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Calder Valley Small Waste Incineration Plant: review and provision of independent advice

Final report

Prepared for
Calder Valley Skip Hire

17th November 2023

CERC

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Author(s):	Rose Jackson, Sarah Strickland, James O'Neill, Amy Stidworthy
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Executive Summary

Cambridge Environmental Research Consultants Ltd (CERC) was commissioned by Calder Valley Skip Hire (CVSH) to provide independent advice on the effect of trees on dispersion, and to review the modelling which has been undertaken using ADMS of a proposed Small Waste Incineration Plant (SWIP) in Sowerby Bridge. This followed an appeal made by CVSH against the refusal of an Environmental Permit application to operate the SWIP and the subsequent Appeal Decision dated 5 July 2023 which dismissed the appeal. A main reason for refusal was the effect of nearby trees on dispersion of emissions from the SWIP relative to the discharge height of the stack

CERC undertook nine tasks which included the following: a site visit; review of relevant documentation; discussion of surface roughness, how it is used in the ADMS dispersion model and how it was applied in the main assessment undertaken by RPS; advice on appropriate methods for treating the impact of tress on dispersion in ADMS; reporting.

The conclusion of the study is that assessment carried out by RPS is robust. More specifically we have shown that the values of surface roughness used by RPS to represent the impact of tress on dispersion are appropriate and that representing the trees around the site as buildings has only a very small effect on calculated pollutant concentrations at sensitive receptors. This is because all sensitive receptors are sufficiently far from the site that the precise details of the dispersion near the site has little impact.

1 Introduction

Cambridge Environmental Research Consultants Ltd (CERC) was commissioned by Calder Valley Skip Hire (CVSH) to carry out services relating to the proposed Small Waste Incineration Plant (SWIP) at Belmont Industrial Estate, Rochdale Road, Sowerby Bridge, Calderdale, HX6 3LL. CERC was commissioned to review the ADMS modelling of emissions from the SWIP and to provide independent advice regarding the effect of trees on dispersion.

This followed an appeal made by CVSH against the refusal of an Environmental Permit application to operate the SWIP and the subsequent Appeal Decision dated 5 July 2023 which dismissed the appeal. A main reason for refusal was the effect of nearby trees on dispersion of emissions from the SWIP relative to the discharge height of the stack. Of note is that CERC are the developers of ADMS and have an in-depth knowledge and expertise of both the science on which the model is based and the model functionality.

This report (Task 9) covers the following Tasks which CERC was commissioned to undertake:

1. A site visit to understand the location and layout of the site and the location and size of the surrounding woodland.
2. Review the Air Quality Assessment, the Appeal Decision, the Tree/Woodland Assessment Plan, the Inspector's questions concerning the trees/woodland and RPS' replies to those questions with a particular focus on how trees were considered in the model.
3. Provide a detailed explanation on how surface roughness operates within the model and how this would affect the dispersion.
4. Include within the detailed explanation whether and, if so, how the surface roughness length is applied to or interacts with or operates within the model in conjunction with the site-specific terrain data.
5. Advise whether the surface roughness length of 1 m used in the main assessment is appropriate for the site, its stack height, its valley location and the trees/woodland and whether the sensitivity tests, including the increased surface roughness used in the sensitivity test, are reasonable.
6. According to the User Guide, a surface roughness length of 1.5 m simulates within the model large urban areas. As appears from the Air Quality Assessment the results at the sensitive receptors were negligible both when a surface roughness length of 1m for woodlands was selected and when, by way of a sensitivity test, a surface roughness length of 1.5 m was selected. The site is not located in a large urban area but it is located in a valley with trees at a higher elevation than the top of the stack. What conclusion, if any, is one entitled to draw from the negligible results in the sensitivity test when the surface roughness of 1.5 m was selected?
7. Advise whether the approach outlined by the Inspector of treating trees as, or similar to, solid structures is appropriate.
8. Advise whether there are alternative approaches of treating trees that are likely to be more accurate and/or representative for this situation.

2 Site visit

Task 1

A site visit to understand the location and layout of the site and the location and size of the surrounding woodland

A site visit was made on 20th September 2023 by Amy Stidworthy, an Associate Director of CERC.

A selection of photographs is presented in Figure 2.1. These show the location of the stack and the extent to which it is surrounded by trees, and give an indication of the density of the trees.

The tree foliage was quite dense at the time of the visit. There were trees close to the stack and the trees were significantly higher than the stack. The day was wet and windy, but the trees downwind around the edge of the site were moving much less than at the top of the canopy, suggesting significant sheltering. In full leaf, the trees did seem to be having an impact on the air flow, though not as much effect as buildings would. As the trees are almost all deciduous, any effects would be much reduced during the dormant months.

Overall, the site visit confirmed that the details of the site and their impact on the dispersion of pollutants emitted to the atmosphere were considered in the assessment.

Figure 2.1: Photographs from site visit, 20th September 2023

3 Review of documentation

Task 2

Review the Air Quality Assessment, the Appeal Decision, the Tree/Woodland Assessment Plan, the Inspector's questions concerning the trees/woodland and RPS' replies to those questions with a particular focus on how trees were considered in the model.

The following documents were provided (in chronological order):

1. ES Addendum 10294p Air Quality Assessment Final 20190702.pdf
2. 962 Insp Ques Hearing Note2.docx
3. RPS Response on behalf of Appellant to Hearing Note 2 MMK RPS 09.05.23.pdf
4. TreeWoodland Assessment Plan.pdf
5. Decision Calderdale EPR603.pdf
6. Calder Valley SWIP Briefing Note for CERC.docx

CERC carried out a review of these documents, in order to fully understand both the original assessment and further work resulting from the hearing. In general, we consider the modelling assessment carried out by RPS to be robust.

With regard to the treatment of trees in the model, the inspector asked the following questions:

(i) Does the model include any other provisions to deal with the effects of the nearby trees/woodland or any other sensitivity testing/analysis in this regard?

(ii) Whether the existing trees/woodland result in a local reduction in ventilation in the vicinity of the proposed stack? If so, whether the model includes any provision in the meteorological data for any local reduction in ventilation due to the trees/woodland given their relative height in relation to the proposed stack?

(iii) Whether, and if so to what extent, the trees/woodland would be likely to result in drag, wake or other aerodynamic effects that would at times be similar to that likely to results from buildings of a comparable size and proximity as the trees/woodland?

(iv) Would it be beneficial to run the model with the height and position of the trees/woodland input as if they were buildings, so as to represent a worst-case scenario for drag/wake/aerodynamic effects on the plume?

We agree with RPS' responses to these questions:

(i) ADMS does not include any other specific provision to model the effects of individual trees or woodland, other than by setting the surface roughness at an appropriately high value as RPS has done.

(ii) Local to the site, the trees would reduce the wind speed due to increased drag, but also increase the turbulence. In the model, increasing the surface roughness has a similar effect on the flow. See Section 4 for a discussion of the impacts of these changes on surface concentrations of pollutants from a local source.

(iii) A block of very closely packed trees may act like a building but, in general, there is some flow through the trees and the wake behind trees is much weaker than would occur behind a building.

(iv) For the reasons given in (iii), we do not recommend representing trees as buildings in ADMS. However, as part of this report we have checked that taking this potentially conservative approach does not make any material difference to the calculated concentrations.

The impact of trees is considered further in Section 6, whilst surface roughness is considered in Section 4.

4 Treatment of surface roughness in ADMS

Task 3

Provide a detailed explanation on how surface roughness operates within the model and how this would affect the dispersion.

When the ADMS model is run, it first calculates meteorological parameters including wind speed and turbulence, and then calculates dispersion of pollutant from a source, using these meteorological parameters, to determine where the pollutant moves and how fast it mixes with the ambient air. Surface roughness affects the vertical wind and turbulence profiles used by the model. Comparing two sources that are otherwise identical and driven by the same upwind meteorology except the surface roughness at one source is greater than at the other source, the larger surface roughness leads to lower wind speeds and higher turbulence due to the increased drag. The impacts of such changes on dispersion and hence pollutant concentrations are very complex and depend on the height and characteristics (exit velocity and temperature) of the source.

With the Gaussian plume approach used in ADMS to model dispersion, pollutant concentrations in the plume are inversely proportional to the wind speed and so reducing the wind speed alone leads to higher ground-level concentrations. However, reducing wind speed also increases plume rise for a source with upwards momentum and/or buoyancy which reduces concentrations. Increasing turbulence results in faster spreading of the plume which, for elevated sources, results in higher ground level concentrations near the source but lower concentrations at larger distances. These competing effects can therefore either reduce or increase concentrations depending on the source configuration and source-receptor distance.

Task 4

Include within the detailed explanation whether and, if so, how the surface roughness length is applied to or interacts with or operates within the model in conjunction with the site-specific terrain data.

The model allows consideration of either a fixed surface roughness, an hourly varying surface roughness or a spatially varying surface roughness file. For the fixed and hourly varying options, it is also possible to specify a different surface roughness at the meteorological (met) measurement site to that at the dispersion site. Met measurement sites are typically located at airfields or similarly flat/open environments where the surface roughness is comparatively low, and so the model adjusts the met-site-specific wind and turbulence profiles to account for the different surface roughness at the dispersion site.

A fixed surface roughness is typically appropriate for smaller modelling domains with relatively homogeneous land use throughout. ADMS provides suggested values for various different land uses, for example 0.02 m for open grassland and 1 m for cities and woodlands. Hourly varying values are often linked to the wind direction to account for distinct land-use regions within different sectors relative to the source location.

The spatially varying surface roughness option is typically used for modelling domains that contain multiple distinct land use regions. This is often used in conjunction with the spatially varying terrain heights option, which has also been used for this study (together the ‘complex terrain module’). For each modelled hour, the complex terrain module calculates the wind and turbulence due to the combined effect of the spatial variations in terrain height and surface roughness across the modelling domain, including within the site itself. These are then used to calculate pollutant dispersion.

5 Values of surface roughness used in ADMS

Task 5

Advise whether the surface roughness length of 1m used in the main assessment is appropriate for the site, its stack height, its valley location and the trees/woodland and whether the sensitivity tests, including the increased surface roughness used in the sensitivity test, are reasonable.

Given the surrounding land use, we consider that the choice of surface roughness of 1 m, as used in the main assessment, is appropriate for this site.

Task 6

According to the User Guide, a surface roughness length of 1.5m simulates within the model large urban areas. As appears from the Air Quality Assessment the results at the sensitive receptors were negligible both when a surface roughness length of 1m for woodlands was selected and when, by way of a sensitivity test, a surface roughness length of 1.5m was selected. The site is not located in a large urban area but it is located in a valley with trees at a higher elevation than the top of the stack. What conclusion, if any, is one entitled to draw from the negligible results in the sensitivity test when the surface roughness of 1.5m was selected?

Sensitivity tests were carried out by RPS, including using a spatially varying surface roughness file, which is the focus here. The spatially varying surface roughness file was used to test the impact on model output of using a higher roughness of 1.51 m. The file used a value of 1.51 m for the areas of tall trees around the site, and 1 m elsewhere. As the roughness of 1 m was originally used to represent woodland, we consider that this value is too high for the surrounding area. We generated a more accurate spatially varying surface roughness file, as described below.

In order to further clarify the impact on model results of different assumptions for surface roughness, CERC carried out the following sensitivity tests using a range of fixed dispersion site surface roughness lengths, and using spatially varying surface roughness input:

- Roughness fixed at 0.3 m (agriculture)
- Roughness fixed at 0.5 m (open suburbia)
- Roughness fixed at 1 m (woodlands)
- Roughness fixed at 1.5 m (large urban areas)
- Spatially varying roughness

A simplified spatially varying surface roughness file was created by RPS, using 1.51 m for the areas of tall trees around the site, and 1 m elsewhere. As the roughness of 1 m was originally used to represent woodland, as stated above, we consider that this value is too high for the surrounding area.

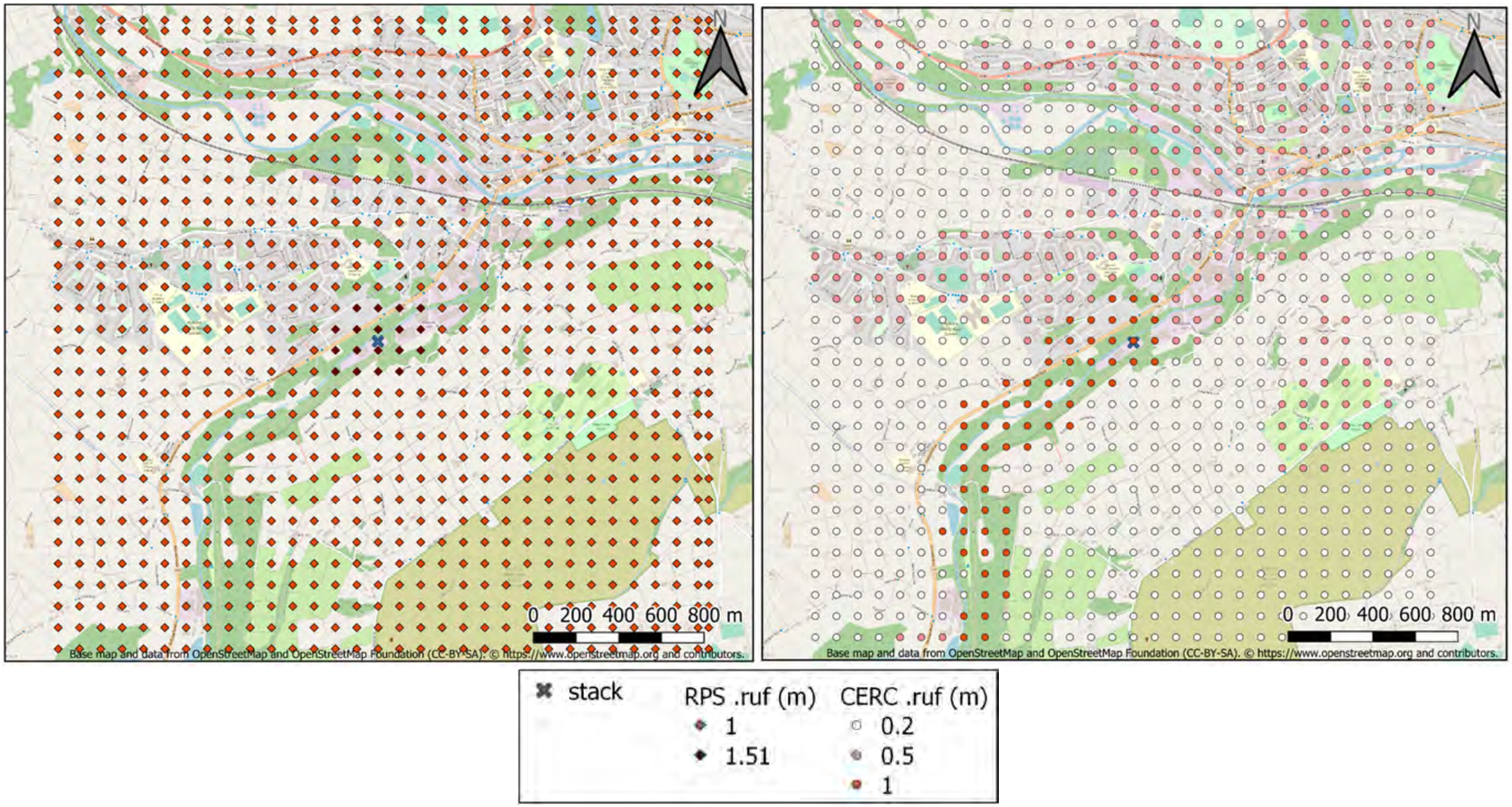

Figure 5.1: Comparison of spatially varying surface roughness lengths over the modelled domain. RPS file on the left, CERC file on the right

CERC created a more detailed spatially varying surface roughness file using CORINE Land Cover[1] data, which are systematically validated by an independent organisation. Figure 5.1 shows the spatial variation of surface roughness length in the files prepared by RPS and CERC, respectively. The CORINE Land Cover data use satellite imagery to assign land cover categories, such as areas of forest or urban environments, across a 100 m resolution grid. Appropriate surface roughness lengths were assigned to each relevant category to create a gridded surface roughness file with values ranging from 0.2 m to 1 m. The CVSH site lay within an area of 1 m surface roughness length.

The spatially varying surface roughness file generated using CORINE Land Cover data was used in conjunction with the complex terrain data across the modelling domain including within the site itself, as referred to in Task 4.

Table 5.1 shows the PCs to annual average NO_2 concentrations at the receptors, for each of the sensitivity tests carried out by CERC. These include results for the assumptions made in the main assessment originally carried out by RPS.

Table 5.1: PCs to annual average NO_2 concentrations (μg/m^3) at receptors, as modelled with varying surface roughness lengths. *equivalent to the main assessment configuration

ID	Receptor	Fixed				Spatially varying	
		0.3 m	0.5 m	1.0 m*	1.5 m	RPS .ruf	CERC .ruf
1	28 Rochdale Road	0.15	0.15	0.17	0.17	0.17	0.15
2	9 Breck Lea	0.09	0.08	0.08	0.08	0.08	0.09
3	Sacred Heart Catholic Primary	0.09	0.09	0.08	0.08	0.08	0.09
4	Haugh End House	0.11	0.11	0.10	0.10	0.10	0.11
5	84 Rochdale Road	0.21	0.22	0.25	0.26	0.25	0.20
6	Highfield Jerry Lane	0.17	0.18	0.21	0.23	0.21	0.17
7	Spring Bank Industrial Estate	2.73	3.04	3.23	3.20	3.17	2.81
8	Mill West (AQMA)	0.16	0.17	0.19	0.20	0.20	0.16
9	Ivy Cottage	0.28	0.26	0.23	0.21	0.22	0.26
10	Cottage	0.21	0.19	0.16	0.15	0.16	0.20
11	Black Sowerby Croft	0.22	0.20	0.18	0.16	0.17	0.21
12	Prospect Terrace	0.05	0.04	0.04	0.03	0.04	0.04
13	Hullen Edge	0.03	0.03	0.03	0.04	0.04	0.03
14	Bank House	0.18	0.18	0.19	0.19	0.19	0.18
15	Mill House Farm	0.22	0.23	0.24	0.23	0.23	0.22
16	Mill House Lodge	0.18	0.17	0.18	0.18	0.18	0.18

[1] https://land.copernicus.eu/en/products/corine-land-cover

In the main assessment (assuming fixed roughness 1 m), RPS found the long-term NO_2 IAQM/EPUK impact descriptor to be 'negligible' at all relevant modelled receptors. The resulting effects were therefore considered to be 'not significant'. Based on the results in Table 5.1 , this conclusion is the same for each of the surface roughness values considered, as the model results at the receptor locations are not sensitive within the range of surface roughness lengths chosen. This is because, by the time the plume reaches the receptors, it is well mixed in the vertical for each of the surface roughness scenarios considered. This is not the case closer to the stack as can be seen from the contour plots in Appendix A, where there are somewhat greater differences, however, there is no relevant exposure in areas closer to the stack. It would also not be the case for much lower surface roughness values, however these would not be appropriate for the site being considered.

In conclusion, it has been shown that the sensitive receptors are all sufficiently far from the source that the pollutant concentrations at these receptors are not sensitive either to the detailed characteristics of the trees or to the fact that the discharge height of the stack is lower than most of the trees.

6 Treatment of trees

Task 7

Advise whether the approach outlined by the Inspector of treating trees as, or similar to, solid structures is appropriate.

As stated in the answer to (iii) in Section 3, we believe that the approach RPS has adopted for the treatment of tees is appropriate and that there is little to be gained from using the approach outlined by the inspector.

However, in order to demonstrate that treatment of trees as buildings does not significantly affect the results obtained, CERC set up a scenario to test this treatment.

Using the heights and locations of the trees surrounding the site, as provided in the Tree/Woodland Assessment Plan, CERC defined groups of trees of similar height as solid structures for input to the ADMS building module. The configuration of modelled structures is shown in Figure 6.1.

Due to the inclusion of the trees surrounding the stack as buildings, the surface roughness in the general area was reduced from 1 m to 0.5 m, so as not to double-count the impact of the trees on dispersion.

Figure 6.1: Trees included as solid structures, labelled with height above ground level in metres

Table 6.1 shows the PCs to annual average NO_2 concentrations at the receptors, for the model run representing the trees as buildings. Included for comparison are the results from the main assessment, assuming a fixed surface roughness of 1 m.

Table 6.1: PCs to annual average NO_2 concentrations (μg/m^3) at receptors

ID	Receptor	Trees as increased roughness (surface roughness 1.0 m)	Trees as buildings (surface roughness 0.5 m)
1	28 Rochdale Road	0.17	0.16
2	9 Breck Lea	0.08	0.09
3	Sacred Heart Catholic Primary	0.08	0.09
4	Haugh End House	0.10	0.11
5	84 Rochdale Road	0.25	0.26
6	Highfield Jerry Lane	0.21	0.20
7	Spring Bank Industrial Estate	3.23	3.23
8	Mill West (AQMA)	0.19	0.17
9	Ivy Cottage	0.23	0.30
10	Cottage	0.16	0.22
11	Black Sowerby Croft	0.18	0.21
12	Prospect Terrace	0.04	0.04
13	Hullen Edge	0.03	0.03
14	Bank House	0.19	0.18
15	Mill House Farm	0.24	0.25
16	Mill House Lodge	0.18	0.19

In the main assessment (assuming fixed roughness 1 m), RPS found the long-term NO_2 IAQM/EPUK impact descriptor to be 'negligible' at all relevant modelled receptors. The resulting effects were therefore considered to be 'not significant'.

Based on the results in Table 6.1, this conclusion is the same for the 'trees as buildings' scenario. The modelled pollutant concentrations do not change very much between these two scenarios. This is because, as already discussed with reference to surface roughness, by the time the plume reaches the receptors it is vertically well mixed for both scenarios.

Task 8

Advise whether there are alternative approaches of treating trees that are likely to be more accurate and/or representative for this situation.

The sensitivity studies we have undertaken have shown that the sensitive receptors are all sufficiently far from the source, that pollutant concentrations calculated at these receptors are insensitive to the treatment of trees/surface roughness, or to the fact that the discharge height of the stack is lower than most of the trees.

In view of this, it is highly unlikely that the use of more complex modelling approaches, such as a Computational Fluid Dynamics model which might have the capability to treat the trees in more detail, would lead to different conclusions.

Appendix A: Contour plots

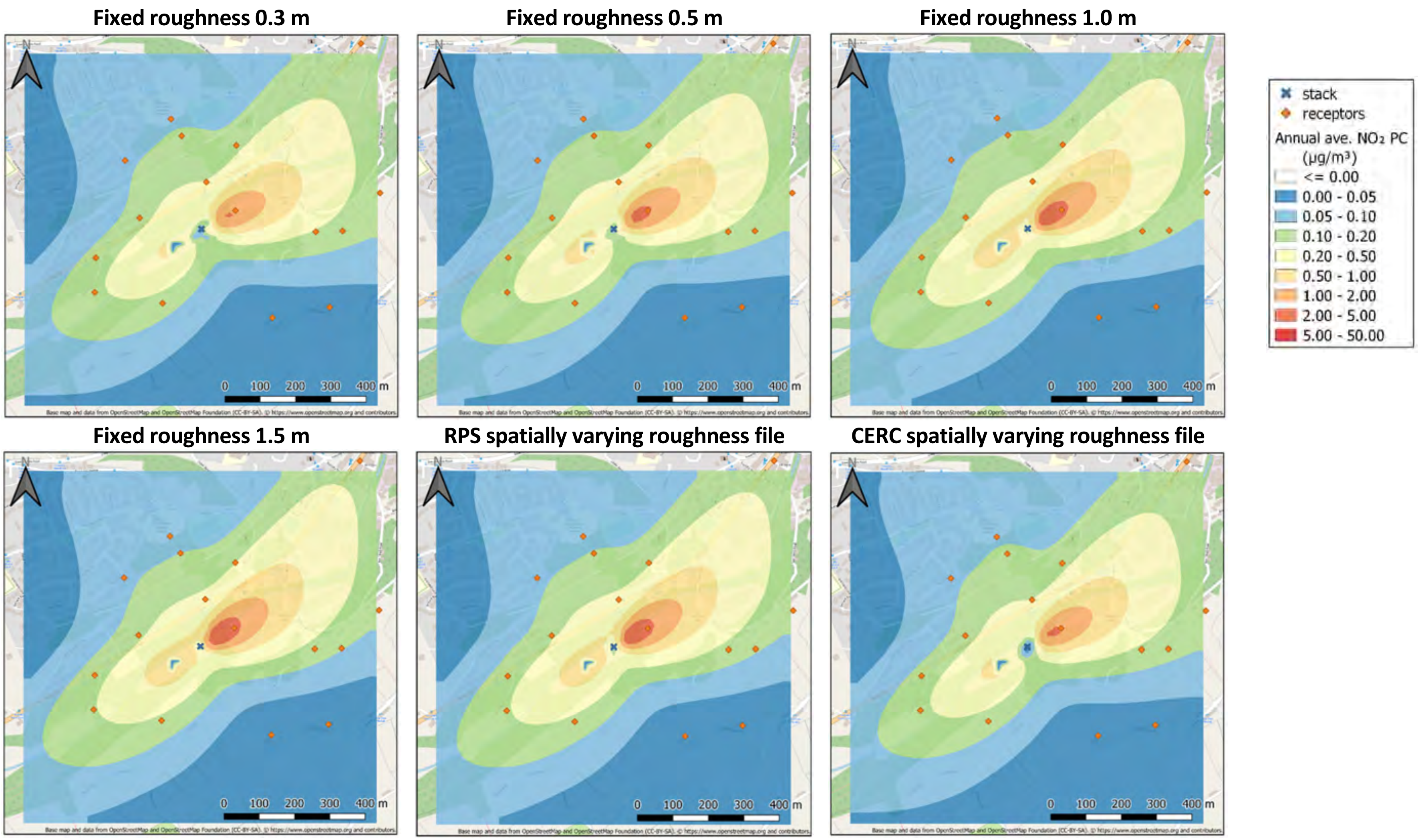

Figure A.1: Comparison of results from varying assumptions of surface roughness length over the modelled domain as described under Task 6