Air Quality Strategy
For the Tidal Thames

JUNE 2018
## Contents

**Definitions**

1 **Summary**

2 **Introduction**

2.1 Port of London Authority

2.2 Thames Vision 2035

2.3 Key Stakeholders

2.4 Aim of the Strategy

2.5 Existing Regulatory Requirements & Policy Framework

3 **Evidence base**

3.1 Inland Waterways Emissions

3.2 International Shipping Emissions

3.3 Port Wide Inventory

3.4 Actions Already Taken

4 **Developing the Strategy**

4.1 Stakeholder consultation

4.2 Strategy framework

4.3 Targets

5 **Implementation**

5.1 Standards

5.2 Operational Efficiency

5.3 Green Technology Development

5.4 Green Technology Implementation

5.5 Developing Supporting Infrastructure

5.5.1 Shore-side power

5.5.2 Alternative fuel

5.6 Monitoring

5.7 Five Year Action Plan

6 **Conclusions**

**Appendices**
## Definitions

<table>
<thead>
<tr>
<th>Abbr.</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIS</td>
<td>Automatic Identification System</td>
</tr>
<tr>
<td>AQMA</td>
<td>Air Quality Management Area</td>
</tr>
<tr>
<td>BEIS</td>
<td>Business Energy and Industrial Strategy</td>
</tr>
<tr>
<td>CNG</td>
<td>Compressed Natural Gas</td>
</tr>
<tr>
<td>CO</td>
<td>Carbon Monoxide</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>COX</td>
<td>Carbon Oxides</td>
</tr>
<tr>
<td>CRT</td>
<td>Canal and River Trust</td>
</tr>
<tr>
<td>Defra</td>
<td>Department for Environment, Food and Rural Affairs</td>
</tr>
<tr>
<td>DfT</td>
<td>Department for Transport</td>
</tr>
<tr>
<td>EA</td>
<td>Environment Agency</td>
</tr>
<tr>
<td>ECA</td>
<td>Emissions Control Area</td>
</tr>
<tr>
<td>ESI</td>
<td>Environmental Shipping Index</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>GHGs</td>
<td>Greenhouse Gases</td>
</tr>
<tr>
<td>GLA</td>
<td>Greater London Authority</td>
</tr>
<tr>
<td>CXHY</td>
<td>Hydrocarbons</td>
</tr>
<tr>
<td>IMO</td>
<td>International Maritime Organisation</td>
</tr>
<tr>
<td>LAEI</td>
<td>London Atmospheric Emissions Inventory</td>
</tr>
<tr>
<td>LEGGI</td>
<td>London Energy and Greenhouse Gas Inventory</td>
</tr>
<tr>
<td>LNG</td>
<td>Liquefied Natural Gas</td>
</tr>
<tr>
<td>MARPOL</td>
<td>International Convention for Prevention of Pollution from Ships</td>
</tr>
<tr>
<td>MCA</td>
<td>Maritime Coastguard Agency</td>
</tr>
<tr>
<td>MVA</td>
<td>Mega Volt Ampere</td>
</tr>
<tr>
<td>NMVOC</td>
<td>Non-Methane Volatile Organic Compounds</td>
</tr>
<tr>
<td>NOX</td>
<td>Nitrogen Oxides</td>
</tr>
<tr>
<td>NO₂</td>
<td>Nitrogen Dioxide</td>
</tr>
<tr>
<td>PM</td>
<td>Particulate Matter</td>
</tr>
<tr>
<td>PLA</td>
<td>Port of London Authority</td>
</tr>
<tr>
<td>SECA</td>
<td>Sulphur Emission Control Area</td>
</tr>
<tr>
<td>SOX</td>
<td>Sulphur Oxides</td>
</tr>
<tr>
<td>TfL</td>
<td>Transport for London</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
</tbody>
</table>
1 Summary

1.1 The River Thames has always been and remains a vital transport route for essential goods into and from London and the wider South East. It is, by far, the busiest inland waterway for the transport of freight in the UK, with over four million tonnes of cargo transported between terminals on the River Thames in 2017, equating to almost 340,000 lorry movements removed from the capital’s roads. The use of the river for the movement of freight has been steadily increasing over recent years, with an additional two million tonnes moved annually since 2011. The tidal Thames is also an important artery for the movement of people, with over ten million passengers carried in 2016.

1.2 Air quality is a health and environmental priority in the UK and has been identified as being the top issue for ports in Europe. Use of the river annually produces only a small percentage of the London atmospheric emission inventory, accounting for 1.05% of London’s emissions in 2013. However, the river’s proportionate contribution to London’s emissions is likely to increase as emissions from road vehicles fall due to tightening legislation and use of the river grows. By 2030, without further action, the river is projected to emit 2.68% of London’s NOx and 0.95% of the PMs.

1.3 In order to address public concern in relation to air quality on the tidal Thames, the Port of London Authority (PLA) has developed its first Air Quality Strategy. The Strategy aims to reduce river-based air pollution on the tidal Thames between Teddington and Southend, whilst facilitating future growth of waterborne freight and passenger transport in line with the aims of Thames Vision. Monitoring has established a baseline of emissions in 2016 from the port upon which to track reductions in the future.
2 Introduction

2.1. Poor air quality has been identified as the largest environmental risk to public health in the United Kingdom. Emissions of NO\textsubscript{2} from international maritime transport are projected to increase and potentially to be equal to land-based sources by 2020 and to constitute 27% of all anthropogenic emissions in Europe by 2030. In contrast, SO\textsubscript{2}, PM\textsubscript{2.5} and PM\textsubscript{10} emissions are set to decrease to 2.8%, 2.2% and 1.5% respectively by 2030 due to legal restrictions of sulphur content in fuel. The European Ports rank air quality as the top priority for ports in line with the priority given to the issue at EU level.

2.2. The River Thames is home to the UK’s second largest port and a critical element in the lives of millions of people living in London and the wider South East. The Port of London handles more than 50 million tonnes of cargo on more than 10,000 ship calls every year. The Thames in London is the UK’s busiest inland waterway for freight and passengers. The port generates an estimated £6.4 billion GVA (gross value added) and total river-related employment is put at 140,000 FTE (full time equivalent) jobs. River operators plan to invest £1 billion in their businesses over the next five years.

2.3. The 70 privately owned terminals and wharves on the Thames handle petroleum products, chemicals, cars, engines, machinery, vegetable oil, sugar, wine, fresh produce, cocoa, coffee, paper and forest products, cement, steel, construction materials, grain, animal feed, clothes, consumer goods, waste and recyclates; the list goes on. The PLA’s published Thames Vision includes a goal to see more goods and materials routinely moved on the river, with the aim to double underlying freight carried between terminals on the Thames by water to over four million tonnes by 2035, which will have clear environmental and quality of life benefits, in terms of reducing air pollution and road congestion.

2.4. Emissions from vessels on the River Thames are estimated to contribute around 1% of total London emissions. Background NO\textsubscript{2} levels have been exceeded in London and are part of national and local air quality management plans. \footnote{The river contributed 1.05% of London Atmospheric Emission Inventory (LAEI) in 2013. For Particulate Matter, which has a considerable impact upon human health, the river contributes 0.6% of London’s emissions in 2013.}

2.5. Climate change is also one of the UK’s top environmental priorities, with commitments to cut greenhouse gas emissions set out in the Climate Change Act and five year carbon budgets. The decrease of carbon dioxide (CO\textsubscript{2}) as
a by-product of engine combustion helps to reduce contribution of greenhouse gases (GHGs). Maritime transport emits around 1,000 million tonnes of CO2 annually worldwide, and is responsible for about 2.5% of global greenhouse gas emissions.

2.6. There has been a focus on reducing carbon emissions from transport and efforts to shift freight from road to more carbon efficient modes have included waterborne transport. This modal shift, which also improves road safety, is backed by key regulators such as the Department for Transport (DfT), Department for Environment, Food and Rural Affairs (Defra) and the Greater London Authority (GLA). Major projects in London see the use of the river for the movement of project cargoes as a significant benefit. The Northern Line Extension project has removed more than 100,000 lorry journeys through the movement of 900,000 tonnes of tunneling spoil by river, saving more than three million road miles during the construction project. Tideway is expected to use the river to move six million tonnes of project cargo.

2.7. However as performance of road engines improves due to tighter regulation, road transport may become relatively more efficient across the spectrum of emissions if no comparable developments are made in the maritime sector.

2.8. Use of the tidal Thames (Figure 1, p5) varies from London into Kent and Essex and, as a consequence, a variety of sources and densities of emissions to air needing innovative solutions.

2.9. Riparian local authorities have developed their own management plans to tackle air quality in specific areas, many of which also support the Air Quality Strategy for the tidal Thames including the GLA’s Transport and Environment Strategies.

2.10. This Air Quality Strategy reflects the PLA’s commitment, as part of its own strategy, to promote a growing, greener port whilst improving the environment. The Strategy aims to encourage a level of air quality from the river that goes beyond the legal requirement by encouraging best practice and helping to establish standards and working for a greener, sustainable future.

2.11. The Strategy was developed in partnership with stakeholders including national regulators, operators, riparian boroughs along the length of the river
and members of the public. It sets out the current legal mechanisms, policies and strategies in place to regulate air quality and emissions as well as addressing previously unidentified gaps which emerged through data gathering and the consultation process.

2.12. The proposals in this Strategy will form an Action plan to be delivered in partnership with stakeholders. These actions include establishing standards, investigating means to develop and implement green technologies, encouraging best practice and further monitoring of river emissions. The development of the Strategy has also been supported by a number of studies that have been undertaken, including the first Port Wide Inventory, which is published alongside this Strategy.

Figure 1 - Map of the Thames Estuary.
2.1 The Port of London Authority

2.1.1. The Port of London Authority (PLA) has jurisdiction over and manages 95 miles (150 kilometers) of the tidal river Thames from Teddington Lock to the North Sea and works to keep commercial and leisure users safe, to protect and enhance the environment and to promote the use of the river for trade and travel. As Custodians of the tidal Thames, the PLA has three core roles which have informed this Strategy:

- **Protect** – targeting zero harm and improved sustainability
- **Improve** – running efficient operations and investing to support growing river use
- **Promote** – leading the Thames Vision to unlock the potential of the Thames

2.1.2. The PLA has been provided with very wide powers within the Thames under the Port of London Act 1968 (as amended). These include the regulation of navigation by means of River Byelaws, General Directions and other associated Byelaws, carrying out and licensing others to undertake river works and dredging, hydrographic surveying; registration and inspection of certain types of craft and boats for hire and the removal of sunken vessels and hazards to navigation.

2.1.3. The PLA promotes the use of the river for transportation of freight in order to reduce the traffic on London’s roads. In 2017, 50 million tonnes of cargo was imported or exported to and from the Port of London, making London the UK’s second largest port. In addition, over four million tonnes of freight was transported between terminals on the River Thames, amounting to the reduction of more than a quarter of a million lorry movements from roads in London and the South.

2.1.4. As an initial action available to the PLA to improve air quality, a Green Tariff was introduced to incentivise calls by cleaner vessels. From January 2017, vessels that met a score of 30 and above on the Environmental Shipping Index (ESI), have benefitted from a discount on port charges.

2.1.5. The PLA has also undertaken research and established a baseline for the tidal Thames to develop its understanding of the scale and distribution of emissions from the various marine sources.
2.2 Thames Vision 2035

2.2.1. Co-ordinated by the PLA, the Thames Vision 2035 has been developed with stakeholders to create a 20 year view of the river’s future, to make the most of its potential for the benefit of all. To implement the Vision, six goals were identified with associated priority actions. The Environment and Heritage Goal is to see:

*The river the cleanest since the Industrial Revolution, with improved habitats and awareness of heritage*

2.2.2. The Thames Vision seeks to combine more use of the river, increasing trade, passenger journeys, sports, and recreation within an improved environment. This will be achieved through improved collaboration with a wide variety of stakeholders and providing guidance for best practice, resulting in a thriving port and a thriving environment. This is the purpose and underpinning rationale of this Strategy.
2.3 **Key Stakeholders**

2.3.1. The PLA has been working alongside many stakeholders to: develop the themes and actions within the Air Quality Strategy; identify different roles and responsibilities in order to bring about change in the most effective way; and establish partnerships that can maximise the opportunities for synergy to tackle the issues faced.

2.3.2. The GLA represents London's interests through the Mayor and the London Assembly. The GLA’s three main areas of responsibility are economic development and wealth creation, social development and environmental improvement.

2.3.3. Transport for London (TfL) is the integrated transport authority responsible for delivering the Mayor's transport strategy and other commitments on transport. The GLA and TfL also develop and report against the London Air Emissions Inventory and London Energy and Greenhouse Gases Inventory.

2.3.4. The Maritime and Coastguard Agency (MCA) works to prevent the loss of life on the coast and at sea, produces legislation and guidance on maritime matters, and licensing and certification to seafarers and vessels. The MCA is an executive agency sponsored by the Department of Transport, whose responsibilities including initiating policy, the improvement of passenger and freight travel, and the development of new major transport schemes supporting the maritime sector by producing the overall strategy and planning policy for ports in England and Wales.

2.3.5. The Department for Transport (DfT) is responsible for the oversight of ports and shipping across England and Wales. The DfT has developed guidance and best practice and is working with Defra on the issue of air pollution from vessel and port activities. A Maritime Strategy and a Clean Air Strategy will be published in 2018.

2.3.6. The Canal and River Trust (CRT) maintains 2,000 miles of canals and rivers and is responsible for a network of bridges, embankments, towpaths, aqueducts, docks and reservoirs. It has a number of residential vessels along its waterways. In London, and joining the Thames, CRT manages the Grand Union Canal, Lee Navigation and West India Docks and engages contractors to manage the Limehouse Cut.
2.3.7. The Environment Agency (EA) is responsible for regulating major industry and waste, treatment of contaminated land, water quality and resources, fisheries, some inland river, estuary and harbour navigations, conservation and ecology and managing the risk of flooding from main rivers, reservoirs, estuaries and the sea. The EA is responsible for navigation on the freshwater Thames upstream and including through Teddington Lock adjoining the PLA’s jurisdiction.

2.3.8. Port and vessel operators such as Port of Tilbury and London Gateway, Thames Clippers, City Cruises and Cory Riverside Energy are taking positive action to improve air quality within their operation and have actively engaged with the development of the Air Quality Strategy.
2.4 The Aim of the Strategy

STRATEGIC AIM

The reduction in harmful emissions to air from marine sources within the tidal Thames, whilst facilitating the Port and London’s sustainable growth.

2.4.1. The Strategy's overarching target is to reduce carbon emissions from the port alongside the actions proposed in this document to reduce local air pollutants. The tidal Thames has the potential to become a low emission corridor in London for the public to utilise.
2.5 Existing Regulatory Requirements & Policy Frameworks

2.5.1. The regulation of air quality is complex and is governed by a number of legal instruments and policies at local, regional, national and international level.

2.5.2. Internationally, air quality is regulated through a number of conventions that have been adopted through national legislation or, in the case of the EU transposed in whole or in part through EU legislation. In relation to vessel emissions, measures have been taken under MARPOL Annex VI to reduce emissions of SOX, NOX and particulate matter through global caps and designating Emissions Control Areas.

2.5.3. At EU level, air quality standards are set through directives including 2008/80/EC on ambient standards and the National Emissions Ceilings Directive 2001/81/EC. EU directives also regulate engine performance and fuel content and additives. Fuel quality is further regulated by Directive 2009/30/EC on the specification of petrol, diesel and gas-oil fuels. In relation to legal instruments specifically for vessel emissions, Directives include 1999/32/EC amended by 2005/33/EC that regulates maximum sulphur content in fuel. Further, alternative fuels infrastructure is regulated through Directive 2014/94/EU.

2.5.4. At national level, air quality is regulated through the Environment Act 1995 which sets out the requirement for a national Air Quality Strategy. The Environment Act also sets out the requirements for local boroughs to produce individual Air Quality Management Plans. The Clean Air Act 1993, applying to inland waters, controls fuels burnt by furnaces and engines. The Merchant Shipping Act 1995 transposes international mechanisms and relevant shipping-related EU legislation including measures under MARPOL and Directive 2006/87/EC on harmonised conditions for issuing technical certificates for inland waterway vessels throughout the EU's inland waterway network. This Act also empowers the MCA to issue UK Air Pollution Prevention Certificates to particular vessels.

2.5.5. Local boroughs in London, Essex and Kent have developed Air Quality Management Plans along the river. Some areas have been designated as Air Quality Management Areas, where Local Air Quality Action Plans are developed to tackle the local exceedances as part of the UK wide Air Quality Strategy. None of these plans currently covers marine sources.
2.5.6. In London, this Strategy supports a number of Mayoral strategies for Environment and Transport and TfL’s Pier Strategy. The GLA’s strategies set the standard for reducing London’s transport emissions over the next few decades, aiming for London to become a zero carbon city. The goal is a zero emission transport network, zero carbon buildings and to have the best air quality of any major world city by 2050. Each strategy also commits to promoting the use of the river to limit emissions and shift vehicles from London’s roads.

2.5.7. Major projects and developers like Tideway have local site specific air quality plans, and in some cases, project wide plans. Other cultural and artistic projects encourage the public access to the riverside, promoting the benefits of river transport and the value of improved air quality.
3. **Evidence Base**

3.1. Early in the preparation of this Strategy it was identified that there was a substantial amount of supposition, estimates and gaps in knowledge in relation to the use of the Thames and the effect on air quality.

3.2. In order to produce an evidence based Strategy, monitoring work and research was undertaken to establish the baseline and improve the understanding of a number of issues related to air quality, principally the contribution of inland freight vessels, shore power and a port wide inventory.

3.3. This information informed the Strategy and developed refined solutions or identified the need for further research in more complex areas.

3.4. Monitoring of the progress is embedded within the strategy to evidence savings.
3.1 Inland Waterways Emissions

3.1.1. Around 10 million passenger trips are made on the Thames annually and four million tonnes of cargo moved. Use of waterborne transport is recognised as an efficient and sustainable way to remove traffic from the roads. The Mayor's Environment and Transport strategies specifically state that the Mayor will work with the PLA through TfL to move freight off London's streets and onto the rail network and the River Thames.

3.1.2. At European level, energy consumption per km/tonne of goods moved by waterways has been calculated to be about 17% of that of road transport and 50% of rail transport. However, more can be done to introduce innovative technologies and reduce greenhouse gases. Due to sulphur limits set by European Directive in 2011, inland waterway vessels must use 0.001% sulphur content in the fuel. The inland waterway standard for engines emission of NOX is currently that for Stage III engines, but a further improvement will be required for new engines to meet Stage V after 2019 (Table 3).

3.1.3. The 2013 London Atmospheric Emissions Inventory (LAEI) suggests that the contribution of emissions from river-based activities on the River Thames in London, is around 1% of total emissions in 2013. NOx emissions from the river were estimated to be 1.05% of the total NOx emissions in London and PM contributions were at 0.63%. The 2013 LAEI projected that the levels of NOX and PM were projected to increase to 2.68% and 0.95% respectively in 2030 due to improvements in road engines and an expected increase of emissions as a result of growth in river traffic.

3.1.4. Monitoring real-time emissions for typical waterborne cargo movements was undertaken through PLA research in partnership with operators during 2017 for a number of parameters particularly CO₂, NOX, and PMs. The measured values were then compared with the likely emissions from the equivalent lorry fleet. In "Freight Scenario 1", Tier II engined vessel movements were compared with the equivalent lorry journeys, where the lorry fleet was a typical mix of Euro IV and V engines. In "Freight Scenario 2" a 1970 vessel's movements were compared with a lorry fleet comprising only the most modern Euro VI and Euro V engines. These journeys were modelled using likely routes, TfL congestion modelling and the latest emission factors (Copert 5).
Table 1 - Emissions relative to tonnes carried g per tonne km.

<table>
<thead>
<tr>
<th></th>
<th>Freight Scenario 1</th>
<th>Freight Scenario 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vessel</td>
<td>Road Equivalent</td>
</tr>
<tr>
<td>NO$_x$</td>
<td>0.52</td>
<td>0.29</td>
</tr>
<tr>
<td>PM$_{10}$</td>
<td>0.003</td>
<td>0.009</td>
</tr>
<tr>
<td>CO$_2$</td>
<td>39.9</td>
<td>72.92</td>
</tr>
</tbody>
</table>

3.1.5. In comparing the actual emissions of transport of freight by waterborne vessels against modelled data from the appropriate numbers of vehicles to carry the same volume of cargo, vessels produce less or equal PM10 per tonne km carried than road transport equivalents (Table 1) and significantly less CO$_2$ grams per tonne km. However, due to the large difference in legal requirements on engine standards, the total emissions for NOX are higher from the vessel.

3.1.6. A third party passenger operator made previously collected data available to the PLA for additional analysis for NO$_x$ grams per tonne km. The passenger vessel emitted 18.5g per km against the road equivalent of 13.56g per km.

3.1.7. From a human health perspective, it is not however the comparative NO$_x$ emissions from vessels or vehicles at the point of emissions, which is the key factor, but rather how this translates into NO$_2$ concentrations close to where people live and work. In other words, how do the emissions affect air quality? To evaluate this, the distance from the point of emission to the ‘receptor’ where air quality is measured is important.

3.1.8. Using the monitoring data, the exposure distances of receptors to the NO$_x$ emission sources, from the road and the river were evaluated. The concentrations of the emissions from the river source drop-off rapidly due to dispersion and greatly reduce the impact in populated areas adjacent to the river.
3.1.9 To evaluate this, a dispersion model (ADMS) has been used to estimate annual mean NO\textsubscript{X} concentrations arising from waterborne and road transport freight sources. ADMS is an internationally recognised dispersion modelling system. Exposure calculations made the assumption that the point of exposure from emissions on the road was five metres from the vehicle exhausts, whilst for river-based emissions the minimum point of exposure was estimated to be 90 metres from the vessel, due to the width of the river along a typical vessel journey. Most freight vessels travel close to the middle of the river during their transit, due to bridge limitations and available depth of water.

3.1.10. Figure 2 shows the annual concentration of NO\textsubscript{X} for Freight Scenario 1 at source was calculated to be 1.7 µg/m\textsuperscript{3}, reaching 0.08 µg/m\textsuperscript{3} at point of exposure. For the comparable road route, the maximum annual concentration is approximately 0.5 µg/m\textsuperscript{3} reaching 0.33 µg/m\textsuperscript{3} at point of exposure. Therefore in this case, NO\textsubscript{X} levels from vessels tend to fall to levels far lower than the road source in terms of receptor exposure.

![Comparison between Road and River scenarios](image)

*Figure 2 - Comparison of NOx exposure from river and road sources (Scenario 1).*

3.1.11. Figure 3 shows Freight Scenario 2, where the maximum annual mean NO\textsubscript{X} concentration from vessels is approximately 0.02 µg/m\textsuperscript{3} reaching <0.01 µg/m\textsuperscript{3} (0.0055µg/m\textsuperscript{3}) at point of exposure. For the comparable road route, the maximum concentration is approximately 0.04 µg/m\textsuperscript{3} reaching 0.032 µg/m\textsuperscript{3} at point of exposure. Once again, the receptor is subject to significantly less exposure from the river source than the comparable road source due to the distance. The annual exposure level at source is also lower than that from the road.

18
3.1.12. It is clear that the waterborne option presents an improved air quality scenario compared to the road equivalent. Based on the two scenarios tested, waterborne emissions resulted in around four to six times less impact on NO₂ concentrations at the point of measuring air quality close to population centres compared to the equivalent transits by road, creating a clean air highway for Londoners along the riverside. This is despite the fact that there has been, to date, rapid improvement in HGV engine performance compared to inland waterways vessels.

Figure 3 - Comparison of NOx exposure from river and road sources (Scenario 2).
3.2 International Shipping Emissions

3.2.1 Air emissions from international ships calling to UK ports are subject to EU legislation and MARPOL’s Annex VI that sets the limits for SOX inside and outside Sulphur Emission Control Areas (SECA). The sulphur limit for fuel in the North Sea SECA is 0.1% which is the same for vessels berthing in the Port of London. The North and Baltic seas have also been designated as an Emission Control Area for NOX. From 2021 new vessels will have to install new Tier III engines, with lower emissions levels for NOX. Figure 4 illustrates the current Emission Control Areas globally.

![Figure 4 - Emission Control Areas (Source: DNV).](image)

3.2.2 Since the Port wide inventory was completed and the Air quality Strategy was drafted the International Maritime Organisation (IMO) has announced a commitment for shipping to reduce Carbon emissions by 50% by 2050. The strategy will reflect this reduction.

3.2.3 The PLA introduced an incentive from the beginning of 2017 that provided a discount on port charges for greener international vessels. The Green Tariff is applied on the basis of data on the vessel emissions on SOX, NOX, CO2 and ability to plug into shore power which produces a score of 30 or above on the Environmental Shipping Index (ESI).

3.2.4 The voluntary index is used around the world and managed by the World Ports Climate Initiative. The Green Tariff is the first in the UK and encourages the reduction in emissions beyond current International Maritime Organisation standards. The use of the Green Tariff not only encourages greener ships through a financial incentive, but also provides data on emission standards of the vessels that visit the port as well as their ability to plug into shore-side power. Evidence suggests some ship owners have
already started using their cleaner vessels for Thames calls in order to receive the discount.

3.2.5 The feasibility and environmental benefits of alternatives including the use of LNG as fuel and the installation of shore-side power have been widely promoted as opportunities to improve the environmental performance of shipping. Both are provided for within the Environmental Ship Index, although the ability of the fleets using the River Thames to utilise these options is currently limited.

3.2.6 The feasibility and environmental benefits – in outline terms - of the provision of shore-side power was evaluated at a number of PLA owned cruise berths. The research calculated the consumption of fuel and resultant emissions at berth from ship data including international vessel calls in 2016 and calculations based on recognised methodology. This method assumed that all ships could use shore power; would otherwise be using all engines and auxiliary power systems; and they were using the same fuel. It also assumed that the grid, power supply, planning consent and infrastructure could be provided. Analysis of ships calling in 2016 as part of the shore-side power feasibility study suggests that 140 tonnes of fuel would have been used whilst at berth, which is the equivalent to 554,744 kWh of electricity. The cruise contribution to the Port Wide emissions in 2016 was 2% for NO\textsubscript{x} based on the Inventory.

3.2.7. Based on the amount of fuel saved in a year, 447.26 tonnes of CO\textsubscript{2}, 9.60 tonnes of NO\textsubscript{x} (1.92% of the 2013 LAEI river contribution, 0.02% overall LAEI and 0.31% of 2016 Port wide inventory), 1.41 tonnes of SO\textsubscript{2} and 0.30 tonnes of Particulate Matter (1.07% of the 2013 LAEI river contribution, 0.0067% overall LAEI) could be removed if shore-side power was used. However, this is likely to be a significant over estimate due to the number of assumptions made.

3.2.8. In particular it is not yet clear in practice how many ships could plug in to use the power when it is provided and indeed whether the local electricity grid has capacity to provide the required power. During the PLA’s initial research to assess the feasibility of using shore-side power, these points could not be fully resolved and work will continue to develop understanding of the effectiveness of this possible mitigation.
3.3 Port Wide Inventory

3.3.1. The first port wide air inventory for the tidal Thames has been commissioned by the PLA and Transport for London (TfL). It is an inventory of air emissions from vessels that visit and use the tidal Thames between Teddington Lock and Southend. The inventory is generated from an improved method of assessment, prepared using Automatic Identification System (AIS) data for the first time. Furthermore, the methodology for the inventory had been designed in a way to ensure it can be repeated for future iterations to monitor improvements made under the strategy.

3.3.2. The information collected on the distribution and sources of marine emissions of NOX, SO\textsubscript{x}, PMs and CO\textsubscript{2} will help to inform development of the strategy and subsequent monitoring of its impact. The GLA and TfL periodically update the London Atmospheric Emissions Inventory (LAEI) and the London Energy and Greenhouse Gas Inventory (LEGI), which include shipping and inland waterways vessels. The next TfL review in 2018 will use the data collected in this Port Wide Inventory.

3.3.3. Using activity data and emission factors for specific sources, emissions estimates in tonnes per annum have been calculated for the base year 2016, and retrospectively calculated for 2013 and 2010 using the new methodology. The inventory also included forward projections that have been made into 2020, 2025 and 2030 using predicted growth in river traffic. Other long-term influences on emissions such as the North Sea Sulphur and Nitrogen Emission Control Areas (SECA and NECA), control of fuel quality for inland vessels and changes in global shipping trends towards larger, more efficient vessels have been taken into account.

3.3.4. The results of the inventory showed that the majority of shipping emissions in the port occur east of Greater London beyond the QE2 Crossing, (Figure 5). In 2016, 195,350 tonnes of CO\textsubscript{2}, 3053 tonnes of NO\textsubscript{x} and 109 tonnes of PM (combined) where emitted from marine sources; of which 66% of CO\textsubscript{2}, 71% of NO\textsubscript{x} and 75% of PM was emitted outside London. The largest sources of emissions were from container (22% Portwide NO\textsubscript{x}), ro-ro vessels (21% Portwide NO\textsubscript{x}) and inland passenger vessels (14% Portwide NO\textsubscript{x}). The emissions for these vessels were found to be much higher while underway than at berth. For other ships types including oil, chemical and LPG tankers, the emissions were relatively much lower although emissions while underway were the same as emissions at berth.
3.3.5. The emissions over time are shown in Figure 6 for CO\textsubscript{2}, NO\textsubscript{X}, PM, and SO\textsubscript{2}. In relation to SO\textsubscript{2} and PM, the trend has been decreasing due to the effect of lower sulphur fuels with some small increases after 2020 as a result of predicted growth in the port. The level of NO\textsubscript{X} is seen to rise steadily until 2020 until newer, cleaner engines are introduced and NO\textsubscript{X} Emissions Control Areas come into force in the North Sea with emissions decreasing as a consequence. In relation to CO\textsubscript{2}, the increase in emissions are due to the increase in shipping overall by 2030 as projected for the Port of London that slows down between 2025 and 2030 due to the introduction of cleaner engines.

Figure 5 - NO\textsubscript{X} emissions in tonnes for 2016.
Figure 6 - Shipping emission trends in the Port of London for selected pollutants, 2010-2030.

3.3.6. The trends cannot take into consideration any fuel-efficient practices that may be taken up locally. Such a context has given the strategy a challenging framework to create improvements.

3.3.7. The detailed results of the Port Wide Inventory is available on the PLA’s website and will be repeated between 2020-2021 to record the changes as a result of the Strategy and other factors.
3.4. **Actions already taken**

3.4.1. Before setting out on the new actions resulting from this strategy, it is important to recognise the work that has already been done to reduce the emissions to air.

3.4.2. The PLA has always innovated with hull design for its vessels to improve performance and fuel use. The PLA has also recently committed to purchasing the first hybrid for operational duties as a pilot transfer vessel in Gravesend.

3.4.3. Passenger boats have also changed over time and as new vessels come on to the Thames, operators look to make savings by use of hybrid technology, lighter boats and engines, and more efficient hull design. The two replacement Woolwich ferries are to be diesel electric hybrids.

3.4.4. Freight vessel operators are also looking into the benefits of the hybrid vessels. Ship towage firm Kotug has two diesel hybrids that operate in the Thames, which use the electric engine for transit and the diesel power when maneuvering ships onto the berth. A number of operators have shared their learning as case studies, which are available on line accompanying this Strategy.

3.4.5. The PLA’s Green Tariff has been running since early 2017 and 150 vessels have taken advantage of the discount for around 340 visits to the Thames, principally container and bulk cargo vessels. Engagement with the Environment Ship Index allows the PLA to share knowledge and learn from European and North America Partners.

3.4.6. The PLA has been working with TfL and CRT to develop a water freight toolkit that will be available online later in 2018. This toolkit enables and encourages developers to consider the use of the river for construction logistic planning, utilising local wharves and operators to reduce the number of lorries on the capital’s roads.
4. Developing the Strategy

4.1. Development of the draft Air Quality Strategy commenced in 2015 with a technical review of the requirements and regulations currently in place. This work identified a number of gaps in knowledge that needed to be filled to help the development of options and actions.
4.1 Stakeholder consultation

4.1.1. Collaboration with all interested stakeholders is fundamental to a successful, dynamic Strategy as the PLA cannot deliver the actions alone. Development of the Strategy needs to reflect the efforts made by other parties and to exploit collaborative opportunities where they exist.

4.1.2. From August 2017 the PLA undertook an initial three month consultation exercise with stakeholders including regulators, operators, local riparian boroughs, and the public. A series of workshops were organised with regulators, port and vessel operators, local riparian boroughs and interest groups between June and October 2017. The full stakeholder list is attached in Appendix A.

4.1.3. During the workshop sessions, the PLA presented the findings of the research now included in this Strategy and its goals. The stakeholders were asked how they could contribute towards achieving the goals of the Air Quality Strategy and work with the PLA through implementation of current or future mechanisms or policies. Those contributions have influenced the Strategy accordingly.

4.1.4. The draft Strategy was published for consultation in late 2017. Responses from a wider range of stakeholders have been considered in the completion of the final document and the actions.

4.1.5. The responses received during the consultation process highlighted the overall support for the goals and proposals of the draft Strategy from the consultees, in particular from Local Government, Regulators and Operators.

4.1.6. Many stakeholders were keen to support and collaborate on air quality along the Thames. All stakeholders actively involved in the development of the Strategy will become part of the working group that will meet to report and discuss progress towards implementation of this Strategy annually.

4.1.7. Reporting progress will also be integrated with PLA’s publications including a new Environment report from 2019, and progress will be available online. http://www.pla.co.uk/Environment/Air-Quality-and-Green-Tariff
4.2 **Strategy framework**

4.2.1. Actions identified by stakeholders or by work undertaken previously, have been categorised through the use of the ‘5Es’ approach adopted within the European Seaports Organisation (ESPO) Green Guide. This follows best practice and follows the commitments outlined in the PLA’s Environment Policy. The 5Es are:

- **Exemplify;** By showing how well ports manage the environmental performance of their own operations, equipment and assets, ports set the good example towards the wider port community.

- **Enable;** By providing favourable operational and infrastructural conditions in the port area, ports enable a better environmental performance by the port users.

- **Encourage;** By providing incentives to port users, ports can encourage a change of behaviour and convince port users to continuously improve their environmental performance.

- **Engage;** By sharing knowledge, means and skills with port users and/or competent authorities in joint projects, ports can drive environmental improvement in the port area and the logistic chain.

- **Enforce;** By making use of enforcement mechanisms, ports can ensure compliance and can oblige users to apply good environmental practices.

4.2.2. Actions identified and developed through stakeholder feedback in meetings or during consultation on the draft Strategy are incorporated throughout this document and included in the Five Year Action Plan.
4.3 **Targets**

4.3.1 Stakeholders were given the opportunity to provide feedback during consultation on the draft Strategy on the targets the Strategy should adopt.

4.3.2 Whilst high targets could be set, the PLA has to evaluate the evidence available for the delivery of the strategy and the speed of regulatory change. The PLA has concluded that targets should encourage improvements, but not overreach the regulatory levels to the degree that they are unachievable. Finally, consideration was given to the difference in speed of change for vessel engines and standards versus those for road vehicles, to make sure the targets are stretching but also realistic.

4.3.3 The percentage reductions for local air pollutants in Table 2 have been adopted for the Strategy. They closely align with the Mayor’s Strategies and the reductions will contribute to improving London air quality, as well as air quality in other parts of the South East.

<table>
<thead>
<tr>
<th></th>
<th>2026</th>
<th>2031</th>
<th>2041</th>
<th>Overarching</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PM</strong></td>
<td>- 20% reduction.</td>
<td>- 40% reduction.</td>
<td>- 50% reduction.</td>
<td>Reduction in CO₂.</td>
</tr>
<tr>
<td><strong>NOX</strong></td>
<td>- 20% reduction.</td>
<td>- 40% reduction.</td>
<td>- 50% reduction.</td>
<td>Reduction in all other emissions produced on the Thames.</td>
</tr>
</tbody>
</table>

*Table 2 – The percentage reductions for local air pollutants adopted for the Strategy.*

4.3.4 Given the commitment of the IMO for international shipping to reduce carbon emissions by 50% by 2050, and the Mayor of London’s commitment to make London zero carbon by 2050, it is clear that the proposed reduction of CO₂ is also important for the Thames and is a further commitment in this Strategy.

4.3.5 Progress against the targets will be reviewed once the inventory is measured in 2020 and 2023. Updates will be provided through the working group, online and through the PLA’s publications.
5 Implementation

5.1. The implementation of the Air Quality Strategy will take place through the delivery of a number of actions identified from the evidence-based studies and stakeholder consultation. The actions, widely supported in the feedback during the consultation of the draft of the strategy, will be delivered over a five year period, be monitored and reported to the working group. These actions are outlined in section 6.7.

5.2. The actions focus on setting standards and meeting targets, increasing operational efficiency, green technology development and implementation as well as the development of supporting infrastructure.
5.1 Standards

5.1.1. In developing the Strategy and through discussion with stakeholders, it is clear that an emission standard rather than requirement to implement specific abatement technologies would be appropriate.

5.1.2. This approach – focusing on the ends rather than the means - enables operators to seek the most cost effective and practical solutions to deliver the outcomes sought within the Strategy.

5.1.3. Requirements from National and International legislation will take time before they are implemented in full. An overview of current emission limits is shown in Table 3. NO\textsubscript{x} emissions limits for future Euro VI road engines are significantly lower than emission limits for both marine engines for inland waterways set under EU law (Stage III and Stage V) and standards set by the IMO for international shipping, that can also apply to inland waterway vessels (Tier II and Tier III).

<table>
<thead>
<tr>
<th></th>
<th>CO (g/kWh)</th>
<th>NO\textsubscript{x} (g/kWh)</th>
<th>PM (g/kWh)</th>
<th>Regulatory source</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro VI Truck</td>
<td>4</td>
<td>0.46</td>
<td>0.01</td>
<td>EU Diesel Road</td>
<td>2013</td>
</tr>
<tr>
<td>Stage III</td>
<td>5</td>
<td>11.2 (HC inclusive)</td>
<td>0.5</td>
<td>EU Inland Waterways</td>
<td>2009</td>
</tr>
<tr>
<td>Stage V</td>
<td>5 – 3.5</td>
<td>4.7 – 1.8</td>
<td>0.015</td>
<td>EU Inland Waterways</td>
<td>2019</td>
</tr>
<tr>
<td>Tier II</td>
<td>4</td>
<td>7.7 – 14.4</td>
<td></td>
<td>IMO Annex VI</td>
<td>2011</td>
</tr>
<tr>
<td>Tier III</td>
<td>2 – 3.4</td>
<td></td>
<td></td>
<td>IMO Annex VI</td>
<td>2021</td>
</tr>
</tbody>
</table>

Table 3 – An overview of current emission limits.

5.1.4. Encouraging early implementation could be possible by incentive schemes. However the levels still need to be established and the appropriate technology or fuel type needs to be available at a cost that allows the saving to be achieved.

5.1.5. Discussions with the MCA and DfT through the development of this Strategy and the Government’s Clean Air Strategy indicate that there is a need for further consideration of appropriate standards for inland vessels at a national level. While this would not be led by the PLA, any implementation could have a significant impact on the reduction of emissions locally and the PLA will be taking an active role in discussions at national level.
ACTION 1 – Appropriate standards for emissions

To consider how to encourage the use of appropriate standards via incentives for vessel emissions to air with which to set future improvements for inland waterway vessels in the future.

Action: MCA & DfT, with PLA support  Discussions to start in 2018
5.2 Operational Efficiency

5.2.1. The voluntary incentive approach of the Green Tariff used on the Thames rewards actions taken to improve environmental performance of international shipping beyond the legal standard. Currently the score of 30 results in a 5% discount on the ship’s conservancy charges. The PLA will be reviewing the tariff annually and can raise the standards or add additional discounts for certain parameters to drive improvements further. The PLA is undertaking a review as to how the green tariff scheme could be expanded to include the inland fleet. This will be reviewed by the PLA annually for international shipping with full engagement with ESI working groups for any changes to the Index. In 2018 the PLA will work with partners to develop and consult on an incentive scheme for inland waterways.

ACTION 2 – Review and improve the Green Tariff

Continue to review and improve the discounts and standards within the green tariff to encourage voluntary reduction of emissions beyond what is legally prescribed. Consult in 2018 on a scheme that could be applied for the inland vessels in London.

Action: PLA 2018 – 2019

5.2.2. Reductions in vessel emissions are possible without engine abatement systems through behavioral change and passage planning including the use of tides to provide ‘free’ energy. Many operators already apply this approach to be more efficient, although others cannot in order to safely undertake their specific operations. Best practice can be encouraged by operators and regulators where it is practicable and safe to implement.

5.2.3. The PLA itself is rolling out ‘energy curves’ across vessels in its fleet to inform skippers and engineers and enable them to encourage more efficient driving during operations.

5.2.4. Often construction logistics plans submitted for planning do not include the positive opportunities that the use of the river can bring. Local boroughs, the
PLA, GLA and TfL will promote the use of the water freight toolkit through the planning process in order to increase the use of the river. The related air emissions savings could be integrated into future development of the toolkit. The tool could also be useful for local planning authorities in Essex and Kent.

------------------------------------------------------------------------------------------------------

ACTION 3 – Encourage freight service on the river

TfL, GLA and PLA to engage in order to ensure that Construction Logistics documentation actively encourages the use and development of freight services on the river, reducing the need to move freight by road and contributing to TfL’s plans to reduce peak time freight movements on the road by 10%.

Action: TfL, GLA and PLA 2018

------------------------------------------------------------------------------------------------------

5.2.5. Local Plans often have to consider the impact of future developments on air quality. Although current planning policy does not require an assessment based on the scale of most projects, it is increasingly a risk for both operators and local boroughs. Local boroughs have identified that there is a lack of guidance on how to make better use of the river while considering improvements to air quality.

------------------------------------------------------------------------------------------------------

ACTION 4 – Guidance for developers

To develop guidance by engaging with the riparian boroughs and GLA, ECC & KCC for planners and developers to encourage the use of the river, while enabling best practice and improvements in air quality.

Action: TfL, GLA, PLA and riparian boroughs and County Councils 2018

------------------------------------------------------------------------------------------------------
5.2.6. Pusher tugs push barges ahead of them whilst pull tugs tow barges behind them. It has been suggested that pusher tugs are more efficient since they are subject to less water resistance. Based on this principle, it is suggested that a tug that pushes its load would use less fuel compared with a tug that pulls, since the pull tug needs more power (energy) to do so. It has also been indicated that the fuel savings could be as much as 25-30%. Emissions are directly related to fuel consumption and therefore less use of fuel would equate to lower emissions over a set distance, although the evidence for this needs to be further investigated.

5.2.7. Some operators are already taking forward initiatives and trials with the aim of upgrading their fleets and, where possible, going beyond current emission requirements.

ACTION 5 – Publish best practice guidance for inland fleet operators

PLA to engage with operators to encourage best practice by developing operator guidance for inland fleet using lessons learnt from international shipping and existing practices.

Action: PLA, TfL and operators 2018 – 2019
5.3 Green Technology Development

5.3.1. The development of green technology is recognised as a means to protect the environment and support future sustainable growth. The Organisation for Economic Co-Operation and Development (OECD) governments are currently providing incentives for the development and adoption of green technology on a large scale to combat challenges such as climate change. Investments at European level to develop greener ships through measures such as retrofitting for existing seagoing and inland vessels both are being supported by institutions including the European Investment Bank and EU Funding.

5.3.2. By 2025, the majority of new ships in the UK will be expected to be 30% more efficient than current designs. The UK government in partnership with industry has committed to spending over £6 million on funding trials for testing innovative energy saving devices including innovative propellers, on board waste heat recovery and rotor sails utilising wind power to cut fuel consumption in order to help create a zero-emissions sector.

5.3.3. However, a lot of green technology is not designed with the inland fleet in mind and in many cases the small scale of demand means that the market is not viable for those wishing to invest. This makes any investment disproportionately costly for the early implementers although some are already looking into beneficial partnerships.

5.3.4. Development of green technology can take place through initiatives such as using cleaner, alternate or renewable energy sources and the use of technology to enable more optimised green behavior, for example through the use of apps to provide information and guidance. On the Thames, the development and adoption of green technology will require collaboration between all stakeholders including regulators, operators and government entities.

5.3.5. The PLA has encouraged innovations including the use of the river for energy generation and provision of shore-side power on sites that would be licensed by the PLA.
ACTION 6 – Installation of green technology

Encourage the installation of green technology including shore power on sites developed along the Thames through the river works licensing regime.

Action: PLA Ongoing

5.3.6. MBNA Thames Clippers has recently been successful as part of a European Consortium in securing EU funding (Horizon 2020) to research the potential of developing a fully electric zero emission high speed vessel. London is amongst the most challenging inland waterways to operate on, so presents a robust case study to identify the critical success factors for a fully electric solution. The project will run until 2021 and a test vessel will be built in Norway. Lessons learnt from this project will help inform further improvements in their fleet.

5.3.7 TfL and Kotug either operate or are due to operate hybrid vessels from 2018.

5.3.8. The PLA has committed to the building of a hybrid pilot vessel for operation in Gravesend, this vessel will save 10% of the PLA’s annual CO₂ emissions for the PLA. The savings for other emissions will be monitored when operational.

5.3.9. There are number of innovation funds, both locally within the GLA, and Kent and Essex county councils, or nationally through Defra and Innovate UK (BEIS) that could be used to encourage the development of new measures to help, in particular the inland fleet.

ACTION 7 – Identify and secure funding and support for R&D

To identify and facilitate the use of the available funds in order to enable the development of research and innovation in technology to further reduce emissions from vessels.

(Also applies to installation of green technologies.)

Action: All Stakeholders led by Cross River Partnership Ongoing

---------------------------------------------------------------------------------------------------
5.3.10. Green technology could also potentially be developed to support the provision of shore power in order not to utilise the grid. Energy demands and consumption can also be reduced through the use of smart technology and the concept of such a smart city is an essential element of the Mayor’s Draft London Environment Strategy. Potential advances include systems that can predict demand and control energy use, together with storage systems can store energy and release it when required.

ACTION 8 – Host an environmental technology EXPO

PLA to convene an exhibition with operators and manufacturers. The event will enable discussion and encourage practical ideas, relevant to for the inland fleet.

Action: All Stakeholders 2019

--------------------------------------------------------------------------------------------------------
5.4 Green Technology Implementation

5.4.1. The implementation of greener technology is incentivised by programmes like the Green Tariff, but again if the technology is aimed at a small market the costs can be disproportionate for early adopters. TfL has partnered with Thames Clippers to develop an abatement trial on one engine in a commuter vessel and monitor the results against the older engine. Thames Clippers are currently liaising with suppliers to make sure it is compatible with their engines and safety requirements. Lessons learnt from this trial will help further understanding and facilitate wider implementation of abatement technology.

ACTION 9 – Lessons Learnt from trials in advancement of vessel technology

Using developments in vessel technology the PLA will work in partnership with other river operators on a project to analyse the costs and benefits of different technological solutions and their applicability to different vessels across the Thames. This could also include a trial on an appropriate vessel or consideration during vessel procurement. Other operators’ trials may also help inform choices made in the future, such as those listed in Actions 10 & 11.

Action: PLA 2018 onwards

5.4.2. The reduction of NO\textsubscript{X} emissions in shipping is being widely discussed and implemented at national and global level. The mandatory standard for engines used in international shipping are referred to as Tier II and these rely on optimised combustion when compared to the previous Tier I engines. Given the issues with NO\textsubscript{X}, Tier III engines that focus on the use of NO\textsubscript{X} specific reduction technologies are being phased in at international level. The migration from Tier II to Tier III envisages a reduction of 75\% of NO\textsubscript{X} emissions. However this is set to occur over a relatively long period of time when compared to changes in vehicle engines and interim solutions are required to address the issue.
ACTION 10 – Retro-fitting fleets

Saving and operational benefits to retro-fitting can result in a significant reduction in particulates, NOx and Hydrocarbon emissions, for every litre of fuel used. The PLA will work with Thames operators to promote the benefits of retro-fitting more modern, cleaner engines and monitor the uptake.

Action: PLA and Thames Operators Ongoing

5.4.3. Vessels operating in inland waterways are subject to different regulation than the international fleet and their engines must comply with the EU Directive 97/68/EC Stage IIIA engine standards. The current emissions for NOx are higher than those of the vehicle engines, but should be reduced through the introduction of Stage V that will be applicable from 2019 – 2020 and are similar to the emissions limits for international shipping.

ACTION 11 – NOx abatement project

MBNA Thames Clippers and TfL are currently collaborating on DfT funded NOx abatement project to review whether Thames Clippers high speed craft can be retro-fitted with a post combustion system.

Action: TfL and MBNA Thames Clippers 2018 – 2019

5.4.4. Available literature on the subject of NOx abatement suggests that the focus in the short-term should be on the use of Selective Catalytic Reduction (SCR), Exhaust Gas Recirculation (EGR) and the use of Liquefied Natural Gas (LNG). The use of SCR can result in reductions of NOx of around 90% and the use of EGR may result in reductions of 20 – 50%, although the
efficiency of the EGR is set to increase for the better once standards for sulphur in marine fuel are lowered further.

ACTION 12 – Cost Benefit Investigation into Abatement

Investigation of the solutions available to the inland vessels on the Thames to retro fit abatement and what environmental reductions they bring.

Action – PLA and Thames Operators 2018 – 2019

5.4.7. While SCR and EGR are currently available abatement technologies that require ‘attachments’ similar to catalytic converters in cars, the use of LNG as an alternative fuel requires changes in ship’s hull that may not be cost-effective for the vessel. However, switching to LNG may result in 85 – 90% reduction in NO\textsubscript{x} for vessels using heavy fuel oil and 35% reduction in vessels using diesel. There are several challenges to the use of LNG worldwide although there are also a number of successful trials to date for the use of LNG to learn from.

5.4.8. Additional abatement technologies for NO\textsubscript{X} include internal engine modifications, conversion of heavy goods vehicle engines, diesel-water emulsions and the use of shore-side power. These could benefit from funding identified in the execution of Action 7.

5.4.9. The use of shore-side power may result in environmental benefits that include a reduction in SO\textsubscript{x}, NO\textsubscript{x}, PMs (both PM\textsubscript{2.5} and PM\textsubscript{10}) and CO\textsubscript{2} at source leading to less impact on human health as well as the elimination of noise and vibrations. Shore-side power options can include the use of feeder pillars that can supply up to four smaller vessels such as workboats at up to 125 Amp, or larger installations that have capacity to supply 3MVA. These solutions can only be used when a supply of electricity from the grid is available and land is available for the required equipment. Savings could be made by operators as electricity is 30% cheaper than equivalent generator fuel through using a number of options. The PLA currently has shore-side power at its piers for harbour patrol vessels.
5.4.10. The PLA also encourages the installation of green technology including shore power through the River Works Licensing regime. Additional mechanisms available to incentivise the installation of green technology will also be considered by the PLA.
5.5 Developing Supporting Infrastructure

5.5.1 Shore-side power

5.5.1.1. Analysis of ships calling on the Thames in 2016 demonstrated that shore-side power has the theoretical potential to create significant emissions savings on the Thames. However due to the number of assumptions made at the time, in particular the proportion of vessels that can practically ‘plug in’ and how this is likely to change over time, further research is required to improve our understanding of how and where this could be most effective. The PLA will continue to investigate this, focusing on particular sites in more detail. This will further develop the understanding of how and where the application of shore-power can help reduce emissions for shipping throughout the port.

ACTION 13 – Shore-side power feasibility study

Undertake a detailed feasibility into the potential of installing shore-side power at a site in London. This should encompass the amount of electricity needed for the type of vessels, scope for the installation of the physical connection, the capacity of the electricity supply grid to meet demand, an analysis of which vessels now and in the future would have capability to connect to the power supply, and an overall evaluation of the costs and environmental benefits of the scheme.

Action: PLA, GLA and relevant riparian boroughs 2018 – 2019

-------------------------------------------------------------------------------------------------------------------
5.5.2 Alternative fuel

5.5.2.1. The use of alternative fuels is being considered as an option to reduce the higher emissions of NO$_x$, SO$_x$ and CO$_2$ that result from the combustion of traditionally used fuels such as Heavy Fuel Oil and Marine Diesel Oil. The most commonly considered alternative fuels are LNG, electricity, biodiesel (and alternatives) and methanol.

5.5.2.2. LNG from the terminal on the Isle of Grain could potentially be a source of alternative fuel. Use of LNG could however result in higher methane emissions as methane is a known greenhouse gas. The dichotomy of NOx and PM savings versus increases in carbon monoxide emissions raises another issue in that air quality cannot be sacrificed to prevent Climate Change and vice versa.

5.5.2.3. The use of LNG raises a number of health and safety concerns that need to be considered as part of its implementation in areas that may have high populations. However there are concerns from environment groups around the sourcing of some fuels such as from palm oil or through fracking.

ACTION 14 – Feasibility study for the use of LNG, CNG and other potential alternative fuels

Carry out a feasibility study on the consequence of using Liquefied Natural Gas and Compressed Natural Gas (CNG) and other potential alternative fuels to improve air quality without compromising safety, increases in greenhouse gases and necessary requirements for infrastructure and investment.

Action: PLA with UK LNG support 2019
5.6 Monitoring

5.6.1. Continued monitoring of emissions to air provides a better understanding of the consequences of actions and enables tracking of progress. Diffuse monitoring could identify the sources and contribution of the transport sectors across the transect.

------------------------------------------------------------------------------------------------------

ACTION 15 – Diffuse monitoring of river emissions

Corporation of London and PLA to engage in order to undertake diffuse monitoring on transects from the river to nearest pathway or highway, to explore dispersion of emissions from different sources. Analysis of the data once received after one year’s data is collated. Sampling started in 2018.

Action: City of London, PLA and wharf operators 2019 – 2020

------------------------------------------------------------------------------------------------------

5.6.2. Investigation into ‘distance from exposure’ modelling has shown that the NOx discharged from inland vessels will reach over 90 metres from the source (though be at very low concentrations at that point). While the river is generally wide enough for most of the NOX to disperse, it is not currently clear what level of emissions the public on the river footpaths might be cumulatively exposed to in comparison to the roads. The Corporation of London has locations that could be suitable to install diffuse equipment to understand the differences in more detail, moving from the river to one of London’s busiest roads.

5.6.3. While collating the Port Wide Inventory, a number of queries were raised about the emissions and their aerodynamic behaviour in the environment under specific conditions. Emissions from a vessel as it travels along the river and under bridges are subject to a variety of complex dynamics and it is not yet possible to consider the effect of exposure on receptors at these locations. Furthermore, it is not currently possible to explain how wind patterns along the river influence vessel emission dispersion. To understand these issues in greater detail analysis needs to be undertaken using the information from the inventory and meteorological data. The PLA will work to explore the effects of dispersion of emissions while vessels are underway.
ACTION 16 – To carry out modelling of river emission dispersion

The modelling of emission dispersion on the river is very complex; the PLA will model how emissions would move once they are produced on the river.

Action: PLA 2018 – 2019

5.6.4. The Port Wide Inventory will be updated in 2020 to keep track of changes in marine emissions and evolving trends for emissions that cause health issues and result in climate change. The same data gathering techniques and methodology for the calculation will be used to facilitate comparability of results. Once a port-wide network for ambient air monitoring is established it will be made publically available on the PLA’s website, together with other measures under the strategy. The monitoring will aim to demonstrate improvements and reduce the gaps in understanding.

5.6.5. As a number of improvements and trials are put in place, the effectiveness of emissions reductions should be evidenced by repeated monitoring of exhausts where practicable.

ACTION 17 – Exhaust monitoring

To monitor the effectiveness in emissions reduction of trials to help encourage the implementation of suitable technology.

Action: PLA and operators Ongoing
5.6.6. Following the results from the completion of Proposal 16, it will be possible to identify areas of concern along the river and then select appropriate positions for the installation of ambient monitoring to collect information on emissions from the river rather than from other sources. This information can be made publically available in line with the National networks such as the Automatic Urban & Rural Network (AURN).

ACTION 18 – Ambient monitoring for marine emissions

To install an ambient monitoring network along the river in appropriate positions to indicate changes in marine emissions in light of the results from Action 16.

Action: PLA 2020
5.7 Five Year Action Plan

5.7.1. The implementation of this Strategy and the actions outlined will be undertaken between 2018 and 2023 and reviewed regularly during that period to ensure that it remains relevant through monitoring and takes any additional research and studies into account. Actions that will be taken in collaboration with other stakeholders and the PLA are included in the schedule outlined in Table 4.

5.7.2. Prior to the end of the implementation period, progress against the targets in the strategy will be reviewed. A future Strategy will be developed reflecting updated targets, actions and mechanisms, making the most of technological advances that have happened in the meantime.

5.7.3. A review of the Air Quality Strategy will be undertaken in 2021 ready for the next five year cycle in 2023 and following the completion of the next Port Wide Inventory.

ACTION 19 – Update Port Wide Inventory

To update the Port Wide Inventory to take into account changes in emissions and trade on the river prior to the revision of the Air Quality Strategy for the Tidal Thames in 2021-2022.

Action: PLA 2020
<table>
<thead>
<tr>
<th>Year</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>ACTION 1 – Appropriate standards for emissions</td>
</tr>
<tr>
<td></td>
<td>ACTION 3 – Encourage freight service on the river</td>
</tr>
<tr>
<td></td>
<td>ACTION 4 – Guidance for developers</td>
</tr>
<tr>
<td></td>
<td>ACTION 5 – Publish best practice guidance for inland fleet operators.</td>
</tr>
<tr>
<td></td>
<td>ACTION 6 – Installation of green technology</td>
</tr>
<tr>
<td></td>
<td>ACTION 7 – Identify and secure support for R&amp;D</td>
</tr>
<tr>
<td></td>
<td>ACTION 9 – Lessons learnt from vessel technology</td>
</tr>
<tr>
<td></td>
<td>ACTION 10 – Retrofitting fleets</td>
</tr>
<tr>
<td></td>
<td>ACTION 17 – Exhaust monitoring</td>
</tr>
<tr>
<td>2018-2019</td>
<td>ACTION 2 – Review and improve the Green Tariff</td>
</tr>
<tr>
<td></td>
<td>ACTION 8 – Host an environmental technology EXPO</td>
</tr>
<tr>
<td></td>
<td>ACTION 11 – NOX abatement</td>
</tr>
<tr>
<td></td>
<td>ACTION 12 – Cost Benefit Investigation into Abatement</td>
</tr>
<tr>
<td></td>
<td>ACTION 13 – Shore-side power feasibility study</td>
</tr>
<tr>
<td></td>
<td>ACTION 14 – Feasibility study for the use of LNG, CNG and other potential alternative fuels</td>
</tr>
<tr>
<td></td>
<td>ACTION 16 – To carry out modelling of river emission dispersion</td>
</tr>
<tr>
<td>2019-2020</td>
<td>ACTION 15 – Diffuse monitoring of river emissions</td>
</tr>
<tr>
<td>2020-2021</td>
<td>ACTION 18 – Ambient monitoring for marine emissions ACTION 19 – Update Port Wide Inventory</td>
</tr>
<tr>
<td>2021-2022</td>
<td></td>
</tr>
<tr>
<td>2022-2023</td>
<td>Revised Air Quality Strategy, Actions and Targets</td>
</tr>
</tbody>
</table>

Table 4 – The Five Year Plan 2018-2023.

Annually the progress and actions will be reported in an annual forum of the working group and within the PLA’s Environment Report.
6. Conclusions

6.1 This Air Quality Strategy represents the first step by the PLA and its partners to drive improvements in air quality within the Port of London and on the tidal River Thames.

6.2 A Strategy of this ambition is not possible without partnerships between regulators and operators. This Strategy allows individuals and organisations to work together to make improvements in emissions and in so doing improve the environment of the river.

6.3 Operator enthusiasm and policy drivers must also be placed within the context of a growing port and without a robust series of inventory data sets will be gathered to help determine how effective the first five years of this Strategy have been. In embarking on this challenge the PLA, and its partners, are taking an important first step and one which will help deliver the collective ambition of a well-used river at the heart of one of the world’s most environmentally friendly cities.

6.4 This first Strategy is the start of the journey and will continue beyond the first five years learning from the collaboration, policy changes and research that will have been delivered in order to set appropriate targets and improved monitoring of progress.
### Appendix A - List of stakeholders involved in workshops

<table>
<thead>
<tr>
<th>Stakeholder type</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authority</td>
<td>Canal and River Trust</td>
</tr>
<tr>
<td>Regulator/Authority</td>
<td>Environment Agency</td>
</tr>
<tr>
<td>Regulator/Authority</td>
<td>City of London</td>
</tr>
<tr>
<td>Regulator</td>
<td>Department for Transport</td>
</tr>
<tr>
<td>Operator</td>
<td>Cory Energy</td>
</tr>
<tr>
<td>Operator</td>
<td>Port of Tilbury</td>
</tr>
<tr>
<td>Operator</td>
<td>London Gateway</td>
</tr>
<tr>
<td>Operator</td>
<td>MBNA Thames Clippers</td>
</tr>
<tr>
<td>Regulator</td>
<td>Maritime and Coastguard Agency</td>
</tr>
<tr>
<td>Authority</td>
<td>Greater London Authority</td>
</tr>
<tr>
<td>Authority</td>
<td>Transport for London</td>
</tr>
<tr>
<td>Interested Party</td>
<td>General Public</td>
</tr>
<tr>
<td>Interested Party</td>
<td>East Greenwich Residents Association</td>
</tr>
<tr>
<td>Interested Party</td>
<td>Clean Air London</td>
</tr>
<tr>
<td>Interested Party</td>
<td>Client Earth</td>
</tr>
<tr>
<td>Interested Party</td>
<td>Transport &amp; Environment</td>
</tr>
<tr>
<td>Interested Party</td>
<td>Environment Defence Fund</td>
</tr>
<tr>
<td>Interested Party</td>
<td>Cross River Partnership</td>
</tr>
<tr>
<td>Interested Party</td>
<td>Campaign for Better Transport</td>
</tr>
<tr>
<td>Interested Party</td>
<td>Friends of the Earth</td>
</tr>
<tr>
<td>Interested Party</td>
<td>Kings College London</td>
</tr>
<tr>
<td>Interested Party</td>
<td>University of West England</td>
</tr>
<tr>
<td>Interested Party</td>
<td>London Sustainability Exchange</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Castle Point Borough</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Thurrock Council</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Southend</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Rochford</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Essex County Council</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Swale Borough Council</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Medway Council</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Gravesend Borough Council</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Kent County Council</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Dartford Borough Council</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Thanet District Council</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Canterbury City Council</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>London Borough of Newham</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>London Borough of Tower Hamlets</td>
</tr>
<tr>
<td>Borough / Council / District London</td>
<td>London Borough of Hammersmith &amp; Fulham</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Royal Borough of Kensington and Chelsea</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>London Borough of Brent</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Royal Borough of Greenwich</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Wandsworth Council</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>London Borough of Lambeth</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>London Borough of Lewisham</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>London Borough of Havering</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Islington Council</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Barking and Dagenham</td>
</tr>
<tr>
<td>Borough / Council / District</td>
<td>Southwark Council</td>
</tr>
</tbody>
</table>