REPORT

# Boston Alternative Energy Facility – Environmental Statement

## Appendix 14.2 Dispersion Modelling Methodology

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# A14 Appendix 14.2: Dispersion Modelling Methodology

A14.1.1 This technical Appendix provides the dispersion modelling methodology for each of the assessments carried out for the air quality assessment chapter of the Environmental Statement (ES).

## A14.1 Construction and Operational Phase Road Traffic Emission Assessment Methodology

A14.1.1 The Atmospheric Dispersion Modelling System for Roads (ADMS-Roads) Version 5.0.0.1 was used to assess the potential impact on local air quality associated with vehicle exhaust emissions generated during both the construction and operational phases of the Facility. The main traffic-related pollutants of concern for human health are nitrogen dioxide ($NO_2$) and fine particulate matter ($PM_{10}$ and $PM_{2.5}$). Concentrations of these pollutants were therefore the focus of the ADMS-Roads assessment at the identified sensitive receptors located adjacent to the assessed road network.

A14.1.2 A base year of 2019 was considered in the assessment to enable model verification to be undertaken against local air quality monitoring data. This is the most recent full calendar year for which both meteorological data and local air quality monitoring data were available.

A14.1.3 The 2019 base year included traffic flows for the existing road network near the Application Site, which were derived from 2018 traffic count data, as provided by the Environmental Impact Assessment (EIA) project transport consultants.

A14.1.4 The realistic first year of construction and operation of the Facility would be 2022 and 2026 respectively. However, to provide a conservative assessment, baseline traffic flows were provided for the preceding years (2021 and 2025) (see **Chapter 19 Traffic and Transport**). As such, the following future scenarios were considered in the assessment:

- 2021 earliest year of construction;
- 2023 year of peak construction; and
- 2025 year of operation.

A14.1.5 These scenarios are considered to be conservative as vehicle emissions and background air pollutant concentrations are expected to reduce year on year, and therefore total predicted concentrations would be greater in 2021, 2023 and 2025 than 2022, 2024 and 2026.

A14.1.6 Whilst the maximum construction-generated traffic flows are predicted to occur in 2023, this may not necessarily be the year in which the maximum air quality impact would be experienced, due to future improvements in air quality as explained above. As such, a greater impact may be experienced in the earliest year of construction, despite a lower number of vehicle movements. A sensitivity test was therefore undertaken to determine the year which would represent a reasonable worst-case for the purposes of the impact assessment. A summary of the predicted concentrations (as a result of road traffic emissions alone) in 2021 and 2023 both without and with the Facility are shown in **Table A14.2-1** for the receptor experiencing the greatest change in concentration (R24) and the receptor experiencing the highest total concentration (R37). Results are presented for annual mean $NO_2$ only as this pollutant is in exceedance of the air quality Objectives within the AQMAs.

**Table A14.2-1 Comparison of 2021 and 2023 Construction Year Results**

| | Annual Mean $NO_2$ Concentrations ($\mu g.m^{-3}$) | | | |
|---|---|---|---|---|
| | 2021 Construction Year | | 2023 Construction Year | |
| | Without Facility | With Facility | Without Facility | With Facility |
| R24 (receptor with the greatest traffic-related change) | 23.5 | 24.1 | 20.8 | 21.3 |
| R37 (receptor with highest total concentration) | 48.9 | 49.2 | 42.5 | 42.8 |

A14.1.7 As shown in **Table A14.2-1**, predicted pollutant concentrations and impacts were greater in 2021 than 2023; as such, the assessment of a 2021 construction year is presented within this chapter.

A14.1.8 All future year traffic flows include the appropriate background traffic growth associated with additional plans and projects within the Study Area.

A14.1.9 In summary, the following scenarios were considered in the road traffic emissions assessment:

- Scenario 1 – Base / verification year (2019);
- Scenario 2 – 2021 first year of construction ‘without construction’;
- Scenario 3 – 2021 first year of construction ‘with construction’;
- Scenario 4 – 2025 operational year ‘without the Facility’; and,
- Scenario 5 – 2025 operational year ‘with the Facility’.

## Traffic Data

A14.1.10 Traffic data for use in the air quality assessment was provided as Annual Average Daily Traffic (AADT) flows and Heavy Duty Vehicles (HDV) percentages on the surrounding road network, including roads within the Haven Bridge and Bargate Bridge AQMAs. The data were derived from traffic flow and turning counts undertaken in 2018, with the exception of flows on John Adams Way (south of the Bargate roundabout) and Spilsby Road, which were derived from Department for Transport (DfT) counts in 2018, as these roads were not included in the traffic counts undertaken for the Facility in 2018. Following consultation on the Preliminary Environmental Information Report (PEIR), it was requested *"that all the options for traffic routes for construction traffic and operational service traffic are examined as part of the process"*. Therefore, traffic flows through the Bargate Bridge Air Quality Management Area (AQMA) were included to assess any potential impact during both construction and operation of the Facility on receptors within this sensitive area.

A14.1.11 Traffic data for the following roads were included in the air quality assessment:

- A16 North and South of Marsh Lane Roundabout;
- A16 Spalding Road;
- A52 Liquorpond Street;
- A16 John Adams Way;
- A16 Spilsby Road
- B1397 London Road;
- Wyberton Low Road;
- Marsh Lane;
- Nursery Lane / Lealand Way; and
- Bittern Way.

A14.1.12 The traffic network included road links within the two Boston AQMAs: the Haven Bridge AQMA and the Bargate Bridge AQMA. The road networks utilised in the assessment for the Base Year and Future Year Scenarios are detailed in **Figure 14.1**.

A14.1.13 Traffic speeds were included in the dispersion model setup as follows:

- Speed data for free-flowing traffic conditions were assumed to be road link speed limits;

- Queues were included in the model at junctions where traffic lights or pedestrian crossings were present, and on entry to roundabouts. Queues were modelled as a reduced average speed of 20 kph, except for the A52 / Sleaford Road / West Street roundabout, which was modelled at 10 kph to reflect the conditions at this junction;
- All roads within the Haven Bridge AQMA were modelled at 20 kph (except for the A52 / Sleaford Road / West Street roundabout, as detailed above, which was modelled at 10 kph) to reflect conditions within the AQMA; and
- The average speed on roundabouts was modelled at 20 kph (except for the A52 / Sleaford Road / West Street roundabout, as detailed above, which was modelled at 10 kph).

A14.1.14 Traffic data used in the assessment are detailed in **Table A14.2-2**. This includes the 2023 construction traffic flows for comparison purposes.

**Table A14.2-2 Traffic Data used in the Assessment**

| Road Link | Verification Year (2019) | | Earliest Construction Year (2021) | | | | Year with the Highest Construction Traffic (2023) | | | | First Year of Operation (2025) | | | | Speed (kph) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Without the Facility | | With the Facility | | Without the Facility | | With the Facility | | Without the Facility | | With the Facility | | |
| | AADT | HDV | AADT | HDV | AADT | HDV | AADT | HDV | AADT | HDV | AADT | HDV | AADT | HDV | |
| Marsh Lane – East of Wyberton Low Road junction | 6,736 | 6.5% | 6,921 | 6.5% | 7,350 | 6.9% | 7,162 | 6.5% | 7,606 | 7.0% | 7,404 | 6.5% | 7,607 | 6.7% | 48 |
| Marsh Lane – West of Wyberton Low Road junction | 9,277 | 4.9% | 9,532 | 4.9% | 9,961 | 5.2% | 9,865 | 4.9% | 10,309 | 5.4% | 10,198 | 4.9% | 10,401 | 5.1% | 48 |
| A16 – South of Marsh Lane Roundabout | 19,379 | 4.9% | 19,911 | 4.9% | 20,021 | 5.2% | 20,606 | 4.9% | 20,731 | 5.2% | 21,303 | 4.9% | 21,359 | 5.0% | 64 |
| A16 – North of Marsh Lane Roundabout | 24,837 | 3.9% | 25,519 | 3.9% | 25,892 | 4.0% | 26,410 | 3.9% | 26,797 | 4.1% | 27,303 | 3.9% | 27,479 | 4.0% | 64 |
| A16 (Spalding Road) | 27,660 | 4.0% | 28,420 | 4.0% | 28,736 | 4.1% | 29,412 | 4.0% | 29,743 | 4.1% | 30,406 | 4.0% | 30,557 | 4.0% | 64 |
| A52 (Liquorpond Street) | 30,175 | 2.3% | 31,003 | 2.3% | 31,135 | 2.3% | 32,085 | 2.3% | 32,217 | 2.3% | 33,170 | 2.3% | 33,231 | 2.3% | 48 |
| A16 (John Adams Way) | 40,462 | 3.6% | 41,573 | 3.6% | 41,758 | 3.7% | 43,024 | 3.6% | 43,224 | 3.7% | 44,479 | 3.6% | 44,569 | 3.6% | 48 |

| Road Link | Verification Year (2019) | | Earliest Construction Year (2021) | | | | Year with the Highest Construction Traffic (2023) | | | | First Year of Operation (2025) | | | | Speed (kph) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Without the Facility | | With the Facility | | Without the Facility | | With the Facility | | Without the Facility | | With the Facility | | |
| | AADT | HDV | AADT | HDV | AADT | HDV | AADT | HDV | AADT | HDV | AADT | HDV | AADT | HDV | |
| B1397 (London Road) | 12,467 | 1.9% | 12,809 | 1.9% | 12,865 | 1.9% | 13,256 | 1.9% | 13,312 | 1.9% | 13,704 | 1.9% | 13,730 | 1.9% | 48 |
| Wyberton Low Road | 2,960 | 0.3% | 3,042 | 0.3% | 3,042 | 0.3% | 3,148 | 0.3% | 3,148 | 0.3% | 3,254 | 0.3% | 3,254 | 0.3% | 48* |
| Nursery Road / Lealand Way | 1,620 | 6.3% | 1,664 | 6.3% | 1,906 | 8.3% | 1,722 | 6.3% | 1,979 | 8.9% | 1,780 | 6.3% | 1,968 | 6.4% | 48 |
| Marsh Lane | 3,239 | 6.3% | 3,328 | 6.3% | 3,516 | 5.9% | 3,444 | 6.3% | 3,632 | 5.9% | 3,561 | 6.3% | 3,576 | 6.6% | 48 |
| Bittern Way | 1,063 | 4.8% | 1,092 | 4.8% | 1,092 | 4.8% | 1,130 | 4.8% | 1,130 | 4.8% | 1,168 | 4.8% | 1,183 | 6.0% | 48 |
| A16 John Adams Way (south of Bargate Roundabout) | 22,069 | 7.0% | 22,675 | 7.0% | 22,860 | 7.1% | 23,467 | 7.0% | 23,667 | 7.2% | 24,260 | 7.0% | 24,350 | 7.1% | 48 |
| A16 Spilsby Road (east of Bargate roundabout) | 21,984 | 5.9% | 22,588 | 5.9% | 22,773 | 6.0% | 23,376 | 5.9% | 23,576 | 6.1% | 24,167 | 5.9% | 24,257 | 6.0% | 48 |
| * Part of this road has a 20 mph school slow speed zone, which was modelled at 32 kph | | | | | | | | | | | | | | | |

## Meteorological Data

A14.1.15 Hourly sequential meteorological data from the RAF Coningsby recording station for 2019 were used in the ADMS-Roads model. This recording station is located approximately 17.8 km north-west of the Application Site, and recorded data are considered to be representative of conditions at the Application Site. The use of these data was agreed with Boston Borough Council (BBC) during consultation.

A14.1.16 The wind rose from the RAF Coningsby recording station for 2019 is shown in **Plate A14.2-3**.

## Model Verification

A14.1.17 Model verification is the process of adjusting model outputs to improve the consistency of modelling results with respect to available monitored data. In this assessment, model uncertainty was minimised following Defra (Defra, 2018) and Institute of Air Quality Management (IAQM) and Environmental Protection UK (EPUK) (IAQM & EPUK, 2017) guidance.

A14.1.18 Monitoring locations within the air quality Study Area were reviewed to establish the suitability for use in model verification. Locations were considered where the assessed road links provided suitable representation of road traffic activity and emission sources that would affect monitored concentrations at that point.

A14.1.19 A review of the monitoring data identified six $NO_2$ diffusion tubes operated by BBC which were located on the road network under consideration and were suitable for use in the verification process. Diffusion tubes 1, 3 and 4 are located within the Haven Bridge AQMA; locations 12 and 21 are located to the west of the AQMA on Sleaford Road. Diffusion tube 18 is located on the roundabout of the A16 and London Road. The locations are shown in **Figure 14.5**.

A14.1.20 The derivation of the model adjustment factor is detailed in **Table A14.2-3.**

**Table A14.2-3 Model Verification**

| | $NO_2$ Diffusion Tube Monitoring Location | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 3 | 4 | 12 | 18 | 21 |
| 2019 Monitored Total $NO_2$ ($\mu g.m^{-3}$) | 49.2 | 46.5 | 39.8 | 28.9 | 33.8 | 29.0 |
| 2019 Background $NO_2$ ($\mu g.m^{-3}$) | 13.1 | 13.1 | 13.1 | 13.1 | 12.6 | 12.1 |
| Monitored Road Contribution $NO_X$ (total – background) ($\mu g.m^{-3}$) | 77.4 | 70.7 | 54.8 | 30.8 | 42.2 | 33.0 |
| Modelled Road Contribution $NO_X$ (excludes background) ($\mu g.m^{-3}$) | 23.6 | 17.6 | 26.8 | 12.9 | 16.8 | 10.4 |

| | $NO_2$ Diffusion Tube Monitoring Location | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **3** | **4** | **12** | **18** | **21** |
| Ratio of Monitored Road Contribution NOx / Modelled Road Contribution NOx | 3.3 | 4.0 | 2.0 | 2.4 | 2.5 | 3.2 |
| **Adjustment Factor for Modelled Road Contribution*** | **2.795** | | | | | |
| Adjusted Modelled Road Contribution $NO_X$ ($\mu g.m^{-3}$) | 66.1 | 49.3 | 75.0 | 36.0 | 47.0 | 28.9 |
| Modelled Total $NO_2$ (based on empirical $NO_X$ / $NO_2$ relationship) ($\mu g.m^{-3}$) | 44.6 | 37.4 | 48.2 | 31.3 | 35.9 | 27.0 |
| 2019 Monitored Total $NO_2$ ($\mu g.m^{-3}$) | 49.2 | 46.5 | 39.8 | 28.9 | 33.8 | 29.0 |
| % Difference [(modelled – monitored) x 100] | -9% | -20% | 21% | 8% | 6% | -7% |

A14.1.21 As shown in **Table A14.2-3**, the verification process highlighted that model performance varied at the monitoring locations considered, which reflects the uncertainties in each of a range of factors which will influence this relationship (including the representation of road traffic flow data, vehicle speeds, and individual vehicle emissions compared to emission factors, as well as model performance in representing dispersion). The average ratio between the modelled and monitored nitrogen oxides (NOx) road contribution across the six sites was used to determine the adjustment factor applied.

A14.1.22 The Root Mean Square Error (RMSE) of the model was 6 $\mu g.m^{-3}$. The RMSE is used to determine the average error or uncertainty of the model. Defra technical guidance (Defra, 2018) states that this would ideally be within 4 $\mu g.m^{-3}$ (10% of the annual mean $NO_2$ Objective of 40 $\mu g.m^{-3}$), but should be less than ± 25% of the Objective (i.e. 10 $\mu g.m^{-3}$). If the RMSE value is higher than ± 25% of the Objective, Defra guidance recommends that model inputs and verification should be revisited. Model performance in this assessment was therefore considered to be suitable, as the RMSE was within ± 25% of the Objective. Without adjustment, an RMSE of 17 $\mu g.m^{-3}$ was predicted; therefore, model performance is improved by the application of the adjustment factor.

A14.1.23 A separate verification was performed on the links which for which traffic flows were derived from DfT count data (i.e. John Adams Way (south of Bargate roundabout) and A16 Spilsby Road). A review of the monitoring data identified three $NO_2$ diffusion tubes operated by BBC which were located on these road links and were suitable for use in the verification process.

A14.1.24 The derivation of the model adjustment factor is detailed in **Table A14.2-4**.

**Table A14.2-4 Model Verification – Bargate Bridge AQMA**

| | $NO_2$ Diffusion Tube Monitoring Location | | |
|---|---|---|---|
| | 8 | 9 | 14 |
| 2019 Monitored Total $NO_2$ (µg.m$^{-3}$) | 31.3 | 37.0 | 35.8 |
| 2019 Background $NO_2$ (µg.m$^{-3}$) | 12.3 | 12.3 | 12.3 |
| Monitored Road Contribution $NO_X$ (total – background) (µg.m$^{-3}$) | 37.4 | 49.9 | 47.2 |
| Modelled Road Contribution $NO_X$ (excludes background) (µg.m$^{-3}$) | 19.0 | 10.7 | 13.1 |
| Ratio of Monitored Road Contribution NOx / Modelled Road Contribution NOx | 2.0 | 4.6 | 3.6 |
| **Adjustment Factor for Modelled Road Contribution*** | **2.88** | | |
| Adjusted Modelled Road Contribution $NO_X$ (µg.m$^{-3}$) | 54.6 | 30.9 | 37.7 |
| Modelled Total $NO_2$ (based on empirical $NO_X$ / $NO_2$ relationship) (µg.m$^{-3}$) | 39.1 | 28.3 | 31.5 |
| 2019 Monitored Total $NO_2$ (µg.m$^{-3}$) | 31.3 | 37.0 | 35.8 |
| % Difference [(modelled – monitored) x 100] | 25% | -24% | -12% |

A14.1.25 The Root Mean Square Error (RMSE) of the model in this area was 7 µg.m$^{-3}$, which is less than ± 25% of the Objective. Model performance was therefore considered to be suitable, as the RMSE was within ± 25% of the Objective. The unadjusted results produced an RMSE of 15 µg.m$^{-3}$; as such, verifying the modelled results by an adjustment factor of 2.88 improved model performance.

A14.1.26 There is no monitoring of $PM_{10}$ and $PM_{2.5}$ carried out within the Study Area. Therefore, the derived NOx adjustment factors were applied to the modelled $PM_{10}$ and $PM_{2.5}$ concentrations to provide a conservative assessment (in accordance with guidance in Local Air Quality Management (LAQM) Technical Guidance TG(16), (Defra, 2018)).

## Emission Factors

A14.1.27 Emission factors were obtained from the Emission Factor Toolkit v10.1 provided by Defra (Defra, 2020a). 2019 emission factors were used in Scenario 1, 2021 emission factors were used in Scenarios 2 and 3, and 2025 emission factors were used in Scenarios 4 and 5. This assumes a reduction in vehicle fleet emissions into the future.

**$NO_X$ to $NO_2$ Conversion**

A14.1.28 $NO_X$ concentrations were predicted using the ADMS-Roads model. The modelled road contribution of $NO_X$ at the identified receptor locations was converted to $NO_2$ using the $NO_X$ to $NO_2$ calculator (v8.1) (Defra, 2020b), in accordance with the Defra guidance (Defra, 2018).

**Consideration of Short-term Pollutant Concentrations**

A14.1.29 Road traffic emissions modelling uses AADT flows and therefore emissions are considered to be relatively constant throughout the day. Furthermore, due to the distance between source and receptor, ground-level emissions from traffic are not greatly affected by short-term meteorological fluctuations. As such, the typical approach to consideration of short-term air quality impacts from road traffic is to apply a relationship between the predicted annual mean concentration and the potential for short-term exceedances to occur. These relationships are detailed in Defra technical guidance (Defra, 2018).

A14.1.30 A combined assessment was undertaken to consider the in-combination effect of emissions from road traffic, stack emissions and vessel emissions in the appropriate scenarios. Pollutant concentrations from elevated point sources are more susceptible to greater short-term variation due to fluctuations in meteorological conditions which affect the dispersion of pollutants in the atmosphere. As such, it is not appropriate to consider short-term concentrations from these sources in relation to the annual mean; the dispersion model undertakes short-term calculations to consider the potential for exceedances.

A14.1.31 As the road traffic component remains relatively constant, in consideration of short-term averaging periods for $NO_2$ and $PM_{2.5}$, the road traffic contribution was added to the background concentration and the sum was then doubled as per Defra and Environment Agency guidance (Defra and Environment Agency, 2016). The modelled short-term process contribution (PC) from the Facility (including stack and vessel emissions, where appropriate) was then added and the total concentration was compared to the appropriate air quality Objective.

## A14.2 Construction and Operational Phase Vessel Emissions Assessment Methodology

A14.2.1 The Atmospheric Dispersion Modelling System-5 (ADMS-5) Version 5.2.4.0 was used to assess the potential impact on local air quality from vessel emissions during the construction and operational phases of the Facility. The main pollutants of concern for human health relating to vessel emissions are $NO_2$, $PM_{10}$, $PM_{2.5}$, sulphur dioxide ($SO_2$) and carbon monoxide (CO), therefore these pollutants were the focus of the dispersion modelling assessment.

### Assessment Scenarios

A14.2.2 Emissions from existing vessel activity movements on The Haven were assumed to be included in the Defra mapped background pollutant concentrations. Therefore, only the impact of the additional vessel movements associated with the construction and operation of the Facility were modelled in the assessment.

### Vessel Data

*Construction Phase*

A14.2.3 Floating plant transporting an excavator will be used to construct the Habitat Mitigation Area; however, these works would be undertaken pre-construction and would be of a short duration (up to one week). As such, the construction phase vessel assessment was undertaken based on the most conservative number of vessel movements associated with the construction of the Facility.

A14.2.4 The estimated number of vessels that will visit the Facility across the duration of the construction phase is 89. These will start delivering raw materials for construction from 6 months into the construction programme, once the Wharf has been sufficiently constructed to allow vessels to berth. It is anticipated that these will be vessels of a bulk carrier type, of approximately 2,500 tonnes, and would berth at the light weight aggregate (LWA) berth.

A14.2.5 As a worst case scenario, it was assumed construction vessels will only be used to deliver raw materials for 18 months of construction, therefore this would correspond to 0.16 vessels per day (see **Chapter 18 Navigational Issues** for further details). To provide a conservative assessment, it was assumed that one bulk carrier would visit the LWA berth per day for the duration of the year.

Operational Phase

A14.2.6 During operation, it is estimated that, each year, 480 vessels will visit the RDF berths and 120 vessels will visit the LWA berth; these vessels would be of general cargo and bulk carrier type respectively. All of the RDF vessels would be approximately 2,500 tonnes and the LWA vessels up to 3,000 tonnes.

A14.2.7 Annually, 480 vessels visiting the RDF berths would equate to 1.32 vessels per day, or 0.68 per day to each berth. It was therefore assumed that two vessels would visit the RDF berths each day, one at each RDF berth, to provide a conservative assessment. Likewise, 120 vessels visiting the LWA berth each year would equate to 0.33 per day; therefore, it was assumed that one vessel would visit the LWA berth each day, to provide a conservative assessment.

### Calculation of Emissions

A14.2.8 The emission parameters and emission rates used in the dispersion model were derived using the GloMEEP Port Emission Toolkit Guidance (GloMEEP & IAPH, 2018), US Environmental Protection Agency (USEPA) guidance on *'Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories'* (US EPA, 2009), information provided by the client team, and previous vessel emission modelling experience.

A14.2.9 The GloMEEP guidance provides emission factors for the pollutants considered in the assessment. Since 1 January 2015, vessels travelling in the North Sea (and thus entering The Haven) are required to use marine fuel oil that does not exceed a sulphur content of 0.1% to comply with the limits for a Sulphur Emission Control Area (SECA). These are laid down in Annex VI of the International Maritime Organisation (IMO) Maritime pollution (MARPOL) Convention. The $SO_2$ emission factors in the GloMEEP guidance are specified for fuel with a sulphur content of 2.7%. As such, a conversion factor of 0.037 (0.1 divided by 2.7) was applied to the $SO_2$ emission factors to represent expected emissions of this pollutant from vessels serving the Facility.

A14.2.10 Emissions associated with vessels moving in The Haven (assumed to be a Reduced Speed Zone (RSZ)), and during manoeuvring at the turning area of the Knuckle point and at The Port of Boston, were represented separately in the assessment. Due to the width of the channel, it was assumed that vessels travelling up The Haven would travel at reduced speeds. Conservative speeds of four knots for vessels in the RSZ, and two knots whilst manoeuvring at the Knuckle and at the Port of Boston, were used in the calculation of vessel emissions.

A14.2.11 Vessels travelling in the RSZ were included in the model as line sources. Areas of manoeuvring at the Wharf, the Port of Boston and at the Knuckle were represented as area sources.

A14.2.12 It was assumed that vessels would take 15 minutes to manoeuvre into berths at the Facility's Wharf and another 15 minutes to manoeuvre back out of the berths; this was also assumed to be representative for vessels to travel through the lock at the Port of Boston when turning in this area. It was assumed that vessels would take approximately 15 minutes to 'swing' into the Knuckle from the Facility and 30 minutes to turn at either the Knuckle or the Port of Boston. The turning areas of vessels will be dictated by the Harbourmaster for each vessel according to the specific circumstances in the Port at the time.

A14.2.13 During construction, there will only ever be one vessel visiting the Facility at a time and therefore only one vessel associated with the Facility would be turning at the Knuckle or Port of Boston. The assessment assumed that, at any given time, a vessel was turning in both of these areas to provide a conservative assessment. During operation, it was assumed that two vessels associated with the Facility would be turning at the same time, one at the Knuckle and the other at the Port of Boston; this is also considered to be conservative. The modelled vessel sources are detailed in **Figure 14.1**.

A14.2.14 Vessels will not operate their main or auxiliary engines once berthed at the Facility's Wharf; as such, emissions from berthed vessels were not considered in the assessment.

A14.2.15 The heights above surrounding ground level of the vessel engine exhaust stacks were estimated from representative vessel parameters. The efflux velocities and emission temperatures were based on previous project experience for comparable vessels.

A14.2.16 The vessel emission parameters and emission rates input into the dispersion model for construction and operation are detailed in **Table A14.2-5** to **Table A14.2-7**.

**Table A14.2-5 Emission Parameters for Construction and Operational Phase Vessels**

| Parameter | | Value |
|---|---|---|
| Stack height (m) | | 10 |
| Efflux velocity (m/s) | RSZ | 10 |
| | Manoeuvring | 10 |
| Temperature (C) | | 300 |

Table A14.2-6 Pollutant Emission Rates for Construction Phase Vessels Movements

| Pollutant | Modelled Emission Rate | | | | | |
|---|---|---|---|---|---|---|
| | RSZ from the entrance of The Haven to the Facility ($g.m^{-1}.s^{-1}$) | 'Swing' to the Port of Boston from the Facility ($g.m^{-1}.s^{-1}$) | Manoeuvring into the LWA berth ($g.m^{-2}.s^{-1}$) | Manoeuvring through the lock at the Port of Boston ($g.m^{-1}.s^{-1}$) | Turning at the Port of Boston ($g.m^{-2}.s^{-1}$) | Turning at the Knuckle ($g.m^{-2}.s^{-1}$) |
| Oxides of Nitrogen ($NO_X$) | 0.0000043 | 0.0000079 | 0.0000010 | 0.0000932 | 0.0000010 | 0.0000015 |
| Particulate Matter ($PM_{10}$) | 0.0000004 | 0.0000008 | 0.0000001 | 0.0000091 | 0.0000001 | 0.0000001 |
| Particulate Matter ($PM_{2.5}$) | 0.0000001 | 0.0000007 | 0.0000001 | 0.0000086 | 0.0000001 | 0.0000001 |
| Sulphur Dioxide ($SO_2$) | 0.0000003 | 0.0000002 | 0.0000000 | 0.0000028 | 0.0000000 | 0.0000000 |
| Carbon Monoxide (CO) | 0.0000043 | 0.0000006 | 0.0000001 | 0.0000070 | 0.0000001 | 0.0000001 |

**Table A14.2-7 Pollutant Emission Rates for Operational Phase Vessels Movements**

| Pollutant | Modelled Emission Rate | | | | | | |
|---|---|---|---|---|---|---|---|
| | RSZ from the entrance of The Haven to the Facility ($g.m^{-1}.s^{-1}$) | 'Swing' to the Port of Boston from the Facility ($g.m^{-1}.s^{-1}$) | Manoeuvring into the LWA berth ($g.m^{-2}.s^{-1}$) | Manoeuvring into each RDF berth ($g.m^{-2}.s^{-1}$) | Manoeuvring through the lock at the Port of Boston ($g.m^{-2}.s^{-1}$) | Turning at the Port of Boston ($g.m^{-2}.s^{-1}$) | Turning at the Knuckle ($g.m^{-2}.s^{-1}$) |
| Oxides of Nitrogen ($NO_X$) | 0.0000135 | 0.0000262 | 0.0000010 | 0.0000009 | 0.0000932 | 0.0000007 | 0.0000015 |
| Particulate Matter ($PM_{10}$) | 0.0000013 | 0.0000026 | 0.0000001 | 0.0000001 | 0.0000091 | 0.0000001 | 0.0000001 |
| Particulate Matter ($PM_{2.5}$) | 0.0000013 | 0.0000025 | 0.0000001 | 0.0000001 | 0.0000086 | 0.0000001 | 0.0000001 |
| Sulphur Dioxide ($SO_2$) | 0.0000004 | 0.0000008 | 0.0000000 | 0.0000000 | 0.0000028 | 0.0000000 | 0.0000000 |
| Carbon Monoxide (CO) | 0.0000010 | 0.0000020 | 0.0000001 | 0.0000001 | 0.0000070 | 0.0000001 | 0.0000001 |

## A14.3 Operational Phase Stack Emissions Assessment Methodology

A14.3.1 Pollutant emissions from the proposed stacks were modelled using ADMS-5. Dispersion modelling was utilised to predict concentrations of pollutants at receptors near the Facility as a result of emissions from the stacks.

**Process Emissions**

A14.3.2 In the absence of site-specific emissions monitoring data for the proposed EfW and LWA stacks, and to undertake a conservative assessment, the relevant Best Available Techniques (BAT)-Associated Emission Levels (AELs) were used, obtained from the most recent BAT-conclusions document for waste incineration (European Parliament, 2019). Where the BAT-AELs were provided as a range, the upper values were used to provide a conservative assessment. For example, the BAT-AEL for NOx emissions is expressed as a daily average in the range 50-120 mg $Nm^{-3}$ for new EfW plants. 120 mg $Nm^{-3}$ was used in this assessment.

A14.3.3 A proportion of the flue gas from two of the EfW lines will be diverted to the $CO_2$ capture plants, which are anticipated to remove 5,000 kg/hr of $CO_2$ per line. The removed $CO_2$ represents a small proportion of the total mass flow from each EfW line (1.45%). As such, at this stage, no adjustment has been made to the volumetric flow rates from the EfW lines to account for the removed $CO_2$. This will be considered in greater detail for the Environmental Permit.

A14.3.4 Guidance provided by Defra and the Environment Agency (Defra and EA, 2016) states that an adjustment can be made to annual mean concentrations where a process does not operate all the time, to provide a more representative annual PC. The actual annual operating hours of the EfW and LWA lines will be approximately 8,000 hours (91% of the year) due to scheduled plant downtime (e.g. planned maintenance). As such, an adjustment factor was calculated (8,000/8,760) and applied to annual mean pollutant concentrations. Short-term concentrations were unadjusted to ensure that the worst-case conditions were captured across shorter durations. Stack emission parameters such as volumetric flow rate and temperature were provided by the design team.

A14.3.5 A sensitivity test was undertaken to consider the effect of varying stack heights on pollutant concentrations at receptors, to determine the most appropriate height for consideration in the assessment. Stack heights of 40 m – 100 m were considered in the assessment, which was undertaken for annual mean and short-term $NO_2$ concentrations at receptor R35 (the receptor experiencing the greatest impact from the Facility). The test was undertaken for all five stacks operating simultaneously. No operational hour adjustment was applied to the annual mean results. The results of the sensitivity test are shown in **Plate A14.2-1** and **Plate A14.2-2.**

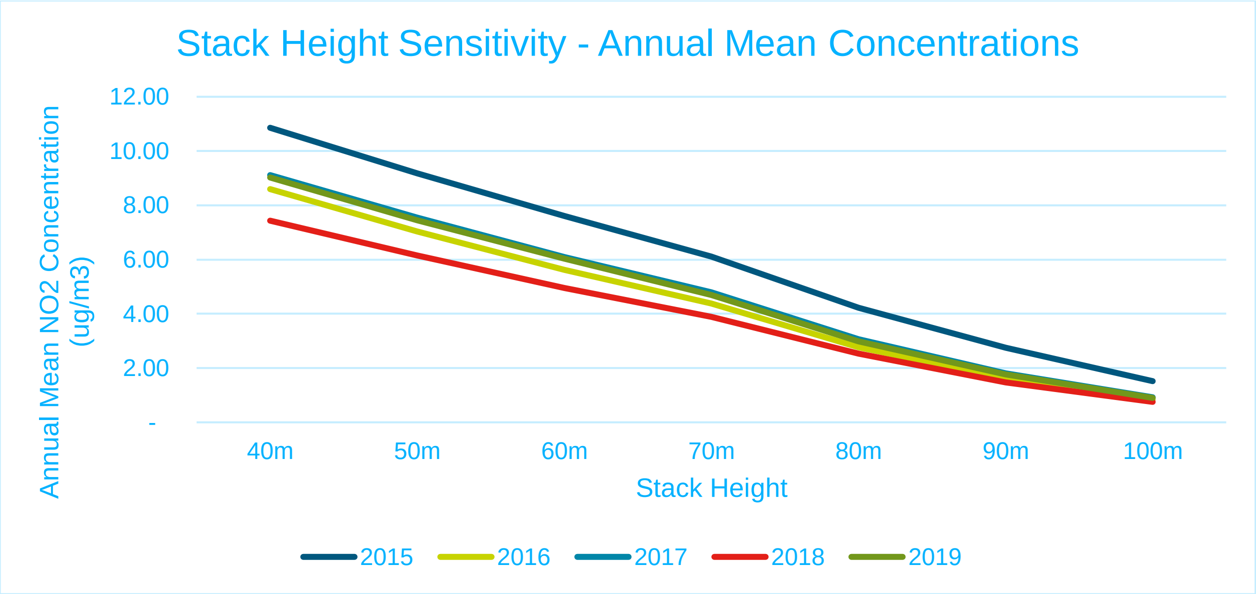


**Plate A14.2-1 Stack Height Sensitivity by year of meteorological data – Annual Mean $NO_2$**

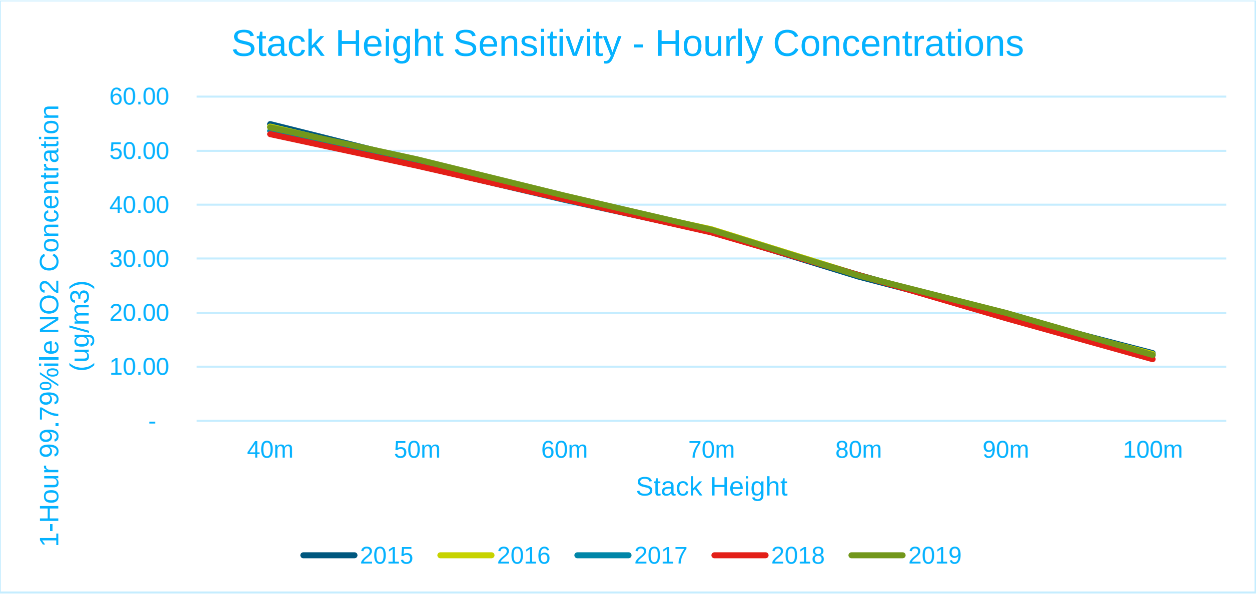


**Plate A14.2-2 Stack Height Sensitivity by year of meteorological data – 1-Hour 99.79%ile $NO_2$**

1.1.1 As shown in both the annual mean and short-term plots, concentrations of $NO_2$ continued to reduce with increasing stack height with no specific levelling out or "knee point" of concentrations.

1.1.2 The height of the stacks is limited by visual and heritage considerations, as no structures within the Boston area should be taller than the top of St Botolph's Church in the centre of Boston which stands at 81.31 m high from ground level, approximately 86.31 m Above Ordnance Datum (AOD). As such, stack heights greater than 80 m are not desirable. Given these considerations, a stack height of 80 m from ground level, or 83.5 m AOD, was considered to be most appropriate for consideration in the assessment, taking into account both air quality and visual/heritage matters. At 80 m, annual mean and short-term concentrations were between 64 and 68% and 49 and 51% respectively of those at 40 m, for the annual meteorological datasets considered.

A14.3.6 Pollutant emission rates, derived from the BAT-AELs for each stack considered in the assessment, are detailed in **Table A14.2-8**. Release parameters from each of the stacks were obtained from plant specifications.

**Table A14.2-8 Process Emission Rates for the EfW Stacks and LWA Stacks 1 and 2**

| Parameter | EfW Stack (x3) | LWA Stack 1 | LWA Stack 2 |
|---|---|---|---|
| Release height (m) | 80 | 80 | 80 |
| Stack diameter (m) | 3 | 3.5 | 2.5 |
| Efflux velocity ($m.s^{-1}$) | 16.8 | 17.6 | 17.2 |
| Actual volumetric flow rate ($Am^{-3}.s^{-1}$) | 119[a] | 169[b] | 84.5[b] |
| Efflux temperature (°C) | 142 | 110 | 110 |
| Normalised volumetric flow rate ($Nm^{-3}.s^{-1}$)[c] | 73.2 | 110 | 55 |
| **Pollutant Concentration ($mg.Nm^{-3}$)[c]** | | | |
| $PM_{10}$ | 5 | 5 | 5 |
| TOC | 10 | 10 | 10 |
| HCl | 6 | 6 | 6 |
| HF | 1 | 1 | 1 |

| Parameter | EfW Stack (x3) | LWA Stack 1 | LWA Stack 2 |
|---|---|---|---|
| CO | 50 | 50 | 50 |
| $SO_2$ | 30 | 30 | 30 |
| NOx | 120 | 120 | 120 |
| Group I Metals (as Cd and Tl) | 0.02 | 0.02 | 0.02 |
| Group II Metals (as Hg) | 0.02 | 0.02 | 0.02 |
| Group III Metals (as Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V) | 0.3 | 0.3 | 0.3 |
| Dioxins and Furans | 0.00000008 | 0.00000008 | 0.00000008 |
| $NH_3$ | 10 | 10 | 10 |
| **Maximum Emission Rates ($g.s^{-1}$)** | | | |
| $PM_{10}$ | 0.37 | 0.55 | 0.28 |
| TOC | 0.73 | 1.10 | 0.55 |
| HCl | 0.44 | 0.66 | 0.33 |
| HF | 0.07 | 0.11 | 0.06 |
| CO | 3.66 | 5.50 | 2.75 |
| $SO_2$ | 2.20 | 3.30 | 1.65 |
| NOx | 8.79 | 13.20 | 6.60 |
| Group I Metals (as Cd and Tl) | 0.0015 | 0.0022 | 0.0011 |
| Group II Metals (as Hg) | 0.0015 | 0.0022 | 0.0011 |
| Group III Metals (as Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V) | 0.022 | 0.033 | 0.017 |
| Dioxins and Furans | 0.000000006 | 0.000000009 | 0.000000004 |
| $NH_3$ | 0.73 | 1.10 | 0.55 |

[a] Actual volumetric flow rate at 415K, 10% $O_2$ and 17% $H_2O$
[b] Actual volumetric flow rate at 383K, 10% $O_2$ and 17% $H_2O$
[c] Reference Conditions: 273K, 11% $O_2$ and 101.3 kPa, dry gas

## Consideration of Metals

A14.3.7 The EA published guidance in 2016 (EA, 2016), regarding the consideration of Group III metals in dispersion modelling. Group III metals are subject to an aggregated emission limit for nine metals (antimony (Sb), arsenic (As), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), manganese (Mn), nickel (Ni), vanadium (V) and their components), and, as such, impacts can be overstated.

1.1.3 Table A1 of the EA guidance (EA, 2016) provides a summary of 34 measured values for each Group III metal recorded from municipal waste and waste wood co-incinerators, which can be used to adjust the Group III emissions. The maximum percentages were applied to the BAT-AEL for the purposes of this assessment.

A14.3.8 The EA guidance also recommends the assumption that hexavalent chromium (CrVI) comprises 20% of the total background chromium. This was applied to determine the proportion of CrVI from the total monitored chromium background concentration.

## Model Parameters

### Meteorological Data

A14.3.9 Five years of hourly sequential meteorological data from the RAF Coningsby recording station were used in the dispersion model (2015 – 2019). The highest results across each of the five years of meteorological data were reported, for each pollutant and averaging time, to provide a worst-case scenario. Wind roses for 2015 – 2019 are provided in **Plate A14.2-3**. These show reasonable consistency in average conditions over a five-year period but the varying peak short-term conditions are also represented.

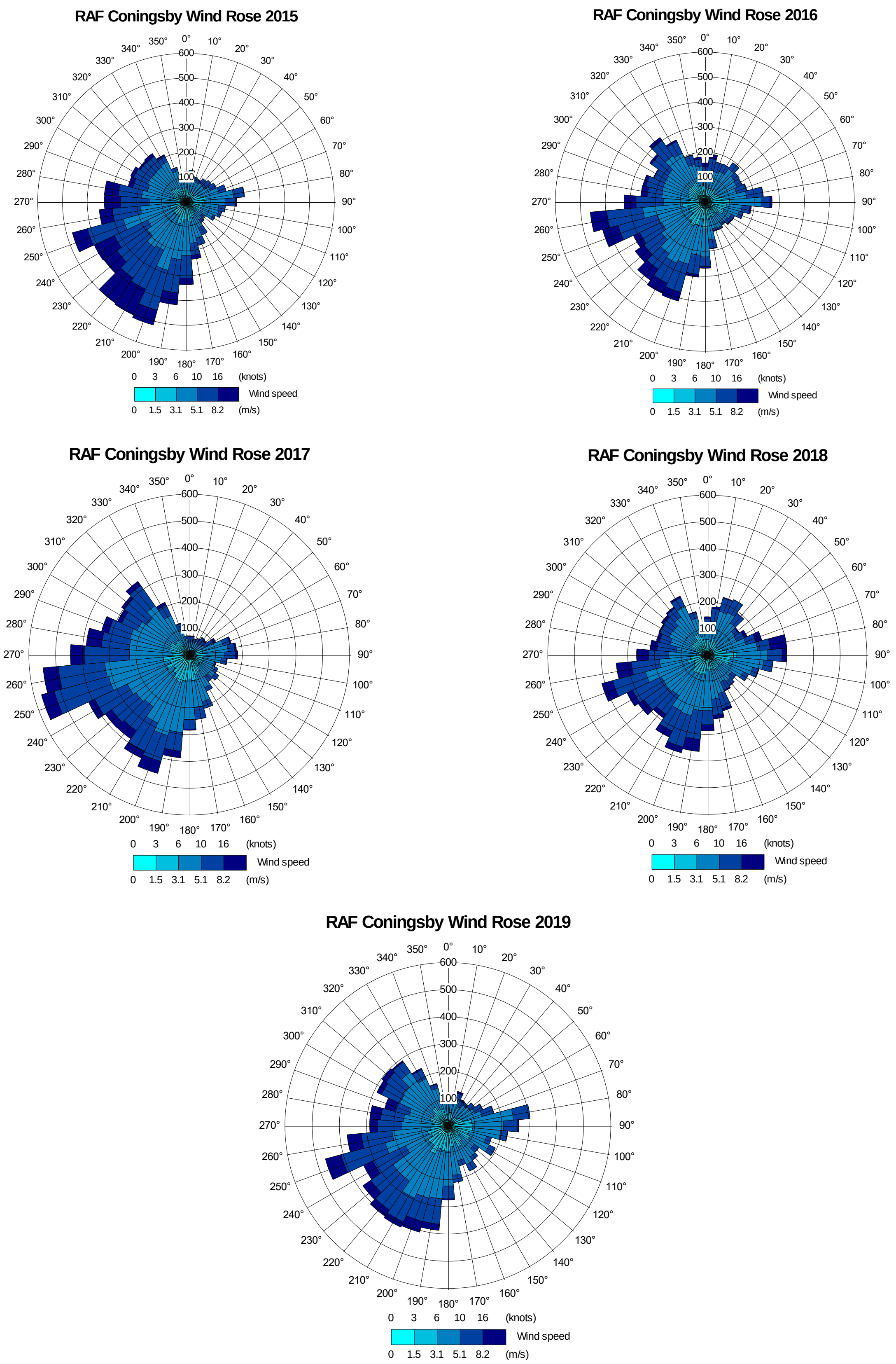


**Plate A14.2-3 Coningsby Wind Rose 2015 - 2019**

### Terrain Data

A14.3.10 The terrain within the dispersion modelling domain is relatively flat (gradients less than 1 in 10 or 10%). In accordance with the model technical guidance (CERC, 2016), terrain data were therefore not included within the dispersion model.

### Conversion of $NO_X$ to $NO_2$

A14.3.11 Environment Agency (EA) technical guidance (EA, 2006) provides an approach to the conversion rates for $NO_X$ to $NO_2$ in modelling studies for stack-based sources. In accordance with this guidance, the short term (1 hour) and long term (annual mean) concentrations of $NO_2$ were derived from the predicted $NO_X$ concentrations using the following approach:

- 35% of $NO_X$ to $NO_2$ for short term; and
- 70% of $NO_X$ to $NO_2$ for long term average concentrations.

### Treatment of Buildings

A14.3.12 Buildings were incorporated into the dispersion model to predict the impact of their interaction on plume dispersion.

A14.3.13 Building dimensions and heights were provided by the design team. All buildings and structures within the site boundary were included in the model, as detailed in **Table A14.2-9**. The buildings included in the ADMS model are shown in **Figure 14.1**.

**Table A14.2-9 Buildings Included in the ADMS-5 Model**

| Building Description | Height (m) | Length (m) | Width (m) |
|---|---|---|---|
| EfW building | 44 | 90 | 127 |
| LWA Plant | 44 | 74 | 39 |
| $CO_2$ Capture Plant 1 | 10 | 30 | 20 |
| Air Cooled Condensers | 30 | 63 | 42 |
| Turbine Hall | 25 | 53 | 40 |
| Offices and Visitor Centre | 8 | 30 | 20 |
| Boston Biomass UK No. 3 Ltd Main Building | 19 | 78 | 39 |

| Building Description | Height (m) | Length (m) | Width (m) |
|---|---|---|---|
| Boston Biomass UK No. 3 Ltd Plant | 23 | 90 | 68 |
| $CO_2$ Capture Plant 2 | 10 | 30 | 20 |
| Plant Workshop | 13 | 40 | 15 |
| Bale Shredders | 20 | 15 | 35 |
| Generator | 6 | 32 | 20 |
| Bottom Ash Store | 10 | 30 | 67 |
| LWA Offices | 13 | 9 | 15 |
| LWA Workshop | 8 | 20 | 8 |
| LWA Pellet Store | 32 | 30 | 30 |

## Receptor Grids

A14.3.14 Cartesian receptor grids were included in the dispersion model to enable contour plots to be produced. The gridded model outputs also enabled the point of maximum impact to be determined within the boundaries of each of the designated ecological sites considered in the assessment. Two grids were included in the dispersion model; one centred on the site, covering an area of approximately 5 km square, the other covering The Wash SAC, SPA, SSSI and Ramsar site. Details of the grid dimensions and resolution are provided in **Table A14.2-10**.

**Table A14.2-10 Modelled Grids**

| Grid | Start X | Start Y | Finish X | Finish Y | Number of Points | Resolution (m) |
|---|---|---|---|---|---|---|
| Site | 531101 | 339555 | 536676 | 344797 | 111 x 105 | 50 |
| The Wash | 535682 | 338103 | 539820 | 340365 | 165 x 90 | 25 |

### Visible Plumes

A14.3.15 Exhaust plumes from the proposed stacks may be visible in the atmosphere under some atmospheric conditions due to condensation of water in the plume. This requires consideration from a landscape and visual perspective.

A14.3.16 The ADMS 5 dispersion model includes a plume visibility module which utilises temperature and humidity data within the meteorological data file, and the mass of water per unit mass of dry release (kg/kg) of flue gas from the EfW and LWA stacks which is entered by the user.

A14.3.17 The mass of water per unit mass of dry release was calculated from data provided by the design team for the EfW stacks as 0.11kg/kg. In the absence of any specific data on the water content of the plumes from the LWA stacks, this value was also included for these sources.

A14.3.18 The dispersion model calculates the number of hours in each year of meteorological data that visible plumes from each stack source will occur, the number of visible plume groundings and the number of plumes visible at release, in addition to the minimum, maximum and average visible plume length. These data were provided to the project's landscape and visual consultant, and impacts associated with visible plumes are considered in **Chapter 9 Landscape and Visual Impact Assessment**.

## A14.4 References

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