TECHNICAL NOTE 1

DATE:	22 October 2024	**CONFIDENTIALITY:**	Public
SUBJECT:	Milegate Extension Landfill Site: Impacts on Ecological Receptors		
PROJECT:	62270001 - Sandsfield Milegate	**AUTHOR:**	Pranav Tamhankar
CHECKED:	Bethan Tuckett-Jones	**APPROVED:**	Bethan Tuckett-Jones

EXECUTIVE SUMMARY

The impacts of the proposed landfill gas engines (micro-generators) and flare on nitrogen oxides and sulphur dioxide concentrations, and nitrogen and acid deposition are **insignificant** at all nature conservation sites in the vicinity of Sandsfield's Milegate Extension Landfill Site.

This conclusion applies whether landfill gas is combusted in the micro-generators, with the excess gas going to the flare, or if all landfill gas is combusted in the flare.

INTRODUCTION

1. Sandsfield Gravel Company Ltd (Sandsfield) is applying for planning permission for:
    - The extension of operations into the neighbouring field to the east
    - Installation of a new landfill gas utilisation compound at the north-west corner of the site, incorporating:
        - two new landfill gas engines ("micro-generators"), and
        - moved and upgraded landfill gas flare (retrospective permission sought).
2. The proposed micro-generators are Scania SGI-13, which have a capacity between 59 and 114m^3/hr, and output up to approximately 190kW_m each.
3. The upgraded landfill gas flare has a maximum capacity of 1000m^3/hr and a minimum capacity of 200m^3/hr.
4. A gas risk assessment (GRA) was prepared by Golder WSP in support of the planning application[1]. This used the GASSIM software v2.5 (Environment Agency, 2011) to model the potential landfill gas generation, fugitive and combustion emissions from the Site. Gassim was used to carry out a Tier 1 screening assessment to consider the impacts of emissions from the flare and gas engines. Impacts on pollutant concentrations were shown to be insignificant on both human and ecological receptors.
5. Subsequent to this submission, Environment Agency requested that the impact of combustion emissions on nitrogen deposition over ecological receptors be assessed. Since Gassim does not include a facility to screen impacts arising from nitrogen deposition, this assessment required the use a separate dispersion model.
6. This technical note supplements the GRA and sets out the methodology and findings of the detailed assessment of nitrogen oxides, and nitrogen and acid deposition arising from the flare and micro-generators emissions, undertaken using the ADMS dispersion model developed by Cambridge

[1] Milegate Eastern Extension Quarry and Landfill: Landfill Gas Risk Assessment, August 2024, Rep No 20148978.635/A.1

Environment Research Consultants Ltd. This model is widely used for the assessment of impacts from combustion processes in the UK and globally.

Guidance

7. The assessment has been undertaken in accordance with the following guidance:

   - Air emissions risk assessment for your environmental permit (Environment Agency, 2024, www.gov.uk)
   - Environmental permitting: air dispersion modelling reports, Environment Agency, 2024, www.gov.uk)
   - AQTAG06, Technical guidance on detailed modelling approach for an appropriate assessment for emissions to air, March 2014

Habitats Sites

8. Environment Agency guidance states that protected conservation areas should be considered where the fall within the following distance buffers from the Site:

   - 10km for Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Ramsar Sites, and
   - 2km for Sites of Special Scientific Interest (SSSI), and local nature sites (including ancient woodlands, local wildlife sites and national and local nature reserves).

9. **Figure 1** (Appendix B) shows the location of the Sandsfield Site (the Site) and the nature conservation sites that fall within these distances, namely:

   - Hornsea Mere SPA (and SSSI), 4.4km east of the landfill gas utilisation compound,
   - Greater Wash (Marine Component) SPA, 7.7km to the east of the compound,
   - Local Nature Sites at
     - Catwick and Brandesburton Pits, 1km south-east of the compound, and
     - Watersedge Park, 0.2km south of the compound.

10. The exact boundaries of the local nature sites could not be definitively identified from online resources. However, the broad area in the vicinity of these sites contains Priority Habitat (deciduous woodland,

11. **Figure** 2) as set out in the Natural Environment and Rural Communities Act (2006) Section 41 habitats of principal importance, waterbodies and areas of grassland.

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METHODOLOGY

Model Set Up

12. The model set up is summarised in Appendix A to this note.

Assessment Scenario

13. The GRA (Section 4.1) concludes that landfill gas generation at the Site will peak at less than 650m^3/hr in 2034. This peak volume flux exceeds the combined capacity of the micro-generators (up to 228m^3/hr) and the excess landfill gas (around 400m^3/hr) will need to be flared. This is well within the capacity of the flare (200 – 1000 m^3/hr).

14. Therefore, this impact assessment is based on a scenario, Scenario A, in which:

    - 2 x micro-generators operate continuously at maximum capacity
    - The gas flare operates continuously at 40% load (combusting ~400m^3/hr of landfill gas).

15. Sensitivity testing has also been undertaken to consider impacts with all landfill gas being sent to the flare rather than utilised in the gas engines, assuming gas combustion rates of 650m3/hr (Scenario B) and 1000m3/hr (Scenario C). Scenario C is highly conservative since the combustion rate exceeds the predicted gas generation rate.

Emissions and Model Input

16. **Table 1** shows the modelled emissions parameters for the generators and flare. The values in the table are, in part, taken from the GRA, with additional data generated on the basis of the following assumptions:

    - Landfill gas is, on average, 50% methane and 50% CO_2,
    - Landfill gas heat content is 17.5MJ/m^3.

Table 1: Modelled emissions parameters for gas engines (micro-generators) and gas flare. The latter is given at various loads.

Metric	Gas Engines (per engine)	Flare (Scenario A)	Flare (Scenario B)	Flare (Scenario C)
Stack Height (m)	5.2	7.48		
Stack Diameter (m)	0.21	1.37		

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Metric	Gas Engines (per engine)	Flare (Scenario A)	Flare (Scenario B)	Flare (Scenario C)
Temperature (ºC)	525	1000		
Air to Fuel Ratio	7.2	10.7		
Load (%)	100	40	65	100
Volume Flow (Am^3/s)	0.64	6.39	10.23	15.98
Exit Velocity(m/s) †	18.6	4.3	6.93	10.8
Oxygen (%, actual)	7.6	12.0		
Moisture (%)	11.6	7.9		
Reference Oxygen (%, dry)	5	3		
Oxygen (%, dry)	8.5	13.1		
Volume flow (Nm^3/s) at Ref O_2, dry	0.15	0.083	0.884	1.38
NOx (mg/Nm3, at Ref O_2, dry) ‡	512	150		
NOx (g/s)	0.078	0.083	0.133	0.207
SO_2 (mg/Nm3, at 5% O_2) †	40	n/a		
SO_2 (g/s)	0.006	-		
Landfill Gas Combusted (m^3/hr)	94	400	650	1000

† The generator exhausts are likely to discharge horizontally. This orientation cannot be explicitly modelled within ADMS and, as such, the sensitivity of the results to the representation of the exhausts has been tested.

‡ The medium combustion plant (MCP) Directive uses a reference O_2 concentration of 15% for gas engines and turbines, and 3% for gas combustion in other MCP. The Emission Limit Values above are equivalent to the MCP values when converted to the O_2 reference conditions assumed within GASSIM, namely 5% O2 for the micro-generators i.e. 190mg/Nm^3 at 15% O_2, dry = 512mg/Nm^3 at 5% O_2, dry.

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ASSESSMENT STANDARDS

Critical Levels and Loads

17. **Table 2** and **Table 3** show the critical levels for NOx and SO2, and habitat specific critical loads for nitrogen and acid deposition for the designated sites.

Table 2: Habitats sites and critical levels

Designated Site	Critical Level for NOx (µg/m^3, Annual Mean)	Critical Level for NOx (µg/m^3, Daily Mean)	Critical Level for SO_2 (µg/m^3, Annual Mean)
Hornsea Mere SPA †	30	75	10
Greater Wash SPA ‡	Not specified		
Catwick and Brandesburton Pits plus Watersedge Park §	30	75	10

† The Hornsea Mere SPA is designated for its populations of Gadwall (*Anas strepera*) and Mute swans (*Cygnus olor*). There are no critical levels specified for these features. Therefore, the critical levels are taken from supporting habitats within the designation for the underlying Hornsea Mere SSSI: Deciduous woodland, Atlantic upper-mid / mid-lower salt marshes and rich fens.

‡ None of the features within the Greater Wash SPA have critical levels specified for NOx or SO_2. There is no SSSI underlying the SPA within 10km of the Site.

§ Critical levels taken from generic terrestrial habitats on APIS

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Table 3: Habitats sites, most sensitive habitats and critical loads for nitrogen (N) and acid deposition

Designated Site	Species / Habitat	Critical Load Range for N-Deposition (kgN/ha/yr)	Minimum Critical Load for Acid Deposition (keq/ha/yr)		
			$CL_{max}S$	$CL_{min}N$	$CL_{max}N$
Hornsea Mere SPA	Alnus glutinosa - Urtica dioica Woodland	10 - 15	10.739	0.142	10.881
	Atlantic upper-mid & mid-low salt marshes	10 - 20	Not specified		
Greater Wash SPA	Coastal dune grasslands (grey dunes) – calcareous type	10 - 15	4.000	0.856	4.856
	Shifting coastal dunes	10 - 20	Not sensitive		
Catwick and Brandesburton Pits plus Watersedge Park	Broadleaved, Mixed and Yew Woodland	10 - 15	10.761	0.142	10.903
	Low and medium altitude hay meadows	10 - 20	4.07	0.223	4.293
	Poor Fen	5 - 15	Not sensitive		

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Insignificance Criteria

18. Following Environment Agency guidance, if impacts on SPA, SAC, and Ramsar sites or SSSIs meet both of the following criteria, then the impacts can be classed as insignificant:

    - the short term Process Contribution (PC) is less than 10% of the short term environmental standard for protected conservation areas
    - the long term PC is less than 1% of the long term environmental standard for protected conservation areas

19. If these criteria are exceeded, then the Predicted Environmental Concentration (PEC) must be calculated (as PC + Background) and, if the PEC is less than 70% of the long term environmental standard, the impacts are classed as insignificant.
20. For local nature sites, the following insignificance criteria apply:

    - the short term PC is less than 100% of the short term environmental standard for protected conservation areas
    - the long term PC is less than 100% of the long term environmental standard for protected conservation areas

21. There is no requirement set out in Environment Agency guidance to calculate the PEC for local sites.

ASSESSMENT

Background Concentrations and Deposition

22. **Table 4** and **Table 5** show the range of background concentrations and deposition for the designated sites, along with a high level screening of the background against the relevant critical levels and loads. The data are taken from the APIS web site (www.apis.ac.uk) and represent the 3 year average between 2020 and 2022.
23. Background pollutant concentrations are well within the annual mean critical levels for NOx and SO_2 over all designated sites. Background deposition exceeds the critical loads for nitrogen deposition over all sites and for both forest and grassland (low growing) habitats. There are, however, no exceedances of the acid deposition critical load function.

Table 4: Designated sites and background pollutant concentrations

Designated Site	NOx Concentration (µg/m^3)	Exceeds Critical Level	SO_2 Concentration (µg/m^3)	Exceeds Critical Level
Hornsea Mere SPA	6.81 - 7.45	No	1.01 – 1.53	No
Greater Wash SPA	5.7 – 17.2	n/a	0.45 – 2.61	n/a
Catwick and Brandesburton Pits plus Watersedge Park	7.29 – 8.34	No	1.23 - 1.64	No

Table 5: Designated sites and background pollutant deposition

Designated Site		Nitrogen deposition (kgN/ha/yr)	Exceeds Critical Load	Maximum Acid deposition (Total or N | S) (keq/ha/yr)	Exceeds Critical Load
Hornsea Mere SPA	Woodland	28.40 – 30.58	Yes	2.18	No
	Salt marsh	15.18 – 16.40	Yes	1.14	No
Greater Wash SPA	Coastal dune	11.61 – 16.30	Yes	1.14	No
Catwick and Brandesburton Pits plus Watersedge Park	Woodland	31.55 – 31.80	Yes	2.27 | 0.19	No
	Hay Meadows / Fen	16.97 – 17.02	Yes	1.22 | 0.14	No

Model Results

24. The following tables show the modelled impacts on NOx and SO_2 concentrations, nitrogen deposition and acid deposition. The data are presented as the maximum over each designated site as a function of meteorological year, modelled for Scenario A i.e. the 2 x microgenerators and gas flare operating continuously at full load.

25. Note that NOx concentrations are presented to 2dp, SO_2 concentrations and nitrogen deposition to 3dp and acid deposition to 4dp. This resolution is provided to demonstrate the scale of the impact and should not be taken to infer the level of accuracy of the dispersion model.

Nitrogen Oxides

26. **Table 6** and **Table 7** show the maximum modelled process contribution (PC) to annual mean and daily mean NOx concentrations respectively. The maximum impact over an SPA is less than 0.1% of the annual mean critical level and <0.25% of the daily mean critical level, and insignificant (<1%). The maximum impact over a local nature site is less than 3% of the annual mean critical level and <11% of the daily mean critical level, and also insignificant (<100%).

27. **Figure 3** and **Figure 4** show the spatial distribution of annual mean NOx and daily mean NOx in 2021. Similar distributions are seen in all years. Concentrations decrease rapidly with distance from the stacks. Annual mean concentrations follow the prevailing south-westerly wind and at any distance from the stacks, maximum concentrations are seen to the north-east. Daily mean concentrations show a concentric distribution around the stacks indicating that the meteorological conditions giving rise to high daily mean concentrations occur under winds from all directions. Maximum concentrations over the local nature sites in the immediate vicinity of the Site occur at the southern boundary of the Site in Watersedge Park.

Table 6: Process Contribution to Annual Mean NOx over habitats sites ($\mu g/m^3$)

Designated Site	2019	2020	2021	2022	2023	Max	Max as % of Critical Level	Insig-nificant ?
Hornsea Mere SPA	0.01	0.01	0.01	0.01	0.01	0.01	0.04%	Yes
Greater Wash SPA	0.01	0.01	0.01	0.01	0.01	0.01	n/a	Yes
Catwick and Brandesburton Pits plus Watersedge Park	0.62	0.53	0.76	0.61	0.54	0.76	2.53%	Yes

Table 7: Process Contribution to Daily Mean NOx over habitats sites ($\mu g/m^3$)

Designated Site	2019	2020	2021	2022	2023	Max	Max as % of Critical Level	Insig-nificant ?
Hornsea Mere SPA	0.10	0.15	0.12	0.10	0.15	0.15	0.21%	Yes
Greater Wash SPA	0.08	0.08	0.08	0.10	0.08	0.10	n/a	Yes
Catwick and Brandesburton Pits plus Watersedge Park	7.47	7.76	7.35	7.42	8.03	8.03	10.71%	Yes

Sulphur Dioxide

28. **Table 8** shows the maximum modelled process contribution (PC) to annual mean SO_2 concentrations. The PC is insignificant over all habitats designated sites.

Table 8: Process Contribution to Annual Mean SO2 over habitats sites ($\mu g/m^3$)

Designated Site	2019	2020	2021	2022	2023	Max	Max as % of Critical Level	Insig-nificant ?
Hornsea Mere SPA	0.001	0.001	0.001	0.001	0.001	0.001	0.01%	Yes
Greater Wash SPA	0.000	0.000	0.000	0.000	0.000	0.000	n/a	Yes
Catwick and Brandesburton Pits plus Watersedge Park	0.039	0.032	0.047	0.038	0.033	0.047	0.47%	Yes

Nitrogen Deposition

29. **Table 9** and **Table 10** show the maximum modelled process contribution (PC) to nitrogen deposition for short (moorland) and tall (forest) vegetation respectively. Impacts are insignificant over all sites.

Table 9: Process Contribution to nitrogen deposition (Low growing vegetation types) (kgN/ha/yr)

Designated Site	2019	2020	2021	2022	2023	Max	Max as % of Critical Load	Insig-nificant ?
Hornsea Mere SPA	0.001	0.001	0.001	0.001	0.001	0.001	0.01%	Yes
Greater Wash SPA	0.001	0.001	0.001	0.001	0.001	0.001	0.01%	Yes
Catwick and Brandesburton Pits plus Watersedge Park	0.063	0.053	0.077	0.061	0.054	0.077	1.53%	Yes

Table 10: Process Contribution to nitrogen deposition (Forest Vegetation (kgN/ha/yr)

Designated Site	2019	2020	2021	2022	2023	Max	Max as % of Critical Load	Insig-nificant ?
Hornsea Mere SPA	0.002	0.002	0.002	0.002	0.002	0.002	0.02%	Yes
Greater Wash SPA	0.002	0.002	0.002	0.002	0.002	0.002	n/a	Yes
Catwick and Brandesburton Pits plus Watersedge Park	0.126	0.106	0.153	0.122	0.108	0.153	1.53%	Yes

Acid Deposition

30. **Table 11** and **Table 12** show the maximum modelled process contribution (PC) to acid deposition for short (moorland) and tall (forest) vegetation respectively. Impacts are insignificant over all sites.

Table 11: Process Contribution to acid deposition (Low growing vegetation types) (keq/ha/yr)

Designated Site	2019	2020	2021	2022	2023	Max	Max as % of Critical Load	Insig-nificant ?
Hornsea Mere SPA	0.0001	0.0001	0.0001	0.0002	0.0002	0.0002	n/a	Yes
Greater Wash SPA	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.00%	Yes
Catwick and Brandesburton Pits plus Watersedge Park	0.0091	0.0076	0.0110	0.0088	0.0078	0.0110	0.26%	Yes

Table 12: Process Contribution to acid deposition (Forest Vegetation (keq/ha/yr)

Designated Site	2019	2020	2021	2022	2023	Max	Max as % of Critical Load	Insig-nificant?
Hornsea Mere SPA	0.0003	0.0002	0.0003	0.0003	0.0003	0.0003	0.00%	Yes
Greater Wash SPA	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	n/a	Yes
Catwick and Brandesburton Pits plus Watersedge Park	0.0181	0.0152	0.0221	0.0177	0.0156	0.0221	0.20%	Yes

PEC

Since all process contributions under Scenario A are insignificant, there is no requirement to calculate the PEC. However, it is readily apparent from the background data and model results that exceedance of the critical levels or loads is primarily determined by the background levels and as such, over all nature conservation sites:

- The PEC for annual mean nitrogen oxides will be well within the critical level
- The PEC for annual mean sulphur dioxide will be well within the critical level

- The PEC for nitrogen deposition will exceed lower limit of the critical load range
- The PEC for acid deposition will be within the critical load function

Sensitivity Tests

Sensitivity testing has been undertaken for a single year of meteorological data (2021) and considers annual mean nitrogen oxide concentrations since this also determines the impact on nitrogen deposition.

Operating Scenario

31. The core scenario assessed above, Scenario A, assumes that the generators are operated at full load, with the flare operating at reduced capacity to combust the excess landfill gas generation (**Table 13**). Scenarios B and C assume only the flare is operating and consider combustion of the maximum landfill gas generation (650m^3/hr) and at the flare capacity (1000m^3/hr) respectively.
32. With only the flare operating, ground level impacts are lower than for operation with the flare plus generators. Scenario A, as presented above, therefore represents the most conservative operating scenario.

Table 13: Process Contribution to Annual Mean NOx over habitats sites as a function of operating Scenario (µg/m^3), modelled using 2021 meteorological data

Designated Site	Scenario A – Generators at full load plus Flare at 400m^3/hr	Scenario B – Flare at Maximum Gas Generation (650m^3/hr)	Scenario C – Flare at Maximum Capacity (1000m^3/hr)	Variation relative to Scenario A
Hornsea Mere SPA	0.010	0.003	0.005	-69%
Greater Wash SPA	0.008	0.003	0.005	-61%
Catwick and Brandesburton Pits plus Watersedge Park	0.759	0.173	0.216	-77%

Horizontal Release

33. It is recommended that the exhausts from the micro-generators release vertically. However, it is likely that operations will be maximised if the exhausts discharge horizontally. This effect cannot be explicitly modelled in ADMS and, as a result, the impact of a horizontal release has been modelled assuming a very low exit velocity (0.82m/s, minimising the plume rise driven by the initial momentum of the plume) but retaining the correct volume flux (by increasing the stack diameter to 1m). This maintains the thermal buoyancy of the exhaust gases. It is, however, likely to be a conservative representation of the impacts since it does not take account of the turbulent mixing of the plume and ambient air immediately upon release from the generator exhaust.

34. **Table 14** shows that whilst the reduced exit velocity marginally increases ground level impacts, the increase is not sufficient to change the overall conclusions i.e. even if impacts are up to 7% higher than modelled for Scenario A, they will still be classed as insignificant using Environment Agency criteria.

Table 14: Process Contribution from the micro-generators to Annual Mean NOx over habitats sites as a function of release direction for micro-generators (µg/m3), modelled using 2021 meteorological data

Designated Site	Scenario A – Vertical Release	Scenario A – Horizontal Release	Variation relative to Scenario A
Hornsea Mere SPA	0.008	0.008	+2%
Greater Wash SPA	0.006	0.006	+1%
Catwick and Brandesburton Pits plus Watersedge Park	0.604	0.649	+7%

Exhaust Temperature

35. The exhaust temperatures for the flare and micro-generators have been estimated based on professional judgement. Reducing the temperature will reduce the plume buoyancy and result in increased ground level concentrations. This effect was investigated by lowering the exhaust gas temperatures and also reducing the exit volume flux to maintain the correct flue gas mass emission (**Table 15**).

36. Reducing the exhaust gas temperature marginally increases the ground level impacts, but the increase in not significant at the nature conservation sites.

Table 15: Process Contribution to Annual Mean NOx over habitats sites as a function of exhaust gas temperature ($\mu g/m^3$), modelled using 2021 meteorological data

Designated Site	Scenario A – Generators at 525ºC, Flare at 1000ºC	Reduced Temperature 1 –Generators at 425ºC, Flare at 800ºC	Reduced Temperature 2 –Generators at 325ºC, Flare at 600ºC	Variation relative to Scenario A
Hornsea Mere SPA	0.010	0.011	0.011	+8%
Greater Wash SPA	0.008	0.008	0.008	+5%
Catwick and Brandesburton Pits plus Watersedge Park	0.759	0.806	0.866	+14%

Buildings

37. The representation of buildings in dispersion models is a source of uncertainty, since the complex real world structures must be simplified to enter into the model as cuboid structures. Furthermore, the parametrisation of the effect of buildings cannot replicate the detailed effects of multiple buildings and structures within the gas utilisation compound.

38. As a result, sensitivity testing was undertaken where the height of the generator housing units was increased from 3.5m to 4.5m, and the stack discharge location on the housing unit was varied from the south-east corner to the north-east corner.

39. **Table 16** shows that, at the nature conservation sites, the representation of buildings in the model has only a marginal impact on modelled concentrations, and this has no effect on the assessment conclusions.

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Table 16: Process Contribution to Annual Mean NOx over habitats sites as a function of generator housing unit layout and geometry ($\mu g/m^3$), modelled using 2021 meteorological data

Designated Site	Scenario A –Housing @3.5m, stacks located near south-west corner	Increased Housing Height – Housing @4.5m	Scenario A –Housing @3.5m, stacks located centrally on unit	Scenario A –Housing @3.5m, stacks located towards north-east corner	Variation relative to Scenario A
Hornsea Mere SPA	0.010	0.010	0.010	0.010	<1%
Greater Wash SPA	0.008	0.008	0.008	0.008	<1%
Catwick and Brandesburton Pits plus Watersedge Park	0.759	0.761	0.761	0.756	<1%

Surface Roughness

40. Professional judgement must be used in specifying the surface roughness input to the model. The area surrounding the Site has few buildings and only isolated areas of woodland. Therefore, the surface roughness was set, for the core runs, to 0.2m. This is the minimum value recommended by CERC, the model developers, for agricultural areas. The effect of increased surface roughness was investigated by increasing the roughness to 0.3m and 0.5m (**Table 17**).

41. The model results demonstrate that increasing the surface roughness reduces the ground level concentrations and that the core scenario is robust and conservative.

Table 17: Process Contribution to Annual Mean NOx over habitats sites as a function of exhaust gas temperature ($\mu g/m^3$), modelled using 2021 meteorological data

Designated Site	Scenario A – Surface Roughness at Site = 0.2m	Increased Roughness 1 – Surface roughness at Site = 0.3m	Increased Roughness 2 – Surface roughness at Site = 0.5m	Variation relative to Scenario A
Hornsea Mere SPA	0.010	0.010	0.010	-7%
Greater Wash SPA	0.008	0.008	0.007	-5%
Catwick and Brandesburton Pits plus Watersedge Park	0.759	0.736	0.704	-7%

CONCLUSIONS

42. The impacts of the proposed landfill gas engines and flare on nitrogen oxides and sulphur dioxide concentrations, and nitrogen and acid deposition are **insignificant** at all nature conservation sites in the vicinity of Milegate Extension Landfill Site.

43. With the worst case operating scenario (Scenario A), the maximum impacts amount to less than 0.1% of any long term critical level or critical load at the Hornsea Mere SPA and Greater Wash SPA, and less than 0.25% of the daily mean critical level. Maximum impacts on the local nature sites are less than 11% of any standard. These impacts are well within the Environment Agency insignificance criteria.

44. Sensitivity testing has shown that this conclusion is robust and unaffected by uncertainty in plant operating scenario, the model representation of buildings and horizontal releases, the assumed exit temperature and meteorological and surface parameters. None of the sensitivity tests showed a potentially significant underestimation of impacts from the proposals. Furthermore, the modelling has employed a number of conservative assumptions, including neglecting plume depletion, assuming long term operation at the maximum landfill gas generation rates, a high conversion of NOx to NO_2 and emissions constantly at their MCP emission limit value.

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APPENDIX A – MODEL SETUP

Parameter	Value	Justification
Model	ADMS v6.0.0.1	Model widely used for modelling industrial sources in UK
Meteorological Data	RAF Waddington 2019 – 2023 (years modelled individually). Wind roses provided below.	Waddington is 80km south-west of the site. Given the lack of significant terrain and orientation of the nearest coastline, data from this met station are appropriately representative of conditions at the site. This site has been accepted for use by Environment Agency for Drax Power Station and other nearby process sites.
Surface Parameters	*Site:* Roughness Length = 0.2m Minimum Monin-Obukhov Length = 10m *Met Site*: Roughness Length = 0.3m Minimum Monin-Obukhov Length = 10m	The site and met station parameters are representative of areas of agricultural use, outside of urban areas. Default Priestley-Taylor parameter used Sensitivity testing was undertaken with increased site roughness length
Buildings	Generator housing units *Building 1* Location: 512831,447345 H x L x W: 3.5 x 6 x 2 Angle: 79 *Building 2* Location: 512832,447341.1 H x L x W: 3.5 x 6 x 2 Angle: 79	The gas flare is a free standing structure with no associated building. The micro-generators The microgenerators will be housed in containers. Sensitivity testing undertaken with respect to building height / stack location
Terrain	Not included	There is no significant terrain (defined as gradients >10%) in the vicinity of the site.

Receptors	Modelled on a grid of varying resolution: 10m with 2km of the site, 50m for Hornsea Mere SPA, and 100m for Greater Wash SPA	Over the local nature sites, the grid resolution is less than 2 x the micro-generator stack height, but with the designated sites being over 200m from the generators, this is sufficient to resolve the impacts. At distance, the 50m and 100m resolutions are sufficient to ensure that the maximum impacts over the designated sites are captured in the modelling.
Chemistry	NOx to NO_2 modelled using blanket approach of: 70% NOx as NO_2 in annual mean 35% NOx as NO_2 in hourly mean	Environment Agency Worse Case assumptions
Deposition	Estimated using deposition velocity in post-processing; No plume depletion NO_2 – 1.5mm/s / 3.0mm/s for moorland / forest vegetation SO_2 – 12mm/s / 24mm/s for moorland / forest vegetation	Conservative approach, with deposition velocities taken from AQTAG06

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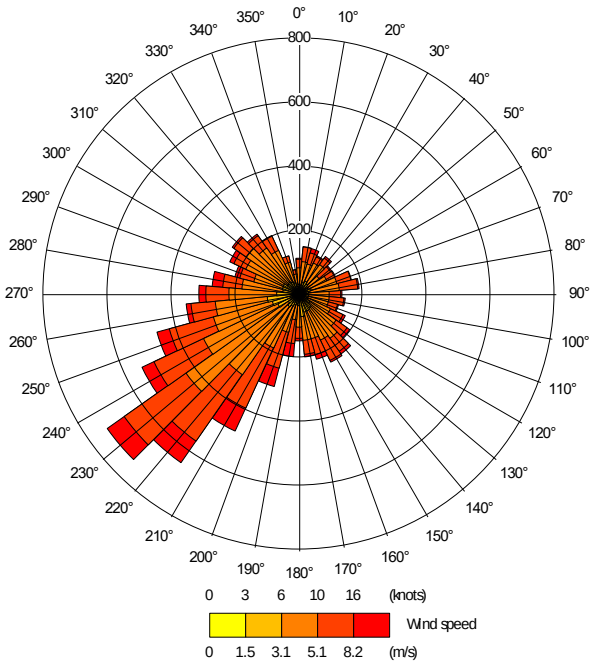
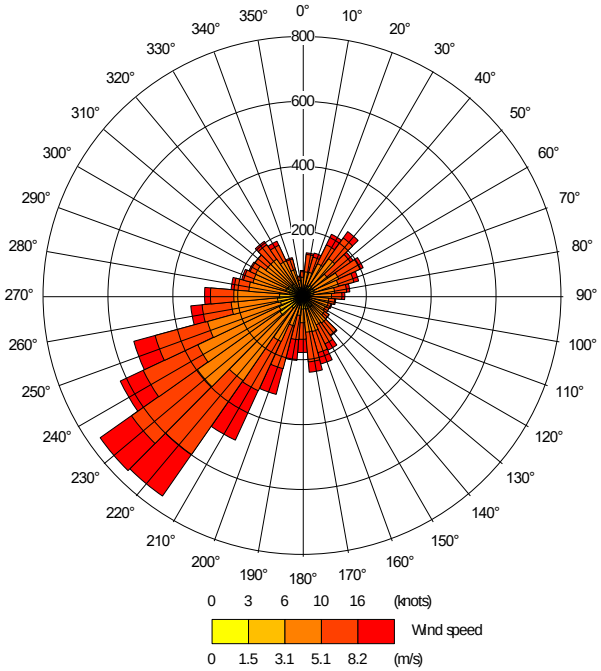
CHECKED:	Bethan Tuckett-Jones	**APPROVED:**	Bethan Tuckett-Jones

Waddington Wind Roses

2019



2020



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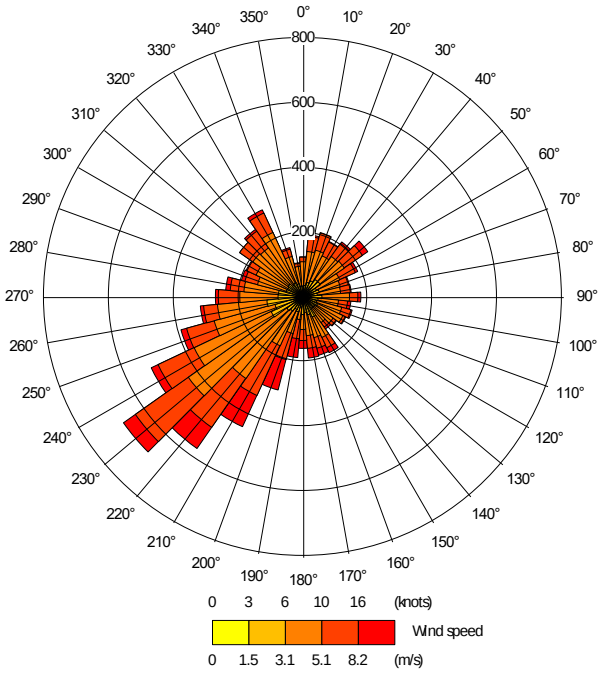
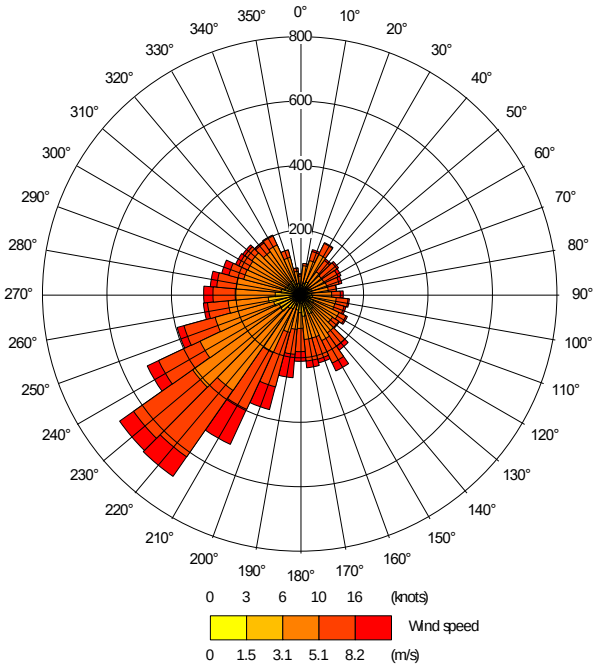
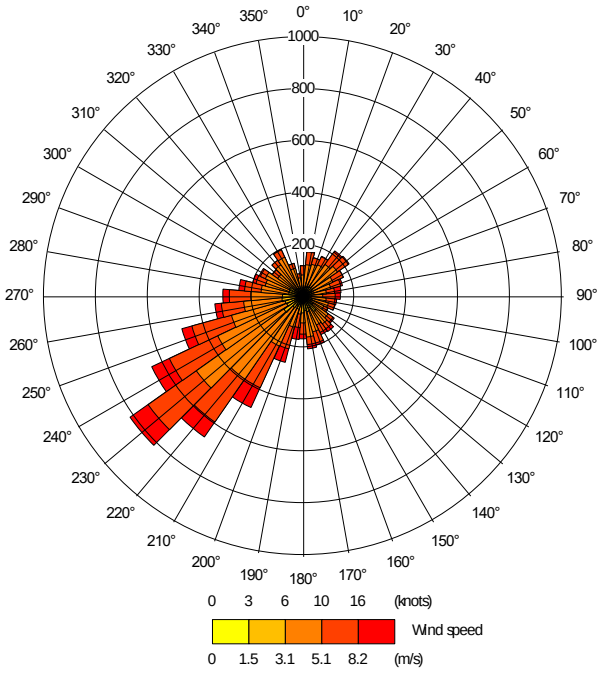
2021



2022



2023



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APPENDIX B – FIGURES

Figure 1. Site location and sites designated for nature conservation. Special Protection Areas (SPA) are shown in blue hatched shading. The 2km and 10km buffers around the Site are shown by green and orange dashed lines. The Site and Flare/Microgenerators are shown by a solid red line and purple triangle respectively.

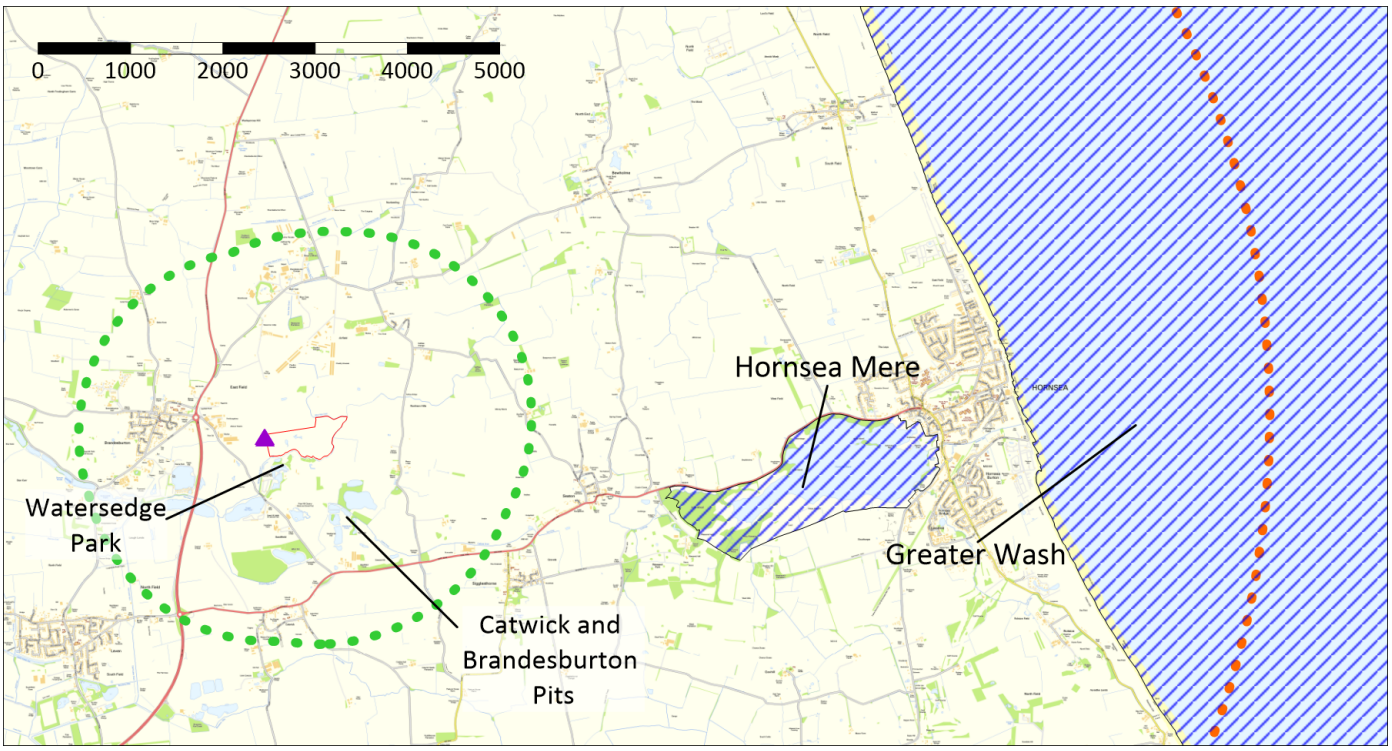

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Figure 2: Priority habitats in the vicinity of local wildlife sites. Areas of woodland, as designated within the National Forest Inventory are shown in green shading. Areas of deciduous woodland within the Priority Habitat Inventory for England are denoted by the letter P.

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Figure 3: Annual Mean NOx for Scenario 1, modelled using meteorological data from 2021 (µg/m^3).

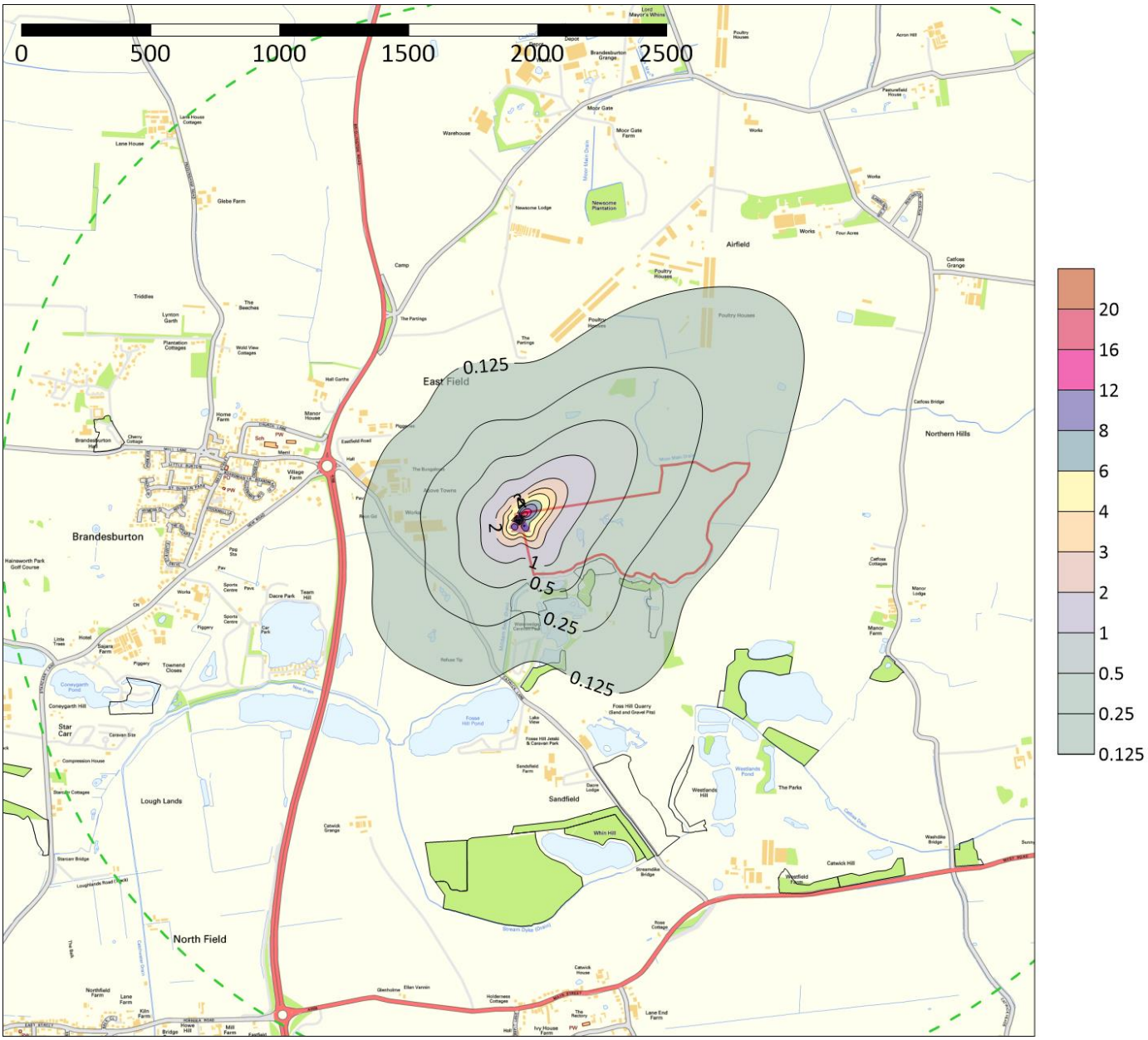

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Figure 4: Daily Mean NOx for Scenario 1, modelled using meteorological data from 2021 (µg/m^3).