katestone
www.katestone.global

Screening Framework for the Air Quality Assessment of Biomass Boilers - Technical Description

Prepared for:

Irish Bioenergy Association

February 2022

Final

Prepared by:

Katestone Environmental Pty Ltd
Office 5a, Portlaoise Enterprise Centre, Clonminam Industrial Estate, Portlaoise, Co Laois

www.katestone.global
admin@katestone.global
Ph +353 (87) 365 6879

katestone
www.katestone.global

Document Control

Deliverable #:	D19011-35
Title:	Biomass Boiler Air Quality Assessment Framework - Technical Description
Version:	1.0 (Final)
Client:	Irish Bioenergy Association
Document reference:	D19011-35 Biomass Boiler AQA Framework - Technical Description.docx
Prepared by:	Micheal Fogarty, Paraic McDowell and Manning Young
Reviewed by:	Manning Young and Simon Welchman
Approved by:	 Simon Welchman 15/02/2022

Foreword by the Irish Bioenergy Association

The Irish Bioenergy Association (IrBEA) commissioned Katestone Global to complete this report in response to the requirement for an EPA IPCC licence review for biomass heating system installations above 250kW at intensive agriculture EPA licensed facilities.

IrBEA promotes best practice across all aspects of the industry from biomass systems design and installation, quality fuel supply and environmental considerations. This three-part report (Technical description, Single boiler framework, Multiple boiler framework) is an example of the organisation working to address barriers to the deployment of renewable heat in Ireland.

This report provides a clear pathway for the installation of biomass heating systems, up to 1MW in size, on intensive agriculture licensed sites, without negatively impacting on local air quality. This is verified through the completion of the screening framework tool or a specific individual air modelling assessment depending on the individual site constraints. The framework also serves as a guide to other proposed installations where licencing is not required. Modern biomass boilers can be installed to dramatically reduce emissions of CO_2 and can do so without having any negative impacts on air quality.

During the course of completing this work, Katestone and IrBEA have consulted widely with industry and stakeholders in the development of this three-part report. This has resulted in Katestone Global developing a scientifically based solution to help resolve the issues identified without adversely impacting on air quality.

I would like to acknowledge the EPA engagement during this work and for their feedback and technical input to the various drafts presented during the review and approval process. I would like to pay tribute to Micheal Fogarty and his team at Katestone Global for their commitment and dedication when compiling this report.

IrBEA would like to express our sincere gratitude to the Sustainable Energy Authority of Ireland (SEAI), the Irish Farmers Association (IFA), the Wood Fuel Quality Assurance (WFQA) Scheme, Woodco, CHP Mechanical and Towards Zero Carbon for their sponsorship.

Seán Finan B.E C.Eng MIEI

IrBEA Chief Executive Officer

Sponsors:

Contents

Tables

Figures

Glossary

Term	Definition
g/s	grams pe second
km	kilometre
m	metre
m/s	metres per second
m^2	square metres
m^3	cubic metres
m^3/s	cubic metres per second
m^3/hr	cubic metres per hour
MW	Megawatts
MWth	Megawatts (thermal)
µg/m^3	micrograms per cubic meter
Abbreviations	**Definition**
AG4	Air Guidance 4
BAT	Best available techniques
CAFE	Cleaner Air for Europe
EPA	Environment Protection Agency
EF	Emission factor
ELV	Emission Limit Value
IrBEA	Irish Bioenergy Association
MCP	Medium Combustion Plant
SEAI	Sustainable Energy Authority of Ireland
SSRH	Support Scheme for Renewable Heat

1. INTRODUCTION

Katestone was commissioned by the Irish BioEnergy Association (IrBEA) to develop a screening framework for the assessment of emissions to air from biomass boilers installed at EPA licensed intensive pig and poultry production facilities in Ireland.

Most intensive agricultural sites have two types of boilers, namely:

- Baseload boilers, which are single or multiple boilers that are used to meet the thermal requirements in production houses.
- Back-up boilers, which are generally single boilers that operate intermittently to meet the thermal requirements in production houses including:
    - Standby boilers that operate when baseload boiler(s) are offline (e.g. during scheduled servicing or maintenance).
    - Auxiliary boilers that can work concurrently with the baseload boiler(s) at certain times to achieve the peak demand / system load

The key focus of this document is baseload boilers, but the information is also relevant to backup boilers.

Traditionally the heating requirements of Irish piggeries and poultry farms has been achieved by the combustion of fossil fuels. Ireland is committed to reducing its dependency on fossil fuels and reducing its carbon emissions under European and international agreements. Biomass is a renewable and cost-effective source of energy for heating piggeries and poultry houses that results in a net reduction in greenhouse gas emissions.

However, a potential negative impact may result from increased biomass utilisation, in the form of increased pollutant emissions, particularly particulate matter (PM) and oxides of nitrogen (NO_x) (IrBEA, 2016).

The heating requirements for typical intensive pig and poultry houses is generally provided by one or more boilers with total thermal input ranging from 250 kW to 1 MW, which is small relative to typical industrial installations. Consequently, these small boilers represent a low risk of adverse air quality impacts. However, in general such boilers cannot be installed without some form of regulatory approval, which requires the applicant to demonstrate that the biomass boiler can be operated without causing adverse air quality impacts.

For large scale or high-risk installations, it is common for proponents to conduct dispersion modelling in order to assess the potential air quality impacts and demonstrate that an activity can be conducted without causing adverse impacts. The Environmental Protection Agency (EPA) has produced a guidance note for air dispersion modelling (EPA, 2020). However, such detailed air quality assessments are a significant cost to agricultural businesses and it is, therefore, desirable to have a risk-based assessment framework that can allow low-risk proposals to be efficiently evaluated and approved where appropriate.

The screening framework described here is a simple tool for the conservative assessment of a single or multiple biomass boilers within the same site boundary. It adopts a number of conservative assumptions to ensure that boilers that are determined to be low risk under the requirements of the screening framework will not result in adverse air quality impacts. Where a proposal does not meet the screening requirements, the proponent may opt to either redesign the biomass boiler or move to a higher level of air quality assessment using site specific dispersion modelling.

Katestone has developed a series of documents that describe and present the screening framework that can be adopted to assess whether proposed biomass boilers that meet certain requirements can be operated without causing adverse air quality impacts and, therefore, can be approved for installation. The titles of the documents in the series include:

- Biomass Boiler Air Quality Assessment Framework - Technical Description (Technical Description)
- Screening framework for Air Quality Assessment of a Single Biomass Boiler (Single Boiler Screening Framework)
- Screening framework for Air Quality Assessment of Multiple Biomass Boilers (Multiple Boiler Screening Framework).

This is the first document in the series provides a technical description of the principles that underpin the screening framework. It should be referred to if background on the development of the screening framework is required.

The second document of the series is the Single Boiler Screening Framework. Its purpose is to provide a procedure that is quick and easy-to-apply to:

- Understand the information required to complete the stepwise approach.
- Determine whether a single proposed biomass boiler can be installed and operated without causing an adverse impact on air quality beyond the site boundary.
- Present the relevant information so that the regulator may confidently approve the boiler.

The third document in the series, the Multiple Boiler Screening Framework provides a similar approach to the Single Boiler Screening Framework to determine whether multiple proposed biomass boilers can be installed and operated at a site without causing an adverse impact on air quality beyond the site boundary.

2. REGULATORY CONTEXT AND ASSESSMENT CRITERIA

2.1 *Environmental Protection Agency Act 1992*

The *Environmental Protection Agency Act 1992* (EPA Act) and Part 2 of the *Protection of the Environment Act 2003* are collectively referred to as the *Environmental Protection Agency Acts 1992 and 2003*. The First Schedule of the *Environmental Protection Agency Acts 1992 and 2003* specifies activities that require licenses, which include rearing of pigs and poultry.

Section 4 (2) of the *Environmental Protection Agency Acts 1992 and 2003* states that Air Pollution:

> *"means the direct or indirect introduction to an environmental medium, as a result of human activity, of substances, heat or noise which may be harmful to human health or the quality of the environment, result in damage to material property, or impair or interfere with amenities and other legitimate uses of the environment, and includes -*
>
> *(a) 'air pollution' for the purposes of the Air Pollution Act 1987,*
>
> *(b) ……………………..*
>
> *(c) ……………………..*"

The *Air Pollution Act 1987* (AP Act) is "*an act to provide for the control of air pollution and other matters connected with air pollution"*. According to the AP Act *"'pollutant' means any substance specified in the First Schedule or any other substance (including a substance which gives rise to odour) or energy which, when emitted into the atmosphere either by itself or in combination with any other substance, may cause air pollution''*.

Section 4 of the AP Act states:

> *"Air pollution" in this Act means a condition of the atmosphere in which a pollutant is present in such a quantity as to be liable to —*
>
> *(i) be injurious to public health, or*
>
> *(ii) have a deleterious effect on flora or fauna or damage property, or*
>
> *(iii) impair or interfere with amenities or with the environment."*

Section 24 of the AP Act states:

(1) The occupier of any premises, other than a private dwelling, shall use the best practicable means to limit and, if possible, to prevent an emission from such premises.

(2) The occupier of any premises shall not cause or permit an emission from such premises in such a quantity, or in such a manner, as to be a nuisance.

(3) In any prosecution for a contravention of this section, it shall be a good defence to establish that—

(a) the best practicable means have been used to prevent or limit the emission concerned, or

(b) the emission concerned was in accordance with a licence under this Act, or

(c) the emission concerned was in accordance with an emission limit value, or

(d) the emission concerned was in accordance with a special control area order in operation in relation to the area concerned, or

(e) in the case of an emission of smoke, the emission concerned was in accordance with regulations under section 25, or

(f) the emission did not cause air pollution.

Section 75 (1) the *Environmental Protection Agency Acts 1992 and 2003* states:

> *"The Agency shall, in relation to any environmental medium and without prejudice to its functions under section 103, specify and publish quality objectives which the Agency considers reasonable and desirable for the purposes of environmental protection."*

2.2 Medium Combustion Plant (MCP) Directive

The *European Union (Medium Combustion Plant) Regulations 2017* were signed into law in December 2017. Their purpose is to limit emissions to atmosphere from boilers and other stationary combustion plants in the 1-50 MW_{TH} (thermal input) range. It covers all fuel types. The Regulations transpose the *Medium Combustion Plant (MCP) Directive (EU 2015/2193)*, which was adopted in Ireland in 2015.

The regulations limit the level of emissions allowable from MCP. New MCP will need to meet specified Emission Limit Values (ELVs) from 20 December 2018, while operators of existing MCPs will not be required to meet specified ELVs until 2025 at the earliest. This will assist in limiting the impact on human health, vegetation and biodiversity which can be caused by air pollution.

Biomass boilers with a thermal input capacity greater than 1 MW_{TH} installed at intensive agricultural farms are subject to the emission limits specified in the *MCP Directive*. Biomass boilers with a thermal input capacity less than 1 MW_{TH} are not subject to the emission limits specified in the *MCP Directive*.

Biomass boilers both below and within the thermal input range specified in the *MCP Directive* are obliged to comply with the *Environmental Protection Agency Act* and the *Air Pollution Act.*

2.3 Application to Industrial Emissions, Integrated Pollution Control or Waste licences

The EPA defines "Main Emission" and "Minor Emissions" in attachments to its Industrial Emissions (IE), Integrated Pollution Control (IPC) and Waste licence application template forms including:

- Authorised Application Form 7.4.1 - Emissions to Atmosphere - Main and Fugitive Emissions - Attachment
- Authorised Application Form 7.4.2 - Emissions to Atmosphere - Minor and Potential Emissions – Attachment.

These documents state the following in relation to Main Emissions and Minor Emissions:

> ***Main Emissions***
>
> *Main emissions include all emissions of environmental significance. Where a mass emission threshold is specified in a BAT document (BAT Conclusions, National BAT note or BREF), emissions which exceed this threshold prior to abatement are regarded as significant, i.e., 'main emissions'. (In some cases emissions below the threshold can still be significant and qualify as Main Emissions).*
>
> ***Minor Emissions***
>
> *Emissions below the mass emission threshold may be considered minor emissions and therefore do not generally need to be specifically controlled by the conditions or schedules of the licence (i.e., setting of ELVs, abatement control measures, or monitoring requirements). Emissions may also be deemed minor by virtue of their source/nature (e.g., laboratory fume hoods, workspace extractions, passive vents from storage tanks, HVAC exhausts), or composition (e.g., water vapour emissions). For combustion plant such*

as boilers, these can be considered minor where the rated thermal input is < 1MW where natural gas is the main fuel, and for liquid and solid fuels where its < 250kW.

In completing the separate 'Emissions to Atmosphere - Minor and Potential' attachment for minor emissions, the applicant should supply sufficient information to justify the determination of the emission as minor. Notwithstanding this guidance, the Agency may consider any emission to be significant (i.e., a main emission) on the basis of environmental impact.

Biomass boilers both below 250 kW thermal input are therefore considered minor emissions and are not specifically controlled by the conditions or schedules of a licence. Minor emission sources are generally not included in air quality assessments to determine air quality impacts as part of a licence review/application.

Boilers with thermal input between 250 kW and 1 MW present a regulatory challenge as emissions are not:

- Considered minor emissions for the purpose of license application/review
- Subject to the emission limits specified in the *MCP Directive.*

Emissions from boilers with thermal input between 250 kW and 1 MW are obliged to comply with the *Environmental Protection Agency Act* and the *Air Pollution Act.*

2.4 Eco Design Directive

The *Eco-design Regulations* (S.I. No. 203 of 2011 and S.I. No. 454 of 2013) set out the national rules that implement the *EU Directive on Ecodesign (EU 2009/125/EC).* The rules are the same for all Member States and are controlled by the Directive, which establishes a framework for the setting of eco-design requirements for energy-related products.

The regulations limit the level of emissions allowable from solid fuel boilers. If applicable, and not excluded by the Eco-Design Regulations, the solid fuel boiler must meet the eco-design requirements detailed in the Eco-Design Regulations and comply with the energy efficiency requirements and the ELVs in the Eco-Design Regulation, under Annex II.

Biomass boilers installed at intensive agricultural facilities will have to meet the requirements of the *Eco-design Regulations.*

2.5 Support Scheme for Renewable Heat

The Sustainable Energy Authority of Ireland (SEAI) is Ireland's national sustainable energy authority. The SEAI is the Scheme administrator determined by the Government for the Support Scheme for Renewable Heat (SSRH). The SSRH is:

"a government funded initiative designed to increase the energy generated from renewable sources in the heat sector. The scheme is open to commercial, industrial, agricultural, district heating, public sector and other non-domestic heat users.

The primary objective of the support scheme for renewable heat is to increase the level of renewable energy in the heat sector. This will contribute to meeting Ireland's 2020 renewable energy targets whilst also reducing greenhouse gas emissions."

A very large proportion of the boilers that will be installed on farms will receive grants under the SSRH. The terms and conditions of receiving SSRH grants include the following:

11. Air quality standards

11.1 Applicants must comply with all applicable environmental legislation and the regulatory requirements of the EPA and/or competent authority, as appropriate, with regard to air, waste and water.

11.2 ELVs for air shall be those set out in the applicable environmental legislation, including but not limited to:

…………………..

ii. For combustion plants with a rated thermal input equal to or greater than 1MWth and less than 50 MWth4

If applicable, and not excluded by the MCP Directive, the combustion plant must be registered with the EPA under the MCP Directive as applied by the MCP Regulations and comply with the ELVs set out in the MCP Regulations. The MCP Regulations also apply to a combination formed by new medium combustion plants pursuant to regulation 10 including a combination where the total rated thermal input is equal to or greater than 50MW, unless the combination constitutes an industrial emissions activity for the purposes of the Environmental Protection Agency Act 1992 as amended.

Periodic measurements shall be required at least:

i. every three years for MCPs with a rated thermal input equal to or greater than 1 MW and less than or equal to 20 MW; or

ii. every year for MCPs with a rated thermal input greater than 20MW.

The frequency of periodic measurements shall in any case not be lower than once every five years, as per Part 1 of the MCP Regulations.

The ELVs set out in Part 2 Schedule 2 of the MCP Regulations must be applied from 20 December 2018 for all new and applicable eligible renewable technologies.

iii. For solid fuel boilers with a rated thermal output of less that 1MWth. If applicable, and not excluded by the Eco-Design Regulations, the solid fuel boiler must meet the eco-design requirements detailed in the Eco-Design Regulations and comply with the energy efficiency requirements and the ELVs in the Eco-Design Regulation, under Annex II.

The scope of this paragraph is greater than the current legal requirements contained in the Eco-Design Regulations.

11.3 SEAI retains the right to request periodic measurements of ELVs for the eligible renewable technology to confirm compliance with the environmental legislation detailed at i, ii, and iii, whichever is applicable.

11.4 All emission measurements shall be conducted by an ISO 17025 accredited air monitoring contractor.

11.5 Applicants will be required to furnish a copy of a certificate of registration or equivalent, or a licence, issued by the EPA, or the equivalent certifying document issued by another competent authority, if requested by SEAI for the purposes of demonstrating compliance with legislative requirements. Similarly, applicants must be able to demonstrate compliance with the Eco-Design Regulations in accordance with the methods set out in the Eco-Design Regulations.:

2.6 Assessment Criteria - Air Quality Objectives

The Ambient Air Quality and Cleaner Air for Europe (CAFE) Directive (2008/50/EC) was published in May 2008. It replaced the Framework Directive and the first, second and third Daughter Directives. The fourth Daughter

Directive (2004/107/EC) will be included in CAFE at a later stage. The limit and target values for both Directives are outlined below.

The CAFE Directive was transposed into Irish legislation by the *Air Quality Standards Regulations 2011* (S.I. No. 180 of 2011) (DEHLG, 2011). It replaces the *Air Quality Standards Regulations 2002* (S.I. No. 271 of 2002), the *Ozone in Ambient Air Regulations 2004* (S.I. No. 53 of 2004) and S.I. No. 33 of 1999.

The limit values of the CAFE Directive that were applied in this assessment are presented in Table 1.

Table 1 Air contaminant limit values from the CAFE Directive

Air contaminant	Averaging period	Limit value ($\mu g/m^3$)	Basis of application of limit value
NO_2	1-hour	200	Not to be exceeded more than 18 times in a calendar year
	annual	40	Average
$NO + NO_2$	annual	30	Average
PM_{10}	24-hour	50	35th Highest
	annual	40	Average
$PM_{2.5}$	annual	20	Average

3. FRAMEWORK DEVELOPOMENT METHODOLOGY

3.1 Overview

The screening framework described in this report is underpinned by a conservative dispersion modelling approach that is applicable to biomass boilers installed in rural areas of Ireland. It can be used to determine if emissions from one or more proposed biomass boilers at a site is likely to result in exceedance of ambient air quality criteria.

A dispersion model is a tool that is used to assess the potential impact of air pollutant emissions from a stack (or other type of emission source) within a defined modelling domain (EPA, 2020). Dispersion modelling is an important tool for assessment of proposed or existing activities (EPA, 2020).

The EPA issues a wide range of guidance documents that are intended to support the holders of EPA licenses. These guidance documents provide information to operators, to assist them comply with their legal requirements and the Conditions set out in their license. Of particular relevance here is the EPA's dispersion modelling guidance: *Air Dispersion Modelling from Industrial Installations Guidance Note (AG4)*, which was re-issued by EPA in 2020. AG4 presents general principles and suitable methods that may be used to assess and report on the impact of air emissions from EPA licensed industrial installations.

This screening framework has been based on dispersion modelling methodology that meets the requirements of AG4.

The information required as input to the screening framework to determine if adverse air quality impacts are likely to occur due to the operation of the biomass boiler(s) includes the following:

- The location of the site of the proposed boiler(s) relative to urban centers
- The site's location relative to other sites that operate non-domestic boilers
- Characteristics of each boiler stack including:
    - Internal stack diameter
    - Stack temperature
    - Exit velocity
    - Stack height
    - Stack location
    - Maximum emission rate (as guaranteed by manufacturer(s)) of:
        - NO_x
        - Particulate Matter
- The operation of back-up boiler(s) at the site
- The operation of Winterwarm heaters at the site
- The moisture content of the fuel recommended by the boiler manufacturer(s)
- The thermal energy input and output specified by the manufacturer of the boiler(s)
- The thermal efficiency of the boiler(s).

The relevance of stack characteristics is discussed in Section 3.2.3.

The screening framework is not applicable to all sites, specifically sites that are located in close proximity to:

- Built-up areas with high levels of fossil fuel combustion (e.g. villages and towns)

- Other sources of combustion emissions (e.g. other farms or industrial sites with combustion emissions).

3.2 Technical Description

3.2.1 Meteorological Data

The meteorological data used in a dispersion modelling assessment is fundamentally important to determining the magnitude and extent of the potential impact of an air contaminant. The selection of an appropriate meteorological station for a dispersion modelling assessment is discussed in AG4. Citing the UK Atmospheric Dispersion Modelling Liaison Committee (ADMLC), it concludes that the most important factor in the selection of a meteorological station is the annual mean wind speed. All other things being equal, a dispersion model will predict higher ground-level concentrations for lower windspeeds. Consequently, a more conservative air quality assessment will be achieved by selecting meteorological stations that have lower average wind speeds.

The annual mean wind speeds at stations operated by Met Eireann are presented in Table 6.1 of AG4. The average wind speed of all stations operated by Met Eireann in Table 6.1 of AG4 is 5.0 m/s. Table 6.1 of AG4 identifies Moore Park as the Met Eireann station with the lowest annual mean wind speed.

The following Met Eireann stations have been adopted in the development of the screening framework:

- Mullingar
- Gurteen
- Dunsany
- Oak Park
- Moore Park.

The sites were selected for the following reasons:

- Lower than average mean wind speed
- Inland locations typical of the areas with high density intensive of pig and poultry production in Ireland

3.2.2 Background Concentrations

The screening framework is principally concerned with biomass boilers that will be installed in rural areas. A background concentration that is conservatively representative of such areas is required for each air contaminant and regulatory averaging time.

As a result of the approach that has been adopted to selecting background concentrations, the screening framework is not applicable to areas within 2 km of population centers.

The EPA has divided Ireland into four air quality zone types for the purpose of air quality monitoring and reporting. This is described in AG4 as follows:

- Dublin is defined as Zone A
- Cork is defined as Zone B
- Zone C is composed of 23 towns with populations greater than 15,000
- The remainder of the country, which represents rural Ireland but also includes all towns with a population of less than 15,000, is defined as Zone D.

In terms of using the air quality monitoring data, AG4 states the following:

"…It is reasonable to assume that if monitoring data is available in a Zone C urban background location that this information would also be broadly representative of other urban background locations in Zone C locations although each scenario should be assessed on an individual basis to ensure that this approach is appropriate. Likewise, data for suburban Dublin should be representative of other suburbs of Dublin. In order to allow for local factors, meteorological variability and anomalies when sourcing background data from stations outside of the modelling domain, an average of at least two and preferably more representative stations should be used. Similarly, the data should be averaged over the most recent 2-3 years available."

Data from Zone D has been selected as representative of background concentrations in areas where biomass boilers are proposed for intensive pig and poultry developments. Zone D includes rural areas such as EOM and Kilkitt and towns with a population of less than 15,000 such as Castlebar, Enniscorthy, Claremorris, Longford, Cobh and Roscommon Town. Monitoring in all these urban areas occurs close to town centers and it is, therefore, will likely overestimate air pollutant levels in rural locations. For the development of this screening framework, monitoring data from the rural stations at Kilkitt and Emo have been used except where data is missing, in which case data from urban areas of Zone D has been used.

Kilkitt is in a rural area of Monaghan that is surrounded by agricultural land and isolated rural households and agricultural sheds. The nearest built up area is the town of Ballybay, approximately 5 km north of the monitoring location with a population reported to be of 1,241 people in the 2016 census.

Emo is in a rural area of Laois that is surrounded by agricultural land, forestry and isolated rural households and agricultural sheds. The village of Emo is located approximately 1,100 m southwest of the monitoring location with a population reported to be of 257 people in the 2016 census. Prevailing winds in the village of Emo would transport air contaminants from the village of Emo towards the monitoring location, northeast of the village.

Background concentrations for the purpose of developing the screening framework were taken from monitoring stations as follows:

- 1-hour average NO2 – Emo and Kilkitt (Table 2)
- Annual Average NO2 - Emo and Kilkitt (Table 3)
- Annual Average NO + NO_2 - Emo and Kilkitt (Table 4)
- 24-hour average PM_{10} – Kilkitt (Table 5)
- Annual Average PM_{10} - Castlebar, Claremorris and Kilkitt (Table 6)
- Annual Average $PM_{2.5}$ – Longford and Claremorris (Table 7).

The highest 1-hour and annual average concentrations of NO_2 reported by the EPA at Emo and Kilkitt were adopted for the purpose of developing the screening framework (Table 2 and Table 3). For comparison, it is notable that the EPA's Science, Research, Technology and innovation for the Environment (STRIVE) Program (Donnelly, 2019) used the following background annual average concentrations of NO_2:

- 1 µg/m³ to 4 µg/m³ in rural areas with high densities of intensive pig and poultry production as Monaghan, Cavan and Limerick.
- 4.0 µg/m³ to 5.5 µg/m³ in the vicinity (within 2 km) of large rural towns such as Monaghan Town (Monaghan), Clones (Monaghan) and Newcastle West (Limerick).
- 5.5 µg/m³ to 13 µg/m³ within large rural towns such as Monaghan Town (Monaghan), Clones (Monaghan) and Newcastle West (Limerick).

An annual average concentration of NO_2 of 4.1µg/m³ has been adopted for the screening framework, which is marginally higher than was adopted in the STRIVE program.

Table 2 **1-hour average background concentrations of NO_2 used in the modelling assessment that forms the basis of the screening framework**

Year	Averaging Time	Emo (µg/m³)	Kilkitt (µg/m³)
2016	1-hr maximum	49	80
2017	1-hr maximum	33	25
2018	1-hr maximum	91	37
Highest 1-hr Maximum		**91**	

Table 3 **Annual mean background concentrations of NO_2 used in the modelling assessment that forms the basis of the screening framework**

Year	Averaging Time	Emo (µg/m³)	Kilkitt (µg/m³)
2016	Annual Mean	4.1	3.0
2017	Annual Mean	3.4	2.3
2018	Annual Mean	3.0	3.0
Highest Annual Mean		**4.1**	

The highest annual average concentration of NO + NO_2 adopted in the assessment as presented in Table 4.

Table 4 **Annual mean background concentrations of NO+NO_2 used in the modelling assessment that forms the basis of the screening framework**

Year	Averaging Time	Emo (µg/m³)	Kilkitt (µg/m³)
2016	Annual Mean	5.5	3.7
2017	Annual Mean	4.0	2.6
2018	Annual Mean	5.0	4.0
Highest annual Mean		**5.5**	

The highest daily maximum and annual mean concentration of PM_{10} are presented in Table 5 and Table 6. The highest annual average concentration of PM_{10}, which has been adopted in the screening framework is 15.0 µg/m³. This concentration was compared to modelled concentrations computed for the EPA's STRIVE Program (Donnelly, 2019). The STRIVE modelling indicated ambient annual average concentrations of PM_{10} that ranged from 16.0 µg/m³ to 17.0 µg/m³ in the vicinity of Kilkitt in Monaghan. It is likely that the STRIVE modelling overpredicts concentrations of PM_{10} in the vicinity of Kilkitt as monitoring between 2014 and 2017 recorded a maximum annual average of 9.0 µg/m³. An annual average concentration of 15 µg/m³ was adopted for the purpose of developing the screening framework. This is the highest annual average concentration of PM_{10} measured in urban Zone D areas including the towns of Cobh, Castlebar and Claremorris between 2014 and 2018.

Table 5 **24-hour average background concentrations of PM_{10} used in the modelling assessment that forms the basis of the screening framework**

Year	Averaging Time	Kilkitt (µg/m³)
2016	Daily Max	30.9
2017	Daily Max	41.5
2018	Daily Max	35
Highest Daily Maximum		**41.5**

Table 6 **Annual mean background concentrations of PM_{10} used in the modelling assessment that forms the basis of the screening framework**

Year	Averaging Time	Castlebar (µg/m³)	Claremorris (µg/m³)	Kilkitt (µg/m³)
2014	Annual Mean	12.0	10.0	9.0
2015	Annual Mean	13.0	10.0	9.0
2016	Annual Mean	11.9	10.1	8.1
2017	Annual Mean	11.2	10.8	7.8
2018	Annual Mean	11.0	12.0	9.0
Highest Annual Mean		**15.0**		

Annual average concentrations of $PM_{2.5}$ at Longford and Claremorris are presented in Table 7. The locations are both small urban areas. The highest annual average concentration of $PM_{2.5}$ of 13.0 µg/m³ was adopted for the purpose of developing the screening framework. This concentration was compared to modelled concentrations computed for EPA's STRIVE Program (Donnelly, 2019). The STRIVE modelling indicated ambient annual average concentrations of $PM_{2.5}$ range from 8 µg/m³ to 10 µg/m³ in sparsely populated rural areas. The concentration of $PM_{2.5}$ of 13µg/m³ is considered a conservative estimate of background concentrations in rural areas.

Table 7 **Annual mean background concentrations of $PM_{2.5}$ used in the modelling assessment that forms the basis of the screening framework**

Year	Averaging Time	Longford (µg/m³)	Claremorris (µg/m³)
2014	Annual Mean	13.0	5.0
2015	Annual Mean	10.0	6.0
2016	Annual Mean	12.0	6.0
2017	Annual Mean	9.2	5.6
2018	Annual Mean	9.0	6.0
Highest Annual Mean		**13.0**	

3.2.3 Modelling Methodology

The AERMOD dispersion model was used to predict ground-level concentrations of PM_{10} and $PM_{2.5}$, NO_2 and NO_x for a unit emission rate from single point source configured with stack heights that ranged from 4 m to 10 m in 1 m increments. AERMOD is one of the advanced air dispersion models recommended by EPA (EPA, 2020).

The screening framework has been based on dispersion modelling of a single point source in AERMOD at the centre of a 1,000 m x 1,000 m grid to represent a boiler stack. AERMOD was not configured with terrain data. The

Plume Rise Model Enhancements (PRIME) plume rise and building downwash algorithm were used with the point source centered on a 10 m x 10 m building, 3 m high.

Each model configuration was run with five (5) years of meteorological data from five (5) Met Eireann weather stations including:

- Mullingar (2015 to 2019)
- Gurteen (2013 to 2017)
- Dunsany (2014 to 2018)
- Oak Park (2014 to 2018)
- Moore Park (2013 to 2017).

The AERMOD configuration with each stack height (4 m, 5 m, 6 m, 7 m, 8 m, 9 m and 10 m) was executed 25 times for each of the five meteorological stations and five years of meteorology.

A review of data on a wide range of existing biomass boiler stacks indicated conservative modelling parameters as follows:

- Internal stack diameter of 0.2 m
- Stack temperature of 90°C
- Stack exit velocity of 2.5 m/s.

These parameters were applied to all modelling scenarios. These parameters, therefore, represent the lower bound of applicability of the screening framework. The screening framework is unsuitable of biomass boilers that have emission parameters that are less than those detailed above.

The output from the AERMOD model for each of run included the ground-level concentrations of air pollutants predicted at each point on the 1,000 m x 1,000 m grid for a unit emission rate for averaging times specified in the air quality guidance levels for NO_x and particulate matter as follows:

- 1-hour, 18th highest concentration (NO_2)
- 24-hour, 36th highest concentration (PM_{10})
- Annual average (NO_2, NO_2+NO, PM_{10}, $PM_{2.5}$).

The ground-level concentrations at each modelled grid point were determined for each combination of:

- Stack height
- Averaging time.

The distance between each grid point and the modelled stack location was calculated. The ground-level concentrations for each averaging period were determined for each modelled stack height at each grid point. These were then grouped based on distance from the modelled stack in increments of 10 m. The maximum ground-level concentration in each increment was calculated and allocated to the minimum distance of the increment.

The location of the stack at the centre of the modelling domain results in the calculation of ground-level concentrations in all directions downwind of the stack. The screening framework has used the highest predicted ground-level concentration for all wind directions for all meteorological stations and years modelled. Considering the five meteorological stations are inland and subject to some of the lowest annual average windspeeds measured in Ireland, the incremental downwind concentration will likely be a conservative for all areas of Ireland.

A conservative background concentration was determined for each air contaminant and averaging time (see Section 3.2.2). Its corresponding air quality standard (AQS) was determined (see Section 2.6). EPA's AG4 guidance specifies that the maximum allowable process contribution is less than 75% of the difference between the air quality standard and the background concentration. The maximum boiler stack emission rate for each increment was calculated as 75% of the allowable process contribution as follows:

$$Maximum\ permitted\ stack\ emission\ rate\ (g/s) = 1\ g/s\ x\ \frac{0.75\ \text{x}\ (AQS - \ background\ concentration\ (\mu g/m^3)}{maximum\ predicted\ GLC\ for\ increment\ (\mu g/m^3)}$$

To ensure that the proposed biomass does not cause elevated levels of air pollutants beyond the site boundary, the minimum distance between the stack and the site boundary will be determined. Using this distance, a maximum permitted boiler stack emission rate for each air contaminant can be determined based on the results of dispersion modelling. The maximum boiler stack emission rate specified by the boiler manufacturer must be less than the maximum boiler stack emission rate for the incremental distance between the boiler stack and the site boundary.

Particulate matter that is emitted from a biomass boiler is likely to be less than 2.5 micrometers in size. Hence, particulate matter emissions expressed as $PM_{2.5}$ also equal the emission rate expressed as PM_{10}. The maximum permitted stack emission rate of particulate matter was calculated as the minimum dust emission rate to achieve each of the following limits:

- The 24-hour 36th highest PM_{10} air quality objective
- The annual average PM_{10} air quality objective
- The annual average PM_{10} air quality objective.

The maximum permitted stack emission rate of NO_x was calculated as the minimum NO_x emission rate to achieve each of the following limits:

- The 1-hour 18^{h} highest NO_2 air quality objective
- The annual average NO_2 air quality objective
- The annual average NO + NO_2 air quality objective.

The NO portion of NOx emitted from a stack is subject to atmospheric processes that convert it to NO_2. AG4 states:

> *During combustion processes, a mixture of both nitric oxide and nitrogen dioxide (termed NO_x) is released and once released a series of complex chemical reactions takes place over time periods varying from seconds to days during which a portion of the nitrogen oxide is converted to nitrogen dioxide.*

A methodology is required to determine the amount of NO that is converted to NO_2. In this regard, AG4 states:

> *Screening modelling of NO2/NOX chemistry should use the following default factors:*
>
> - *A default annual NO2/NOX ratio of 1.00,*
> - *A default 1-hour NO2/NOX ratio of 0.50.*

The screening framework has used the default factors described in AG4.

The modelling was undertaken on a grid with 10 m spacing. For some of the grid points closest to the modelled point source, the maximum predicted ground-level concentrations increase with distance from the stack. These grid points are within the distance that the plume is predicted to first impact the ground. If the ground-level concentration at any incremental distance is less that any ground-level concentration at any incremental distance further from the stack, the ground-level concentration at incremental distances further from the stack were adopted for all incremental distances closer to the stack.

3.2.4 Modelling Results

The results of the dispersion modelling approach are presented as the maximum permitted stack emission rate of NO_x and PM_{10} for each combination of:

- Distance between boiler stack and site boundary (in 10 m intervals)
- Modelled stack height.

The results are presented in graphical and tabular format. Data from the graphs and tables are intended to be used to estimate levels of air pollutants beyond the boundary of the site in accordance with the screening framework.

3.2.4.1 Particulate Matter

The results of modelling assessment are presented as graphs plotting the maximum permitted concentration with distance for various stack heights. The distance refers to the minimum distance between the location and the site boundary. The maximum emission rates of particulate matter are presented in Table 8. The maximum emission rates of particulate matter are presented as graphs for:

- Stacks with heights of 4 m, 5 m and 6 m within 100 m of the site boundary in Figure 1
- Stacks with heights of 7 m, 8 m, 9 m and 10 m within 100 m of the site boundary in Figure 2
- Stacks with heights of 4 m, 5 m and 6 m located at distances between 100 m and 200 m from the site boundary in Figure 3
- Stacks with heights of 7 m, 8 m, 9 m and 10 m located at distances between 100 m and 200 m from the site boundary in Figure 4
- Stacks with heights of 4 m, 5 m and 6 m located at distances between 200 m and 350 m from the site boundary in Figure 5
- Stacks with heights of 7 m, 8 m, 9 m and 10 m located at distances between 200 m and 350 m from the site boundary in Figure 6.

Table 8 Maximum emission rate of particulate matter (g/s) depending on stack height and the minimum distance between the stack and the site boundary

Minimum distance between boiler stack and site boundary (m)	Stack Height (m)						
	4 m	5 m	6 m	7 m	8 m	9 m	10 m
	Maximum emission rate of Particulate Matter (g/s)						
10 m	0.002	0.003	0.005	0.014	0.029	0.038	0.049
20 m	0.002	0.003	0.005	0.014	0.029	0.038	0.049
30 m	0.003	0.004	0.006	0.014	0.029	0.038	0.049
40 m	0.004	0.006	0.007	0.015	0.029	0.038	0.049
50 m	0.005	0.006	0.008	0.015	0.029	0.038	0.049
60 m	0.006	0.008	0.010	0.017	0.029	0.038	0.049
70 m	0.007	0.009	0.012	0.018	0.029	0.039	0.049
80 m	0.009	0.010	0.013	0.019	0.031	0.040	0.050
90 m	0.010	0.012	0.016	0.023	0.034	0.043	0.052
100 m	0.012	0.014	0.017	0.023	0.035	0.047	0.054
110 m	0.013	0.016	0.020	0.026	0.039	0.049	0.058
120 m	0.015	0.017	0.022	0.030	0.041	0.054	0.063
130 m	0.016	0.019	0.024	0.032	0.043	0.057	0.065
140 m	0.019	0.022	0.028	0.035	0.046	0.058	0.071
150 m	0.021	0.024	0.030	0.037	0.047	0.058	0.073
160 m	0.023	0.027	0.033	0.040	0.049	0.061	0.074
170 m	0.025	0.029	0.034	0.043	0.052	0.064	0.074
180 m	0.028	0.032	0.036	0.046	0.054	0.065	0.075
190 m	0.030	0.034	0.039	0.048	0.057	0.066	0.078
200 m	0.032	0.036	0.041	0.049	0.059	0.069	0.081
210 m	0.034	0.038	0.043	0.051	0.062	0.072	0.083
220 m	0.038	0.042	0.048	0.053	0.066	0.075	0.087
230 m	0.040	0.045	0.050	0.057	0.069	0.077	0.089
240 m	0.042	0.046	0.052	0.058	0.070	0.081	0.094
250 m	0.045	0.049	0.054	0.060	0.071	0.084	0.095
260 m	0.047	0.051	0.057	0.062	0.074	0.087	0.098
270 m	0.049	0.053	0.060	0.065	0.076	0.090	0.100
280 m	0.052	0.055	0.062	0.068	0.076	0.090	0.103
290 m	0.053	0.058	0.064	0.070	0.079	0.094	0.107
300 m	0.055	0.060	0.067	0.073	0.081	0.096	0.109
310 m	0.056	0.062	0.069	0.076	0.083	0.098	0.112

Minimum distance between boiler stack and site boundary (m)	Stack Height (m)						
	4 m	5 m	6 m	7 m	8 m	9 m	10 m
	Maximum emission rate of Particulate Matter (g/s)						
320 m	0.060	0.066	0.072	0.080	0.086	0.100	0.116
330 m	0.062	0.068	0.074	0.083	0.091	0.103	0.117
340 m	0.064	0.069	0.076	0.085	0.092	0.106	0.121
350 m	0.065	0.071	0.079	0.088	0.094	0.107	0.125

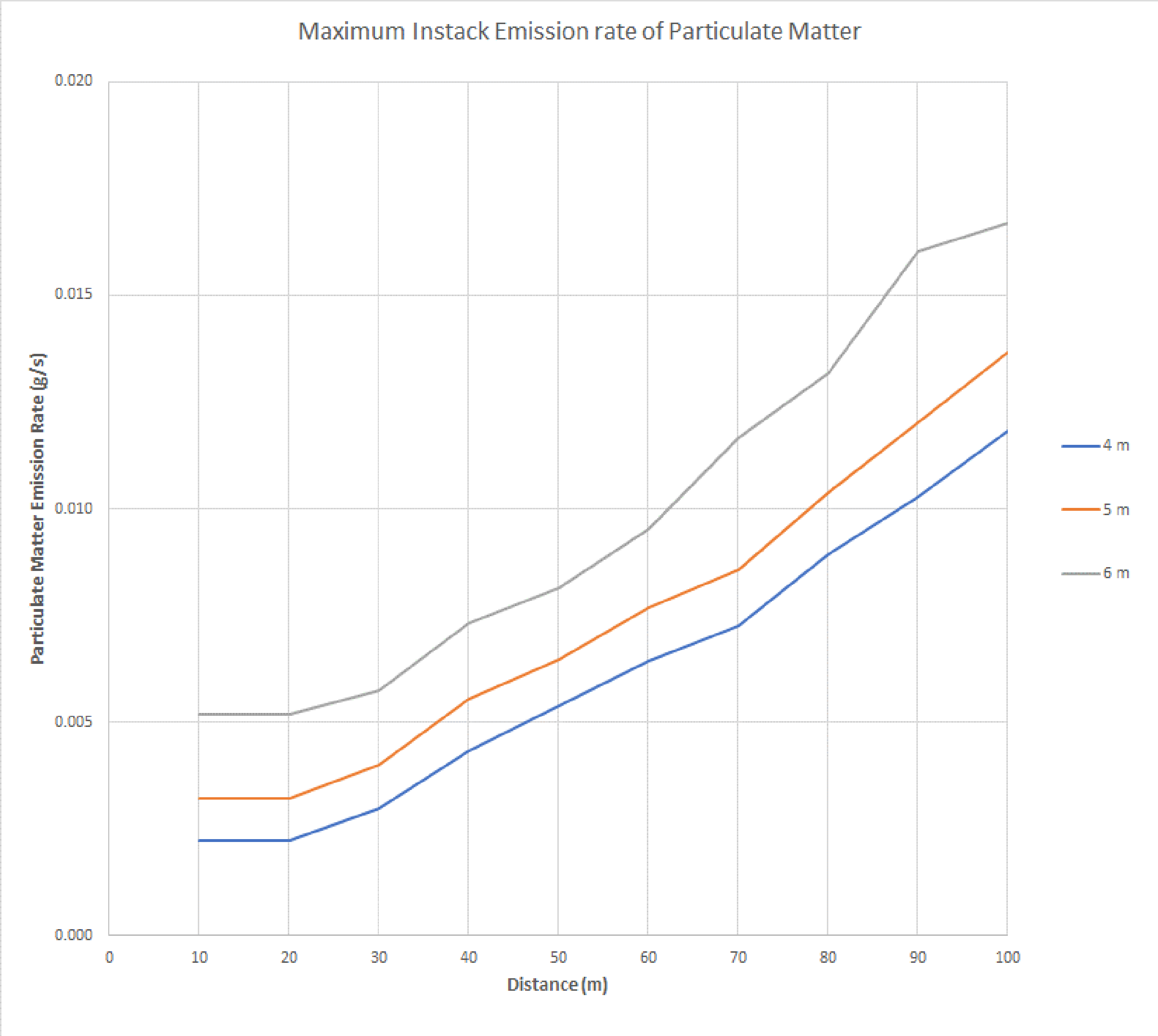

Figure 1 **Maximum emission rates of particulate matter for stacks with heights of 4 m, 5 m and 6 m within 100 m of the site boundary**

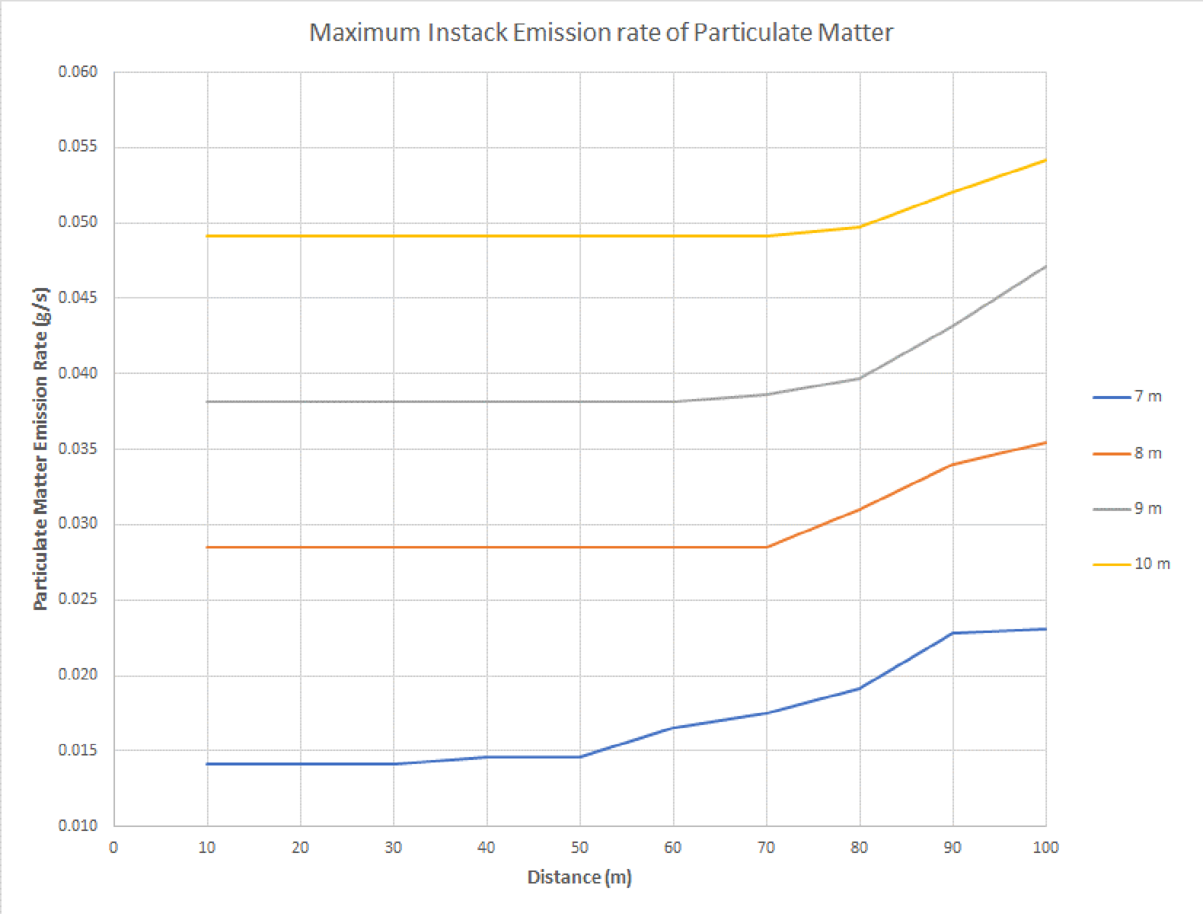

Figure 2 Maximum emission rates of particulate matter for stacks with heights of 7 m, 8 m, 9 m and 10 m within 100 m of the site boundary

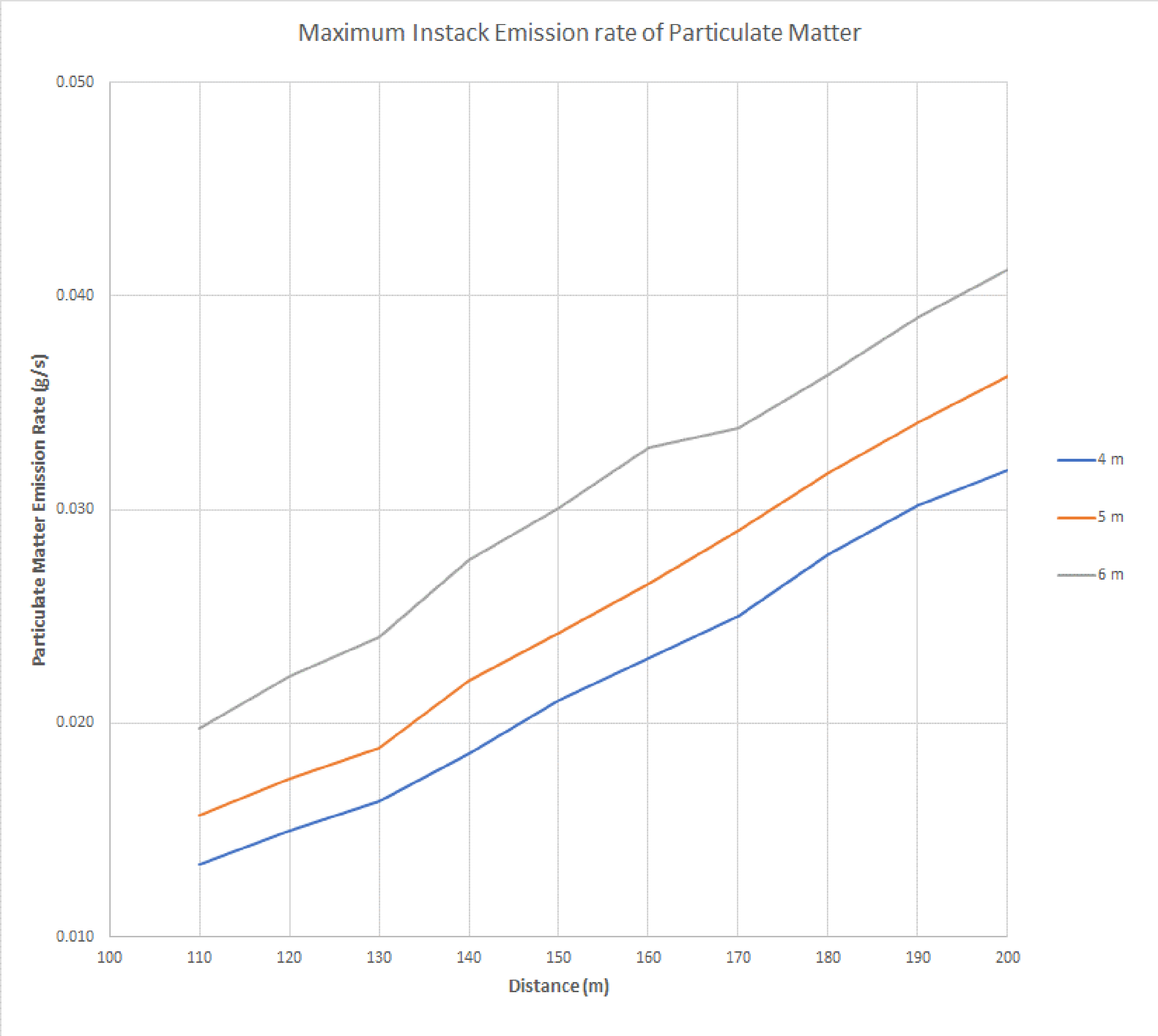

Figure 3 **Maximum emission rates of particulate matter for stacks with heights of 4 m, 5 m and 6 m located at distances between 100 m and 200 m from the site boundary**

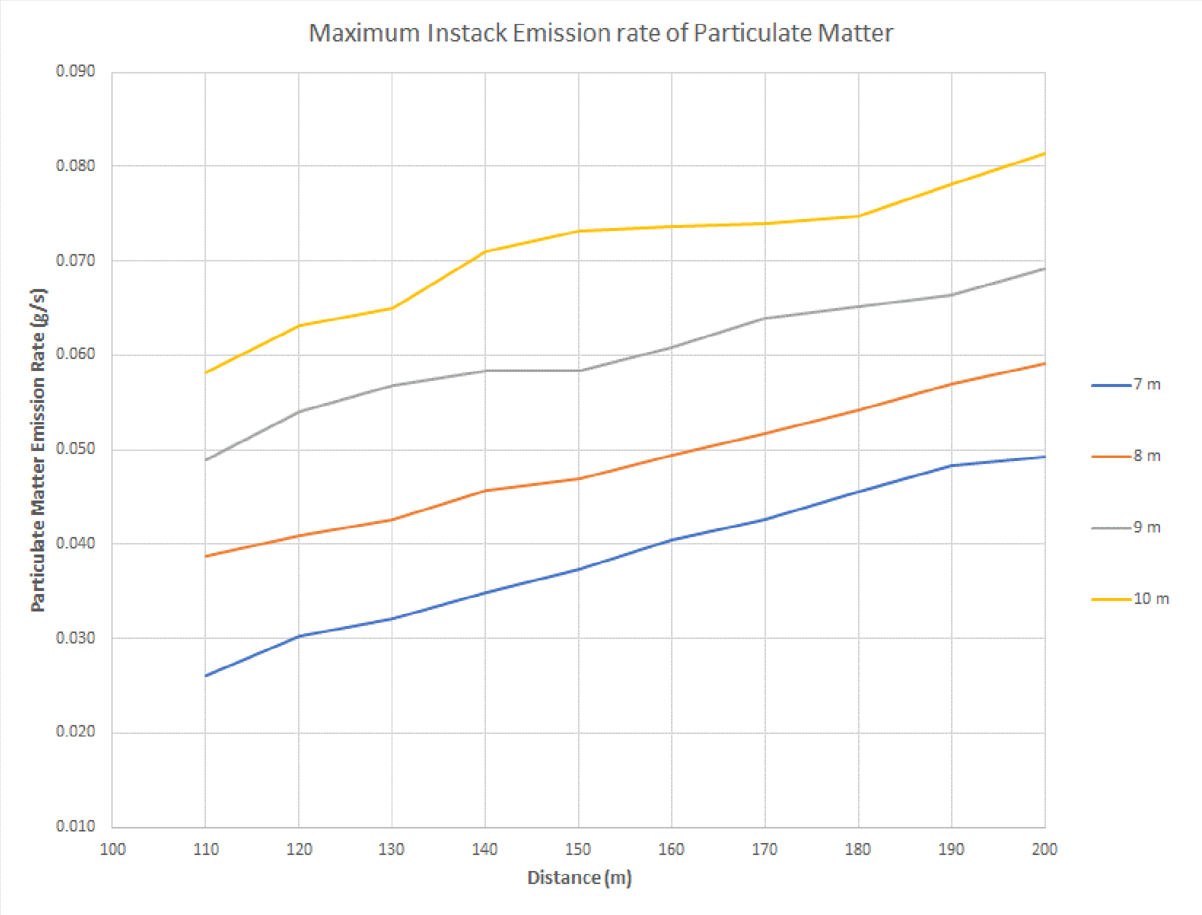

Figure 4 **Maximum emission rates of particulate matter for stacks with heights of 7 m, 8 m, 9 m and 10 m located at distances between 100 m and 200 m from the site boundary**

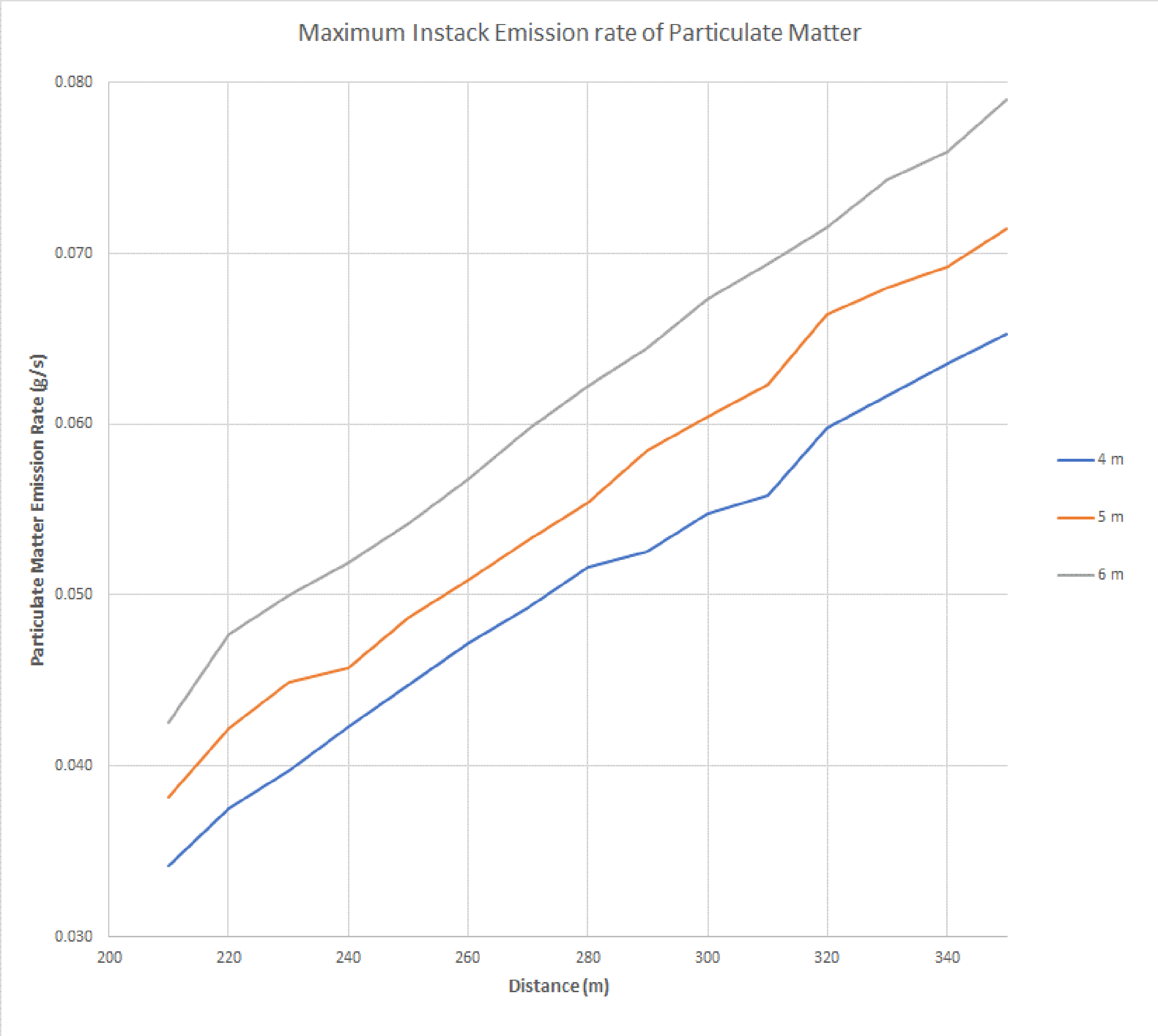

Figure 5 **Maximum emission rates of particulate matter for stacks with heights of 4 m, 5 m and 6 m located at distances between 200 m and 350 m from the site boundary**

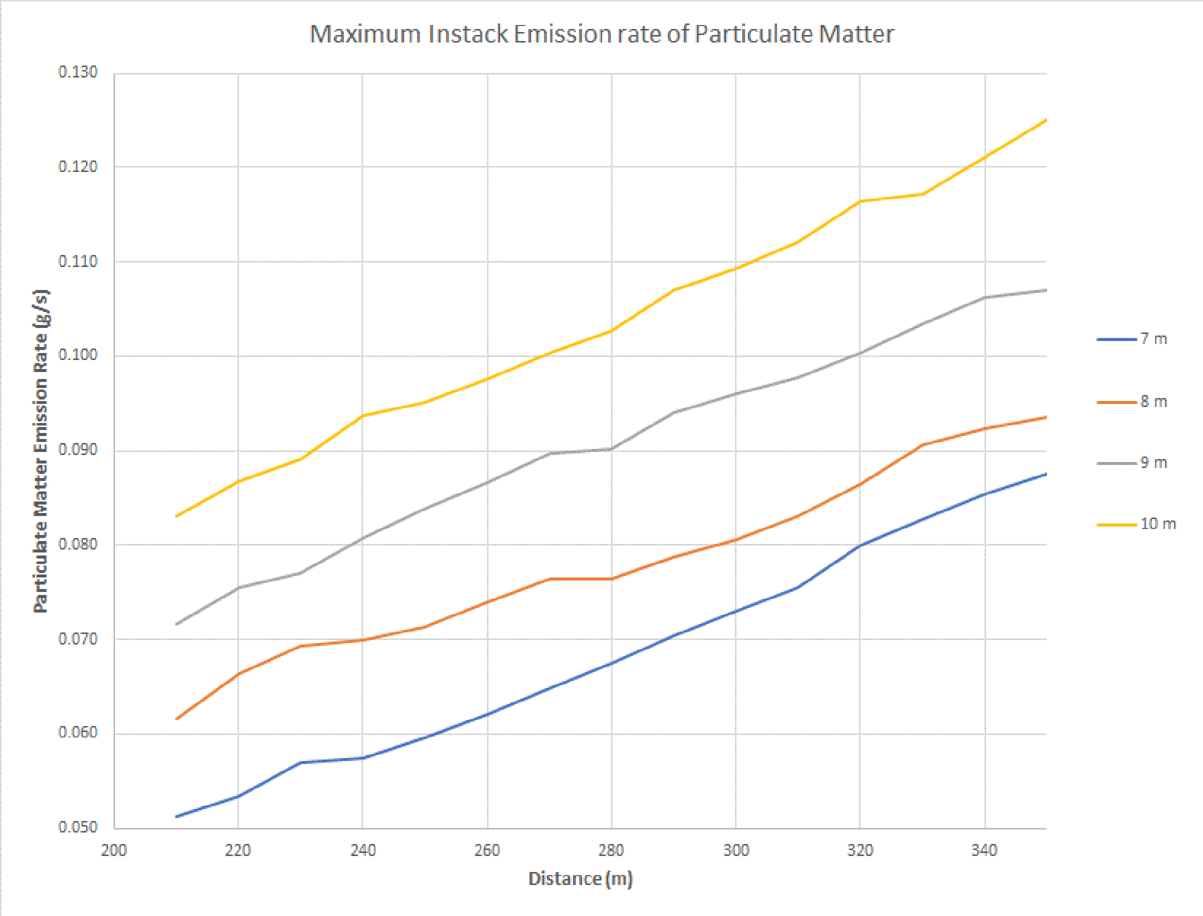

Figure 6 **Maximum emission rates of particulate matter for stacks with heights of 7 m, 8 m, 9 m and 10 m located at distances between 200 m and 350 m from the site boundary**

3.2.4.2 Oxides of Nitrogen (NO_x)

The maximum emission rates of NO_x are presented in Table 9. The maximum emission rates of NO_x are presented as graphs for:

- Stacks with heights of 4 m, 5 m and 6 m within 100 m of the site boundary in Figure 7
- Stacks with heights of 7 m, 8 m, 9 m and 10 m within 100 m of the site boundary in Figure 8
- Stacks with heights of 4 m, 5 m and 6 m located at distances between 100 m and 200 m from the site boundary in Figure 9
- Stacks with heights of 7 m, 8 m, 9 m and 10 m located at distances between 100 m and 200 m from the site boundary in Figure 10
- Stacks with heights of 4 m, 5 m and 6 m located at distances between 200 m and 350 m from the site boundary in Figure 11
- Stacks with heights of 7 m, 8 m, 9 m and 10 m located at distances between 200 m and 350 m from the site boundary in Figure 12.

Table 9 **Maximum emission rate of NO_x (g/s) depending on stack height and the minimum distance between the stack and the site boundary**

Minimum distance between boiler stack and site boundary (m)	Stack Height (m)						
	4 m	5 m	6 m	7 m	8 m	9 m	10 m
	Maximum emission rate of Oxides of Nitrogen (g/s)						
10 m	0.014	0.022	0.039	0.09	0.17	0.23	0.30
20 m	0.014	0.022	0.039	0.09	0.17	0.23	0.30
30 m	0.020	0.028	0.042	0.09	0.17	0.23	0.30
40 m	0.030	0.036	0.050	0.09	0.17	0.23	0.30
50 m	0.035	0.041	0.051	0.09	0.17	0.23	0.30
60 m	0.037	0.042	0.052	0.09	0.17	0.23	0.30
70 m	0.042	0.049	0.060	0.09	0.17	0.23	0.30
80 m	0.044	0.051	0.060	0.09	0.19	0.24	0.30
90 m	0.049	0.057	0.067	0.10	0.19	0.26	0.31
100 m	0.054	0.064	0.079	0.12	0.22	0.28	0.33
110 m	0.057	0.067	0.086	0.13	0.23	0.29	0.35
120 m	0.064	0.076	0.097	0.14	0.23	0.29	0.35
130 m	0.073	0.086	0.11	0.16	0.24	0.29	0.35
140 m	0.078	0.092	0.12	0.17	0.25	0.29	0.35
150 m	0.087	0.103	0.13	0.21	0.26	0.30	0.35
160 m	0.096	0.113	0.14	0.22	0.27	0.31	0.36
170 m	0.104	0.122	0.15	0.22	0.28	0.31	0.36
180 m	0.115	0.135	0.17	0.23	0.28	0.33	0.37
190 m	0.123	0.145	0.18	0.24	0.29	0.34	0.38
200 m	0.126	0.151	0.18	0.24	0.30	0.35	0.39
210 m	0.139	0.165	0.20	0.25	0.30	0.35	0.40
220 m	0.142	0.172	0.21	0.26	0.31	0.36	0.41
230 m	0.149	0.184	0.22	0.27	0.32	0.37	0.43
240 m	0.155	0.192	0.23	0.28	0.33	0.37	0.44
250 m	0.155	0.196	0.23	0.28	0.33	0.38	0.44
260 m	0.163	0.207	0.25	0.29	0.34	0.39	0.45
270 m	0.170	0.215	0.25	0.30	0.35	0.40	0.46
280 m	0.171	0.217	0.26	0.30	0.36	0.41	0.46
290 m	0.177	0.223	0.26	0.31	0.36	0.42	0.47
300 m	0.180	0.229	0.27	0.32	0.37	0.43	0.48
310 m	0.185	0.233	0.28	0.32	0.38	0.43	0.48
320 m	0.190	0.239	0.29	0.33	0.39	0.44	0.50

Minimum distance between boiler stack and site boundary (m)	Stack Height (m)						
	4 m	5 m	6 m	7 m	8 m	9 m	10 m
	Maximum emission rate of Oxides of Nitrogen (g/s)						
330 m	0.196	0.244	0.29	0.34	0.40	0.46	0.51
340 m	0.198	0.247	0.30	0.35	0.40	0.46	0.52
350 m	0.205	0.252	0.31	0.35	0.41	0.47	0.53

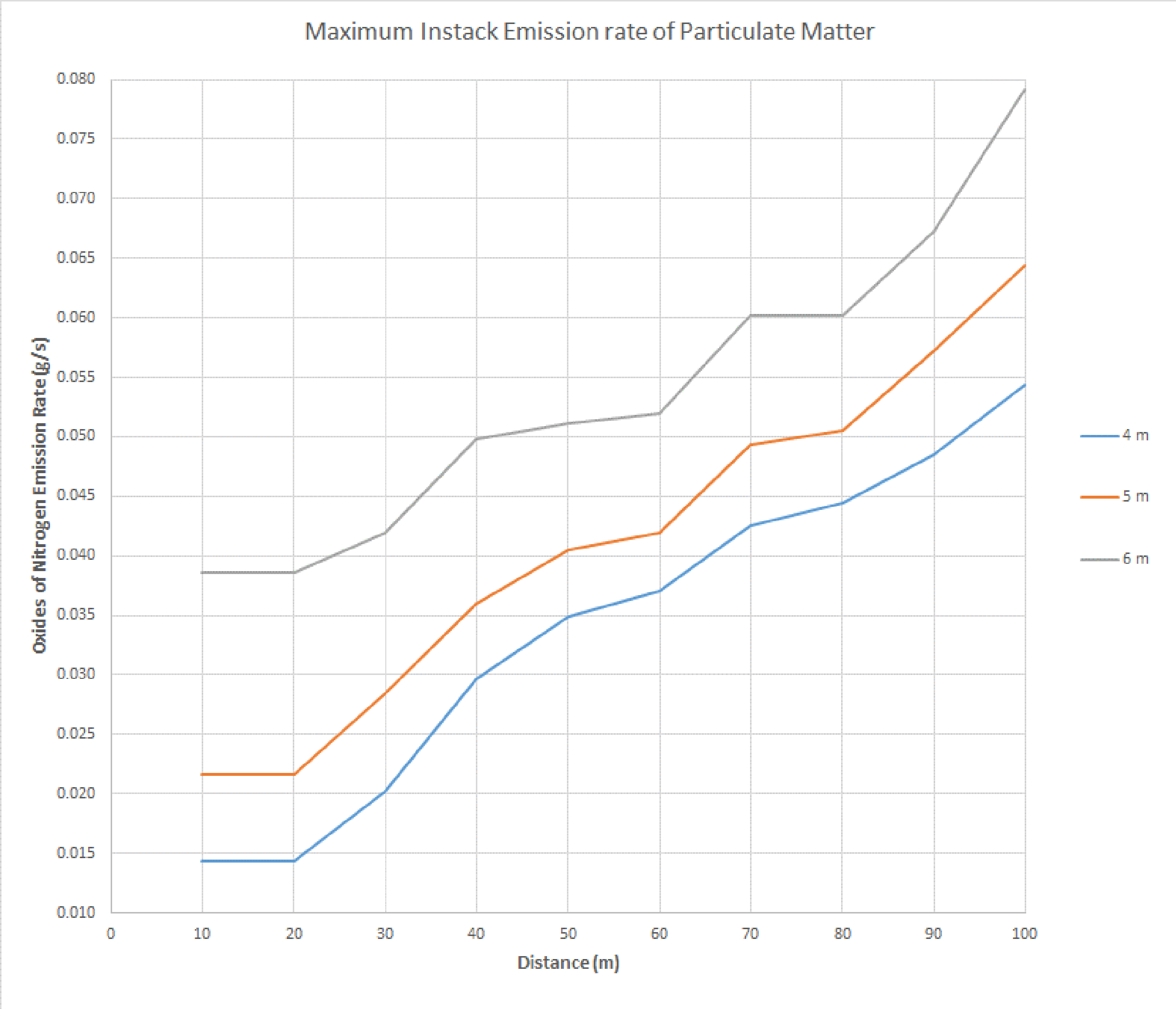

Figure 7 **Maximum emission rates of oxides of nitrogen for stacks with heights of 4 m, 5 m and 6 m within 100 m of the site boundary**

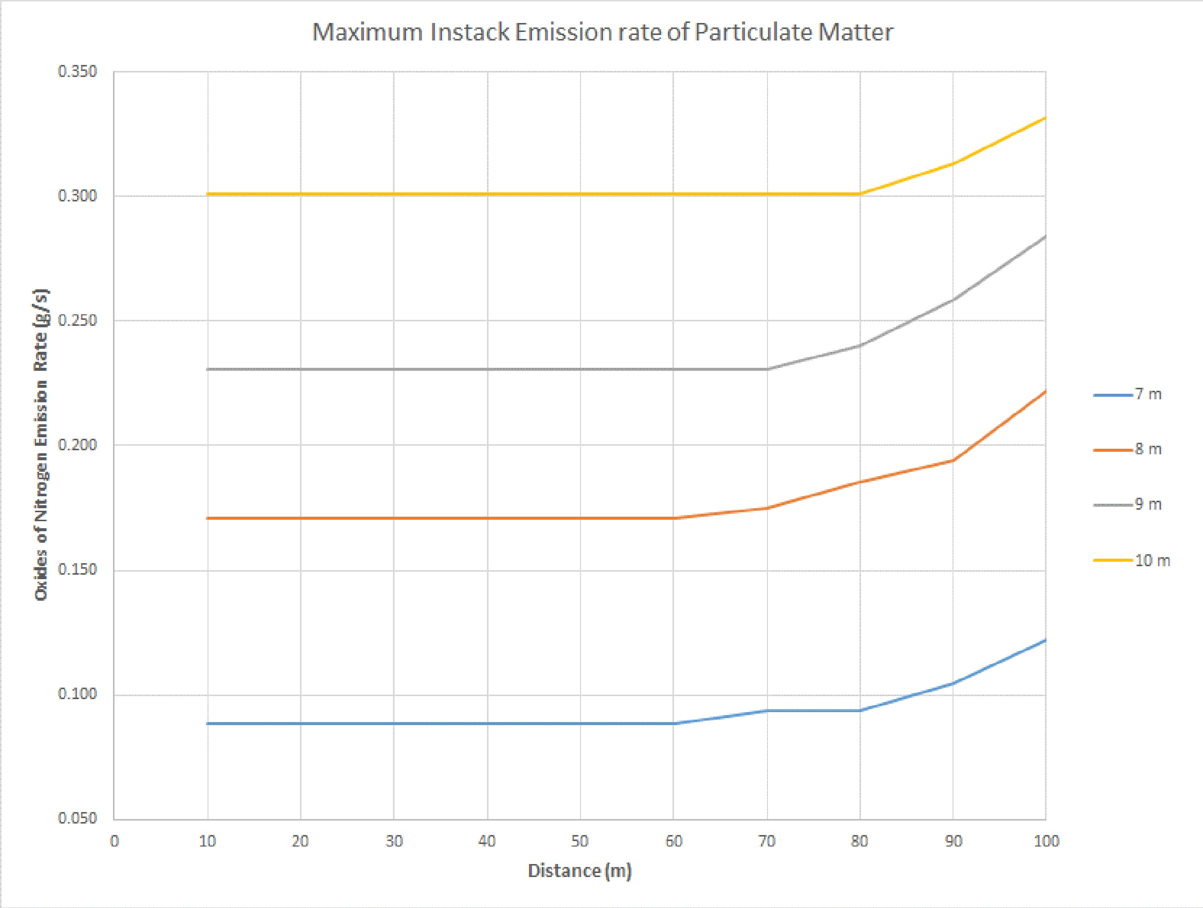

Figure 8 **Maximum emission rates of oxides of nitrogen for stacks with heights of 7 m, 8 m, 9 m and 10 m located at distances between 10 m and 100 m from the site boundary**

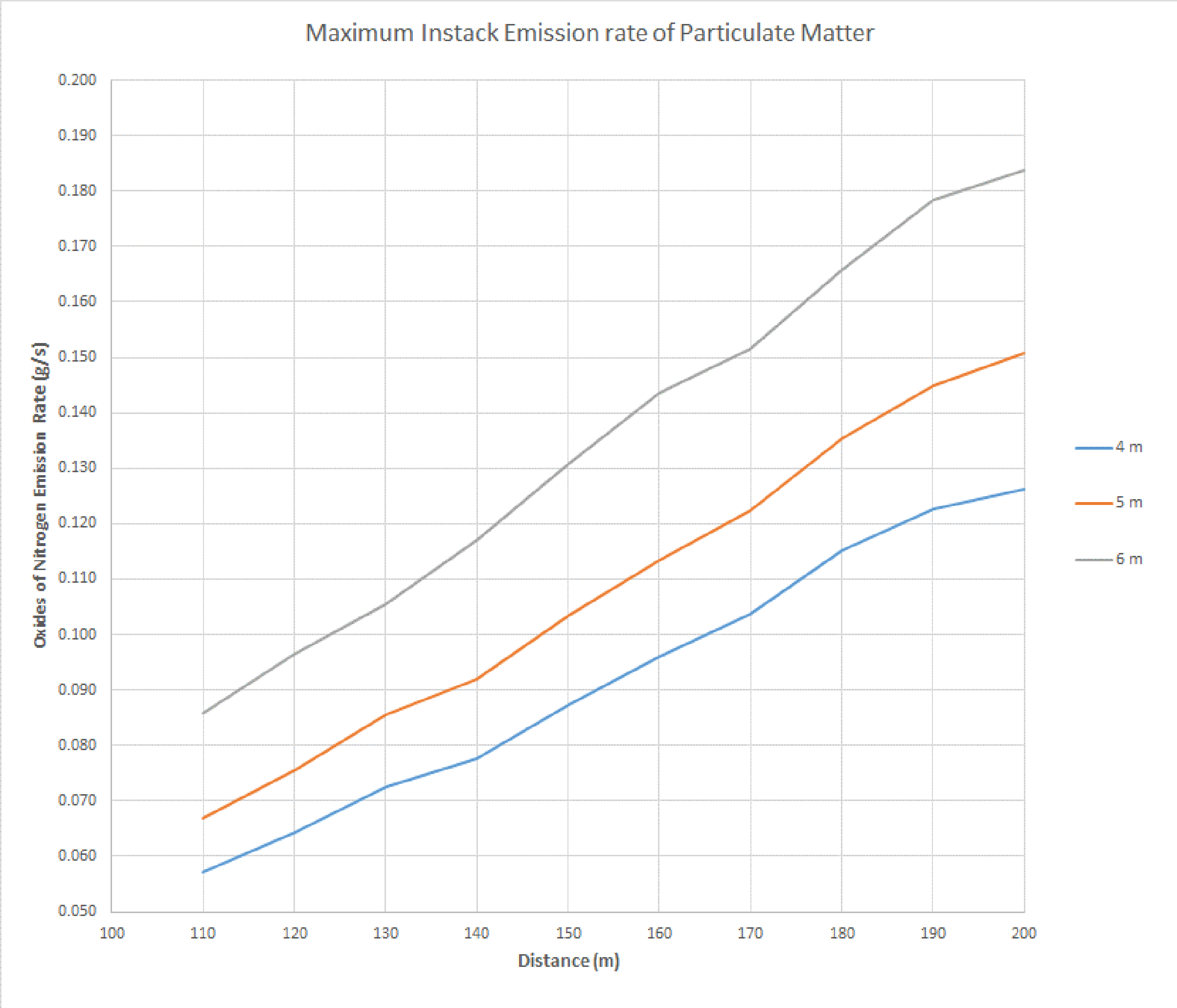

Figure 9 **Maximum emission rates of oxides of nitrogen for stacks with heights of 4 m, 5 m and 6 m located at distances between 100 m and 200 m from the site boundary**

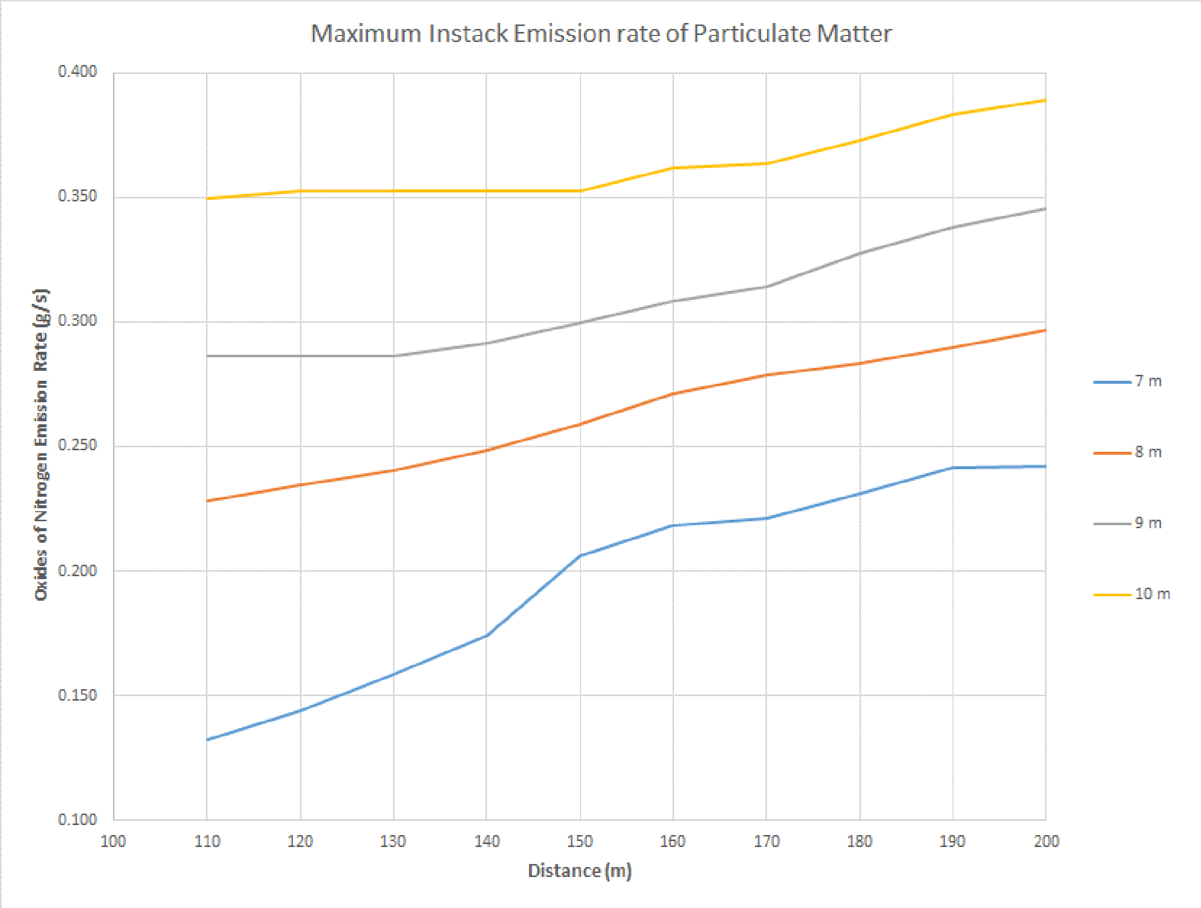

Figure 10 **Maximum emission rates of oxides of nitrogen for stacks with heights of 7 m, 8 m, 9 m and 10 m located at distances between 100 m and 200 m from the site boundary**

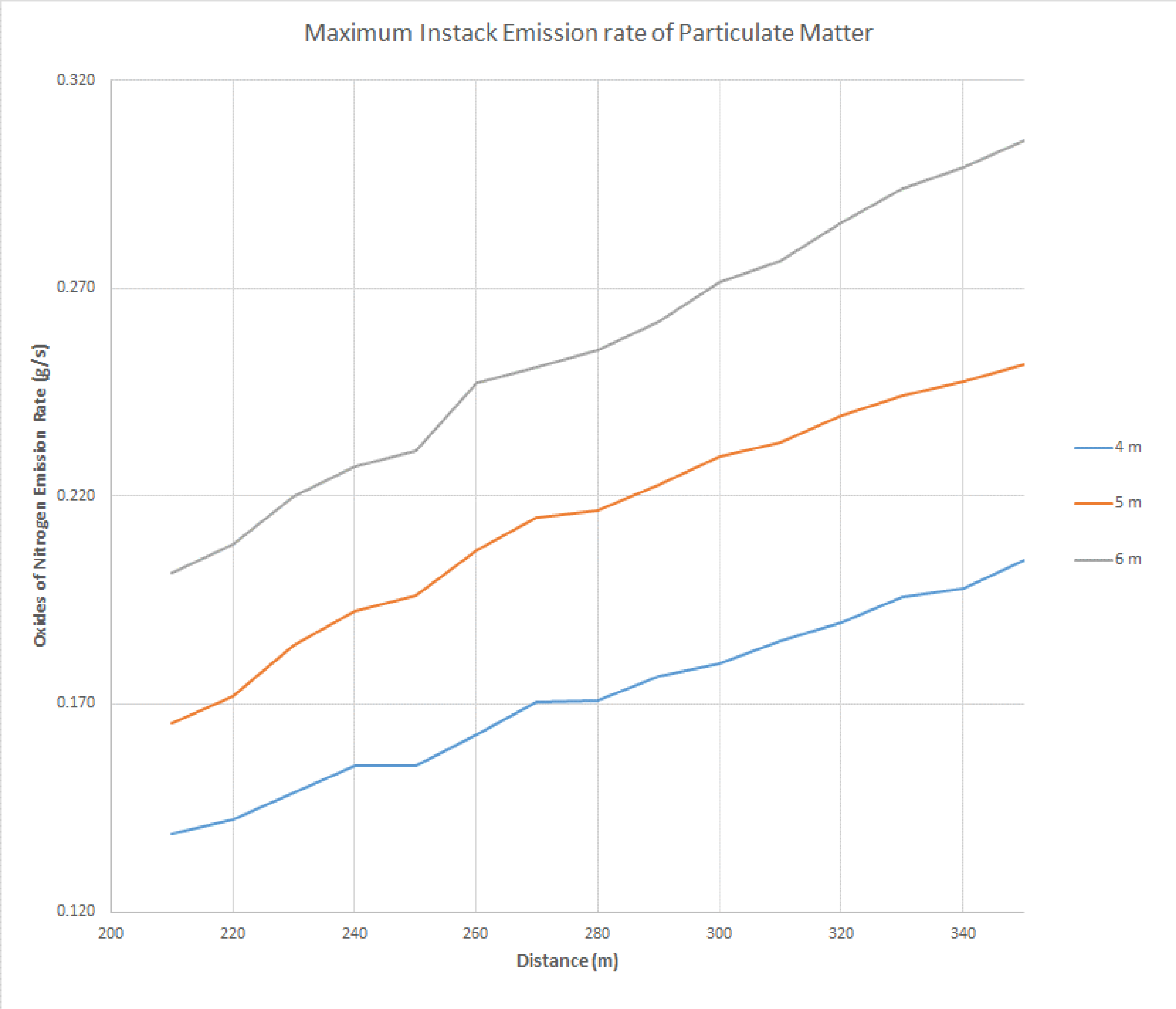

Figure 11 **Maximum emission rates of oxides of nitrogen for stacks with heights of 4 m, 5 m and 6 m located at distances between 200 m and 350 m from the site boundary**

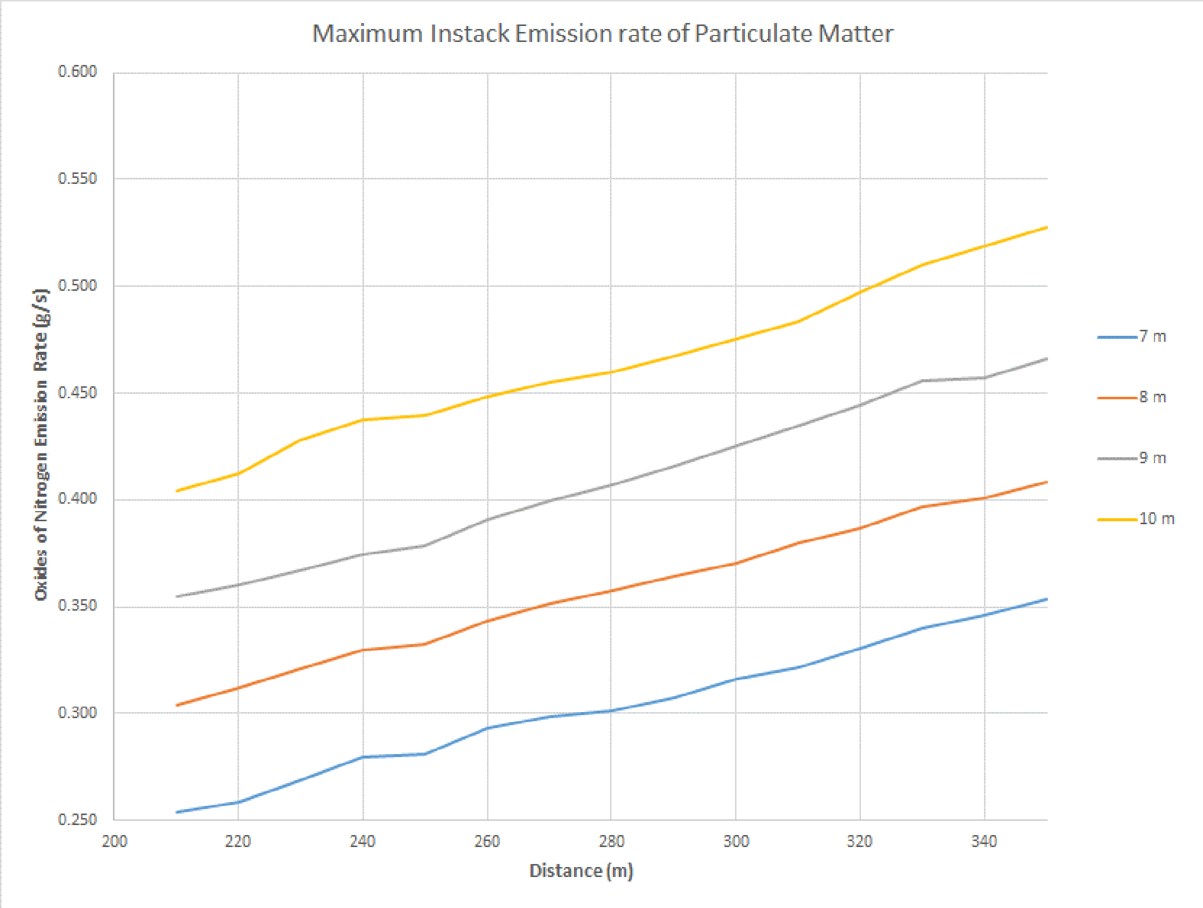

Figure 12 **Maximum emission rates of oxides of nitrogen for stacks with heights of 7 m, 8 m, 9 m and 10 m located at distances between 200 m and 350 m from the site boundary**

4. SCREENING FRAMEWORK FOR AIR QUALITY ASSESSMENT OF BIOMASS BOILERS

This section describes the screening framework for air quality assessment of biomass boilers, specifically the stepwise approach to determine compliance or non-compliance with air quality objectives at the site boundary based on a boiler's stack and emission characteristics.

4.1 Single boiler within a site boundary

The heating requirements of intensive agricultural sites can be provided by a single boiler or multiple smaller boilers within a site boundary. This section describes the screening framework to be adopted where one boiler is proposed to be developed within the site boundary. The screening framework is presented in a stepwise manner.

4.1.1 Step 1: Information

The following information is required to implement the screening framework and should be detailed in an application for approval:

- The distance from the site boundary to the nearest town/village with a population between 250 and 500 people
- The distance from the site boundary to the nearest urban centre with a population of 500 people or more
- The shortest distance from the boiler stack to the boundary of any other intensive agricultural facility or commercial activity (e.g. hotel or nursing home) that requires a boiler for non-domestic purposes
- The internal diameter of the boiler stack at the point of release (metres)
- The minimum temperature of exhaust gases emitted from the boiler stack (°C)
- The minimum velocity of exhaust gases emitted from the boiler stack (m/s)
- The presence of back-up boiler(s) at the site
- The presence of back-up Winterwarm heaters at the site
- The maximum moisture content specified by the manufacturer for the fuel
- The height of the boiler stack (above ground level) at the point of release
- The minimum distance between the boiler stack location and the closest point of the site boundary rounded down to the nearest 10 metres
- The thermal output rating of the boiler
- The thermal efficiency of the boiler
- The thermal input rating of the boiler
- The maximum emission rate of NO_x from the boiler at full load as specified by the boiler manufacturer (g/s)
- The maximum emission rate of particulate matter from the boiler at full load as specified by the boiler manufacturer (g/s)

4.1.1.1 Particulate Matter

The maximum emission rate of particulate matter for the subject site is dependent on the minimum distance between the boiler stack and the site boundary and the proposed height of the boiler stack.

The maximum permitted emission rates for particulate matter can be determined from Table 8 or the following figures:

- Figure 1 for boiler stacks 4 m, 5 m or 6 m high with a minimum distance less than 100 m from the site boundary
- Figure 2 for boiler stacks 7 m, 8 m, 9 m or 10 m high with a minimum distance less than 100 m from the site boundary
- Figure 3 for boiler stacks 4 m, 5 m or 6 m high with a minimum distance between 100 m and 200 m from the site boundary
- Figure 4 for boiler stacks 7 m, 8 m, 9 m or 10 m high with a minimum distance between 100 m and 200 m from the site boundary
- Figure 5 for boiler stacks 4 m, 5 m or 6 m high with a minimum distance between 200 m and 350 m from the site boundary
- Figure 6 for boiler stacks 7 m, 8 m, 9 m or 10 m high with a minimum distance between 200 m and 350 m from the site boundary.

The maximum permitted emission rate from Table 8 or the above figures should be compared to the maximum emission rate of particulate matter from the boiler as specified by the boiler manufacturer. If the value specified by the boiler manufacturer is lower than the value determined from Table 8 or the above figures, the boiler is compliant with the air quality objectives for:

- 24-hour average PM_{10}
- Annual Average PM_{10}
- Annual Average $PM_{2.5}$.

4.1.1.2 Oxides of Nitrogen (NO_x)

The maximum permitted in-stack emission rates for oxides of nitrogen can be determined from Table 9 or the following figures:

- Figure 7 for boiler stacks 4 m, 5 m or 6 m high with a minimum distance less than 100 m from the site boundary
- Figure 8 for boiler stacks 7 m, 8 m, 9 m or 10 m high with a minimum distance less than 100 m from the site boundary
- Figure 9 for boiler stacks 4 m, 5 m or 6 m high with a minimum distance between 100 m and 200 m from the site boundary
- Figure 10 for boiler stacks 7 m, 8 m, 9 m or 10 m high with a minimum distance between 100 m and 200 m from the site boundary
- Figure 11 for boiler stacks 4 m, 5 m or 6 m high with a minimum distance between 200 m and 350 m from the site boundary
- Figure 12 for boiler stacks 7 m, 8 m, 9 m or 10 m high with a minimum distance between 200 m and 350 m from the site boundary.

The maximum permitted emission rate from Table 9 or the above figures should be compared to the maximum emission rate of oxides of nitrogen from the boiler as specified by the boiler manufacturer. If the value specified by the boiler manufacturer is lower than the value determined from Table 9 or the above figures, the boiler is compliant with the air quality objectives for

- 1-hour average NO_2
- Annual Average NO_2
- Annual Average NO + NO_2.

4.1.2 Step 2: Analysis

The following questions should be answered based on the information listed in Step 1:

- Is the proposed boiler located in a rural area more than 1.2 km from the nearest house of a town/village with a population between 250 and 500 people?
- Is the proposed boiler located in a rural area more than 2 km from the nearest house of an urban centre with a population of 500 people or more?
- Is the sum of the distance from the boiler stack to the boundary of any other intensive agricultural facility or commercial activity (e.g. hotel or nursing home) that requires a boiler for non-domestic purposes and the minimum distance between the boiler stack and the closest point of the site boundary rounded down to the nearest 10 metres greater than 500 m?The following questions relate to the stack characteristics:
  - Is the boiler stack internal diameter greater than 0.2 m?
  - Is the minimum boiler stack temperature greater than 90°C?
  - Is the minimum boiler stack air velocity greater than 2.5 m/s?
- If there is a back-up boiler at the site, will it operate as a stand-by boiler exclusively when base-load boiler is offline?
- Is the maximum moisture content specified by the boiler manufacturer for the fuel 40% or lower?
- Is the maximum emission rate specified by the manufacturer less than the maximum permitted stack emission rate for NO_x?
- Is the maximum emission rate specified by the manufacturer less than the maximum permitted stack emission rate for PM?

If the answer to any of the above questions is “NO” the proposed boiler **FAILS** the screening framework. To progress further, either a detailed modelling assessment should be completed in accordance with the requirements of AG4 or a revised proposal should be developed. If the answer to all of the questions is “YES” then the screening framework step 2 is a **PASS** and the applicant can proceed to the final step – Assessment Declaration and Outcome.

4.1.3 Step 3: Assessment Declaration and Outcome

The aim of Step 3 is to provide a declaration that based on the information supplied and assessed, emissions from the boiler:

- Meet the requirements of the screening framework and will not cause air pollution.
- Do not meet all the requirements of the screening framework and the applicant must consider:
- Further design to reduce:

- Emissions to air
- Air quality impacts

- Detailed modelling to consider site representative data compared to the conservative screening framework assumptions.

4.2 Multiple boilers within a site boundary

This section describes the screening framework to be adopted where multiple boilers are proposed to be developed within the site boundary. The screening framework is presented in a stepwise manner that is almost identical to the screening framework to be adopted where there is one boiler within the site boundary.

4.2.1 Step 1: Information

The following information is required to implement the screening framework and should be detailed in an application for approval:

- The distance from the site boundary to the nearest town/village with a population between 250 and 500 people
- The distance from the site boundary to the nearest urban centre with a population of 500 people or more
- The shortest distance from any onsite boiler stack to the boundary of any other intensive agricultural facility or commercial activity (e.g. hotel or nursing home) that requires a boiler for non-domestic purposes?
- The internal diameter of **each** boiler stack at the point of release (metres)
- The minimum temperature of exhaust gases emitted from **each** boiler stack (°C)
- The minimum velocity of exhaust gases emitted from **each** boiler stack at the point of release (m/s)
- The presence of back-up boilers at the site
- The maximum moisture content specified by the manufacturer for the fuel
- The height of **each** boiler stack at the point of release (m)
- The minimum distance between **each** boiler stack location and the closest point of the site boundary rounded down to the nearest 10 metres
- The thermal output rating of **each** boiler
- The thermal efficiency of **each** boiler
- The thermal input rating of **each** boiler
- The maximum emission rate of NO_x from **each** onsite boiler at full load as specified by the boiler manufacturer (g/s)
- The maximum emission rate of particulate matter from **each** onsite boiler at full load as specified by the boiler manufacturer (g/s)
- The number of onsite boilers.

4.2.1.1 Particulate Matter

The maximum emission rates or particulate matter for the subject site is dependent on the minimum distance between any onsite boiler stack and the site boundary and the minimum stack height of any onsite boiler. Using these values, the maximum permitted emission rate for particulate matter can be determined using the same methodology as if there is only a single boiler stack within a site boundary. Values are taken from:

- Figure 1 for boiler stacks 4 m, 5 m or 6 m high with a minimum distance less than 100 m from the site boundary

- Figure 2 for boiler stacks 7 m, 8 m, 9 m or 10 m high with a minimum distance less than 100 m from the site boundary
- Figure 3 for boiler stacks 4 m, 5 m or 6 m high with a minimum distance between 100 m and 200 m from the site boundary
- Figure 4 for boiler stacks 7 m, 8 m, 9 m or 10 m high with a minimum distance between 100 m and 200 m from the site boundary
- Figure 5 for boiler stacks 4 m, 5 m or 6 m high with a minimum distance between 200 m and 350 m from the site boundary
- Figure 6 for boiler stacks 7 m, 8 m, 9 m or 10 m high with a minimum distance between 200 m and 350 m from the site boundary.

The maximum permitted emission rate from Table 8 or the above figures should be listed. This value should be compared to the sum of the maximum emission rates of particulate matter from each boiler as specified by each boiler manufacturer. If the value of the sum of the maximum emission rates of particulate matter from each boiler as specified by the boiler manufacturer is lower than the value determined from Table 8 or the above figures emissions from the boilers are compliant with the air quality objectives for:

- 24-hour average PM_{10}
- Annual Average PM_{10}
- Annual Average $PM_{2.5}$.

4.2.1.2 Oxides of Nitrogen (NO_x)

The maximum permitted in-stack emission rates for oxides of nitrogen can be determined from:

- Figure 7 for boiler stacks 4 m, 5 m or 6 m high with a minimum distance less than 100 m from the site boundary
- Figure 9 for boiler stacks 7 m, 8 m, 9 m or 10 m high with a minimum distance less than 100 m from the site boundary
- Figure 11 for boiler stacks 4 m, 5 m or 6 m high with a minimum distance between 100 m and 200 m from the site boundary
- Figure 8 for boiler stacks 7 m, 8 m, 9 m or 10 m high with a minimum distance between 100 m and 200 m from the site boundary
- Figure 10 for boiler stacks 4 m, 5 m or 6 m high with a minimum distance between 200 m and 350 m from the site boundary
- Figure 12 for boiler stacks 7 m, 8 m, 9 m or 10 m high with a minimum distance between 200 m and 350 m from the site boundary.

The maximum permitted emission rate from Table 9 or the above figures should be listed. This value should be compared to the sum of the maximum emission rate of oxides of nitrogen from each boiler as specified by the boiler manufacturer. If the sum of the maximum emission rates of oxides of nitrogen from each boiler as specified by the boiler manufacturer is lower than the value determined from Table 9 or the above figures the boiler is compliant with the air quality objectives for:

- 1-hour average NO_2
- Annual Average NO_2
- Annual Average $NO + NO_2$.

4.2.2 Step 2: Analysis

The following questions should be answered based on the information listed in Step 1:

- Are the proposed boilers located in a rural area more than 1.2 km from the nearest house of a town/village with a population between 250 and 500 people?
- Are the proposed boilers located on a site in a rural area that's boundary is located more than 2 km from the nearest house of an urban centre with a population of 500 people or more
- Is the sum of the shortest distance from any onsite boiler stack to the boundary of any other intensive agricultural facility or commercial activity (e.g. hotel or nursing home) that requires a boiler for non-domestic purposes and the minimum distance between the boiler stack and the closest point of the site boundary rounded down to the nearest 10 metres greater than 500 m?
- The following questions relate to the stack characteristics:
  - Is the minimum stack internal diameter of all onsite boilers greater than 0.2 m?
  - Is the minimum stack temperature of all onsite boilers greater than 90°C?
  - Is the minimum boiler stack air velocity of all onsite boilers greater than 2.5 m/s?
- Is the maximum moisture content of fuel specified by the boiler manufacturer for all onsite boilers 40% or lower?
- Is the sum of the maximum emission rates of NO_x from all boilers as specified by the boiler manufacturer less than the maximum permitted stack emission rate for NO_x
- Is the sum of the maximum emission rates of PM from all boilers as specified by the boiler manufacturer less than the maximum permitted stack emission rate for PM.

If the answer to any of the above questions is "NO" the proposed boilers **FAIL** the screening framework. To progress further either a detailed modelling assessment should be completed in accordance with the requirements of AG4 or a revised proposal should be developed. If the answer to all of the questions is "YES" then the screening framework step 2 is a **PASS** and the applicant can proceed to the final step – Assessment Declaration and Outcome.

4.2.3 Step 3: Assessment Declaration and Outcome

The aim of Step 3 is to provide a declaration that based on the information supplied and assessed, emissions from the proposed boilers:

- Meet the requirements of the screening framework and will not cause air pollution.
- Do not meet all the requirements of the screening framework and the applicant must consider:
  - Further design to reduce:
    - Emissions to air
    - Air quality impacts
  - Detailed modelling to consider site representative data compared to the conservative screening framework assumptions.

4.3 Back-up boilers

The stepwise procedure is also relevant to the assessment of back-up boilers. The application to back-up boilers is described below and depends on the way the back-up boiler operates. Back-up boilers may be operated in two ways, as follows:

> Case A: a back-up boiler may operate exclusively on its own because it is a direct substitute for the farms requirements when baseload boilers are offline (standby boiler).
>
> Case B: a back-up boiler may only supplement part of the farm's requirements and other baseload boilers may also operate with a standby boiler (auxiliary boiler).

Back-up boilers that fit Case A should be assessed in accordance with Section 4.1.

Back-up boilers that fit Case B should be assessed in accordance with Section 4.2.

5. REFERENCES

DEHLG, 2011, Air Quality Standards Regulations (2011). S.I. No. 180/2011 - Air Quality Standards Regulations 2011. http://www.irishstatutebook.ie/eli/2011/si/180/made/en/print

Donnelly, Aoife; Misstear, Bruce; and Broderick, Brian, "Air Quality Modelling for Ireland" (2019). Reports. 13. http://www.epa.ie/pubs/reports/research/air/Research_Report_270.pdf

EPA, (2001). Odour impacts and odour emission control measures for intensive agriculture. Commissioned by the Environmental Protection Agency (Ireland). OdourNet UK Ltd. https://www.epa.ie/pubs/reports/research/air/Odour%20Impacts%20Final.pdf

EPA (2018) Air Quality in Ireland 2017- Indicators of Air Quality. Environmental Protection Agency, An Ghníomhaireacht um Chaomhnú Comhshaoil, PO Box 3000, Johnstown Castle Estate, County Wexford, Ireland. http://www.epa.ie/pubs/reports/air/quality/Air%20Quality%20In%20Ireland%202017.pdf

EPA (2020) Air Dispersion Modelling from Industrial Installations Guidance Note (AG4). Environmental Protection Agency, Johnstown Castle Estate, Wexford, Ireland. https://www.epa.ie/pubs/advice/air/emissions/airdispersionmodellingfromindustrialinstallationsguidancenoteag4.html