100m from properties but the site boundary is within 40m of sensitive receptors. Some dust producing activities such as bund construction will take place closer than 100m from properties.

The following activities may give rise to dust emissions:

- Site preparation and topsoil stripping, bund and screening construction;
- Extraction of sand and gravel;
- Handling of minerals and transport on-site;
- Mineral processing to separate sand and gravel; and
- Dust from open surfaces.

Very generally, the higher risk activities are site preparation and construction and transport on site, however, high levels of dust can also be generated from open surfaces if these cover a large enough area.

4 Review of Dust Assessment

This section has reviewed the air quality/dust assessment submitted in the Environmental Statement and includes reference to earlier chapters describing the proposed development. The planning application was validated by the planning authority in December 2022.

4.1 Report Authors

The assessment has been carried out by Air Quality Assessments Ltd, MBAL are not familiar with this company but the principal author is a member of the IAQM and appropriately qualified for this assessment.

4.2 Methodology

The assessment has methodologies detailed in the relevant IAQM guidance for assessment. One method used is a type of Source Pathway Receptor (SPR) approach, where each possible source of dust is examined and the scale of the "residual source emission" determined, the effectiveness of the pathway for dust to travel from the source to a sensitive receptor is determined and finally the receptor sensitivity considered. Any residential receptors would be considered to as High sensitivity.

This method is a simple approach but suggested within the guidance for this type of assessment and would be the expected approach. However, the IAQM guidance was published in 2016 (with a more recent revision) and as noted, air quality standards for particulate matter have changed and the advice requires updating to reflect these changes. The IAQM guidance relates almost entirely to PM_{10} and not to $PM_{2.5}$. A revision to the $PM_{2.5}$ standard was part of the Environmental Act 2021 and there was a consultation in May 2022 on the likely new targets. The figure of 10µg/m^3 was well known as the potential target at the time of the assessment and therefore it would be reasonable to include in the assessment. Furthermore the regulations were in place at the time the Regulation 25 response to Norfolk County Council was prepared and there is no reference to the new standards within the response (nor any mentioned at all of $PM_{2.5}$).

The current dust assessment does not provide an assessment against the new target values and the interim value. Although not formally placed into legislation at the time of the assessment, the change in regulatory environment was known and it is surprising this was not considered. This is an important matter when considering whether an appropriate assessment method has been used. Where there is concern regarding the potential human health effects, a more detailed assessment method would be appropriate to provide confidence that the impacts were acceptable.

4.3 Baseline particulate matter concentrations

Background particulate matter concentrations have been obtained from the Defra background maps. This is an appropriate source of this information. However, the information has only been obtained for PM_{10} and there is no consideration of $PM_{2.5}$. This is an important omission as the comparison of $PM_{2.5}$ backgrounds concentrations with the new targets gives a different impression of the background levels.

Grid Square	PM_{10} (% of WHO Target)	$PM_{2.5}$ (% of UK Target)
643500, 296500	15.2 (101%)	8.7 (87%)
643500, 297500	14.6 (97%)	8.7 (87%)
644500, 296500	13.7 (91%)	8.4 (84%)
644500, 297500	13.0 (87%)	8.2 (82%)
Objective/WHO Target (µg/m^3)	**40/15**	**25/10**

Table 3 Background PM_{10} and $PM_{2.5}$ concentrations

The levels reported are correct but the reporting of how these level compare with air quality objectives/standards requires updating for comparison with the new targets and comment against the WHO guidelines. This would change the reporting quite dramatically. For instance, the report states that the predicted PM_{10} background is below the objective. While this is true, it exceeds the revised WHO guideline in one case and is over 90% of the target in most grid squares. Similarly, the background concentrations represent a significant proportion of the new air quality target and are well above the proposed WHO target of 5µg/m^3.

The dust assessment report refers to the IAQM guidance that if the predicted background PM_{10} concentration is below 17µg/m^3 there is little risk of an exceedance of the relevant air quality objective. But this was based on the older objectives and clearly a lower value would now be appropriate based on the most recent evidence, this should have been considered in the assessment. The applicant also fails to recognise the new $PM_{2.5}$ targets in their Section 25 response. While they state that Public Health has not provided any evidence that background levels are above 17µg/m^3 (the threshold value for a health assessment in the IAQM guidance) their response ignores the recently introduced more stringent standards and how these would affect the decision for a more detailed health assessment. The Health Impacts Assessment submitted also does not refer to the new targets for $PM_{2.5}$ and the more stringent guidelines proposed by the WHO. Given that the WHO now suggest a target value of 15µg/m^3 for PM_{10}, claiming that there are no health effects where the background levels do not exceed 17 µg/m^3 is clearly incorrect.

4.4 Potential Impacts

The assessed disamenity dust impacts are reported in Section 6.1. Tables 6.1 – 6.6 provide the Pathway Effectiveness and estimated dust risk for relevant receptors during various phases of the project (site preparation, mineral extraction, materials handling, onsite transport, exposed surfaces and stockpiles and offsite transportation). Note that this exercise has only been carried out for disamenity dust and not PM_{10}/$PM_{2.5}$ because this was excluded (see Section 4.3 of this report).

This assessment has only been carried out in general terms and not on a phase by phase basis. The SPR assessment method is essentially a qualitative assessment approach where professional judgement is a key part of the assessment. This means that different assessors can take different views particularly on the Source Magnitude and Pathway Effectiveness. To provide more evidence for the categories selected, it is possible to examine the relative scale of the dust emissions from each activity and provide estimates of these. There are several sources of emission factors that could be applied including the United States Environmental Protection Agency AP42 document[5] and the European Environment Agency/EMEP air pollutant emission inventory guidebook[6]. Overall emission factors are also provided in the UK National Atmospheric Emissions Inventory[7].

Transport of dust towards sensitive receptors is partly dependent on the wind direction. As can be seen from the Norwich wind rose provided in the assessment, the proposal places dust generating activities directly upwind of the prevailing wind direction. This increases the risk of potential adverse impacts to the local community and requires further investigation.

The assessment has also omitted some sensitive receptors near to the development. These have been identified by Stopit2 as Hunters Lodge and White House Farm on Thorpe Road and Windy Ridge and 1 Gravel Pit Lane on Gravel Pit Lane. These are located very close to the site boundary.

Given the proximity of some receptors within 40m of the site boundary and the potential for human health effects, the SPR method does not provide sufficient information to confidently assess the potential dust impacts from the proposal. As shown in Section 5, by taking information from the National Atmospheric Emissions inventory regarding particulate emissions, a much larger impact is predicted using a method that is not based on professional judgement. The value of such an approach is that it provides a quantitative assessment of the scale of impact that is not based on professional judgement and allows a more objective assessment of impacts.

4.5 Potential Impacts to Human Health.

Section 6.2 discusses potential impacts to human health and discounts these as background concentrations are below 17 µg/m^3 and monitored levels were below the 2010 air quality standards. The same approach is taken in the Health Impact Assessment submitted. However, this has not considered the changes in regulatory environment for $PM_{2.5}$ (and the thinking on PM_{10} in general). This has changed considerably since the publication of the IAQM guidance and it is no longer justified to use the IAQM threshold. Indeed given the increased focus of $PM_{2.5}$ concentrations, a details assessment of the potential impacts, potentially using some dispersion modelling to assess the likely scale of change in concentrations would have been appropriate. This is considered to be a major omission from the report and requires further information.

4.6 Mitigation Measures

Some details of mitigation measures are provided in Section 10.5 of the Environmental Statement and a draft Dust Management Plan provided. However, this plan only proposes

[5] https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors
[6] https://www.eea.europa.eu//publications/emep-eea-guidebook-2023
[7] https://naei.beis.gov.uk/

visual dust monitoring and no continuous monitoring for particulate matter. This provides only limited protection for the local residents given that concentrations of PM_{10} and $PM_{2.5}$ could be well above the standards without any visible sign of emissions. Equipment for continuous monitoring of particulate matter that can automatically alert the site management to increased dust emissions is readily available and fitted almost as standard at major construction sites. This would be a minimum expectation for this type of activity to provide reassurance particulate emissions were being controlled and to provide an audit trial should any incidents of elevated levels be noted.

4.7 Summary

The assessment has followed expected guidance and methodologies. However, the assessment has not taken into account the considerable changes in regulation since the publication of these documents, particularly the more stringent $PM_{2.5}$ targets. By not considering these changes, the assessment has not assessed the human health impacts of $PM_{2.5}$. This is considered to be a major omission.

Estimates of dust emission rates have not been made for the major activities on site and it is therefore not possible to assess their relative size and potential for adverse effects. For a development of this nature, a semi (or fully) quantitative assessment would be an expected approach. Extraction activities will be 100m from properties but the development site boundary is within 40m of residential receptors and within 400m of many of the properties in Haddiscoe.

The SPR assessment method used relies on professional judgement which can clearly be open to interpretation depending on the assessor. As this application proposes particulate generating activities close to sensitive receptors, a more objective assessment method is required to provide the planning authority with more objective information.

More detail is required regarding the mitigation measures, some outline details have been provided but the DMP proposed should be compiled at this stage and should include monitoring given the distance to sensitive properties.

5 Wind and Dust Modelling

As noted in Section 4, the SPR assessment method relies on professional judgement and consequently provides a less objective approach than quantitative methods such as modelling. This section provides an initial assessment using quantitative methods to demonstrate the potential for adverse impacts from this proposal. Three different approaches have been undertaken, firstly looking at overall particulate emission rates from sand and gravel extraction and using these in screening modelling to show the predicted increases in particulate concentrations, secondly the effect of local terrain conditions on wind patterns has been assessment and finally the use of site specific meteorological data has been examined.

5.1 Dust Screening Modelling

Overall particulate dust emission rates for sand and gravel extraction are provided in the National Atmospheric Emissions Inventory[7]. This details an emission rate of 0.1 kilotonnes per megatonne of mineral extracted (or 100 grammes per tonne). For this proposal with an extraction rate up to 100,000 tonnes a year this results in a particulate emission rate of 10,000 kg/year. This emission rate can be applied to an area source representing a phase of the development, this has been carried out for Phases 4 and 5 (see Figures 3 and 4).

The assessment has used the ADMS 6.0 model, a widely used dispersion model for regulatory and planning purposes in the UK. The model has been set up with a single area source to represent each phase. Numerical Weather Prediction (NWP) meteorological data for the area has been obtained from Air Pollution Services Ltd. This provides weather data that is specific for the local area (within 3km). The model has been set up to predict the annual mean particulate concentrations using a 2000 by 2000 grid with receptors at 22m intervals. The surface roughness has been set to 0.3m (agricultural area). All other model options have been set to their default values.

The results are shown in Figure 5 and 6 for Phases 4 and 5 respectively. The increase in annual mean particulate concentrations in is up to 10 µg/m^3 at residential properties. This increase is for total particulate but it would be expected (using information from the NAEI) that 50% of this would be PM_{10}. Monitoring of $PM_{2.5}$ levels near to sand and gravel works has shown that $PM_{2.5}$ levels are around 56% of the PM_{10} levels[8]. This suggests that $PM_{2.5}$ concentrations could increase by 2-3 µg/m^3. This represents a change of up to 25% of the air quality assessment level (i.e. the $PM_{2.5}$ target set by the UK government). This would represent a moderate to substantial impact according to the EPUK/IAQM guidance (see Table 2). Stopit2 has counted the properties and residents within 400m of the proposal and there are 106 houses and approximately 205 people within this distance who would be affected by increases in particulate concentrations. Given the numbers of people potentially affected by the development, the developer should undertake a quantitative dust assessment and compare the results within the revised particulate standards particualrly for $PM_{2.5}$.

The MBAL modelling has been carried out on a screening basis assuming the dust emissions are evenly spread over the area of each phase. In reality, the emissions will be concentrated

[8] Dustscan, Dust Assessment : Proposed Quarry near Wasperton, Warwickshire, August 2022.

around particular activities such as the haul roads and extraction/storage areas. The emission rate used is also an overall emission rate and not specific to the individual activities (although taken from a reputable source). Inclusion of these factors may result in increases or decreases in predicted concentrations but given the predicted increases, it is clear that a much more detailed assessment than that provided is required to understand the potential impacts of the proposed development.

5.2 Impact of Local Terrain Heights

Changes in terrain height can affect wind speed and direction, these changes would then also affect how particulates disperse from the proposed development site. The terrain heights in the area have been obtained from OS Terrain 50 files and those used in the modelling are shown in Figure 7. As can be seen, the area is characterized by very flat and low terrain to the north east with a higher ridge (with a small valley running roughly north east to south west). The proposal is on the north east face of the ridge. This will result in changes in wind speed and direction in the area.

This can be seen using the ADMS model which includes a wind field model that calculates the wind speed and direction at every point within the model domain. To illustrate the possible changes, the ADMS model has been run for two single weather conditions, south westerly winds and north easterly winds at 5 m/s (a typical wind speed for the UK). As can be seen from the results in Figures 8 and 9, the terrain results in changes in wind speed, and to a limited extent, changes in wind direction.

The impact on these changes on predicted concentrations can be assessed with the ADMS model. The model has been rerun including the terrain data for the same cases (i.e. Phase 4 and 5) assessed in Section 5.1, the results are shown in Figures 10 and 11. As can be seen, the inclusion of terrain into the modelling changes the shape and extent of the area affected indicating that it is an important factor to take into account in the modelling.

5.3 Use of site specific meteorological data

The assessment in the Environmental Statement has used meteorological data from Norwich. This is approximately 28 km from the site and located further inland and the wind rose is shown in Figure 12 for the year 2020. This has been compared with the site specific rose for Haddiscoe for 2020 which is shown in Figure 13 and for the years individual years of 2016-2019 in Figure 14.

As can be seen, although there are overall similarities between the Norwich and the Haddiscoe data, there are considerable inter year differences between the five years of data available. This is why guidance on assessment suggests that you use 3-5 years of meteorological data and select the worst case year. Taking a long term average, as has been done in the Environmental Statement will average out the individual differences between years and hence may results in an underestimate of the impacts.

6 Summary and Conclusions

MBAL has been asked to review the dust assessment report prepared for the proposed sand and gravel extraction near to Haddiscoe, Norfolk. The review shows that, while the assessment has followed expected guidance, it has not responded to the large changes in regulatory environment for fine particulate matter. The Environment Act 2021 clearly stated that a new $PM_{2.5}$ target value would be proposed for England and this proposed value was known at the time of the assessment and is now in place. In addition, the World Health Organisation (WHO) had also published updates to their air quality guidelines in 2021 which resulted in much more stringent PM_{10} and $PM_{2.5}$ guidelines.

These changes should have been recognized in the assessment, particularly when considering the potential human health impacts. The dust assessment has used the threshold of 17µg/m^3 for background concentrations of PM_{10} detailed in the IAQM guidance to state that no detailed health assessment is required. However, this threshold was based on the older PM_{10} standard and given that particulate matter standards have since become much more stringent, this threshold should have been reconsidered in the assessment and a lower value selected. The absence of an assessment of the human health impacts of $PM_{2.5}$ is considered to be a major omission.

The SPR assessment method used in the Environmental Statement is a recognised approach for this type of assessment but relies on professional judgement. Extraction activities will take place 100m from properties but the proposal boundary is within 40m of sensitive properties. Some dust producing activities such as bund preparation will therefore be closer to properties than 100m. Given the number of residential properties that are within 400m, a more detailed assessment would be appropriate. The assessment could have been improved by adding quantitative elements. The dust emission rates for the individual activities could estimated using published emission factors and these could have informed the assessment.

MBAL has used emission information taken from the UK National Atmospheric Emissions Inventory to estimate the overall particulate emissions from the proposed sand and gravel extraction. These were then placed into a dispersion model to calculate the increase in particulate concentrations in the area. This modelling showed that the scale of increase in $PM_{2.5}$ concentrations cannot be discounted and are potentially significant. A more detailed quantitative assessment should be provided to investigate the impacts of this proposal.

The impact of the changes in terrain height have been considered by examining how these affect the wind field in the area and the consequent impact on dispersion of dust from the proposed development. Although much of the area is relatively flat, the proposal is on an area of land that is elevated and the terrain levels are variable in the area. By using the ADMS model, it has been shown that these terrain changes affect dispersion changing the wind speed as it passes on the higher ground. This then results in changes in the dispersion patterns of dust as illustrated by the changes in predicted concentrations when terrain is included in the model. The impact of terrain height changes therefore needs to be included in the assessment.

The are differences between the meteorological data used in the Environmental Statement and more local data available. More importantly, there is a considerable inter year variation between individual years of data which may result in an under estimate of the overall impacts.

A comprehensive dust mitigation plan has not been included in the assessment and continuous dust monitoring has not been proposed. A DMP is therefore required and this should include continuous monitoring.

Glossary of Terms

ADMS : Atmospheric Dispersion Modelling System – a well known dispersion model.

AQAL : Air quality assessment level.

DEFRA : Department of Environment, Food and Rural Affairs.

EPUK : Environmental Protection UK.

IAQM : Institute of Air Quality Management.

MBAL : Michael Bull and Associates Ltd.

PM_{10} : Fine particulate matter with a diameter of less than 10 microns.

$PM_{2.5}$: Fine particulate matter with a diameter of less than 2.5 microns

SPR : Source, Pathway, Receptor – an assessment method detailed in the IAQM guidance

WHO : World Health Organization

Figures

Figure 1 Aerial Plan of Site (Source - Submitted Planning Application Drawings)

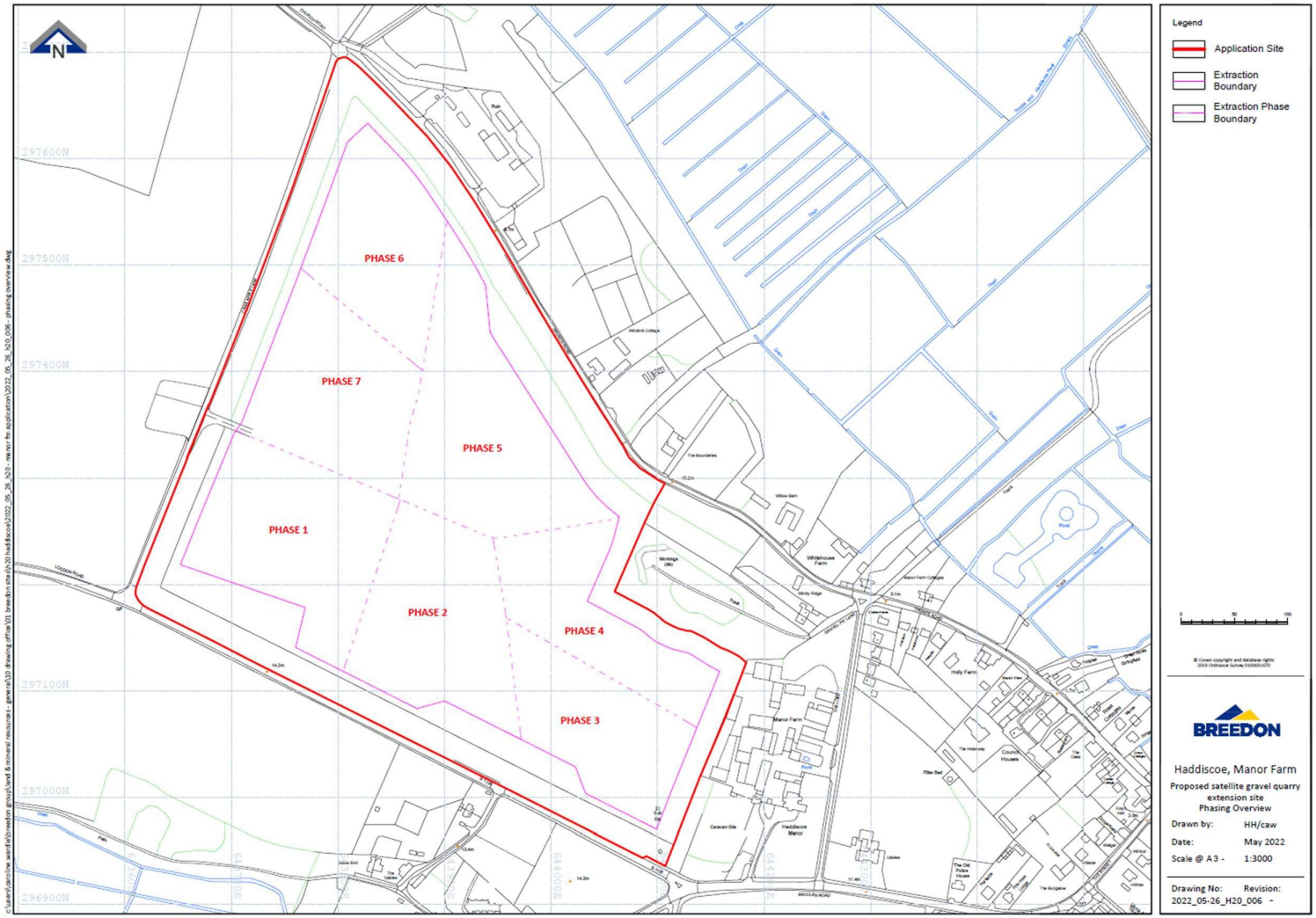

Figure 2 Proposed Site Phasing (Source: Submitted Planning Application Drawings)

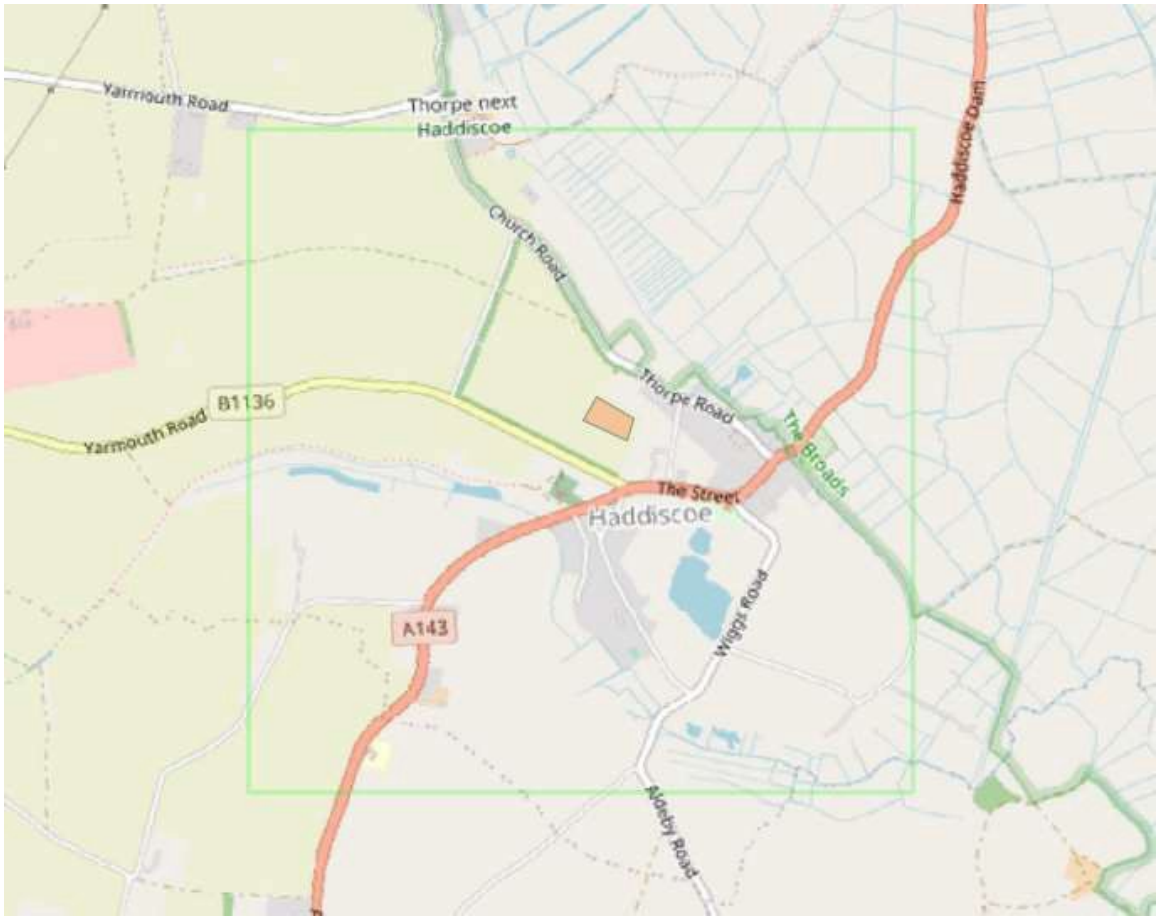

Figure 3 Phase 4 dust modelling

Figure 4 Dust Modelling Phase 5

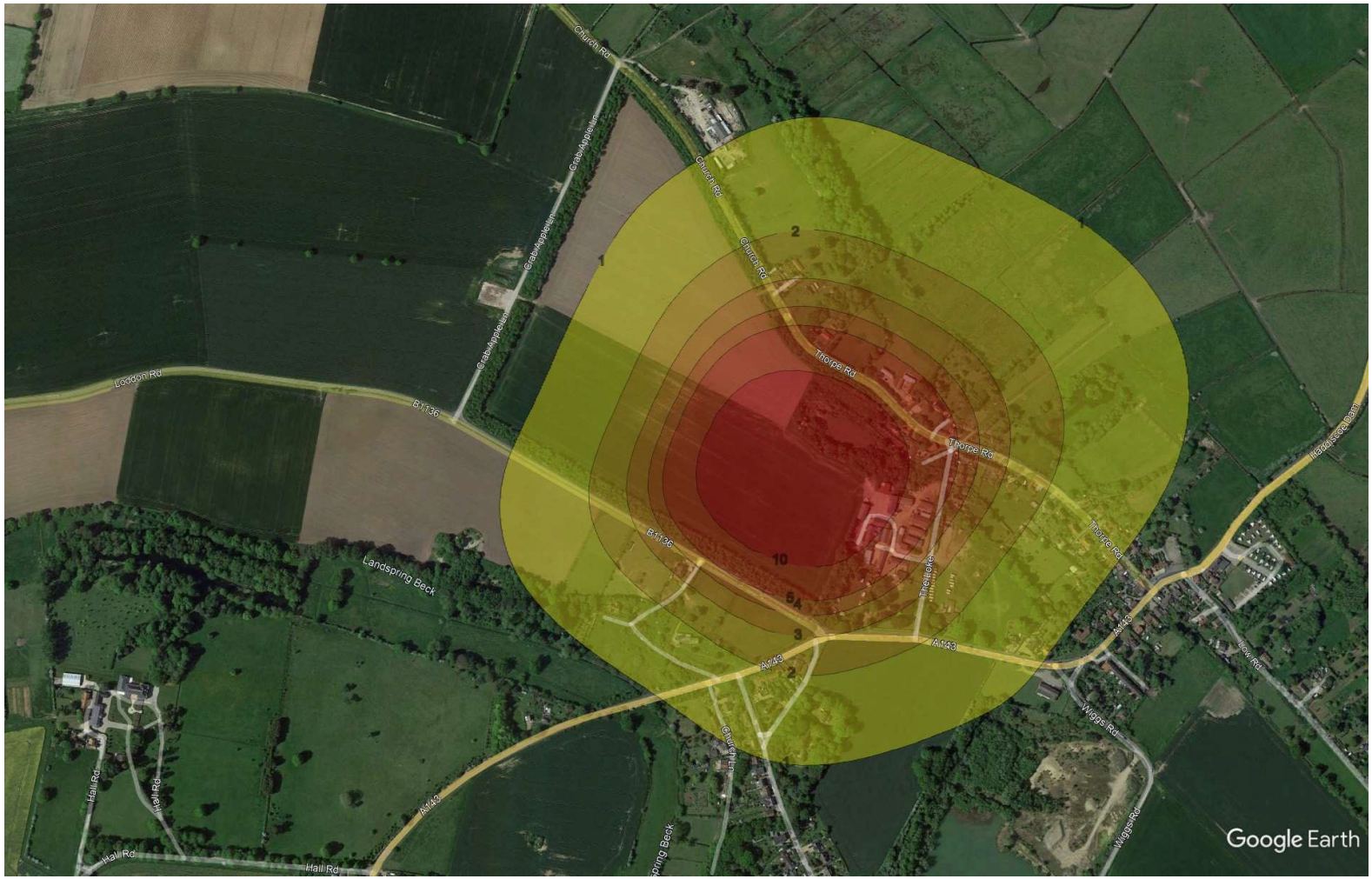

Figure 5 Predicted increase in annual mean particulate levels (µg/m^3) - Phase 4

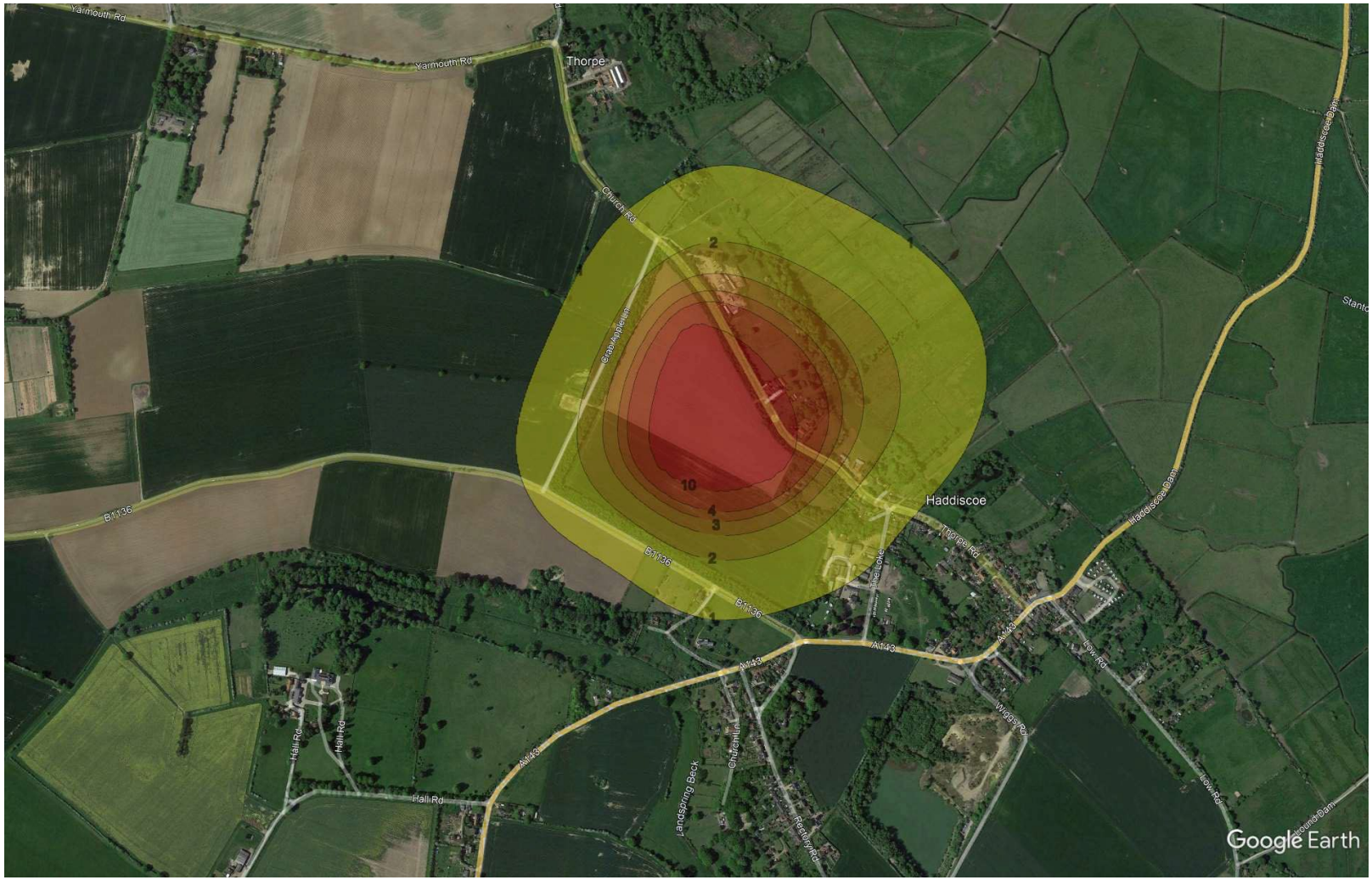

Figure 6 Predicted increase in annual mean particulate levels (µg/m^3) - Phase 5

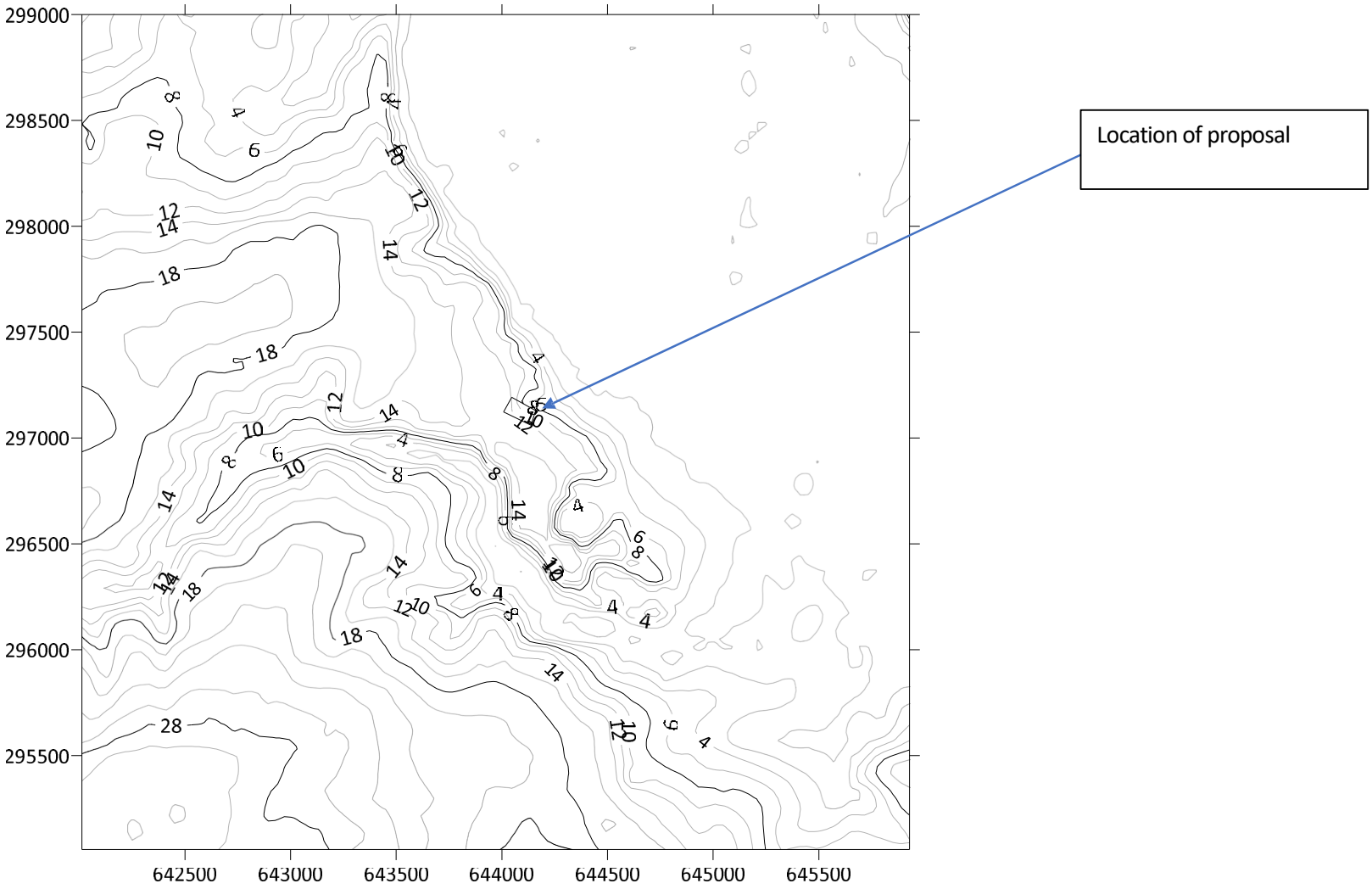

Figure 7 Terrain Heights used in Model

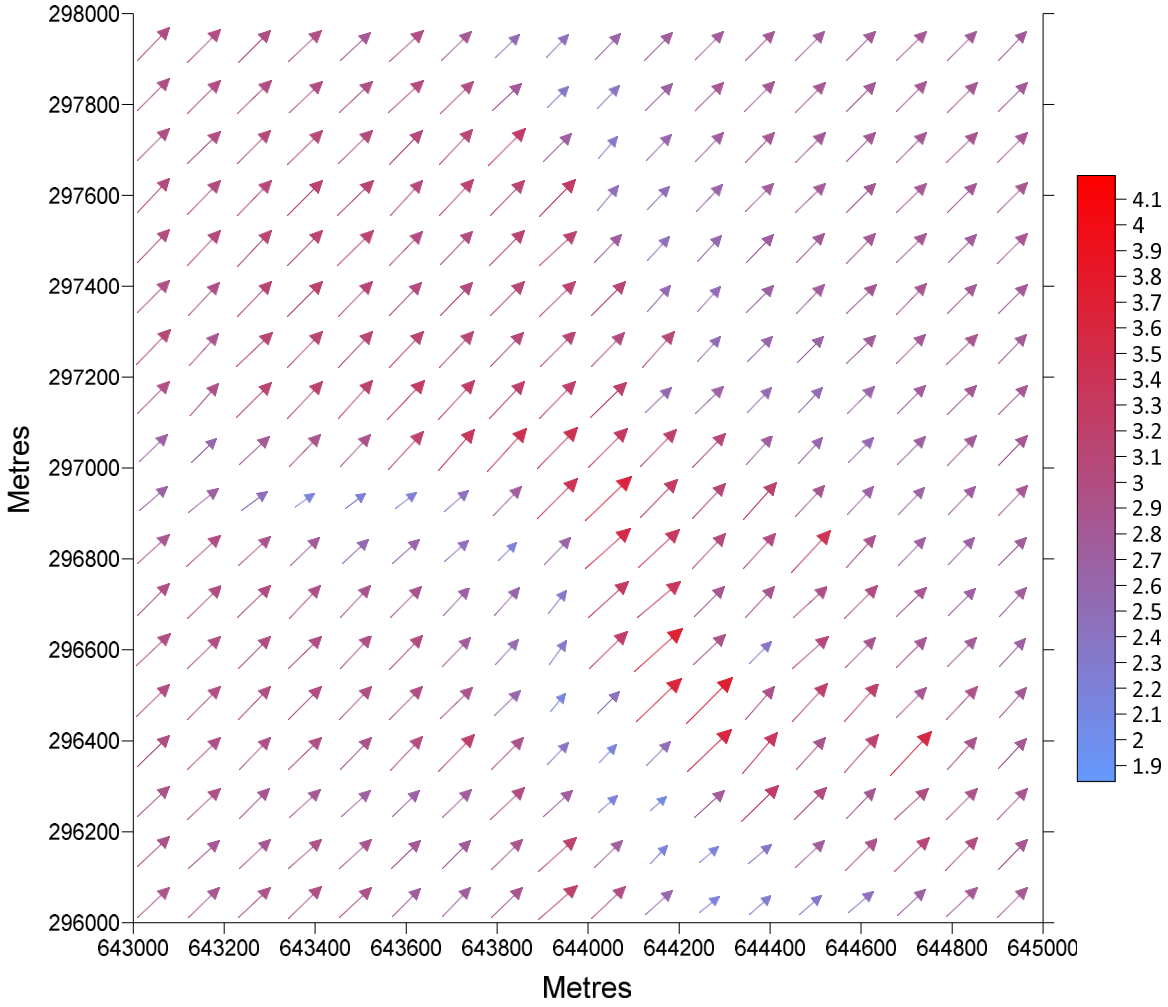

Figure 8 Wind field model output - south westerly winds, 5m/s

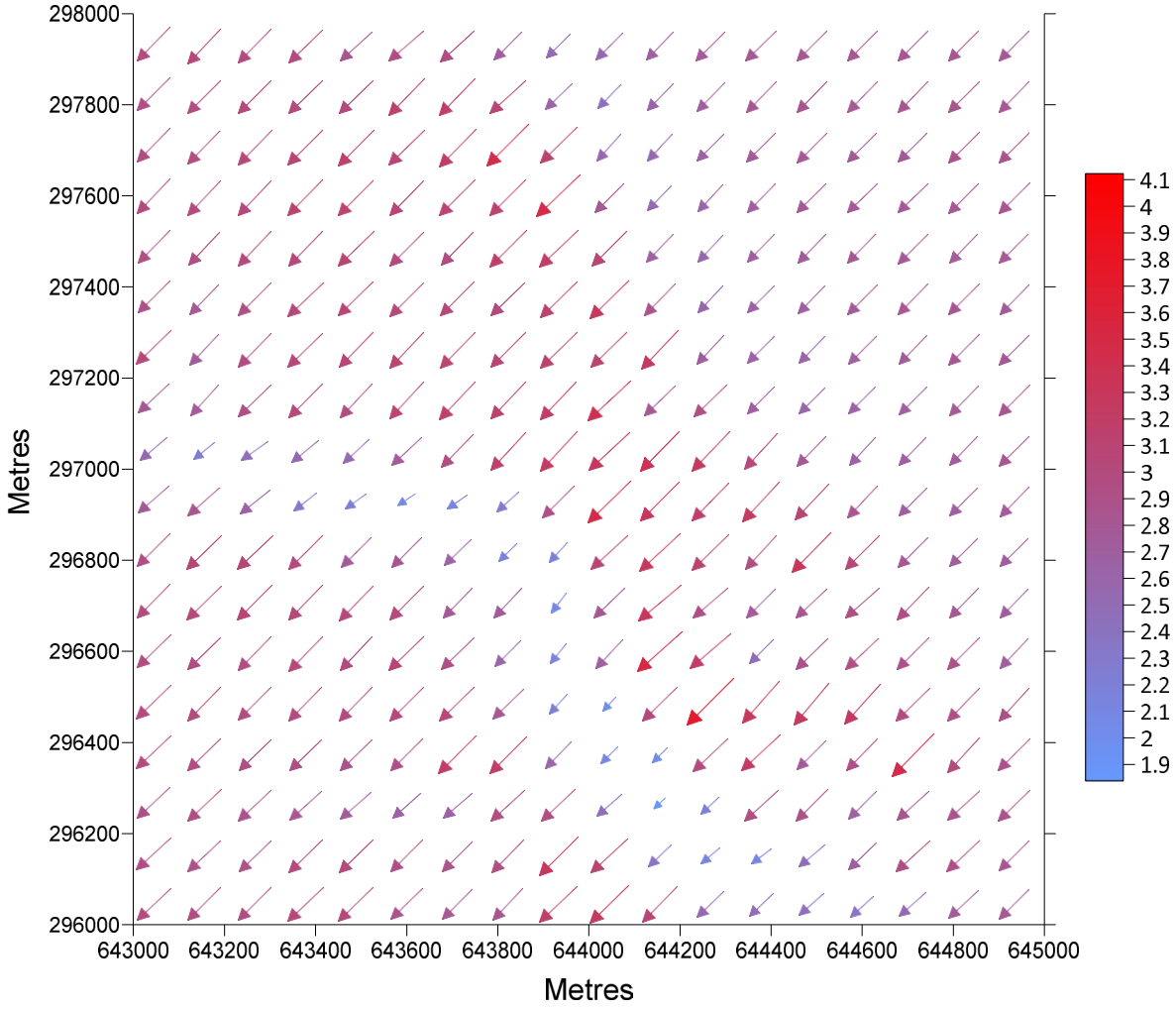

Figure 9 Wind field model output, north easterly winds 5 m/s

Figure 10 Annual Mean Particulate Concentrations (µg/m^3) Phase 4 - with terrain

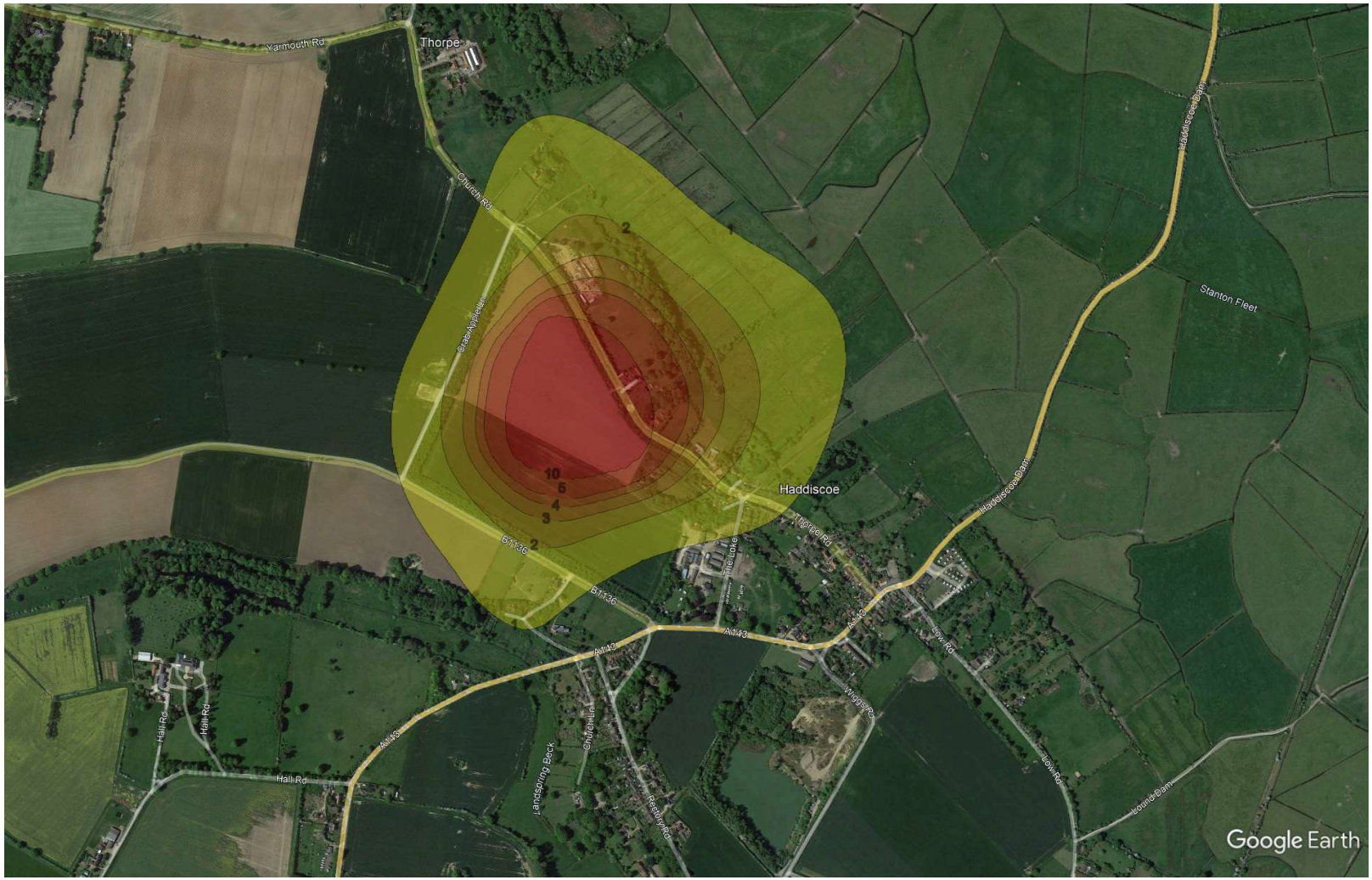

Figure 11 Annual Mean Particulate Concentrations (µg/m^3) Phase 5 - with terrain

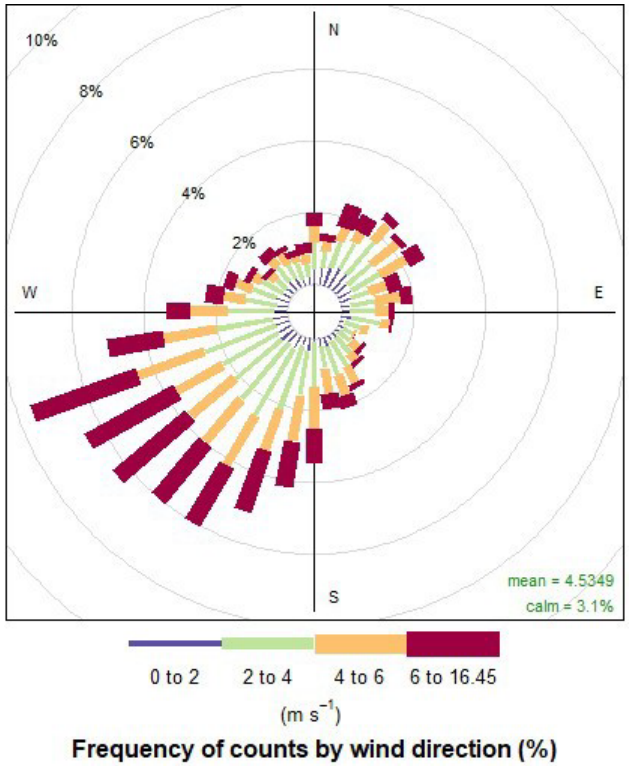

Figure 12 Wind Rose for Norwich 2020

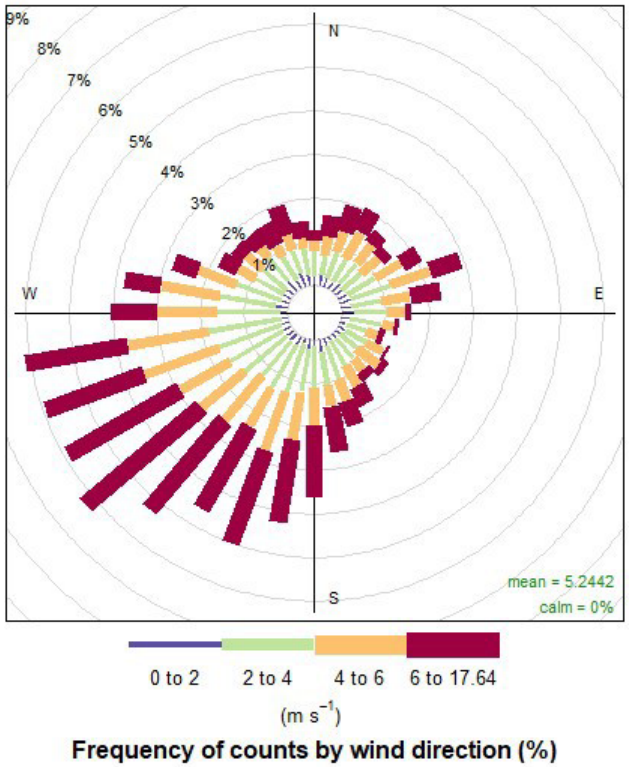

Figure 13 Wind Rose for Haddiscoe 2020

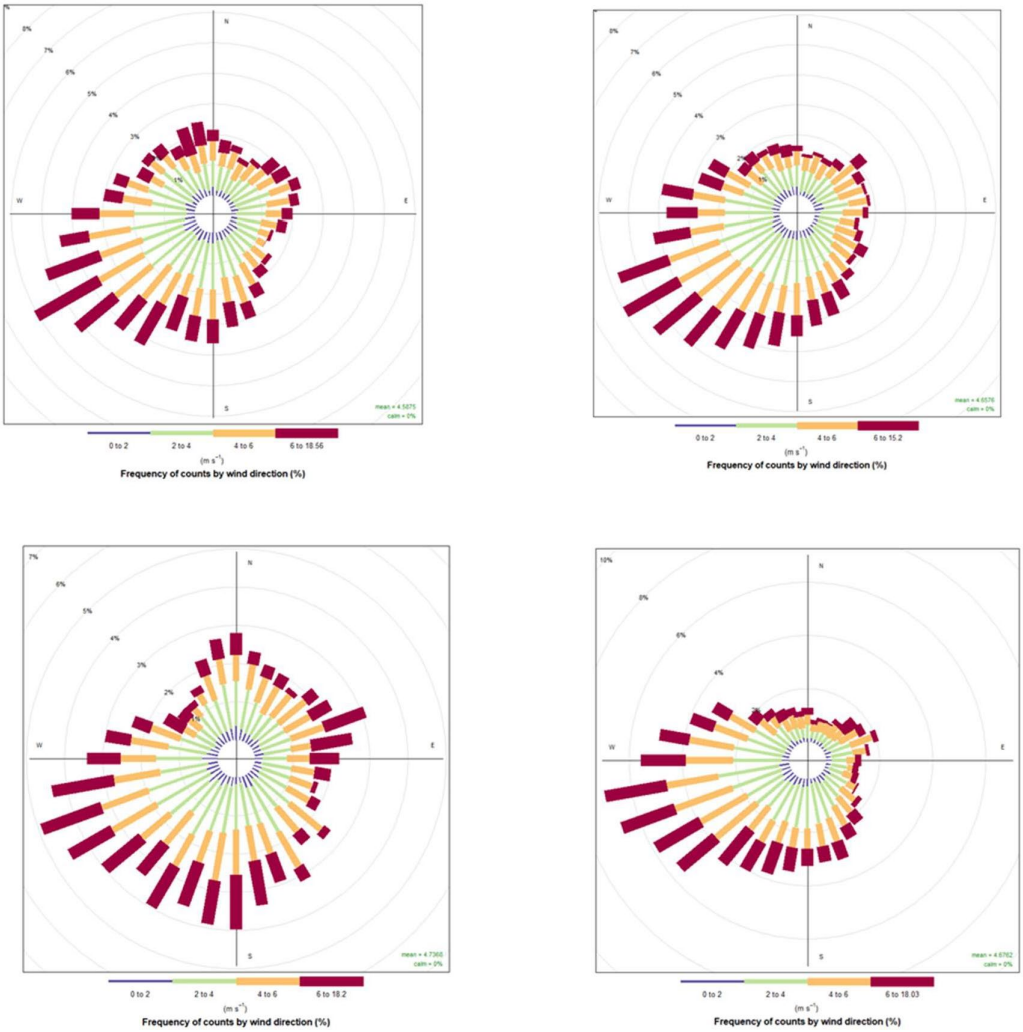

Figure 14 Wind roses for Haddiscoe 2016-2019