Air Quality Modelling & Assessment Unit (AQMAU)

Environment Agency

**AQMAU reference:** AQMAU-C2261-RP01

**Permit reference:** EPR/AP3304SZ/A001

**Project title:** Portland Energy Recovery Facility (ERF)

**Work title:** Audit of air quality impact assessment – follow up

**Date requested:** 3rd December 2021

**AQMAU response date:** 22th December 2021

| AQMAU recommendation | Conditions / noted |
|---|---|
| • The applicant's conclusions presented in the air quality assessment can be used for permit determination. | • The applicant's submitted evidence supporting the ADMS model performance in this specific situation is reasonable.<br>• Predicted exceedances based on the AERMOD model are likely to be unrealistic worst-cases. Based on the ADMS model, uncertainty and the evidence presented, contributions from the ERF are unlikely to exceed any environmental standard at sensitive receptors. |
| • The Permitting Officer should document the grounds in which the risk of potential exceedances at Portland SSSI/SAC can be ruled out. | • In this case, ADMS may predict more realistic NOx impacts than AERMOD based on the available evidence. The predicted annual NOx impacts (i.e. PC of 2.2%, indicatively) are likely to be located at the 1 $km^2$ tile where NOx backgrounds indicate sufficient headroom. Therefore, exceedances are unlikely. |

## Evidence for conclusions

1. The outcome of our audit of the applicant's air quality assessment[1] of emissions from the main ERF stack indicated that for specific meteorological conditions, the plume was likely to impact at relatively steep parts of the terrain. Software algorithms treat this situation differently depending on approximations to atmospheric conditions and whether the plume would have enough momentum to move upwards in its entirety, partially or downwards. Due to such a complex situation, for regulatory purposes, we considered we could not fully categorise either algorithm solution as invalid. Our results indicated potential exceedances for observed meteorological data with relatively more frequent north easterly winds in AERMOD. As a result, we concluded we could not rule out potential exceedances and requested the applicant to provide further evidence, including sensitivity to alternative modelling software and evaluation of the uncertainty to further evidence their conclusions.

2. In the Schedule 5 response document[2], the applicant presented sensitivity analysis to various input parameters to evaluate uncertainty. They conclude that, except for the choice of modelling software, these "do not have a significant effect on the predicted results and the conclusions would be the same if different input parameters were used". The applicant presents predicted concentrations when they varied the minimum Monin-Obukov length, surface roughness data, terrain data, meteorological data and modelling software. We are satisfied with this analysis.

3. As a result of their analysis, the applicant states: "The choice of model has a significant effect with significantly higher impacts predicted using AERMOD on the area of elevated terrain close to the plant". They further state that "AERMOD is not a suitable model for the terrain around the Portland ERF and therefore considers that the results from AERMOD should be disregarded". The applicant included a technical note from Cambridge Environmental Research Consultants (CERC), the ADMS model developers, to support the performance of the ADMS model in this particular situation. We highlight and comment on their main statements, as follows:

    3.1 CERC states that "at Portland, strongly stable conditions are very rare, the terrain is of small scale and temperature contrasts between land and sea are small". They also state: "If modelled, ideally hills should have moderate slopes (say less than 1 in 3) but the model is useful even when this criterion is not met." CERC claims that the hill impaction mass-weighted algorithm considered in AERMOD is likely to provide unrealistic results in this situation, as the flows are likely to be channelled, which is considered within the ADMS algorithm. The US EPA guidance[3] also supports that straight-line models such as AERMOD might not be appropriate in this situation. Our analysis indicates that stable conditions are predicted for approximately 40 to 55% of the time, however, CERC clarified in a follow-up email[4] that "these conditions are nowhere near stable enough to give plume impaction for this hill height". Our checks confirm the validity of this statement and, as a result, we found no defensible grounds to disagree with the evidence in this situation.

    3.2 The Tracy validation document[5] comparing model predictions with measured values at reasonably similar heights and windward locations indicates potential ADMS under-predictions. Note that exceedances were predicted at Portland using AERMOD modelling software. However, CERC claims: "The Tracy Power Plant

[1] AQMAU-C2171-RP01. Audit of air quality impact assessment. Portland Energy Recovery Facility (ERF) EPR/AP2204SZ/A001. October 2021.
[2] Schedule 5 Response No 1. Powerfuel Portland Ltd. Ref: S2953-0330-0001JRS. December 2021.
[3] Revisions to the Guideline on Air Quality Models. US Environmental Protection Agency, Appendix W January 2017. Available at https://www.epa.gov/sites/default/files/2020-09/documents/appw_17.pdf
[4] 211213-SS-JH CERC Technical Note: Portland Energy Recovery Facility 26th November 2021
[5] ADMS 5 Complex Terrain Validation. Tracy Power Plant. Cambridge Environmental Research Consultants. November 2016. Available at https://www.cerc.co.uk/ [Accessed on September 2021]

study is more valley-like, with high (>400m) terrain on two sides of the modelling area". They clarified in a follow-up email[4] that the locations in the Tracy study were measured on a tower within the valley, located at 1.2 km from the source and cannot be representative of the Portland ERF study area. The under-predictions are also explained in the validation document by the observed reverse flow of the valley conditions that cannot be calculated by the ADMS algorithms. As a result, we found no defensible grounds to disagree with this.

3.3 Regarding the most representative validation study similar to the Portland ERF study area, CERC claims that "the Lovett Power Plant study has a similar situation of a stack near to a hill. This study shows good agreement between the modelled and observed data and, as noted in the discussion section, the best agreement occurs at receptors on the upwind face of the hill rather than at the sides or downwind face." We agree that the conditions at Portland are unlikely to be representative of complex valley flow patterns, thus found no grounds to disagree with their statement.

4. We have reviewed additional evidence[6,7] to support our recommendations and conclusions presented in the first page. These are summarised as follows:

4.1 A model inter-comparison study[7] between AERMOD and ADMS in complex terrain suggests that "where there is plume impaction, AERMOD has a tendency to overestimate concentrations and, therefore, may act as a screening model in this case, whereas ADMS may predict more realistic concentrations, but these concentrations may be over-predictions or under-predictions". The applicant's sensitivity analysis considered an evaluation of reasonable worst-case predictions based on the ADMS model.

4.2 An Atmospheric Dispersion Modelling Liaison Committee (ADMLC) research report[6] comparing the performance of air dispersion models in complex terrain states the following: "Substantial differences were found in the predictions of the effect of terrain. In complex terrain, the lack of a detailed horizontal flow-field model within AERMOD lead to concentration contour plots that did not realistically represent the channelled flow that would be expected" (ADMLC 2005). This statement may support the use of the ADMS model predictions over AERMOD in this particular situation.

4.3 The ADMLC report[6] also includes consideration to the non-steady state aspects and Gaussian approximations. The Cinder Cone Butte study (1991) which had gradients on the hill of approximately 1:5 indicated that the direction in which the plume moved around the hill was highly sensitive to the incident angle. Linear models might provide a good approximation. However, Computational Fluid Dynamic (CFD) models by Apsley and Castro (1997) noted (1) strong atmospheric stability emphasised non-linear effects, and (2) the asymmetry of the flow and considerable horizontal divergence suggest that neither linear models (i.e. ADMS) nor dividing streamline (i.e. AERMOD) were entirely valid for this site (ADMLC 2005). This study considered much more complex terrain gradients and flow fields than Portland, however, the first point suggests that the linearity approximations in ADMS or AERMOD are not suitable in strongly stable conditions with complex terrain features. As noted, strongly stable conditions are unlikely in Portland[4], which supports the ADMS solution in this particular case.

[6] Review of atmospheric dispersion in complex terrain. Westlakes Scientific Consulting. Atmospheric Dispersion Modelling Liaison Committee (ADMLC) 2005. Ref: ADMLC/2005/1.
[7] Comparison of the Complex Terrain Algorithms Incorporated into Two Commonly Used Local-Scale Air Pollution Dispersion Models (ADMS and AERMOD) Using a Hybrid Model. Carruthers et al. 2011. Available at https://doi.org/10.1080/10473289.2011.609750 [Accessed on December 2021]

5. As a result of our evaluation and review of the evidence, we found no defensible grounds to disagree with the applicant's conclusion in this particular situation and recommend that applicant's conclusions can be used for permit determination.

    5.1 The applicant's submitted evidence supporting the ADMS model performance in this specific situation is reasonable. Predicted exceedances based on the AERMOD model are likely to be unrealistic worst-cases. Based on the ADMS model, uncertainty and the evidence presented, contributions from the ERF are unlikely to exceed any environmental standard at sensitive receptors.

    5.2 AERMOD predictions are likely to represent an unrealistic worst-case. The higher AERMOD NOx predictions at Portland SAC/SSSI (i.e. PC of 6%, indicatively) are located closer to the port, at the 1km$^2$ tile where $NO_X$ background concentration exceeds the annual Critical Level (i.e. at 35.3 µg/m$^3$, according to 2018 APIS data). The applicant's contour plots on page 69 of the Schedule 5 response document can be used to estimate NOx background concentrations inland from the port area. In this case, however, based on the available evidence presented above, ADMS may predict more realistic NOx impacts than AERMOD. Annual NOx predictions (i.e. PC of 2.2%, indicatively) are likely to be located at the 1 km$^2$ tile where NOx backgrounds indicate sufficient headroom. Therefore, exceedances are unlikely.