PORT AIR QUALITY STRATEGY

WELCOME

At Port of Tyne we recognise that poor air quality is a significant threat to human health, alongside the adverse impacts of climate change. We are committed to taking a lead in improving air quality within the Port.

Our Tyne 2050 strategy sees Port of Tyne commit to leading the maritime industry in environmental sustainability, ensuring that we take every opportunity to minimise our impact on the environment.

Our specific environmental commitments will see an automated environmental impact assessment tool by 2023, and the Port as a clean energy testbed by 2025, helping us achieve our goal for Port of Tyne to be a net-zero Greenhouse Gas emitter by 2030.

Work to reduce CO_2 emissions and to reduce energy consumption continues to be one of our priorities. We have also made significant investments to enhance air quality in and around the Port – electrification of equipment, introducing electric vehicles, free to use charging points and by replacing all lighting with low energy LED alternatives. This has so far reduced our energy consumption by 20%.

We are committed to working with partners to meet regional environmental targets, and have a responsibility as a good neighbour and a major employer to be at the forefront of addressing these challenges to help ensure that North East England continues to be a healthy, thriving and prosperous place to live, work and do business.

Steven Clapperton
Maritime Director
Harbour Master

April 2021

CONTENTS

1 EXECUTIVE SUMMARY

As a qualifying port by virtue of a bulk cargo throughput in excess of 1 million te/annum the Port of Tyne is required to develop an air quality strategy for its statutory area in line with Department for Transport's Port Air Quality Strategy guidance.

Whilst the scope and assessment methodology were set out by the Port in December 2019, this document summarises the final assessment undertaken by the Port of Tyne, its findings and the measures it will take to further improve air quality within the Tyne estuary.

In line with guidance, the air quality assessment was undertaken in two key stages:

(1) An inventory of relevant emissions was compiled for the baseline year (which Port of Tyne declared to be 2017) and included emissions from port related activities on land as well as emissions from all vessels visiting the Tyne in 2017.

(2) An impact assessment utilising complex atmospheric dispersion modelling to predict pollutant concentrations at identified sensitive receptors and their compliance with standards defined within the National Air Quality Regulations.

Due to the scale and complexity of this assessment the Port of Tyne enlisted support of Arup and Partners, highly regarded experts in this field.

The inventory of emissions assessment for the 2017 baseline year concluded that:

- An estimated 363 tonnes of pollutant gas emissions arise from in-scope maritime related activity within the Tyne estuary

- Emissions from vessels were by far the dominant source accounting for 88% of total emissions (vessels at berth 72% and vessels manoeuvring 16%)

- NOx was the dominant pollutant accounting for 86% of total emissions with vessels producing 94% of that

- Roll-on roll-off car carrier vessels are the largest source of vessel NOx emissions with offshore vessels being the second highest

- Non Road Mobile Machinery operating on the Port estates account for around 5% of estimated NOx emissions

- Vessels at berth is also the largest contributor to PM_{10} emissions with Non-Road Mobile Machinery being the second largest

- Particulate and SOx emissions are trivial compared to NOx emissions

The air quality impact assessment showed that:

- Air quality within the Tyne lower estuary is good, averaging around 25% of the relevant National Air Quality Standards objectives, with the exception of NO_2 which is typically around 50% of the objective

- Port related activity accounts for typically 1-2% of the predicted pollutant concentrations and is relatively trivial when compared to the existing background concentrations

- No exceedance of relevant air quality standards was predicted at any of the receptors by the dispersion modelling (based upon 2017 data)

Within the Stage 1 Port Air Quality Strategy the Port of Tyne stated that it would not consider implementing specific emissions reduction measures for pollutant emissions predicted to be less than 50% of the relevant National Air Quality Standards. Based upon the model predictions there is therefore no clear need for any immediate action to be taken the Port of Tyne.

In January 2020 however the Port of Tyne launched its Tyne 2050 strategy. Within this overall vision there are a number of key environmental projects:

- Net Zero Greenhouse Gas emissions by 2030
- All Electric Port by 2040
- Clean energy test bed
- Automated Environmental Impact

Whilst the detailed plans are still being developed it is clear at this stage that these initiatives will directly contribute to the reduction of pollutant emissions from the Port of Tyne through:

- The progressive substitution of gas oil fired equipment with electric equivalents by 2030
- The transition to an all-electric port by 2040 including the provision of shore based power sources visiting vessels

To encourage the early adoption of green shipping technology the Port of Tyne is considering the implementation of a "Green Ship" Tariff.

Whilst air quality within the Tyne estuary is good the Port of Tyne is nevertheless committed to the continued implementation of measures to further reduce pollutant emissions with a target to achieve zero emissions by 2040. This assessment clearly demonstrates the Port of Tyne's commitment to air quality and hence human health improvement within the Tyne Estuary.

2 INTRODUCTION

The Department for Transport (DfT) placed a duty on English ports which handle greater than 1 million tonnes of cargo to develop Port Air Quality Strategies (PAQS) for their relevant statutory areas.

The Port of Tyne (PoT) handles bulk volumes significantly in excess of this threshold and therefore, as a qualifying port is, required to develop an air quality strategy for its own statutory area. Although the Port of Tyne statutory harbour area stretches from 1 mile beyond the piers at Tynemouth to the tidal limit at Wylam, 17 miles inland to the West, no significant maritime activity take place upriver of the Tyne Bridge and so that has been defined at the upriver limit of the PAQS.

Since air quality management is not a duty traditionally placed upon port authorities it follows that many ports had little previous experience of air quality management and possessed only limited background air quality data at the outset.

Recognising this, DfT therefore agreed a two stage approach to the development of PAQS's, the first "plan to plan" stage required qualifying ports to develop and publish scoping documents by the end of 2019 which set out the key steps they would take to develop the final stage 2 PAQS by the end of 2020. The first stage PAQS, which was published by Port of Tyne in December 2019, defined the scope of the air quality assessment it intended to take and demonstrated a high level of commitment to the management of air quality within the Tyne Estuary.

This document is the final PAQS which summarises the actions taken to honour the commitments made within the stage 1 PAQS, the results of the assessment and the actions the Port of Tyne intends to take to improve air quality within the Tyne estuary.

Figure 1: Port of Tyne Statutory Harbour Area

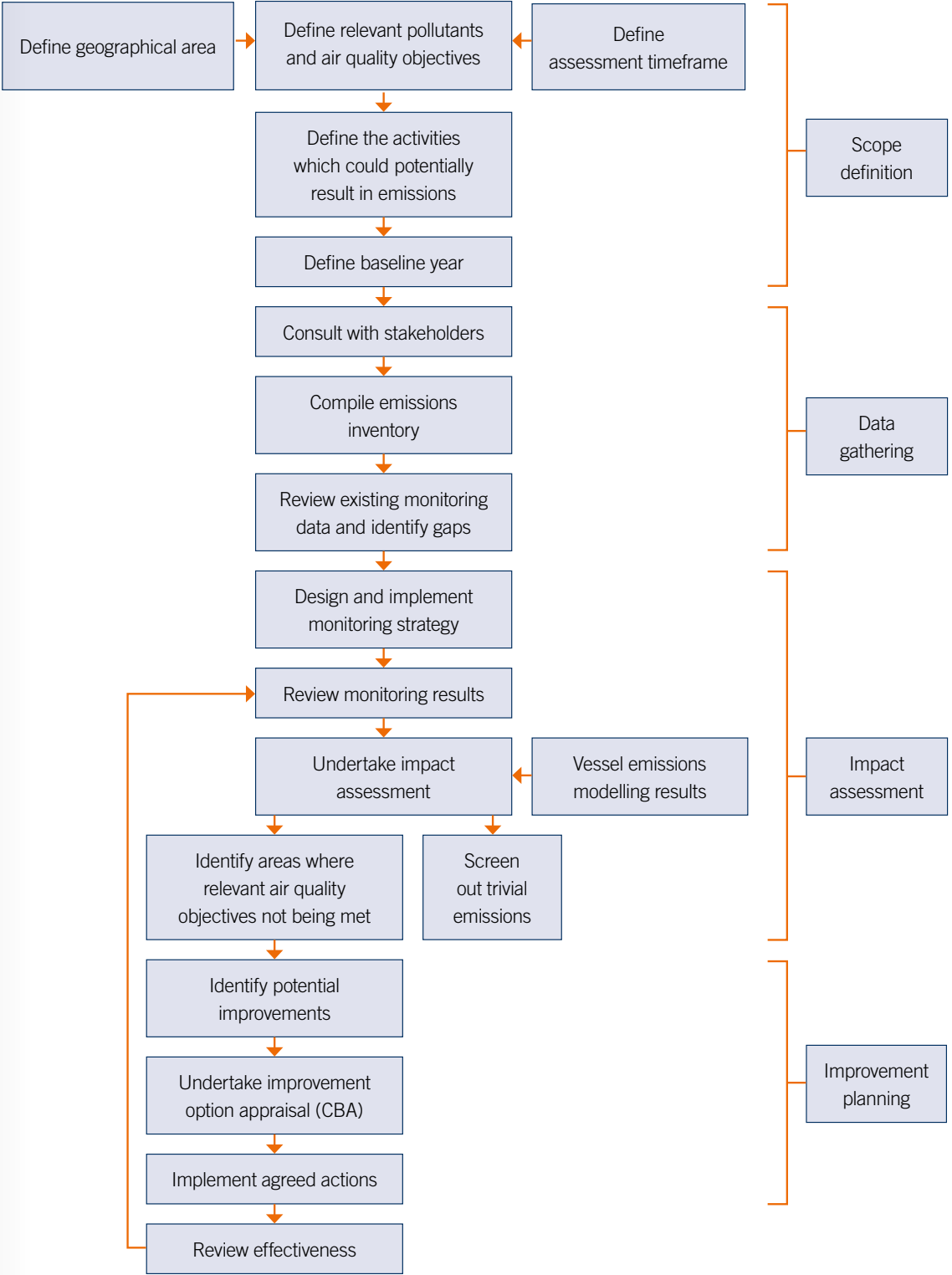# 3 KEY OBJECTIVES OF THE PORT AIR QUALITY STRATEGY

In order to develop an effective and credible air quality strategy it was imperative that the objectives were agreed in advance and understood by key stakeholders. The key objectives of the Port of Tyne's AQS are:

- To compile and maintain an inventory of emissions from port and maritime related activity within the Port of Tyne statutory area
- To develop an understanding of the air quality impacts of those emissions on agreed sensitive receptors
- To ensure a high level of protection for people living and working in and around port areas
- To comply as a minimum with relevant air quality objectives and standards defined within the National Air Quality Strategy
- To work with key stakeholders in a partnership approach to drive continuous improvement in air quality
- To complement and support the work of local authorities but to avoid duplication of effort
- To be open and transparent in its efforts to improve air quality and to communicate effectively
- To make evidence based decisions on potential improvement actions
- To implement reasonably practical improvement measures whilst avoiding adverse economic impacts on the Port or its stakeholders

3.1 KEY ASSESSMENT STAGES

The key stages of the assessment include but are not limited to the following:

1. To identify the geographical area and the relevant activities within it
2. To identify the assessment timeframe, the in scope pollutants and their relevant air quality objectives
3. To identify the potential sources of in scope pollutants from those activities
4. To consult with relevant stakeholders such as local authorities and significant river users
5. To define the "baseline" year and to compile and maintain an inventory of relevant emissions for the in scope activities for that year onwards
6. To estimate both short and long term pollutant flux
7. To review existing air quality monitoring data and to identify gaps in coverage
8. To implement a programme of ongoing air quality monitoring
9. To undertake an impact assessment for the baseline year onwards, to estimate the likely ground levels concentrations of those pollutants and their significance against relevant air quality standards and the objectives of relevant local air quality plans
10. To review the impact of improvements implemented since the baseline year
11. For significant impacts to identify the potential improvement objectives
12. To undertake costs benefit analysis and to identify practical improvements
13. To Implement the agreed improvements
14. To monitor effectiveness of the improvements and where necessary update improvement plan

3.2 ASSESSMENT FLOWCHART

4 NATIONAL AIR QUALITY STRATEGY OBJECTIVES FOR IN SCOPE AIR POLLUTANTS

Within the UK a number of these air pollutants have legal air quality standards which must be achieved, albeit by relevant local authorities, as prescribed by the National Air Quality Strategy and the Air Quality Standards Regulations 2010.

In the first instance the plan will attempt to determine whether the implied or measured ground level concentrations of the in scope pollutants meet the relevant objectives. Any ground level concentrations of pollutants which approach or exceed these limits will be prioritised for short term improvement. Ground level concentrations of pollutants which are less than 50% of the relevant limit shall be screened from further assessment.

Table 1: Permissible Ground Level Concentrations for In Scope Pollutants

POLLUTANT	PERMISSIBLE CONCENTRATION	MEASUREMENT INTERVAL
Particulate Matter 10 (PM$_{10}$)	50µg/m³ not exceeded more than 35 times per year	24 hour mean
	40µg/m³	Annual mean
Particulate Matter 2.5 (PM$_{2.5}$) EU Limit Value	25µg/m³	Annual mean
	Target of 15% reduction in concentrations at urban background	Annual mean
Nitrogen Dioxide (NO$_2$)	200µg/m³ not to be exceeded more than 18 times per year	1 hour mean
	40µg/m³	Annual mean
Sulphur Dioxide (SO$_2$)	266µg/m³ not to be exceeded more than 35 times per year	15 minute mean
	350µg/m³ not to be exceeded more than 24 times per year	1 hour mean
	125µg/m³ not to be exceeded more than 3 times per year	24 hour mean
Carbon Monoxide	10 mg/m³	Maximum Daily 8hr mean
NMVOC	No current ambient air quality standard	

[Note that the Air Quality Standards Regulations 2010 do not contain limits for carbon monoxide or Non Methane Volatile Organic Compounds. The limits for CO have been taken from EU Ambient Air Quality Directive 2008/50/EU]

5 EMISSIONS INVENTORY

A key requirement of PAQS's is to develop an inventory of relevant emissions arising from vessel traffic and shore based maritime related activity within the baseline year which the Port of Tyne defined as being 2017. The stage 1 PAQS stated that whilst total emissions from vessel traffic and land based maritime activities on the Port of Tyne estate will be determined, the emissions from both port tenants and the shore based activities of 3rd party river users would be excluded from the assessment.

The Port of Tyne commissioned highly regarded air quality experts Ove Arup and Partners to compile an emissions inventory for the following emission sources;

- Vessel movements within the statutory harbour area;
- Vessels at berth;
- Non-Road Mobile Machinery (NRMM) including cranes, tugs, wheel loaders etc on the Port estate;
- Vehicle imports and exports on the Port's North (VAG) and South (Nissan) estates;
- Vehicles using the Port of Tyne internal road network;
- Loading and unloading of Roll-on/Roll-off (RoRo) ferries;
- The storage and handling of wood pellets;
- Locomotives for the transporting of wood pellets from the Port of Tyne

The pollutants considered for each source are detailed in Table 2 below;

Table 2:Pollutants Considered From Each Source

SOURCE	POLLUTANTS				
	NOx	PM$_{10}$	PM$_{2.5}$	SOx*	CO**
Vessels At Berth	✓	✓	✓	✓	
Vessels Manoeuvring	✓	✓	✓	✓	
NRMM	✓	✓	✓		
Vehicles On Road Network	✓	✓	✓		
Vehicle Import And Export	✓	✓	✓		
Roro Operations	✓	✓	✓		
Locomotives	✓	✓	✓		
Wood Pellet Storage					✓

*SOx not been considered for sources other than vessels and the fuel used has a low sulphur content.

**CO emissions are only relevant to the wood pellet storage and have not been calculated for other sources.

5.1 EMISSIONS FROM SHIPPING

5.1.1 Methodology

The detailed vessel movement data for 2017 was provided to Ove Arup by the Port of Tyne and in order to simplify the assessment vessels were first grouped into modelling categories by size and by generic type.

Table 3 presents the details of the vessel modelling categories.

Table 3: Vessel Modelling Categories

VESSEL TYPE	DESCRIPTION	UNITS	MODELLING CATEGORY
Bulk carrier	0-9,999	dwt	BULK1
	10,000-34,999	dwt	BULK2
	35,000-59,999	dwt	BULK3
	60,000+	dwt	BULK4
General cargo	0-4,999	dwt	CARGO1
	5,000-9,999	dwt	CARGO2
	10,000+	dwt	CARGO3
Container	0-999	TEU	CON1
	1,000-1,999	TEU	CON2
Cruise	0-1,999	grt	CRUISE1
	10,000-59,999	grt	CRUISE3
	60,000-99,999	grt	CRUISE4
Chemical tanker	0-4,999	dwt	CT1
	10,000-19,999	dwt	CT3
	20,000+	dwt	CT4
Miscellaneous - fishing	0+	grt	FIS
Miscellaneous - other	0+	grt	MIS
Offshore	0+	grt	OFF
Ferry - no-pax	2,000+	grt	ROPAXFERRY2
Ro-ro	5,000+	grt	RORO2
Service - tug	0+	grt	TUG
Yacht	0+	grt	YAT

Size categories are deadweight tonnage (dwt), twenty-foot equivalent units (TEU) and gross registered tonnage (grt).

VESSELS AT BERTH

Emissions for each vessel at berth were calculated using Equation 1, which takes into account the auxiliary engine load, time spent at berth, specific fuel oil consumption and actual emission factor. The average auxiliary engine load at berth was taken from Annex 1 of the Third International Maritime Organisation (IMO) Greenhouse Gas study[1] and the calculated average time spent at berth. The specific fuel oil consumption and baseline emission factor for auxiliary engines (Medium speed, NOx Tier II engine) were taken from Annex 6 of the Third IMO Greenhouse Gas study[1] and the corresponding method was followed to calculate the actual emission factor. The baseline emission factors assume heavy fuel oil with 2.7% sulphur content. However, the Port is in a Sulphur Emissions Control Area so it can be assumed that all vessels are using marine gas oil with a sulphur content of 0.1%. Therefore, a fuel correction factor was applied to convert the baseline emission factor to actual emission factor, which is presented in Table 5. The fuel correction factors were also taken from Annex 6 of the Third IMO Greenhouse Gas study[1].

Equation 1:

Emissions per vessel at berth =   AL x T x SF x EF

AL = Auxillary engines load at berth for modelling category (kW)

T = Time spent at berth (hrs)

SF = Specific fuel oil consumption (SFOC) (g fuel / kWh)

EF = Actual emission factor (g pollutant/g fuel)

Table 4 below summarises the number of vessels within each of the vessel classifications, the assumed auxiliary engine power and average time at berth for the 2017 baseline year.

Table 4: Details of Vessels at Berth by Modelling Category

MODELLING CATEGORY	TOTAL NUMBER OF VESSELS	AVERAGE AUXILIARY ENGINE LOAD AT BERTH (Kw)	AVERAGE TIME AT BERTH (HRS)
BULK1	48	280	36.5
BULK2	7	280	11.0
BULK3	12	370	52.7
BULK4	12	600	37.3
CARGO1	381	120	134.8
CARGO2	11	330	45.7
CARGO3	48	970	44.1
CON1	17	340	14.1
CON2	1	600	1,108.4
CRUISE1	41	450	11.9
CRUISE3	100	3,500	59.5
CRUISE4	1	11,480	16.6
CT1	12	160	54.8
CT3	1	490	44.5
CT4	2	1,170	447.3
FIS	8	200	88.7
MIS	318	190	93.5
OFF	193	320	249.1
ROPAXFERRY2	8	710	21.8
RORO2	103	1,200	43.6
TUG	201	50	175.4
YAT	9	130	38.4
Total	1,534	n/a	n/a

The total number of vessels at berth by modelling category is also presented in Figure 2.

Figure 2: Total Number of Vessels at Berth by Modelling Category
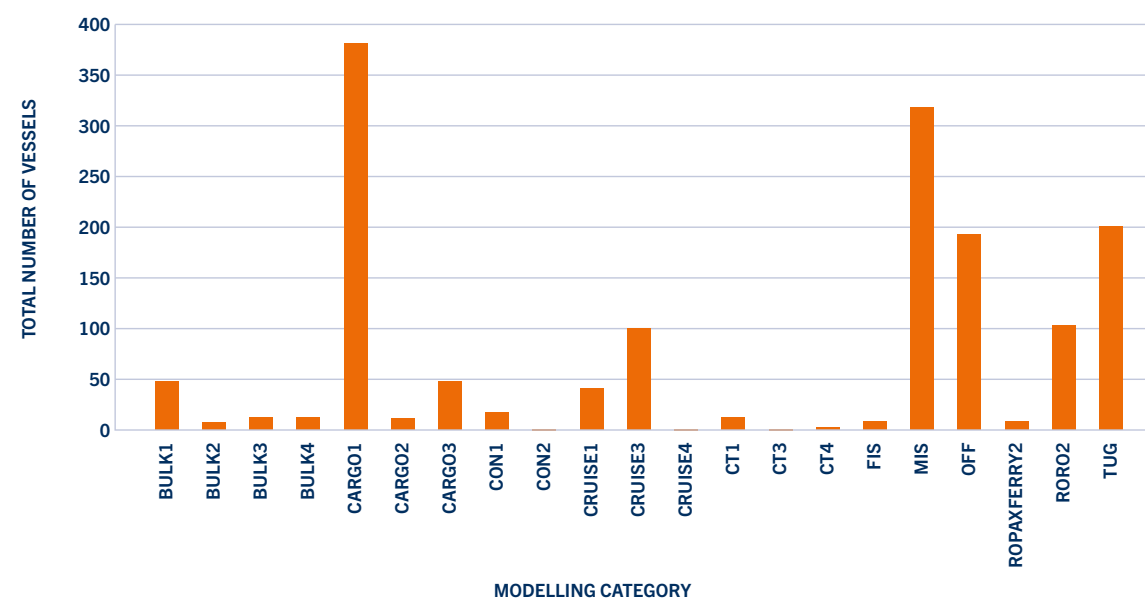

Table 5 below summarises the emissions factors used to determine emissions from vessels at berth.

Table 5: Emission Factors for Auxiliary Engines at Berth

POLLUTANT	AUXILIARY ENGINES AT BERTH		
	NOx	PM$_{10}$	SOx
Baseline Emission Factor (g pollutant/kWh)	11.2	1.4	12.0
SFOC (g fuel/kWh)	227.0	227.0	227.0
Baseline Emission Factor (g pollutant/g fuel)	0.049	0.006	0.053
Fuel Correction Factor	0.94	0.14	0.05
Actual Emission Factor (g pollutant/g fuel)	0.046	0.001	0.003

VESSELS MANOEUVRING

The detailed vessel movement data for 2017, was provided to Ove Arup by the Port of Tyne who used it to calculate the total number of vessel movements for each modelling category. The number of movements does not directly correlate with the number of vessels at berth but is approximately double the number the vessels at berth.

Table 6 presents the details of vessels manoeuvring by category, the average time spent manoeuvring (calculated using the total distance travelled and assuming an average speed of six knots whilst moving on River Tyne) and the average auxiliary engine load and main engine load during manoeuvring. The average auxiliary engine load manoeuvring was taken from Annex 1 of the Third IMO Greenhouse Gas study[1] and the average main load whilst manoeuvring was estimated by data provided in the IMO databases on installed engine size of vessels, such as

Veristar[2] and Baltic Shipping[3]. It was assumed that 15% of the installed main engine power was used during manoeuvring[4].

The emissions for vessels manoeuvring were calculated using Equation 2, which takes into account the main and auxiliary engine loads, time spent at berth, specific fuel oil consumptions and actual emission factor. The specific fuel oil consumption and baseline emission factor for main engines (Slow speed, NOx Tier II engine) and auxiliary engines (Medium speed, NOx Tier II engine) were taken from Annex 6 of the Third IMO Greenhouse Gas study[1] and the corresponding method was followed to calculate the actual emission factor. The baseline emission factors were then converted using a fuel correction factor that is presented in Table 7 due to the Sulphur Emissions Control Area. The fuel correction factors were also taken from Annex 6 of the Third IMO Greenhouse Gas study[1].

Equation 2:

Emissions per vessel movement =   (ML x T x SF x EF)+ (AL x T x SF x EF)

ML = Main engine load manoeuvring for modelling category (kW)

AL = Auxillary engine load manoeuvring for modelling category (kW)

T =Time spent manoeuvring (hrs)

SF = SFOC (g fuel / kWh)

EF = Actual emission factor (g pollutant/g fuel)

Table 6: Details of 2017 Vessel Manoeuvres by Modelling Category

MODELLING CATEGORY	TOTAL NUMBER OF VESSELS	AVERAGE AUXILIARY ENGINE LOAD MANOEUVRING (KW)	AVERAGE MAIN ENGINE LOAD MANOEUVRING (KW)	AVERAGE TIME MANOEUVRING (HRS)
BULK1	159	310	727	0.5
BULK2	28	310	1,095	0.5
BULK3	38	420	1,209	0.5
BULK4	16	680	1,449	0.5
CARGO1	72	90	591	0.7
CARGO2	10	250	1,418	0.8
CARGO3	18	730	1,561	0.8
CON1	200	550	1,158	0.5
CON2	26	1,320	2,348	0.5
CRUISE1	1	580	72	0.4
CRUISE3	90	5,460	3,066	0.4
CRUISE4	12	14,900	8,640	0.4
CT1	1	110	519	1.1
CT3	5	330	689	0.5
CT4	7	780	826	0.5
FIS	18	200	801	0.2
MIS	484	190	782	0.8
OFF	149	320	577	0.7
ROPAXFERRY2	684	710	2,940	0.4
RORO2	911	2,720	1,051	0.5
TUG	258	50	548	0.7
YAT	15	130	34	1.2
Total	3,202	n/a	n/a	12.8

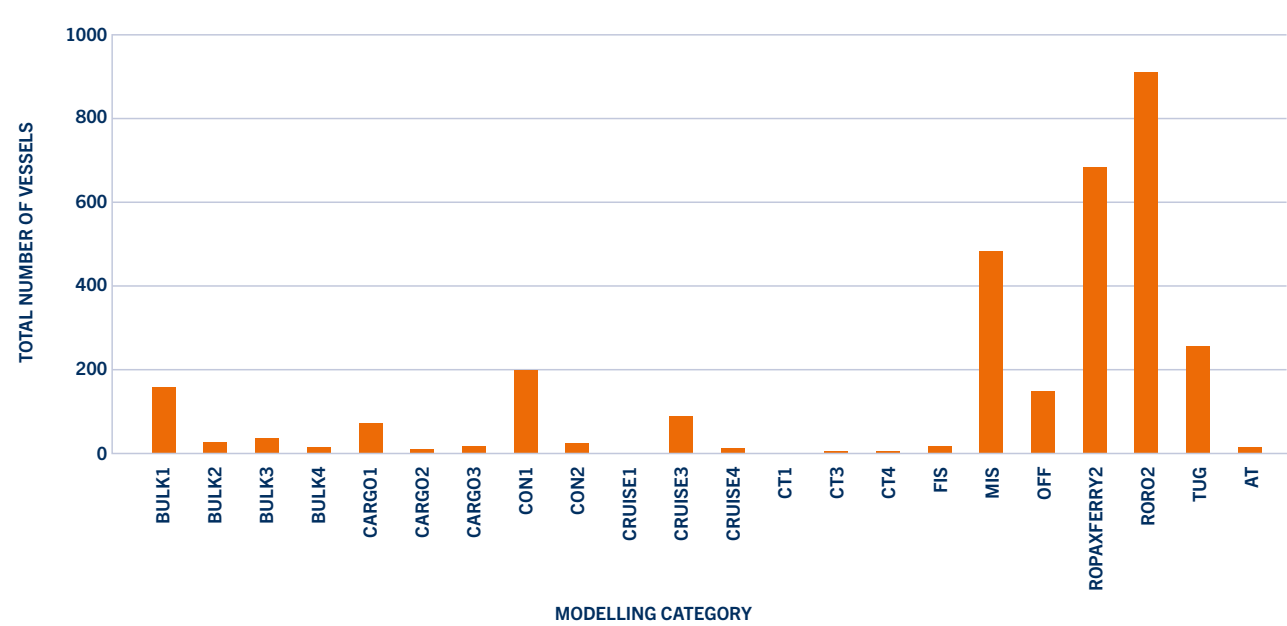Figure 3: Total Number of Vessels Manoeuvres by Modelling Category

Table 7: Emission Factors for Main and Auxiliary Engines Whilst Manoevring

POLLUTANT	MAIN ENGINE MANOEUVRING			AUXILIARY ENGINE MANOEUVRING		
	NOx	PM$_{10}$	SOx	NOx	PM$_{10}$	SOx
Baseline Emission Factor (g pollutant/kWh)	15.3	1.4	10.3	11.2	1.4	12.0
SFOC (g fuel/kWh)	195.0	195.0	195.0	227.0	227.0	227.0
Baseline Emission Factor (g pollutant/g fuel)	0.08	0.01	0.05	0.05	0.01	0.05
Fuel Correction Factor	0.94	0.14	0.05	0.94	0.14	0.05
Actual Emission Factor (g pollutant/g fuel)	0.074	0.001	0.003	0.046	0.001	0.003

5.2 EMISSIONS FROM SHORE BASED MARITIME RELATED ACTIVITY WITHIN THE PORT OF TYNE ESTATE

The Port of Tyne maintains detailed information on the various cargo throughputs and the machines used within each operation along with operating hours and average fuel consumption data. This was provided to Ove Arup in order that the shore based contributions to the emissions inventory could be estimated.

5.3 EMISSIONS FROM NON-ROAD MOBILE MACHINERY

5.3.1 Methodology

All Non-Road Mobile Machinery NRMM at the Port of Tyne is fuelled using gas oil. The emission factors used to calculate NOx, PM$_{10}$ and PM$_{2.5}$ emissions from the consumption of gas oil were taken from the National Atmospheric Emissions Inventory (NAEI). Emissions were calculated using these emission factors and the data provided by Port of Tyne on the number NRMM units, operating hours and total fuel usage.

5.4 EMISSIONS FROM INTERNAL ROAD NETWORK

5.4.1 Methodology

Emissions from vehicles utilising the Port's internal road network were calculated using Defra's Emissions Factor Toolkit (EFT – Version 9.0)[5] in conjunction with Port traffic data including, for example, number of containers moved, number of automotive transporters and internal bulk cargo transport. Traffic data used in the assessment are presented in section 6.

5.5 EMISSIONS FROM VEHICLE IMPORT AND EXPORT

5.5.1 Methodology

There are two main vehicle import and export areas at the Port of Tyne; the Volkswagen/Audi Group facility on the Port's Northern estate and the Nissan import/export facility on the Port's Southern estate.

Emissions for the import/export areas were calculated in accordance with the Cambridge Environmental Research Consultants (CERC) note on modelling for car parks[6]. The number of vehicles and locations of import/export activities are shown in section 6.

5.6 EMISSIONS FROM INTERNATIONAL PASSENGER TERMINAL AND RO-RO OPERATIONS

5.6.1 Methodology

Operations at the Port of Tyne International Passenger Terminal (IPT) includes the provision of the following services

- Ro-Ro ferry operations including freight
- Foot passengers using the daily ferry service (inc. car parking)
- Cruise passengers (inc. car parking)
- Car parking is provided for cruise and ferry passengers

Emissions from vehicle movements were calculated in accordance with the Cambridge Environmental Research Consultants (CERC) note on modelling for car parks[6]. The number of vehicles, car locations and loading and unloading areas are shown in section 6.

5.7 EMISSIONS FROM RAIL OPERATIONS

5.7.1 Methodology

There are a number of rail lines within the Port that are used for the onward transport of wood pellets. Trains are operated by GB Railfreight and, for emission calculation purposes, the locomotives employed are assumed to be Class 60 or 66.

Trains Idling

Emissions for idling trains were calculated using total fuel consumed and a Tier 1 EMEP emission factor for diesel trains[7]. The total fuel consumed was estimated using an average fuel consumption rate (kg/hr) taken from the Southampton Clean Air Zone – Air Quality Modelling Methodology report[8].

Trains moving in and out of Port

Emissions for moving trains were calculated using the distance of the track and a pollutant emission factor (g/km) taken from the AEA Technology Rail Emission Model report[9]. It is assumed that for each trip the total length of the rail line was travelled twice, once inbound and once outbound.

5.8 EMISSIONS FROM WOOD PELLET STORAGE

5.8.1 Methodology

Wood pellet, like any organic material decomposes due to the microbial action. This results in the generation of gases such as methane, hydrogen and carbon monoxide dependent upon the oxygen availability, the temperature and the moisture content of the wood pellet. For this reason the Port goes to great lengths to keep the wood pellet dry and cool. Despite these measures a degree of microbial activity still occurs and due to the oxygen content this is mainly aerobic and results in the generation of carbon monoxide. Due to the toxicity of carbon monoxide this must be vented to provide a safe working environment for workers within the shed. To affect this the shed is vented along the entire roof apex and additionally via a number of large louvres under the eaves and on gable ends. Although it is unlikely that there will be hazardous concentrations at ground level arising from of the venting of carbon monoxide at high level, for completeness this has been incorporated within the scope of the assessment.

5.9 EMISSIONS INVENTORY RESULTS

Table 8 below provides a summary of the estimated annual emissions of NOx, PM_{10}, $PM_{2.5}$, SOx and CO in 2017.

Table 8: Total Pollutant Emissions in 2017

SOURCES	POLLUTANT EMISSIONS (t/yr)				
	NOx	PM_{10}	$PM_{2.5}$	SOx*	CO**
Vessels At Berth	239.9	4.6	4.6*	13.6	
Vessels Manoeuvring	53.8	0.9	0.9*	2.4	
NRMM	15.2	1.6	1.6*		
Vehicles On Road Network	1.6	0.1	<0.1		
Vehicle Import And Export	0.4	<0.1	<0.1		
Car parks and loading/unloading RoRo ferry	0.3	<0.1	<0.1		
Locomotives	0.8	<0.1	<0.1*		
Wood Pellet Storage					20.4
Total	311.9	7.2	7.2	16.1	20.4

Note: * $PM_{2.5}$ emissions assumed to be same as PM_{10}

The following key conclusions can be drawn from the assessment:

- Based upon 2017 activity levels, an estimated 363 tonnes of pollutant gas emissions arise from in-scope maritime related activity within the Tyne estuary.

- Emissions from vessels are by far the dominant source accounting for 88% of total emissions (vessels at berth 72% and vessels manoeuvring 16%)

- NOx is the dominant pollutant accounting for 86% of total emissions with vessels producing 94% of total NOx

- NRMM on the Port estates account for around 5% of estimated NOx emissions

- Vessels at berth is also the largest contributor to PM_{10} emissions with Non-Road Mobile Machinery (NRMM) being the second largest

- Particulate and SOx emissions are relatively trivial compared to NOx emissions and are therefore a lower emissions reduction priority

5.10   SOURCE APPORTIONMENT

Whilst it is important to understand the total inventory of emissions arising from port activities, in order to develop improvement strategies it is crucial, for the most significant emission sources, to apportion the contribution to it by generic activity and by geographical location. Since NOx emissions arising from vessels at berth is by far the largest source, detailed source apportionment was therefore only undertaken for that. Figures 4 to 7 below summarise total 2017 vessel NOx emissions by vessel classification and berth location.

The following key conclusions can be drawn from this exercise:

- RORO2 (car ro-ro vessels) accounts for the largest source of NOx emissions

- Emissions from offshore vessels (OFF category) is the second highest source of emissions. It should be noted however that these emissions arise from 3rd party berths on the river Tyne

- The overwhelming majority of the RORO2 emissions occur within the Tyne Car Terminal berths on the Port of Tyne South Estate (ref TCT1 to 3)

- Riverside Quay East accounts for the second highest source of NOx emissions (arising from bulk handling operations)

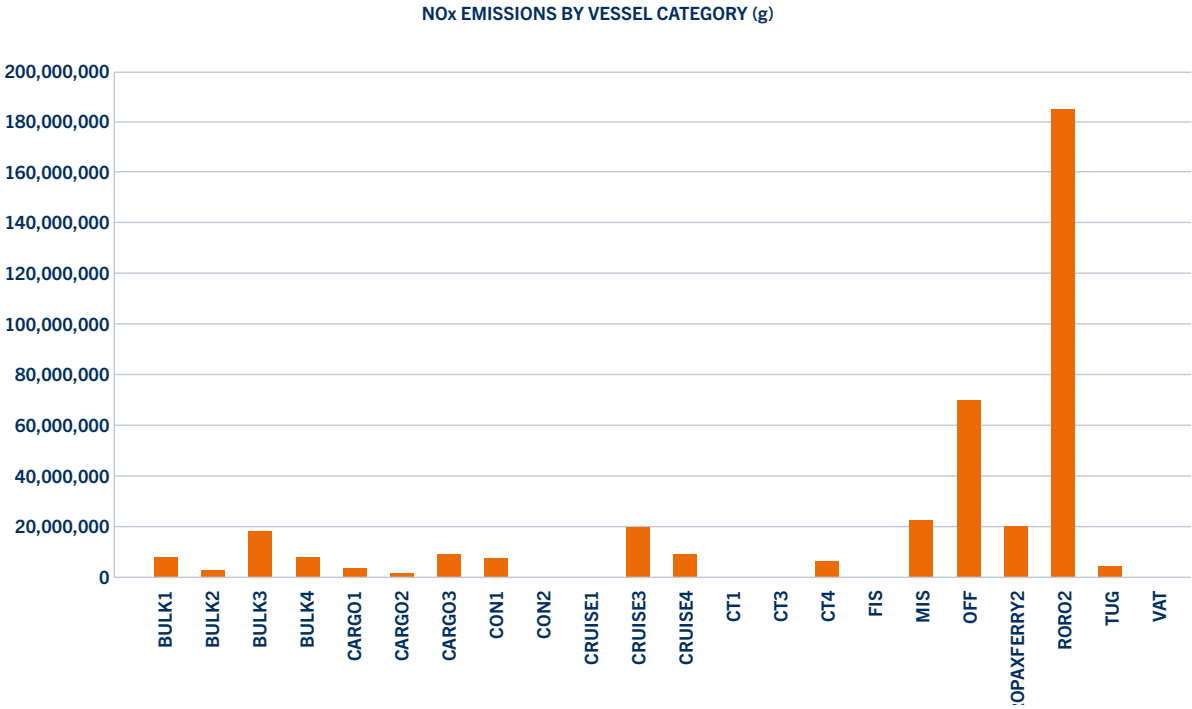Figure 4: Apportionment of Total 2017 Vessel Emissions by Category

NOx EMISSIONS BY VESSEL CATEGORY (g)

Figure 5: Apportionment of Total 2017 Vessel Emissions by Location
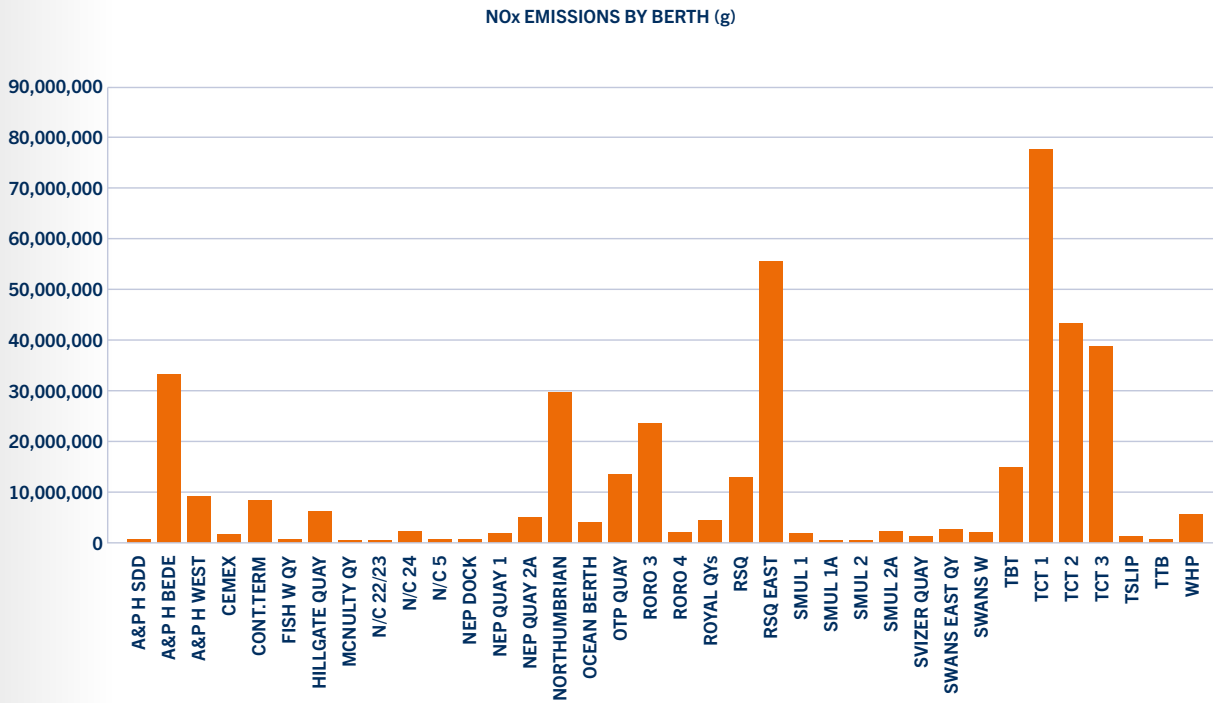

NOx EMISSIONS BY BERTH (g)

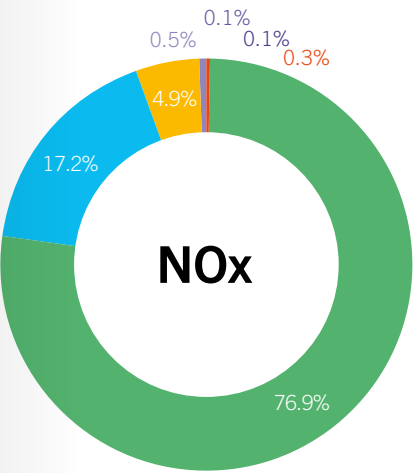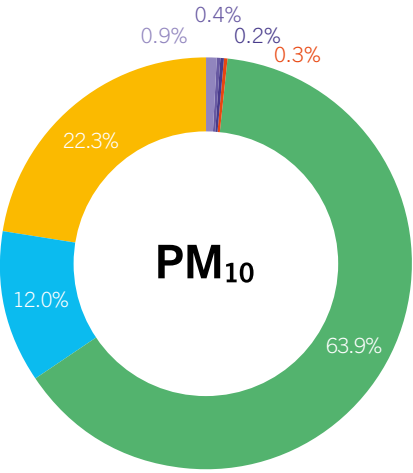Figure 6: Source Apportionment of NOx Emissions in 2017

NOx

Figure 7: Source Apportionment of PM₁₀ Emissions in 2017

PM$_{10}$

- Vessel Vessels manoeuvring
- Vessels at berth
- Vehicles on road network
- Vehicle import and export
- NRMM
- Car parks
- Locomotives

6 EMISSIONS IMPACT ASSESSMENT

Whilst it is important to maintain an emissions inventory to determine the effectiveness of improvement strategies year on year, it is far more important to understand the impact of those emissions on agreed sensitive receptors within the Port area to ensure the objectives of the National Air Quality Strategy are being met at a local level and to allow the Port of Tyne effectively target its emissions reduction strategies.

There are a number of different methodologies and tools which can be employed to undertake such an assessment dependent upon the complexity of the task and the required accuracy.

6.1 METHODOLOGY FOR AIR QUALITY DISPERSION MODELLING

In the busy industrial area of the Tyne estuary there are a significant number of pollutant sources and a significant number of potentially sensitive receptors. In order to geographically predict the cumulative impact of these emissions upon the sensitive receptors it is normally necessary to undertake Complex atmospheric dispersion modelling using proprietary modelling software. Such modelling software takes into account the effects of local terrain and buildings, existing background air quality and time averaged meteorological data within the study area. Using these inputs the models undertake complex non-linear (Gaussian) dispersion calculations to predict ground level concentrations and utilise local terrain and meteorological data to predict the time-averaged spatial distribution of pollutants. This modelling technique however requires the key inputs and outputs to be defined in detail.

Model Inputs

- The study area which, for complex models, may need to be subdivided into smaller areas

- Local meteorological data

- The in-scope pollutant emissions

- Baseline air quality data within the study area

- The location and elevation of key sensitive human and ecological receptors

- The location and elevation of emission sources. These can be defined as:

    - Static (point) sources such as factory chimneys and vessels whilst at berth

    - Diffuse (area) sources such as working quays and

    - Mobile (line) sources such as vessels and vehicles

Model Outputs

- The predicted ground level concentrations of pollutants at sensitive receptors

- Contour plots showing spatial distribution of pollutants

- The cumulative net contribution of port activities to existing background pollutant concentrations

Due to the highly specialist nature of such work the Port of Tyne appointed industry leading air quality experts Ove-Arup to model the impact of in-scope emissions from vessels and land based port activities on agreed sensitive human and ecological receptors. For this task Ove Arup employed ADMS 5 (Version 5.2.4) and ADMS-Roads (Version 5.0) modelling software which were the most up-to-date versions available at the time of the assessment. The ADMS models have been widely validated for dispersion modelling and are accepted by the industry as being 'fit-for-purpose' for air quality assessments.

6.2 MODEL INPUTS

6.2.1 Study Area

In order to make the task of emissions modelling more manageable the study area (scoped as between the Tyne Bridges at Newcastle and the piers at Tynemouth) was divided up into 4 grids (designated grids 1-4) shown in Figure 8 below.

Figure 8: Study Area Boundary and Modelled Grids

Local Meteorological Data

Local Meteorological data for the model, covering the period 1st January to 31st December 2017, was obtained from Newcastle Airport and shows that the prevailing wind direction is from the west. This can be seen in the wind rose in Figure 9 below.

Figure 9: Wind Rose for 2017 (Newcastle Airport)
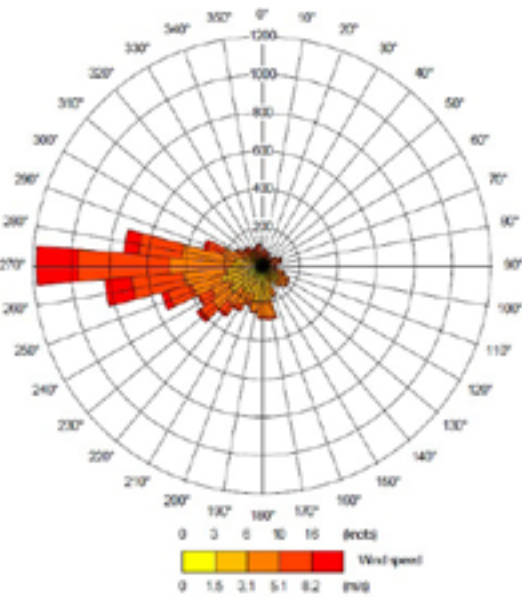
6.2.2 IN SCOPE POLLUTANT EMISSIONS

Table 2 in section 5 above summarises the pollutants which are within the scope of the assessment and table 1 summarises the relevant air quality objectives within the National Air Quality Regulations.

6.2.3 BASELINE AIR QUALITY DATA

In order to determine whether air quality objectives of the NAQS are being met at sensitive receptors an Air quality impact assessment must predict the cumulative impact of maritime related activity within the Tyne estuary over and above the existing background pollutant concentrations. It is hence crucial that a good understanding of background data is established. This can be derived from:

- Defra background pollution data
- Port and local authority air quality monitoring

DEFRA Background Data

Defra provide estimates of background pollutant concentrations based on modelling techniques[10]. This provides a useful indication of pollutant levels in an area. The estimates are widely used in local authority reviews and assessment work and are a source of information in most air quality assessments. The current estimates are for a base year of 2017 with projections available for each year up to 2030.

The reported background levels for 1km grid squares covered by the site boundary is shown in Figures 10 to 15 below. The estimated Defra background concentrations are below the air quality objectives for annual mean NO_2, PM_{10} and for $PM_{2.5}$).

The CO and SO2 short-term backgrounds shown are double the annual mean backgrounds. It should be noted that the CO and SO_2 background concentrations are based on 2001 data. The CO background concentration has been adjusted to 2017 level using the tool as provided by Defra[11]. No adjustment has been applied to SO_2 background concentration as per Defra's guidance as the change would be very little since 2001[12].

Figure 10: Estimated Defra Background NOx Concentrations ($\mu g/m^3$)
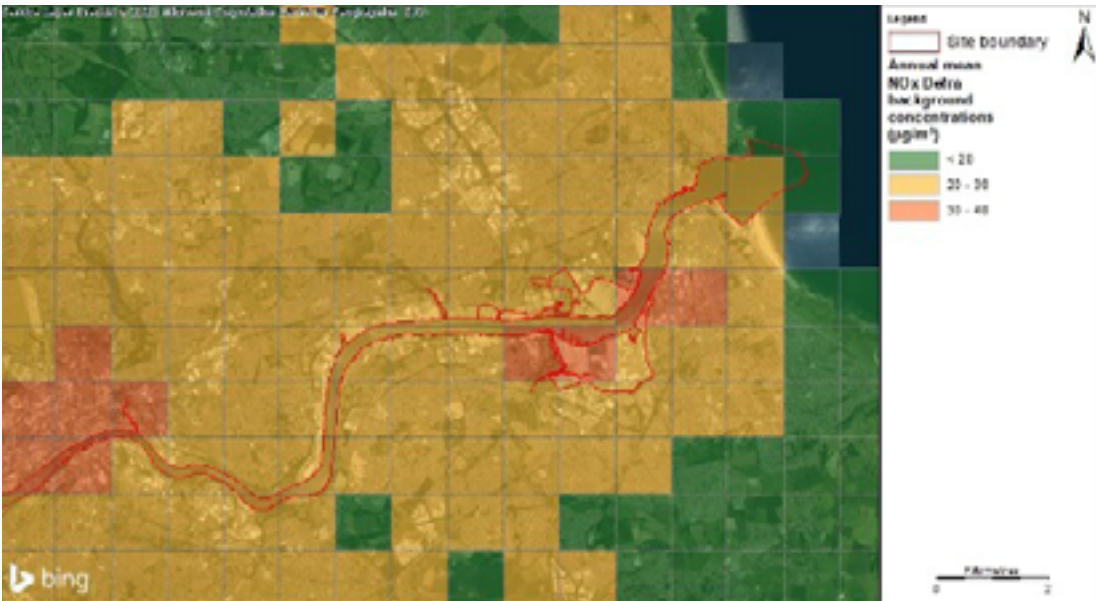
Figure 11: Estimated Defra Background NO_2 Concentrations (µg/m³)
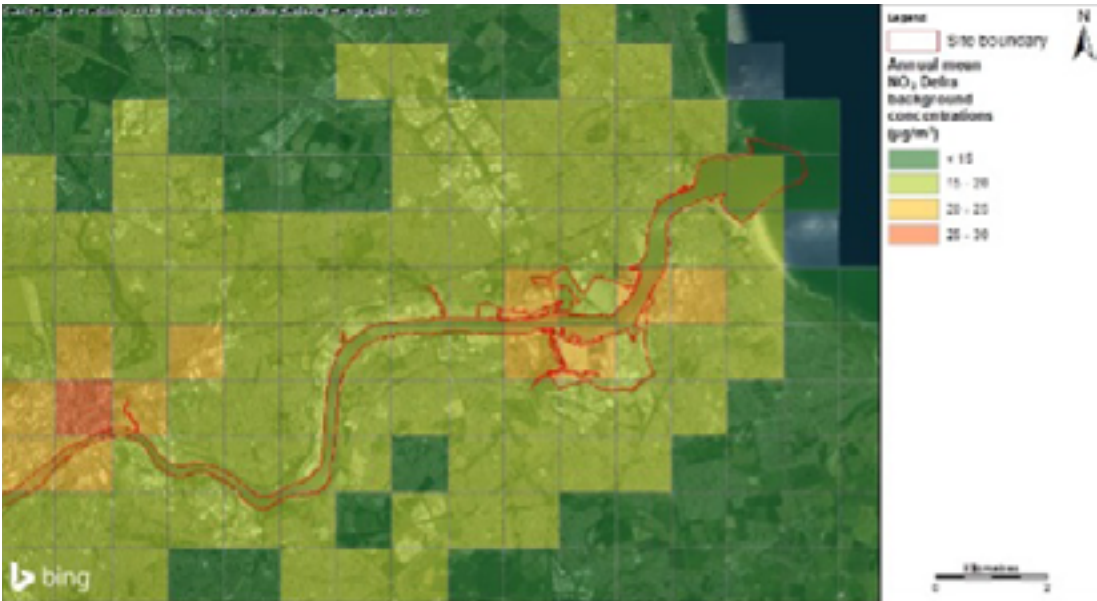

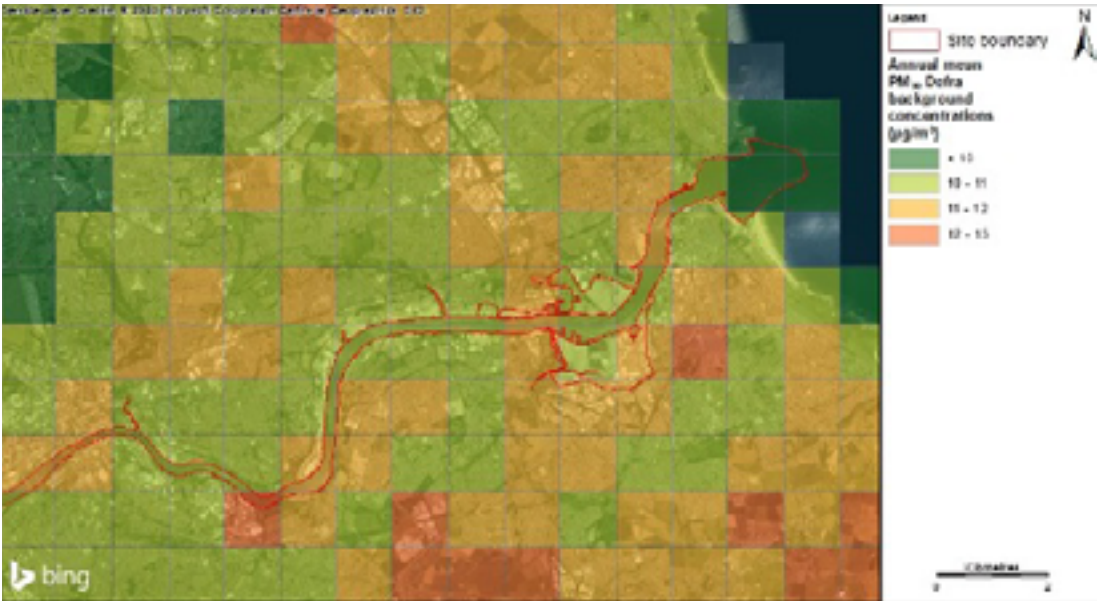Figure 13: Estimated Defra Background $PM_{2.5}$ Concentrations (µg/m³)

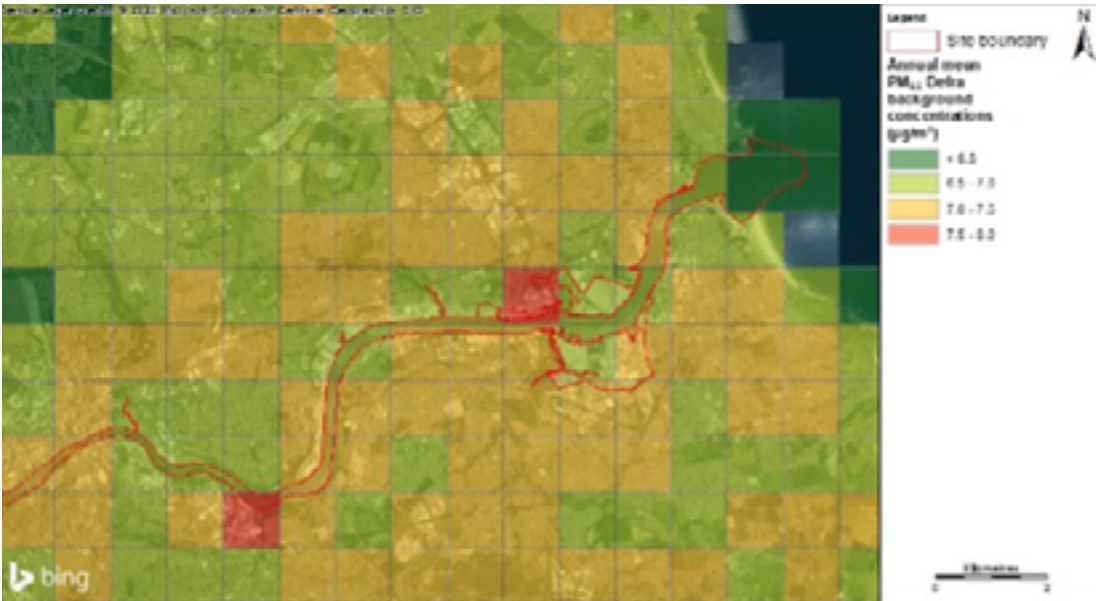Figure 12: Estimated Defra Background PM_{10} Concentrations (µg/m³)

Figure 14: Estimated Short-term Defra background SO_2 Concentrations (µg/m³)
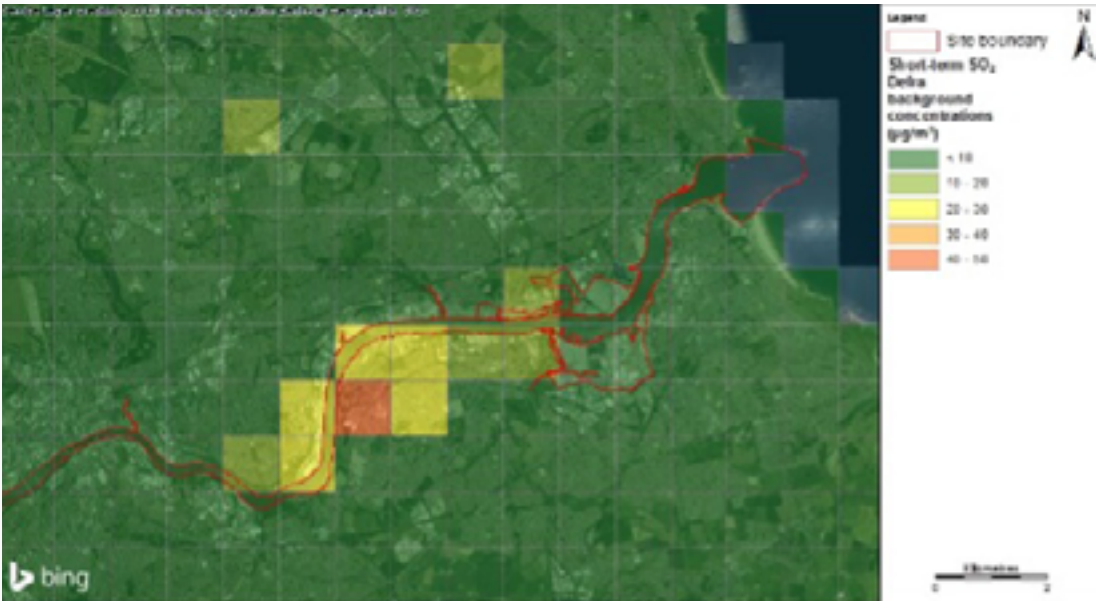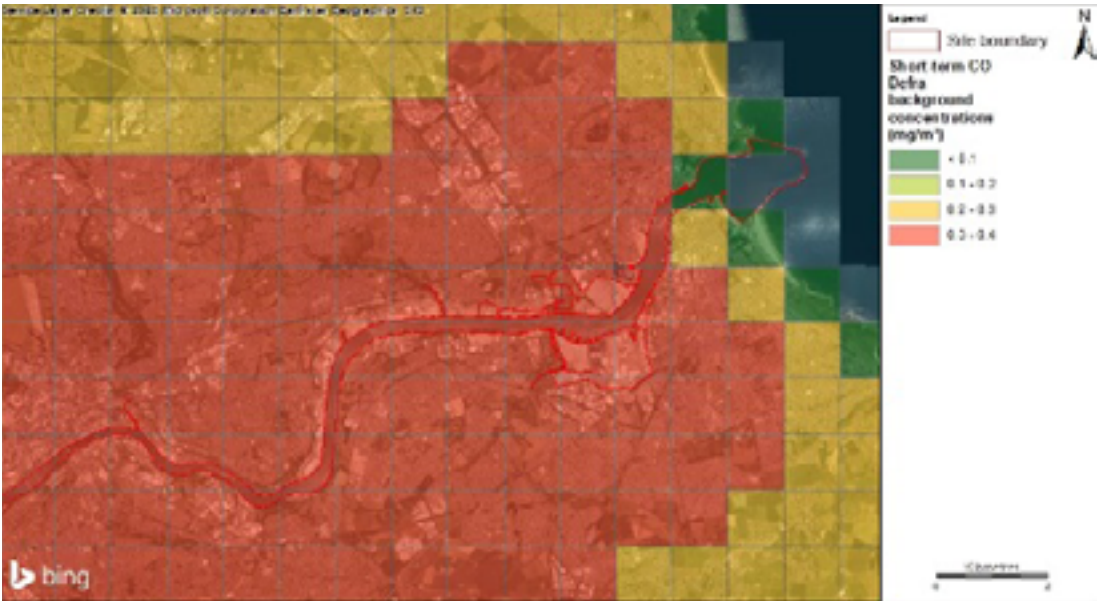
Figure 15: Estimated Short-term Defra background CO Concentrations (µg/m³)

Port and Urban Observatory Monitoring data

The Port of Tyne has operated a network of 4 continuous real time particulate monitors for the last 8 years or so. Table 9 below summarises the data for 2017 and 2018. This shows that the air quality objectives for particulates were met for those years.

Table 9: Port PM Monitoring Results from 2017 and 2018

SITE NAME	ANNUAL MEAN PM_{10} (µg/m³)		ANNUAL MEAN $PM_{2.5}$ (µg/m³)	
	2017	2018	2017	2018
Newcastle	14.9	15.6	-*	-
TCT West	-	19.8	-	8.0
TCT East	-	18.2	-	9.0
Raleigh	15.1	17.6	-	-
Air Quality Objective	40µg/m³		25µg/m³	

* No data was available for entries with '-'

For the majority of 2020 the Port has also hosted a number of continuous emissions monitors from the Newcastle University Urban Observatory[13]:

- Two TOPAS[14] units on the south side, both measuring PM_{10} and $PM_{2.5}$, and;

- Two sites on the north side, including one TOPAS unit and an AQMesh[15] unit. Both units measure PM_{10} and $PM_{2.5}$, where the AQMesh unit also measures NO_2

It should be noted that the UO monitoring sites only started operation from December 2019 and as a result full monthly data was only available from the beginning of 2020 onwards. With the effect of Covid 19, data from March 2020 onwards was affected by the lockdown. However, the data collected, especially on the daily and weekly profile, is still relevant in understanding the change in concentration through with the change in activities at and around Port of Tyne. This is because the pattern of activities is largely similar between 2017 and 2020.

Further information about these monitors and their locations are provided in Table 10 and Figure 16 below.

Table 10: Information about the UO Monitors within 1km of the Site Boundary

SITE NAME	DEPLOYED	DESCRIPTION	OS GRID REF.		POLLUTANTS MONITORED
			X	Y	
TOPAS 1730	19 December 2019	Port of Tyne Riverside Quay Extension (RQE) Dolphin, South Shields. Location is on a 'dolphin' located on Port of Tyne estate in South Shields, at the east end of the RQE.	435337	565919	PM_{10}, $PM_{2.5}$
TOPAS 1732	17 February 2020	Located at the west side of Port of Tyne estate in South Shields, on the middle of the three berths, Tyne Car Terminal No 2. The unit is located on the gangway to the boats, at the west side of the pier.	434200	565763	PM_{10}, $PM_{2.5}$
TOPAS 1733	18 December 2019	The monitor is on a post in the car park, along Coble Dean, but behind a fence in the car park formerly used as the FjordLine Compound Car park.	435203	566663	PM_{10}, $PM_{2.5}$
AQMesh					NO_2, NO, CO, PM_{10}, $PM_{2.5}$

Note: the TOPAS 1733 site and AQMesh site are at the same location on the northside of Port of Tyne.

Figure 16: Locations of the UO Monitors within 1km of the Site Boundary

Figure 17: Time Variance for PM$_{10}$ and PM$_{2.5}$ at UO Site 1730 and 1732 (South Side)

The graphs as shown in Figures 16 to 18 below show the variation in these pollutants over time, for each of the four UO monitoring sites.

TOPAS 1730 and 1732 (next to Car Terminal 2 and Riverside Quay Extension)

Figure 16 shows the PM$_{10}$ and PM$_{2.5}$ concentrations measured at the two monitoring locations on the southern side of Port of Tyne. These figures show the average PM$_{10}$ and PM$_{2.5}$ concentrations by day, hour and month during 2020 (over the available period).

Over a period of a day, there is no discernible difference in PM$_{2.5}$ and PM$_{10}$ concentrations. Over a period of a week, weekend concentrations are lower than weekday concentrations. This is likely a reflection of the changes in activities over the wider area rather than changes in activities at Port of Tyne. A sharp decrease in concentrations can be observed from April 2020 onwards when the full lockdown due to Covid 19 commenced in late March 2020.

TOPAS 1733 and AQ Mesh (next to IPT)

Figures 17 and 18 show the PM$_{10}$, PM$_{2.5}$ and NO$_2$ concentrations measured next to the IPT.

These figures show the average PM$_{10}$, PM$_{2.5}$ and NO$_2$ concentrations by day, hour and month during 2020 (over the available period).

During the monitoring period, there were two peaks for NO$_2$ concentration throughout the day at approximately 9am and 5pm. These peaks coincided with the scheduled inbound and outbound time for the RoRo ferries, when an increase in amount of traffic in the area is expected. The concentration of NO$_2$ was generally lower overnight than during the daytime and was highest in the early morning. Such peaks cannot be observed in the PM$_{10}$ and PM$_{2.5}$ data.

Over a period of a week, lower NO$_2$ concentration can be observed over the weekend relative to the weekdays. Such pattern cannot be observed for PM$_{10}$ and PM$_{2.5}$.

A sharp decrease in PM$_{10}$ and PM$_{2.5}$ concentrations can also be observed from TOPAS 1733 from April 2020 onwards when the full lockdown due to Covid 19 commenced in late March 2020. A rapid decrease in PM$_{10}$, PM$_{2.5}$ and NO$_2$ concentrations can also be observed at the AQMesh site, but the decrease started in January/February 2020 instead.
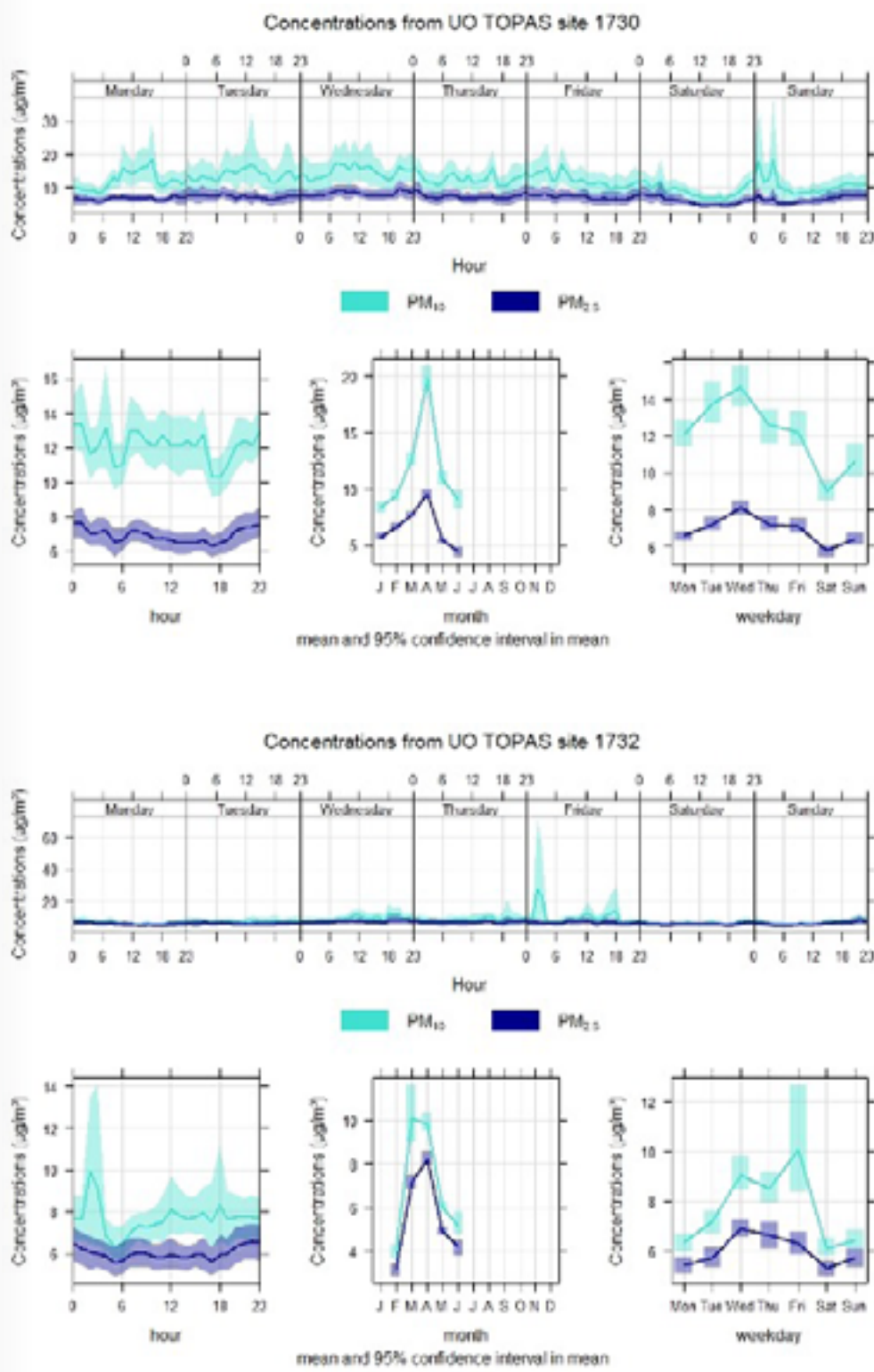
Figure 18: Time Variance for NO_2, PM_{10} and $PM_{2.5}$ at UO AQ MESH Site (North Side)
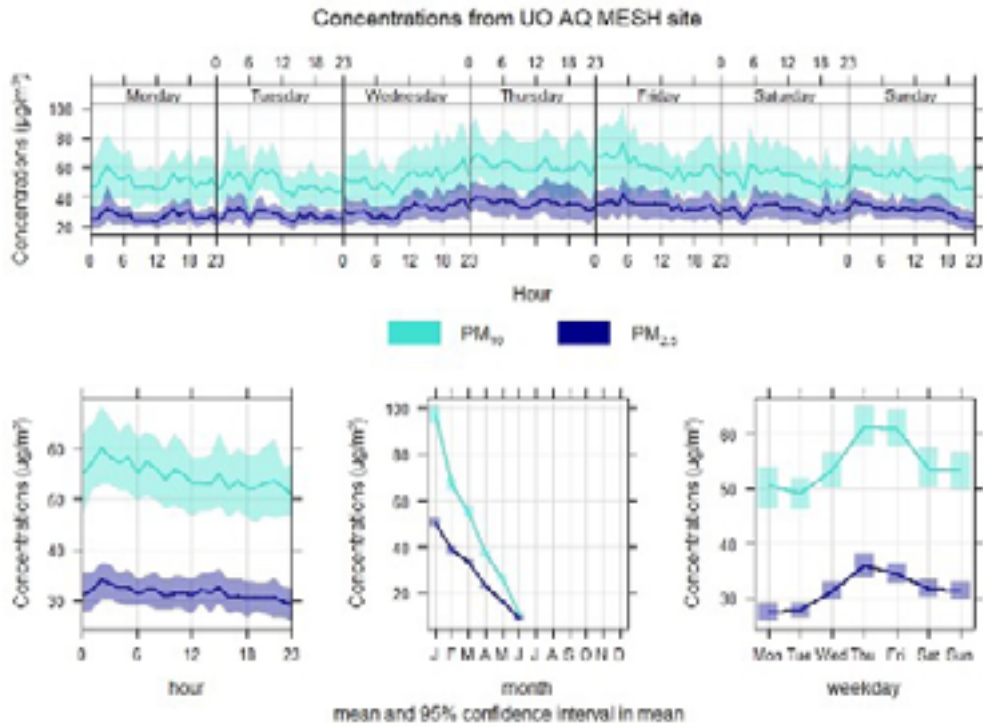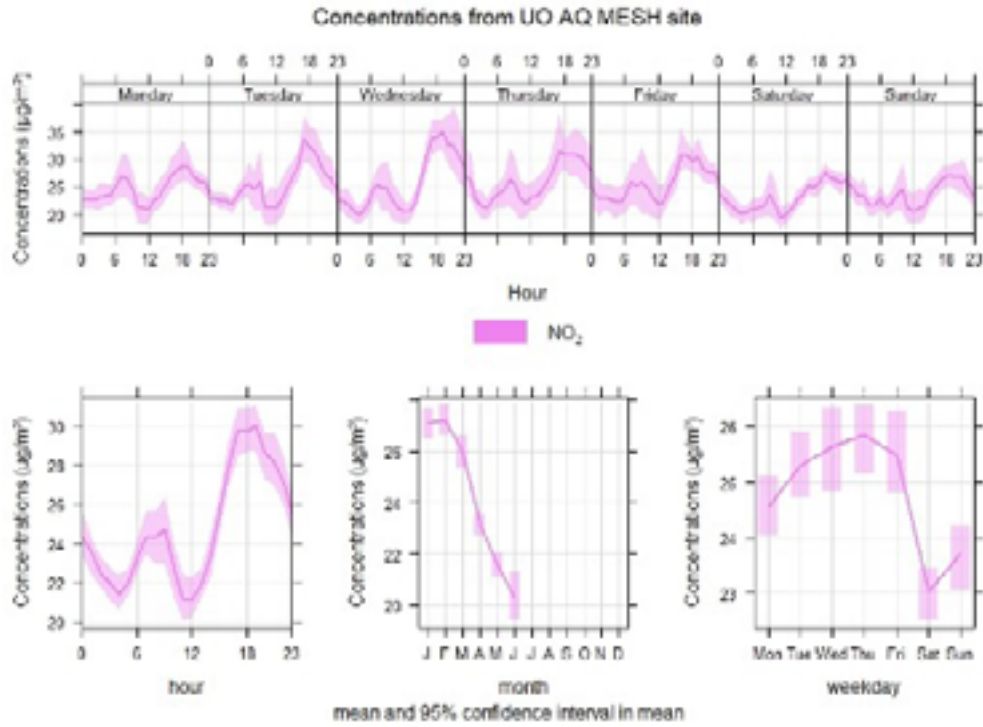

Figure 19: Time Variance for PM_{10} and $PM_{2.5}$ at UO Site 1733 (North Side)
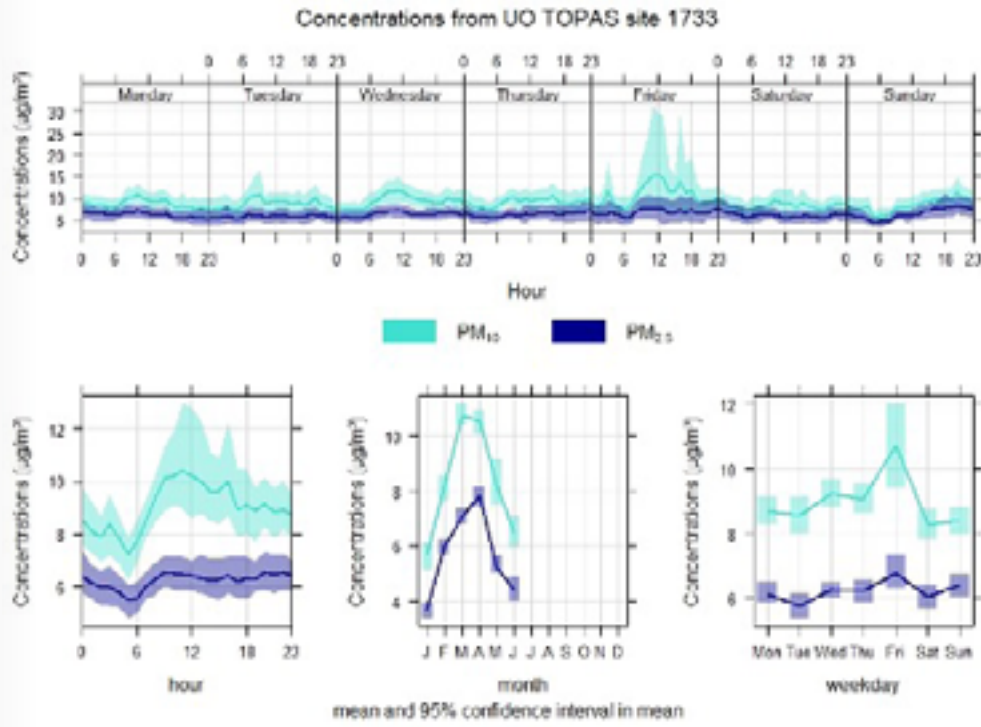
Local Authority Monitoring Data

A detailed review of local authority monitoring within 500m of the site boundary was undertaken as part of the assessment. Automatic monitoring and passive monitoring (using diffusion tubes) is carried out by South Tyneside Council, North Tyneside Council, Gateshead Council and Newcastle City Council from 2014 to 2019 and show that monitoring at roadside locations close to major roads such as Tyne Bridge and the A167 motorway, near Gateshead town centre and Newcastle city centre are likely to exceed the annual mean NO_2 air quality objectives. However, monitoring data generally indicates a downward trend in concentrations. The hourly mean NO_2 was not exceeded between from 2014 to 2019.

Monitoring undertaken around the north side and south side of Port of Tyne showed that annual mean NO_2 concentrations were well below the air quality objective. As Port of Tyne and other parts of the riverside are further away from major roads, it is considered that the annual mean NO_2 and hourly-mean NO_2 concentrations are likely to be below the air quality objectives in these areas.

Automatic monitoring results for PM_{10} and $PM_{2.5}$ from 2014 to 2019 show that there were no exceedances of their respective air quality objectives in the area.

6.2.4 SENSITIVE HUMAN AND ECOLOGICAL RECEPTORS

Human Sensitive Receptors

Table 11 presents the details of the human receptors included in the air quality assessment, which are classified as 'Residential' or 'Commercial/ recreational' receptors. Figure 19 presents the location of these receptors in the study area. Receptors at elevated heights were selected should they be present on multi-storey buildings.

Table 11: List of Human Receptors

ID	DESCRIPTION	TYPE OF RECEPTOR	OS COORDINATES (m)		HEIGHT(S)
			X	Y	(m)
R1	Quayside	Residential	426191	564148	1.5
R2	St Peter's Basin	Residential	427433	563508	1.5
R3	Green Lane	Residential	427629	563349	1.5
R4	The Oval	Residential	427989	563448	1.5
R5	Marian Drive	Residential	429926	563037	1.5
R6	Hebburn - The Riverside	Residential	430248	565267	1.5
R7	Hebburn - The Riverside	Residential	430295	565342	1.5
R8	Dock Street, South Shields	Residential	435614	564987	1.5
R9	Temple Town	Residential	435649	565200	1.5
R10	Temple Town	Residential	435592	565307	1.5
R11	Temple Town	Residential	435574	565376	1.5
R12	Vernon Close	Residential	435729	565607	1.5
R13	Raleigh Close	Residential	435787	565789	1.5
R14	Anson Close	Residential	435817	565905	1.5
R15	East Holborn	Residential	435740	566572	1.5
R16	Commissioners' Wharf, North Shields	Residential	434961	566798	1.5, 4.5
R17	Commissioners' Wharf, North Shields	Residential	435167	566687	1.5, 4.5
R18	Commissioners Wharf	Residential	435293	566698	1.5, 16.5
R19	Long Row	Residential	435940	567369	1.5, 4.5
R20	Harbour View, South Shields	Residential	436501	568172	1.5, 4.5
C1	Newcastle Quayside	Commercial/ Recreational	425435	563902	1.5
C2	Bede's World	Commercial/ Recreational	433768	565471	1.5
C3	Fish Quay	Commercial/ Recreational	436013	568330	1.5
C4	North Pier	Commercial/ Recreational	438245	569065	1.5
C5	South Pier	Commercial/ Recreational	438401	568664	1.5

Figure 20: Map of Human Receptor Locations

Ecological Sensitive Receptors

Table 12 provides the details of ecological receptors included in the air quality assessment. All ecological receptors were modelled at a height of 0m. Figure 20 presents the locations of these receptors.

Table 12: List of Ecological Receptors

ID	DESCRIPTION	TYPE OF RECEPTOR	OS COORDINATES (m)	
			X	Y
E1	Northumbria Coast SSSI and Ramsar	Residential	436473	568471
E2	Northumbria Coast SSSI and Ramsar	Residential	437151	568747
E3	Northumbria Coast SSSI and Ramsar	Residential	437393	568849
E4	Durham Coast SSSI	Residential	437302	567838
E5	Durham Coast SSSI	Commercial/ Recreational	437751	568304

Figure 21: Ecological Receptors

Table 13: Industrial Sources within 1km of the Assessment Area

SITE NAME	OS COORDINATES (m)		OPERATOR NAME	TYPE OF INDUSTRY	REGULATED SUBSTANCES
	X	Y			
Howdon Sewage Treatment works	433340	566290	Northumbrian Water	Water industry	NH_3, CO_2, Carbon tetrachloride (Tetrachloromethane), Dichloromethane (Methylene chloride), Methane, Naphthalene, Nitrous oxide and NOx as NO_2.
Wagonway Works	431300	565700	Industrial Chemicals Limited	Inorganic chemicals	NOx as NO_2.
Felling Polymers and Coatings	428400	562700	International Paint Limited	Organic chemicals, plastic materials e.g. polymers	CO, CO_2, NOx as NO_2, Non-methane volatile organic compounds (NMVOCs) and SOx as SO_2.

Figure 22: Industrial Sources within 1km of the Assessment Area

6.2.5 POLLUTANT SOURCES

As detailed in section 6.1 above air pollution can arise from the following sources:

- Static (point) sources such as factory chimneys and vessels whilst at berth

- Diffuse (area) sources such as working quays and;

- Mobile (line) sources such as vessels and vehicles

Industrial (Point) Sources

Industrial sources of air pollution are regulated through a system of permits and authorisations and are classified as a Part A or Part B process. The aim of this system is to ensure that releases to the environment meet any prescribed emissions limits or are rendered harmless. Larger more polluting processes, generally classed as Part A, are regulated by the Environment Agency (EA) while smaller, Part B processes are regulated by Local Authorities.

The 2017 EA Pollution Inventory lists three industrial sources that are within 1km of the of the assessment area, these are documented in the Table 13 and the locations are shown in Figure 21.

Emissions from Vessels at Berth

To model the vessels at berth, emissions were combined for each of the 33 berths detailed in Table 13 (below). The berths were then modelled as area sources, as shown in Figures 22 to 24 with emissions distributed spatially. The area sources were modelled with the heights shown in Table 2, which were selected based on the height of the vessel type most common at that berth. The estimated heights were taken from Southampton Clean Air Zone - Air Quality Modelling Methodology report[8]. The area sources were modelled with a velocity of 15m/s and at ambient temperature (as determined by the meteorological data used). This provides a conservative approach to the dispersion modelling as it assumes there is no thermal buoyancy associated with the exhaust. In reality, the exhaust temperature will be higher than the ambient and will therefore disperse further before reaching ground level.

Table 13: Details of Vessels at Berth

ID IN FIGURE	NAME OF MODELLED BERTH	TOTAL NUMBER OF VESSELS	MODELLED BERTH HEIGHT (m)
1	A & P Bede Quay	76	30
2	A & P West Quay	4	5
3	Cemex	9	30
4	Container Terminal	5	44
5	Fish Quay	17	5
6	Hillgate Quay	4	5
7	HMS Calliope	- *	30
8	McNulty East	4	5
9	Neptune Dry Dock	9	5
10	Neptune Quay 1	1	10
11	Neptune Quay 2A	15	5
12	Newcastle Quayside East	28	5
13	Newcastle Quayside West	5	5
14	Northumbrian Quay	169	61
15	Ocean Berth	35	30
16	Offshore Technology Park	61	5
17	Riverside Quay	41	30
18	Riverside Quay East	14	5
19	RoRo3	73	30
20	RoRo4	12	30
21	Royal Quays	8	5
22	Smulders	372	5
23	Svitzer	11	5
24	Swans East	374	5
25	Swans West	16	30
26	TCT1	6	30
27	TCT2	1	30
28	TCT3	33	30
29	Tyne Bulk Terminal	39	30
30	Tyne Dock Entrance	- *	30
31	Tyne Slipway	1	5
32	Tyne Tanker Berth	5	30
33	Whitehill Point	86	30
Total		**1,534**	**n/a**
Note: *no vessels recorded at this berth in detailed data			

Figure 23: Modelled Berths

Figure 24: Modelled Berths (East)

Figure 25: Modelled Berths (West)

Figure 26: Modelled Vessel Channels

Figure 27: Modelled Vessel Channels (East)

Emissions from Vessels Whilst Manoeuvring

Table 6 (above) presents the details of vessels manoeuvring by modelling category, the average time spent manoeuvring (calculated using the total distance travelled and assuming an average speed of six knots whilst moving on River Tyne) and the average auxiliary engine load and main engine load during manoeuvring. The average auxiliary engine load manoeuvring was taken from Annex 1 of the Third IMO Greenhouse Gas study[1] and the average main load manoeuvring was estimated by data provided in the IMO databases on installed engine size of vessels, such as Veristar[2] and Baltic Shipping[3]. It was assumed that 15% of the installed main engine power was used during manoeuvring[4]. The total number of vessels manoeuvring by modelling category is also presented in figure 4 (above). RoRo vessels were the most common, followed by RoRo passenger ferries and miscellaneous. The channel was also divided into segments for modelling as shown in figures 25 to 27 below.

To model the vessels manoeuvring all emissions were combined by segment and modelled as line sources. The line sources were modelled at a height of 30m (the average height of all vessels) taken from the Southampton report[8] and a width of 1m. This is a conservative approach, as there are likely to be multiple exhausts with widths of over 1m for the larger vessels. This increases the concentration of pollutant at the point of release, leading to higher ground level concentration.

The vessels manoeuvring where modelled with a vertical exit velocity for the exhaust at 15m/s and at ambient temperature (as determined by the meteorological data used). This provides a conservative approach to the dispersion modelling as it assumes there is no thermal buoyancy associated with the exhaust. In reality, the exhaust temperature will be higher than the ambient and will therefore disperse further before reaching ground level.

Figure 28: Modelled Vessel Channels (West)

Emissions from Port Shore Based Activity

The emissions for Non-Road Mobile Machinery (NRMM) were calculated using the number of units for each activity within Port of Tyne, their respective operating hours (based on the 2017 total throughput), total fuel usage for each unit and pollutant emission factors.

The total fuel usage for NRMM was provided by Port of Tyne in litres. A conversion to tonnes was required, which was carried out based on the government's Greenhouse Gas Reporting: Conversion Factors 2019 database[16]. A specific gas oil (diesel) density of 853.97kg/m^3 was used for the conversion.

Emission factors of NOx, PM_{10} and $PM_{2.5}$ were taken from the NAEI17 for NRMM, using gas oil fuel. The NAEI category was 'Industrial off-road mobile machinery', shown in Table 14 below.

To model the NRMM emissions, emissions from different activities were combined for each of the 14 areas detailed in Table 15 below. These areas were modelled as area sources, as shown in Figure 28 with emissions distributed spatially. The modelled heights for these area sources are also shown in Table 11 and were taken from the height of NRMM most commonly used in each area. The area sources were modelled without any vertical velocity (0m/s) and the temperature of the exhaust follows the ambient temperature (as determined by the meteorological data used).

Table 14: NAEI Emission Factors for NRMM

FUEL TYPE	NOx (kt/Mt FUEL)	PM_{10}/$PM_{2.5}$ (kt/Mt FUEL)
Gas Oil	17.3	1.8

Table 15: Details of Area Sources for NRMM

NAME OF AREA SOURCE	ACTIVITIES	MODELLED BERTH HEIGHT (M)
Wood Pellet 1	Wheeled loaders	3
Wood Pellet 2	Wheeled loaders	3
Wood Pellet 3	Wheeled loaders	3
Vessels On-board	Ship hold activities	10
Scrap Metal	Consolidating scrap piles	3
Hopper 1	Storage and moving wood pellets	19
Hopper 2	Storage and moving wood pellets	19
Hopper 3	Storage and moving wood pellets	19
Liebherr Harbour Mobile Operating Area	Loading and unloading vessels	3
Plywood	Loading forklifts	1
Petroleum Coke Screening	Wheeled loaders and screeners	1
Container Yard 1	Container movements	1
Container Yard 2	Container movements	1

NRMM emissions were also modelled as road sources (Figure 9) for three specific activities, as they operate on specific routes instead of within an area:

1. Forklifts transferring luggage for cruise passengers between berth and custom building;

2. Tugs for pulling unmanned freights on and off RoRo ferries; and

3. Tugs for pulling containers between container yard and warehouses

Figure 29: Modelled NRMM Areas and Road Sources

Vehicles on the Port of Tyne Road Network

The annual average daily traffic (AADT) for the modelled roads in 2017 was derived from the information provided by Port of Tyne in the form of 2017 total throughput for each activity within the Port. Any assumptions made were discussed and agreed with Port of Tyne. The derived daily trips were allocated to each individual road link based on the distribution of traffic provided by Port of Tyne.

Figures 29 to 31 below show the extent of the modelled roads and the location of junctions and roundabouts for the northside and southside of the Port respectively.

Road traffic emissions for NOx, PM10 and $PM_{2.5}$ were calculated using 2017 factors from Defra Emissions Factor Toolkit (EFT) version 9.0[5], with road type classified as 'Urban (not London)'. Emissions were calculated separately for port owned and non-port owned Heavy Goods Vehicles (HGVs) as according to Port of Tyne, all port owned HGVs are Euro V compliant.

It was advised that the vehicle speed on roads within the boundary of the Port is 25 kilometres per hour (kph). For roads outside of the boundary of the Port, the speed limit was assumed. Junctions and roundabouts were modelled at a reduced speed of 20kph in accordance with the Defra TG(16) guidance[18].

Emissions from road vehicles were modelled as road sources and no temporal profile was applied to road traffic.

Figure 30: Modelled Road Network for the North Side of the Port

Figure 31: Modelled Road Network for the South Side of the Port

Figure 32: 2017 AADT

Figure 33: Modelled Vehicle Import/Export Areas

Vehicle Import/Export

Table 16 opposite presents the traffic flows for vehicle import and export at the Port which are stored in car parks. It is understood that all vehicles involved in the import and export activities were passenger cars. The data was provided by Port of Tyne in the form of total throughput for 2017 and was distributed evenly across the year to derive AADT flows (in-flows plus out-flows). Figure 32 presents the locations of the modelled car parks for vehicle import/export.

Emissions were calculated following the Cambridge Environmental Research Consultants (CERC) note on modelling car parks[6]. Emission factors for 2017 were taken from Defra's EFT (version 9.0)[5] with the type of roads classified as 'Urban (not London)' and all vehicles assumed to be travelling at a speed of 5kph. Cold start emissions were taken from the NAEI database[17] and it was assumed that all cars were diesel to provide a conservative estimate of emissions. Emissions from vehicle import/export were modelled as area sources. The area sources were modelled without any vertical velocity (0m/s) and the temperature of the exhaust follows the ambient temperature (as determined by the meteorological data used).

Table 16: Traffic Flows for Modelled Vehicle Import/Export Areas

DESCRIPTION	AADT
Volkswagen 1	26
Volkswagen 2	145
Volkswagen 3	39
Volkswagen 4	12
Nissan 1	461
Nissan 2	233
Nissan 3	124
Nissan 4	52
Nissan 5	184
Nissan 6	43
HNT 1	100
HNT 2	26

Car Parks and Ferry Loading/Unloading

Table 17 opposite presents the traffic data flows for car parks and ferry unloading/loading at Port of Tyne. The data was provided by Port of Tyne in the form of total throughput in 2017, split by activity which was distributed evenly across the year to derive AADT flows (in-flows plus out-flows) for cars and HGVs. Figure 33 presents the locations of the modelled car parks and ferry unloading/loading in 2017.

Emissions were calculated following the CERC note on modelling car parks[6]. Emission factors for 2017 were taken from Defra's EFT (version 9.0)[5] with the type of roads classified as 'Urban (not London)' and all vehicles assumed to be travelling at a speed of 5kph. Cold start emissions were taken from the NAEI database[17] and it was assumed that all cars were diesel to provide a conservative estimate for emissions.

The emissions from ferry unloading/loading were calculated and modelled the same way as car parks, as ferry unloading/loading is associated with queuing and slow-moving vehicles with starting and stopping at several dedicated areas.

Emissions from car parks and ferry unloading/loading were modelled as area sources. The area sources were modelled without any vertical velocity (0m/s) and the temperature of the exhaust follows the ambient temperature (as determined by the meteorological data used).

Table 17: Traffic Flows for Modelled Car Parks

DESCRIPTION	AADT
Ferry Car Park 1	164
Ferry Car Park 2	41
Freight 1	27
Freight 2	5
2017 Car Lane	164
Ferry Car Holding Area 1	164
Ferry Car Holding Area 2	164
Ferry Car Holding Area 3	324
Ferry Freight Holding Area	32
Car And Freight Bridges	355
Transit Cell	13

Figure 34: Modelled Car Parks and Ferry Unloading/Loading

Figure 35: Location of Modelled Trains

Freight Trains

The frequency of trains and operating hours were provided by the Port of Tyne. The class 60 or 66 engines run twice a day for 320 days of the year.

Trains Moving In and Out of the Port of Tyne

For each train trip it was assumed that the total length of the track was travelled twice (inbound and outbound). The pollutant emissions were calculated by multiplying this distance by the total freight train trips and the emission factors for train classes 60 and 66 taken from the AEA technology Rail Emission Model report[9]. It is unknown what the split between class 60 and class 66 engines was, so an average emission factor was calculated as shown in Table 18.

The emissions were then spatially distributed as area sources along the length of the railway line at a height of 4.5m[19] as shown in Figure 34. The area sources were modelled with a vertical velocity of 1m/s and the temperature of 40°C, as per the AEA Technology Rail Diesel study[9].

Table 18: Emission Factors for Distance Travelled by Train Classes 60 and 66

| TRAIN CLASS | EMISSION FACTOR (g/km) | |
	NOx	PM$_{10}$
60	129.6	4.7
66	120.0	2.9
Average	124.8	3.8

Trains Idling Within the Port

The total fuel consumed whilst trains were idling at the station was calculated by multiplying the fuel consumption rates in litres/hour for idling (9.1kg/hr) by the estimated idling time for each train visiting the Port (1hr 40 mins), as estimated by the Port of Tyne.

The pollutant emissions were calculated by multiplying the tonnes of fuel used by idling trains in 2017 by the Tier 1 EMEP emission factor[7] for diesel trains, shown in Table 19. The emissions were then spatially distributed as area sources along the sidings at a height of 4.5m[19] as shown in Figure 34. The area sources were modelled with a vertical velocity of 1m/s and a temperature of 40°C, as per the AEA Technology Rail Diesel study[19].

Table 19: Emission Factors for Fuel Consumed by Freight Trains

| FUEL TYPE | EMISSION FACTOR (kg/t FUEL) | |
	NOx	PM$_{10}$
Diesel/ Gas Oil	52.4	1.4

Wood Pellet Storage

The ventilation rate inside the wood pellet storage shed was provided by the Port of Tyne in m³/hour and was used to calculate the volumetric flow rate. The carbon monoxide concentration was also provided by the Port of Tyne in parts per million (ppm) and then converted to µg/m³ in ambient conditions using the conversion factors provided by Defra[20]. The carbon monoxide emissions are released at several louvres along the apex of the shed roof, so the emissions were spatially distributed as an area source along the apex of the shed roof. Table 20 presents the emissions and model parameters used, and the area source is shown in Figure 36.

Table 20: Model Input Parameters

PARAMETER	UNIT	WOOD PELLET STORAGE
Area	m²	544.5
Height	m	25.0
Volume Flow Rate	m³/s	11.1
Temperature	°C	Ambient
Emissions	g/m²/s	0.001

Figure 36: Location of Modelled Wood Pellet Storage

6.3 MODEL OUTPUTS

6.3.1 Predicted Pollutant Concentrations at Sensitive Receptors and Net Contribution to it from Maritime Related Activity

Human Receptors

The details of the predicted pollutant concentrations at the selected human receptors for 2017 are presented in Table 21 below.

Table 21: Background Concentrations and Predicted Contribution at Human Receptor Locations

ID	DESCRIPTION	NO2 LOCAL BACKGROUND	NO2 PORT CONTRIBUTION	PM10 LOCAL BACKGROUND	PM10 PORT CONTRIBUTION	PM2.5 LOCAL BACKGROUND	PM2.5 PORT CONTRIBUTION	SO2 LOCAL BACKGROUND	SO2 PORT CONTRIBUTION	CO LOCAL BACKGROUND	CO PORT CONTRIBUTION
R1_1.5	Quayside	20.3	0.1	10.6	<0.1	6.9	<0.1	5.1	0.2	0.3	<0.1
R2_1.5	St Peter's Basin	17.0	0.1	10.5	<0.1	6.9	<0.1	5.1	0.2	0.3	<0.1
R3_1.5	Green Lane	17.0	0.1	10.5	<0.1	6.9	<0.1	5.1	0.2	0.3	<0.1
R4_1.5	The Oval	17.0	0.1	10.5	<0.1	6.9	<0.1	5.1	0.2	0.3	<0.1
R5_1.5	Marian Drive	16.3	0.1	11.6	<0.1	7.4	<0.1	21.0	0.2	0.3	<0.1
R6_1.5	Hebburn - The Riverside	15.9	0.1	10.7	<0.1	6.9	<0.1	22.8	0.2	0.3	<0.1
R7_1.5	Hebburn - The Riverside	15.9	0.1	10.7	<0.1	6.9	<0.1	22.8	0.3	0.3	<0.1
R8_1.5	Dock Street, South Shields	17.3	0.4	11.1	<0.1	7.2	0.1	7.0	0.4	0.3	<0.1
R9_1.5	Temple Town	18.6	0.6	11.1	0.1	7.1	0.1	6.1	0.4	0.3	<0.1
R10_1.5	Temple Town	18.6	0.8	11.1	0.1	7.1	0.1	6.1	0.4	0.3	<0.1
R11_1.5	Temple Town	18.6	0.9	11.1	0.1	7.1	0.1	6.1	0.4	0.3	<0.1
R12_1.5	Vernon Close	18.6	0.8	11.1	0.1	7.1	0.1	6.1	0.5	0.3	<0.1
R13_1.5	Raleigh Close	18.6	0.8	11.1	0.1	7.1	0.1	6.1	0.6	0.3	<0.1
R14_1.5	Anson Close	18.6	0.8	11.1	0.1	7.1	0.1	6.1	0.6	0.3	<0.1
R15_1.5	East Holborn	24.2	0.8	10.7	0.1	6.9	<0.1	6.2	0.5	0.3	<0.1
R16_1.5	Commissioners' Wharf, North Shields	17.3	0.8	10.4	0.1	6.7	0.1	-	0.5	0.3	<0.1
R16_4.5	Commissioners' Wharf, North Shields	17.3	0.7	10.4	0.1	6.7	0.1	-	0.5	0.3	<0.1
R17_1.5	Commissioners' Wharf, North Shields	24.2	1.0	10.7	0.1	6.9	0.1	6.2	0.5	0.3	<0.1
R17_4.5	Commissioners' Wharf, North Shields	24.2	1.0	10.7	0.1	6.9	0.1	6.2	0.5	0.3	<0.1
R18_1.5	Commissioners Wharf	24.2	1.1	10.7	0.1	6.9	0.1	6.2	0.5	0.3	<0.1
R18_16.5	Commissioners Wharf	24.2	0.9	10.7	0.1	6.9	0.1	6.2	0.5	0.3	<0.1
R19_1.5	Long Row	19.1	0.7	11.1	<0.1	7.0	<0.1	9.3	0.6	0.3	<0.1
R19_4.5	Long Row	19.1	0.7	11.1	<0.1	7.0	<0.1	9.3	0.6	0.3	<0.1
R20_1.5	Harbour View, South Shields	19.2	0.7	10.4	<0.1	6.8	<0.1	9.4	0.5	-	<0.1
R20_4.5	Harbour View, South Shields	19.2	0.7	10.4	<0.1	6.8	<0.1	9.4	0.5	-	<0.1
C1_1.5	Newcastle Quayside	22.5	0.2	11.2	<0.1	7.2	<0.1	4.9	0.2	0.3	<0.1
C2_1.5	Bede's World	20.2	0.2	11.2	<0.1	7.2	<0.1	12.4	0.5	0.3	<0.1
C3_1.5	Fish Quay	19.2	0.5	10.4	<0.1	6.8	<0.1	9.4	0.7	<0.1	<0.1
C4_1.5	North Pier	12.5	0.5	9.3	<0.1	6.2	<0.1	-	0.5	-	<0.1
C5_1.5	South Pier	13.8	0.6	9.5	<0.1	6.3	<0.1	-	0.5	-	<0.1
Average (µg/m³)		19.0	0.6	10.7	0.1	6.9	0.1	8.7	0.4	0.3	<0.1
Maximum (µg/m³)		24.2	1.1	11.6	0.1	7.4	0.1	22.8	0.7	0.3	0
Relevant AQ Objective (µg/m³)		40		40		25		125		10	

Human Receptor Impact Assessment Summary

The predicted annual mean NO_2 concentrations for 2017 were well below the air quality objective ($40\mu g/m^3$) at all modelled receptor locations. The highest annual mean NO_2 concentration was predicted to be $25.3\mu g/m^3$ at R18_1.5. This receptor is a ground floor residential receptor at Commissioners' Wharf, North Shields which is close to the IPT and the Port of Tyne boundary at the north side. The highest contribution of Port of Tyne to the total concentrations was predicted to be $1.1\mu g/m^3$ at that receptor.

The predicted annual mean PM_{10} concentrations for 2017 were below the air quality objective ($40\mu g/m^3$) at all modelled receptor locations for 2017. The highest annual mean PM_{10} concentration was predicted to be $11.6\mu g/m^3$ at R5_1.5, with a contribution of less than $0.1\mu g/m^3$ from Port of Tyne. This receptor is a ground floor residential receptor at Marian Drive, over 3km to the west of the south side of Port of Tyne. The highest contribution of Port of Tyne to the total concentrations was predicted to be $0.1\mu g/m^3$ at multiple modelled receptor locations near the Port of Tyne boundary.

The predicted annual mean $PM_{2.5}$ concentrations for 2017 were below the air quality objective ($25\mu g/m^3$) at all modelled receptor locations. The highest annual mean $PM_{2.5}$ concentration was predicted to be $7.4\mu g/m^3$ at R5_1.5, with a contribution of less than $0.1\mu g/m^3$ from Port of Tyne. The highest contribution of Port of Tyne to the total concentrations was predicted to be $0.1\mu g/m^3$ at multiple modelled receptor locations near the Port boundary.

The predicted 15-minute mean SO_2 concentrations for 2017 were well below the air quality objective ($266\mu g/m^3$ not to be exceeded more than 35 times a year). The highest 15-minute mean SO_2 concentration at the 99.9[th] percentile was predicted to be $23.1\mu g/m^3$ at R7_1.5, with a contribution of $0.3\mu g/m^3$ from Port of Tyne.

The receptors is a ground floor residential receptor at Hebburn – The Riverside along River Tyne, opposite to the Neptune Quay. The highest contribution of Port of Tyne to the total concentrations was predicted to be at receptor C3_1.5, which is a ground floor commercial receptor at Fish Quay, on the riverside towards the mouth of River Tyne. The SO_2 contribution from Port of Tyne was predicted to be $0.7\mu g/m^3$, with a total concentration of $10.1\mu g/m^3$.

The predicted hourly mean SO_2 concentrations for 2017 were well below the air quality objective ($350\mu g/m^3$ not to be exceeded more than 24 times a year). The highest 1-hour mean SO_2 concentration at the 99.73[rd] percentile was predicted to be $23.0\mu g/m^3$ at receptors R6_1.5 and R7_1.5, with a contribution of $0.2\mu g/m^3$ from Port of Tyne. The highest contribution of Port of Tyne to the total concentrations was predicted to be $0.5\mu g/m^3$ at multiple receptors along the riverside towards the mouth of River Tyne.

The predicted 24-hour mean SO_2 concentrations for 2017 were well below the air quality objective ($350\mu g/m^3$ not to be exceeded more than 24 times a year). The highest 1-hour mean SO_2 concentration at the 99.18[th] percentile was predicted to be $22.8\mu g/m^3$ at receptors R6_1.5 and R7_1.5, with a contribution of less than $0.1\mu g/m^3$ from Port of Tyne. The highest contribution of Port of Tyne to the total concentrations was predicted to be $0.2\mu g/m^3$ at multiple receptor locations along the riverside towards the mouth of River Tyne.

The predicted 8-hour mean CO concentrations for 2017 were well below the air quality objective ($10mg/m^3$). The highest 8-hour mean CO concentration was predicted to be $0.3mg/m^3$ at multiple locations. The contribution of the Port to total concentrations was predicted to be less than $0.1mg/m^3$ at all modelled receptors.

No exceedance of the relevant air quality standards was predicted at any of the selected human receptors based on the 2017 baseline dispersion modelling.

Ecological Receptors

Table 22 below presents the predicted NOx concentrations at the selected ecological receptors in this study. The table shows predicted annual mean NOx concentrations in 2017, split by background and PC to provide the total PEC.

Table 22: Predicted NOx Concentrations

RECEPTOR ID	DESCRIPTION	ANNUAL MEAN NOX CONCENTRATIONS (µg/m3)		
		BACKGROUND	PC	PEC
E1	Northumbria Coast SSSI and Ramsar	28.4	0.8	29.2
E2	Northumbria Coast SSSI and Ramsar	23.0	0.8	23.8
E3	Northumbria Coast SSSI and Ramsar	23.0	0.8	23.8
E4	Durham Coast SSSI	22.9	0.6	23.5
E5	Durham Coast SSSI	23.0	0.7	23.7
Air Quality Objective (µg/m3)		30		

Ecological Receptor Impact Assessment Summary

The highest annual mean NOx concentration at Northumbria Coast SSSI and Ramsar is predicted to be $29.2\mu g/m^3$ at receptor E1, which is at the western boundary of the ecological site. The contribution of the Port to annual mean NOx concentrations at the location is predicted to be $0.8\mu g/m^3$.

The highest annual mean NOx concentrations at Durham Coast SSSI is predicted to be $23.7\mu g/m^3$ at receptor E5. The contribution of the Port to annual mean NOx concentrations at this receptor location is predicted to be $0.7\mu g/m^3$.

No exceedance of the critical level of $30\mu g/m^3$ was predicted at any of the selected ecological receptors based on the 2017 baseline dispersion modelling.

6.3.2 SPATIAL DISTRIBUTION OF POLLUTANTS

NO$_2$

A contour plot showing the annual mean NO$_2$ process contribution (PC) from Port of Tyne at ground level (1.5m) is presented in Figure 36. The highest predicted PC of 20 30μg/m^3 is highly localised to the north of the wood pellets shed. This is likely to be associated with the NRMM and road vehicles activities for the wood pellets shed and the container yard, as well as contribution from train emissions. The predicted PC is in the range of 10 20μg/m^3 at the Liebherr Harbour Mobile Operating Area on the south side of Port of Tyne. This is likely to be associated with operations in this area from NRMMs, vessels at berth and road vehicles. These high concentration areas are limited to within the site boundary.

Figure 37: Contour Plot of Annual Mean NO2 PC from Port of Tyne at Ground Level (1.5m)

[Note that the dispersion model predicts NOx concentrations which comprises NO and NO$_2$. NOx is emitted primarily as NO with a small percentage of NO$_2$. The emitted NO reacts with Ozone to form NO$_2$ which is associated with effects on human health and therefore air quality standards for the protection of human health are based upon NO$_2$ rather than NOx or NO. The conversion used within the model, applied to all sources except road transport, assumes that 70% of long-term NOx concentrations will convert to NO$_2$. This is based upon the Environment Agency's recommendation for a detailed assessment and is considered appropriate in this case. For road transport the model has used Defra's TG16 guidance to calculate the conversion of roadside NOx to NO$_2$].

SO$_2$

A contour plot showing the 99.18th percentile 24-hour mean SO2 PC from Port of Tyne at ground level (1.5m) is presented in Figure 37. SO^2 emissions have been modelled for vessels only and these emissions are released at height (5m and above). The highest predicted PC of 0.020 0.025μg/m^3 is local to the Riverside Quay East and this is likely to be associated with the vessels at berth at the Tyne Bulk and Container Terminals.

The predominant wind direction is from the west, therefore, the highest concentrations are predicted to be to the east of the sources. A low level of SO^2 PC can also be observed from yacht and berths near the IPT at the main berths at Port of Tyne. It should be noted that the predicted concentrations for SO^2 are very small across the study area and therefore the contours present very low concentrations.

Figure 38: Contour Plot of 99.18th Percentile 24-hour Mean SO2 PC from Port of Tyne at Ground Level (1.5m)

[Note that the emission factor for sulphur from vessels is in the form of SOx and as such a suitable conversion of SOx to SO$_2$ is required. SOx emissions from vessels are directly related to the sulphur content of the fuel and SO$_2$ is understood to be the main component of SOX from vessels' exhaust, with 1-19% being in other forms (SO3 and SO4). In this modelling it has been assumed that all SOX emissions will be converted into SO$_2$ (100% conversion)].

7 CONCLUSIONS

The Port of Tyne has completed a detailed air quality assessment for the Tyne estuary in line with Port Air Quality Strategies guidance published by DfT. An emissions inventory for all shipping and shore based activity on the Port estate has been compiled for the 2017 baseline year which was subsequently used to undertake a detailed air quality impact assessment. The following key conclusions have been drawn from this assessment:

- Based upon 2017 activity levels, approximately 363 tonnes of pollutant emissions arise from in-scope maritime related activity within the Tyne estuary, with NOx being estimated to account for 86% of total emissions

- NOx emissions from vessels are the dominant contribution to this total accounting for 88% of total emissions of which vessels at berth account for 72% and vessels manoeuvring account for 16%

  - RORO2 (car ro-ro vessels) accounts for the largest source of NOx emissions

  - Emissions from offshore vessels (OFF category) is the second highest source of emissions. It should be noted however that these emissions arise from 3rd party berths on the river Tyne

  - The overwhelming majority of the RORO2 emissions occur within the Tyne Car Terminal berths on the Port of Tyne South Estate (ref TCT1 to 3)

  - Riverside Quay East accounts for the second highest source of port related NOx emissions (arising from bulk handling operations)

- NRMM on the Port estates account for around 5% of estimated NOx emissions

- Vessels at berth is also the largest contributor to PM10 emissions with Non-Road Mobile Machinery (NRMM) being the second largest

- Annual PM_{10} and SOx emissions are trivial compared to NOx emissions and are therefore a lower emissions reduction priority

- The local background air quality within the Tyne lower estuary of good, averaging around 25% of the relevant NAQS objective within the exception of NO_2 which is typically around 50% of the NAQS objective

- The additional impact to the local background arising from port related activity is trivial averaging typically 1-3% of the relevant air quality objective

- No exceedance of relevant air quality standards was predicted at any of the receptors based upon the 2017 dispersion modelling

8 POTENTIAL IMPROVEMENTS AND COST BENEFIT ASSESSMENT

The Port of Tyne stage 1 PAQS, which sets out the scope of the assessment, clearly states that pollutant emission impacts less than 50% of the relevant NAQS objective will be screened out as not requiring specific emissions reduction measures.

Table 21 clearly shows that, on average this criterion has been met for all in scope pollutants (NO_2, PM_{10}, $PM_{2.5}$, SO_2 and CO) and as such no specific emissions reduction effort is required. The modelling exercise however indicates that peak NO_2 emissions do in fact exceed 50% of NAQS objective at a small number of the identified sensitive receptors. The contribution to this from port related activity is however very low (typically 1% of the relevant objective) and these concentrations arise from background NO_2 levels which are likely to be road traffic related.

EMS and Tyne 2050

Although this assessment demonstrates that there is no immediate need for corrective action to improve air quality in the Tyne estuary, through its environmental management system, the Port of Tyne has nevertheless committed to continuously improve its environmental performance and to reduce its environmental impact.

The Port of Tyne's first formal strategy was published back in early 2013 and whilst at that time, air pollution arising from port related activity was recognised it was not seen as a significant issue. Instead the strategy centred upon the development a climate change adaptation strategy to reduce the Port's carbon footprint through improvements in Energy efficiency.

Since that time the Port of Tyne has implemented a significant number of projects to reduce its energy demand and its CO_2 emissions such as:

- The wholesale installation of LED lights across the Port

- The upgrading of its power factor and voltage correction equipment

- The purchase of its electricity from carbon zero sources only

- The implement renewable sources of electricity generation such as biomass boilers for space heating

Whilst this work it has significantly reduced the Port's CO_2 generation the Port accepts that it is unlikely to have had a significant impact upon local air quality.

Tyne 2050

In response to DfT's Maritime 2050 strategy to deliver a cleaner, greener maritime environment with zero net emissions by 2050 the Port of Tyne published its own "Tyne 2050" strategy in Q4 2019. Much like Maritime 2050, Tyne 2050 recognises the need to transition the Port of Tyne to a more sustainable environmental basis and makes the following key observations:

- The majority of the Port of Tyne's NRMM fleet fire gas oil and as such gas oil usage accounts for some 70% of the Port's overall energy demand

- The remaining 30% of the Port's energy demand is from imported, interruptible, grid electricity

- Very little renewable electricity is generated on site although there is great potential to do so

- Customers are becoming increasingly interested in the environmental impact of the activities which the Port undertakes on their behalf

Tyne 2050 therefore commits the Port of Tyne to the following key initiatives for which detailed plans are currently being developed:

(1) **To achieve net zero greenhouse gases by 2030.** This will involve the progressive replacement of the current fleet of gas oil fired NRMM with electric or hybrid equivalents. It is however recognised that for many of the applications electric or hybrid equivalents are either not currently available or are cost prohibitive but that in the coming years, as demand for such equipment increases, the technology and the economics will catch up. Clearly the elimination of gas oil usage will also deliver an improvement in local air quality on the Port estate.

(2) **To transition to an all-electric Port by 2040.** Whilst the net zero greenhouse gas project aims to eliminate gas oil demand from the Port's own activities by 2030 it is recognised that visiting ships, which account for the majority of pollutant emissions, may still be heavily dependent upon the use of gas oil. "Green ship" technology (electrical, hybrid or potentially even hydrogen powered) is however developing rapidly and it is envisaged that demand for shore based vessel power will significantly increase in the next decade. The Port of Tyne has committed to install shore side power capability with any new quay developments from 2021 onwards. It is ultimately envisaged that by 2040 all ships visiting the Port of Tyne will operate on shore side power or green fuels and that pollutant emissions from vessels will be effectively zero whilst in port. It is however recognised that vessel power demand can vary significantly. Whist a typical Panamax bulk carrier may require less than 1 Mw the power demand from large cruise vessels can be huge, at up to 15Mw.

Clearly to enable the Port of Tyne to offer cold ironing services to all visiting vessels a massive upgrade to ports electrical infrastructure (both capacity and control equipment) would be required and cost estimates suggest this could cost in excess of £50 million. The emissions inventory however shows that the most significant vessel emissions whilst at berth arise from RoRo2 operations at Tyne Car Terminal followed by Riverside Quay and clearly prioritising the installation of shore side power at those location will deliver the greatest cost benefit ratio.

(3) **To be recognised as a clean energy test bed by 2022.** The Tyne 2050 strategy recognises that there is currently an overreliance upon grid electrical power and as the Port transitions towards fully electric operations this dependence is set to increase. Similarly as the wider UK transitions away from petrol and diesel cars towards electric vehicles and the proportion of electricity generated from renewables increases this is likely to result in significant imbalance within the UK power network and power reliability/availability issues. Recognising that this presents a significant risk to port operations the Port of Tyne has committed to the installation of renewable sources of power within the Port estate. Since innovation and collaboration are also core principles within the Tyne 2050 ethos the Port of Tyne further aims to establish itself as a centre for innovation within the UK renewable power sector, building upon the strong position within the offshore wind sector which the River Tyne already has. To facilitate this transition the Port of Tyne has hosted a large number of innovation "deep dive" sessions throughout 2020 involving renewable energy providers and the wider UK ports industry and is looking to form collaborative relationships to accelerate innovation within the renewables sector.

(4) **To automate its environmental impact assessment.** The Port of Tyne's customers are becoming increasingly interested in the environmental impact of the operations the Port undertakes on their behalf and the Port of Tyne is exploring the potential to automate this assessment. This will enable existing and prospective customers to determine the impact of their existing operations or potential new operations when considering new business or investment decisions involving the Port of Tyne.

Third Party Vessel Emissions and Conservancy Charges

Whilst the Tyne 2050 strategy aims to achieve a position of net zero emissions by 2030 it should be noted that this only applies to the Port of Tyne's own operations and vessels visiting the Port berths. The emissions inventory however clearly shows that emissions from vessels whilst at third party berths can also be significant. To incentivise actions to reduce these emissions vessel operators visiting third party berths within the Tyne estuary and to encourage shipping companies to adopt clean technology, the Port of Tyne is also considering the development and implementation of a Green Ship tariff.

9 NEXT STEPS

This assessment has shown that air quality within the Tyne estuary is good and pollutant concentrations do no exceed 50% of the relevant NAQS air quality objectives. There is hence no immediate need to implement measures to improve air quality further.

Through the Tyne 2050 strategy however the Port of Tyne has committed to a number of key environmental improvement initiatives all of which will further improve air quality within the Tyne estuary. These initiatives are however still at the options appraisal stage and as such the Port of Tyne can neither commit to a list of specific improvements hard targets for their implementation. It is expected that the final road map will be available for publication by the end of 2021.

10 REFERENCES

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13   Urban Observatory. Data publicly available from https://urbanobservatory.ac.uk/ [Accessed June 2020]

14   TOPAS stands for 'Turnkey Optical Particle Analysis System'. It is designed to continuously record environmental particulate matters concentrations using a nephelometer.

15   AQMesh is a small air quality monitoring equipment based on electro-chemical sensors, which offers real-time data and analysis.

16   Defra (2019) Greenhouse Gas Reporting: Conversion Factors

17   Available at: http://naei.defra.gov.uk/ [Accessed: July 2020]

18   Defra (2016) Local Air Quality Management Technical Guidance.TG(16)

19   Rail Diesel study - WP3: The contribution of rail diesel exhaust emissions to local air quality (2006) AEA Technology

20   Defra (2014) Conversion factors between ppb and µg/m3 Available at: https://uk-air.defra.gov.uk/assets/documents/reports/cat06/0502160851_Conversion_Factors_Between_ppb_and.pdf

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12 GLOSSARY OF TERMS

AIS	Automatic Identification System
AQMA	Air Quality Management Area
CAS	Clean Air Strategy
CAZ	Clean Air Zone
CH4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
DEFRA	Department for Environment, Fisheries and Rural Agriculture
DfT	Department for Transport
EA	Environment Agency
IMO	International Maritime Organisation
NAQS	National Air Quality Strategy
NECA	NOX Emission Control Area
NMVOC	Non-methane volatile organic compounds
N2O	Nitrous oxide
NOx	Oxides of Nitrogen
PAQS	Port Air Quality Strategies
PM	Particulate matter
PM_{10}	Particulate matter with an aerodynamic size of less than 10 micrometres
$PM_{2.5}$	Particulate matter with an aerodynamic size of less than 2.5 micrometres
RoRo	Roll on, Roll off
SECA	SOX Emission Control Area
SO_2	Sulphur dioxide
SOx	Oxides of Sulphur

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