Bonneagar Iompair Éireann
Transport Infrastructure Ireland

Position Paper on TII's Approach to Air Quality Monitoring on the M50

June 2020

Transport Infrastructure Ireland

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1 Introduction

Transport Infrastructure Ireland (TII) has prepared this briefing document for the Urban Transport Related Air Pollution Steering Group. This document provides an overview of traffic movements on the M50 as well as providing information on the approach adopted by TII in relation to the assessment of nitrogen dioxide (NO_2) and particulates PM_{10} and $PM_{2.5}$ at a range of locations in close proximity to the M50

TII is a non-commercial semi-state body which operates under the aegis of the Department of Transport, Tourism and Sport (DTTAS). TII's mission is to provide high quality transport infrastructure and services, delivering a better quality of life and supporting economic growth. TII was formed in 2015 from a merger of the Railway Procurement Agency (RPA) and the National Roads Authority (NRA).

TII'S MISSION STATEMENT

"To provide high quality transport infrastructure and services, delivering a better quality of life and supporting economic growth"

TII's primary function is to provide an integrated approach to the development, maintenance and operation of the national road network and light rail infrastructure.

In relation to national roads, TII's key role is to secure the provision of a safe and efficient network of national roads. This includes responsibility for the planning and supervision of construction and maintenance of national roads. TII works with the following partners to fulfil this role:

- A number of major motorways have been procured on a Public Private Partnership (PPP) basis
- The remainder of the motorways and dual carriageways are maintained by contractors under long-term contracts
- Local authorities continue to work as road authorities for their respective areas

The focus of this technical paper is particularly on NO_2 concentrations and how they relate to the operation of the M50.

2 TII Sustainability Statement and Environmental Strategy

In TII's Statement of Strategy (2019–2023) TII is committed to ensuring that Ireland's national road and light rail infrastructure is safe, sustainable and resilient, delivering better accessibility and mobility for people and goods.

As outlined, sustainability (including environmental sustainability) is fundamental to TII's Statement of Strategy.

In 2018, TII published a Sustainability Statement with the aim of incorporating sustainability principles into the development and operation of the national road, light rail and metro networks; therefore, contributing to social wellbeing, supporting economic efficiency, and protecting, restoring and enhancing environmental systems for future generations.

TII is committed to delivering a Sustainability Implementation Plan to ensure that current and future sustainability actions are fully understood and applied consistently across TII. The principles of the Sustainability Implementation Plan will align with the UN Sustainable Development Goals and will provide the foundation for the development of all future sustainability initiatives as well as providing a platform for stakeholder engagement and reporting.

In 2019, TII published a new Environmental Strategy (www.tii.ie/technical-services/environment/strategy) which outlines TII's vision for an environmentally sustainable future and it sets challenging short, medium and long-term objectives to achieve that vision.

3 Overview of traffic movements on the M50

3.1 The M50

The M50 is an urban motorway of approximately 45km in length which is located in the suburbs of Dublin. The route forms part of the Trans-European Transport Network (TEN-T) core network between the M1 and the N7, and part of the TEN-T comprehensive network between the N7 and M11. The M50 is currently the most heavily trafficked road in the country with average weekday volumes in the region of 160,000 vehicles using the busiest sections. The highest daily flow of 175,141 vehicles was recorded on May 24th 2019 between the N3 and the N4.

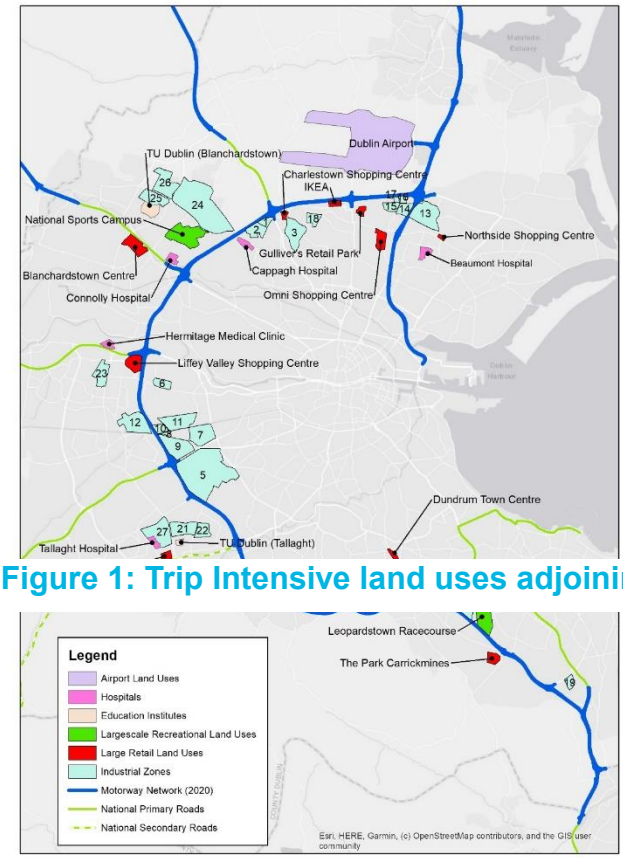


Figure 1: Trip Intensive land uses adjoining M50

While the annual traffic growth rate on the M50 averaged 5% per annum since 2013 the growth rate reduced toward 2019. There were similar growth rates on the radial routes into Dublin. In the case of the Dublin Tunnel, traffic growth between 2017 and 2018 was 6%.

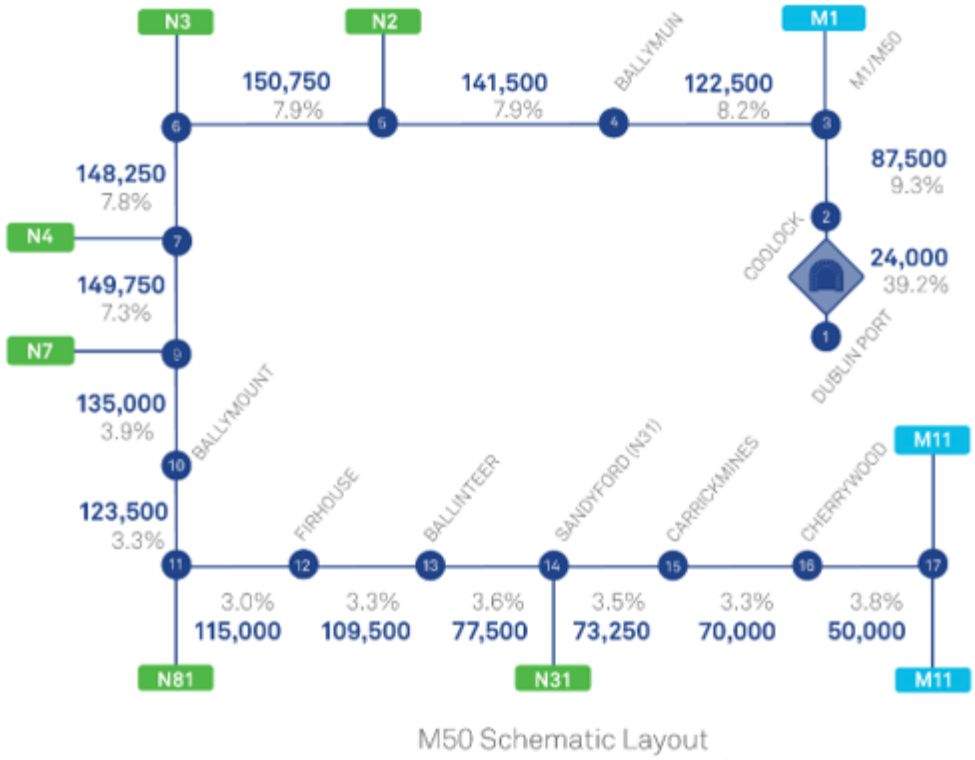
The route performs several functions as a strategic national inter-urban corridor including direct linkage to Dublin Airport and Dublin Port, as well as facilitating a significant proportion of national freight traffic and business trips. In addition, the route accommodates a substantial amount of local trips in the Dublin suburbs, with the average trip length on the M50 being in the region of 12km, equating to a distance of 1–2 junctions.

3.2 Travel demand and impact on M50

The M50 provides direct access to Dublin Airport and Dublin Port. In addition to the high volumes of freight and business trips, the corridor also accommodates a significant level of commuter and non-discretionary trips during the weekday AM and PM periods.

There are also several trip intensive land uses adjoining the M50. These include retail centres, hospitals and recreational facilities, as shown in Figure 1. Such locations are primarily accessed by private vehicle. Demand for travel to these locations, and towards the city centre, results in significant vehicular flows along the M50 corridor. The demand for travel in the periods between 06:00 and 09:00 and 16:00 and 18:00 can reach 6,000 vehicles per hour in each direction. This results in regular flow breakdown at peak times.

Overall the performance of the M50 is significantly impacted by morning and evening commuting patterns on a typical working day. This congestion has a consequential impact on vehicle performance and the levels of vehicle emissions.



M50 Schematic Layout

Figure 2: 2019 Annual Average Daily Traffic (%HGV) on M50

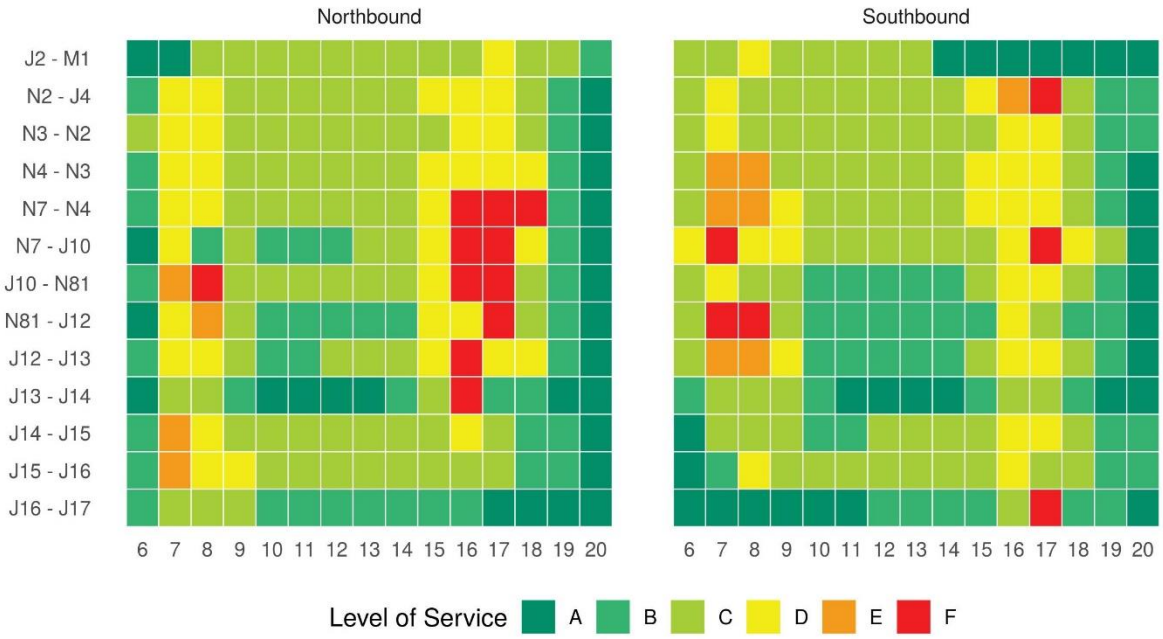


Figure 3: Levels of Service along M50 Corridor 2019 (by hour and section)

4 Nitrogen Dioxide and Particulate Monitoring on the M50

A key focus of TII is to ensure that air quality for communities adjoining national road, light rail and metro projects is not significantly impacted. TII continues to work with stakeholders and partners to explore opportunities to manage the operation of major roads and to provide a road network that will allow a more flexible approach to the adoption of Ultra Low Emission Vehicles (ULEVs) and new emerging vehicle technologies.

In 2011, the NRA published the *'Guidelines for the Treatment of Air Quality During the Planning and Construction of National Road Schemes',* which was underpinned by a three year post EIA air quality study on major national roads. All new national roads are assessed in accordance with these guidelines and the 2011 Air Quality Standards Regulations.

The Air Quality Standards Regulations (S.I. No. 180 of 2011) came into effect in April 2011 and specify limit values for benzene, carbon monoxide, lead, nitrogen dioxide (NO2) and oxides of nitrogen, particulate matter (PM) and sulphur dioxide. Only the standards related to NO_2, oxides of nitrogen, PM_{10} and $PM_{2.5}$ are relevant for the assessment of national road schemes.

The National Planning Framework policy related to air quality aims to improve air quality and help prevent people being exposed to unacceptable levels of pollution in urban and rural areas. It is proposed to achieve this objective through integrated land use and spatial planning that supports public transport, walking and cycling as more favourable modes of transport to the private car, the promotion of energy efficient buildings and homes, heating systems with zero local emissions, green infrastructure planning and innovative design solutions.

4.1 Air Quality in Ireland and Impacts on Human Health

Poor air quality negatively affects human health and can cause heart disease, stroke and respiratory diseases. The EPA estimate that there are 1,180 premature deaths a year in Ireland due to poor air quality (EPA, 2018). The primary sources of poor air quality in Ireland are fossil fuel vehicles and residential solid-fuel burning.

However, air pollution does not, in general, rise to levels at which people need to make changes to their habits to avoid exposure. Air quality levels at EPA monitoring stations around the country were below the EU legislative limit values in 2018 (EPA, 2019). Ireland's air quality is good, relative to other EU Member States but maintaining this standard is a growing challenge.

4.2 Air Quality Monitoring along the M50

Since 2014, monitoring of NO_2, PM_{10} and $PM_{2.5}$ has been undertaken on the M50 in accordance with An Bord Pleanála's approval to upgrade the M50.

4.2.1 Nitrogen Dioxide Monitoring and Results

TII is currently undertaking NO_2 monitoring at 44 locations in close proximity to the M50. NO_2 concentrations are being determined using passive diffusion tube samplers which are classified to be an indicative approach to monitoring ambient air quality.

TII monitoring commenced at two locations in February 2014. The first monitoring station is located on the eastern quadrant of the N4/M50 interchange, 3m in from the edge of the N4 carriageway. Therefore, it is not appropriate to assess the data obtained from this monitoring location against the NO_2 limit values specified in the 2011 Air Quality Regulations as pedestrians do not normally access this location. Annual average concentrations at this location range from 41.4 to 49.9µg/m^3.

The second monitoring station is located to the western quadrant of the Sandyford interchange. This station is located in an industrial location and again it is not appropriate to compare the monitored values with the relevant ambient air standards. To date, annual averages concentrations at this location ranged from 27.0–31.6 micrograms per cubic metre (µg/m^3).

TII, in advance of the introduction of Variable Speed Limits and the delivery of M50 Traffic Flow Optimisation (MTFO) Project, See Section 4.3.2.1 for more detail TII significantly extended its NO_2 monitoring network in June 2018 with the establishment of 34 new monitoring stations at residential and leisure facility locations (Figure 4) adjacent to the M50. Despite using an indicative approach to monitoring, these locations were selected to assess compliance with the NO_2 limit values specified in the 2011 Air Quality Regulations for the protection of human health.

The average NO_2 concentrations measured at these 34 new monitoring stations in 2019, ranged from 13.6–36.4µg/m^3 and all values recorded are below the annual average NO_2 limit value of 40µg/m^3 for the protection of human health (refer to Figure 5).

Figure 6 shows a comparison of NO_2 concentrations measured at the 34 new monitoring stations between June – December 2018 and June – December 2019. It is evident from Figure 6 that a strong correlation exists between the measured concentrations for both monitoring periods. With the exception of monitoring stations AQ14 and AQ18, concentrations measured in 2019 are within ±2µg/m^3 of concentrations measured in 2018. Concentrations measured at AQ14 and AQ18 in

2018 are approximately 6µg/m^3 greater than concentrations measured in 2019. It is anticipated that other sources of NO_2, specifically agricultural activities at AQ14 and the presence of a large carpark at AQ18, may have contributed to the higher concentrations in 2018.

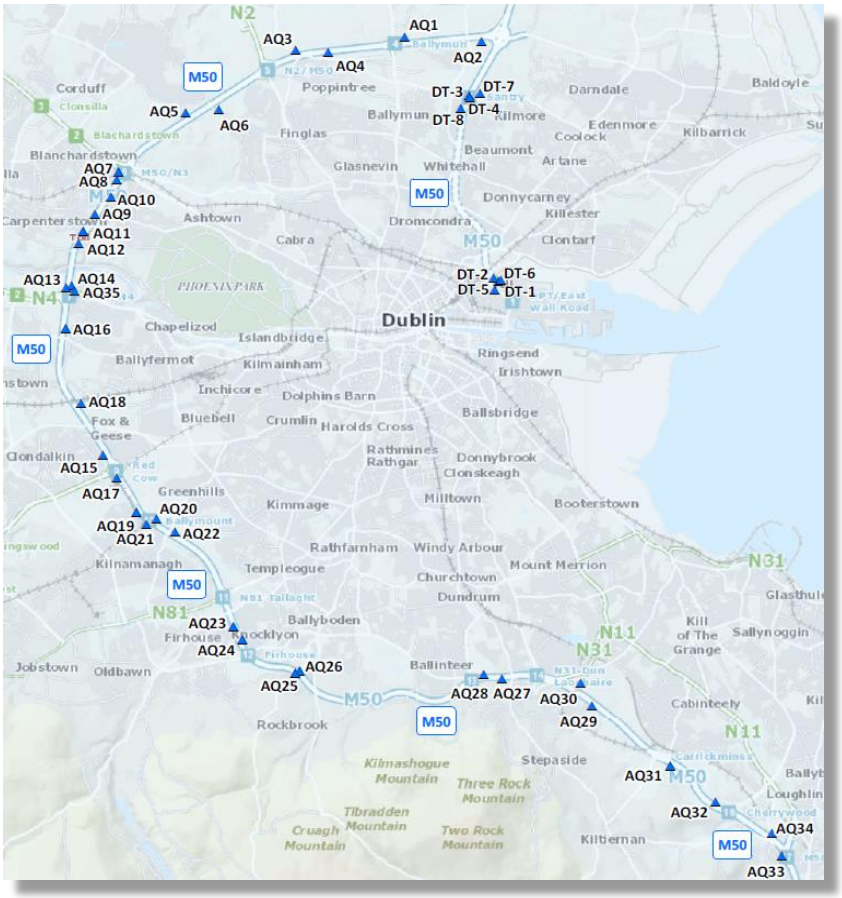


Figure 4: Location of the NO_2 monitors on the M50 and Dublin Tunnel

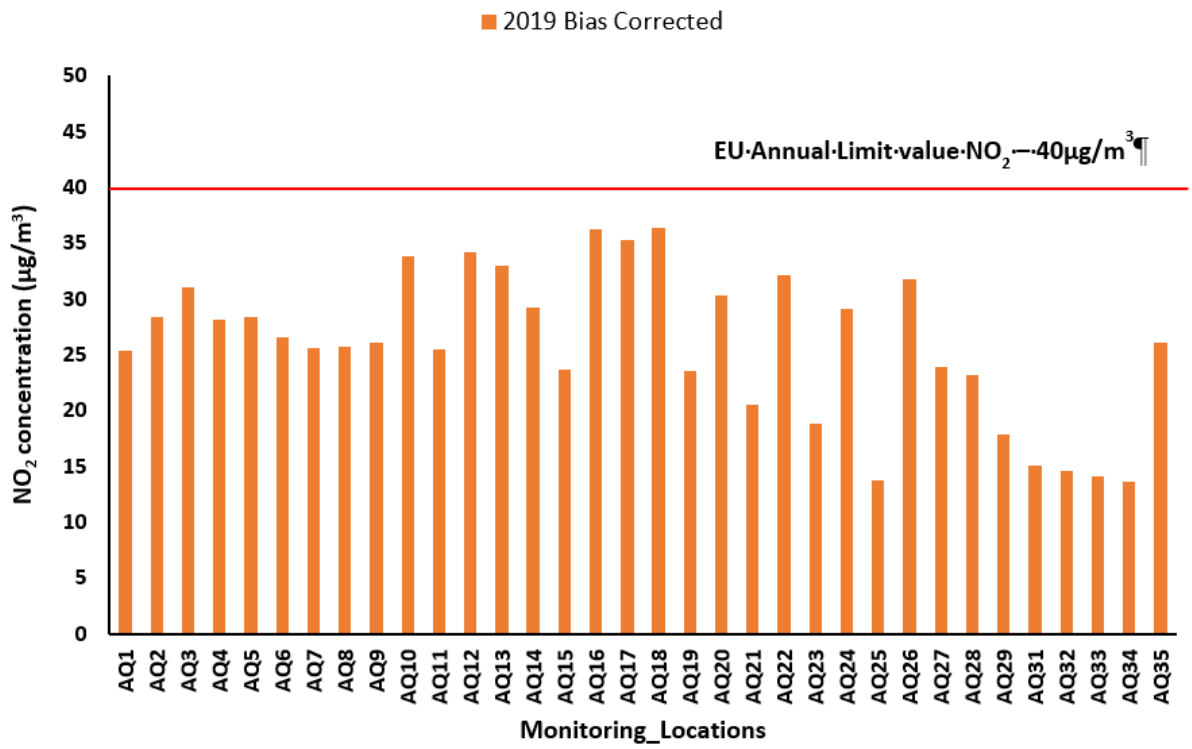


Figure 5: Average NO_2 concentrations (bias corrected) recorded at residential locations in close proximity to the M50 for 2019

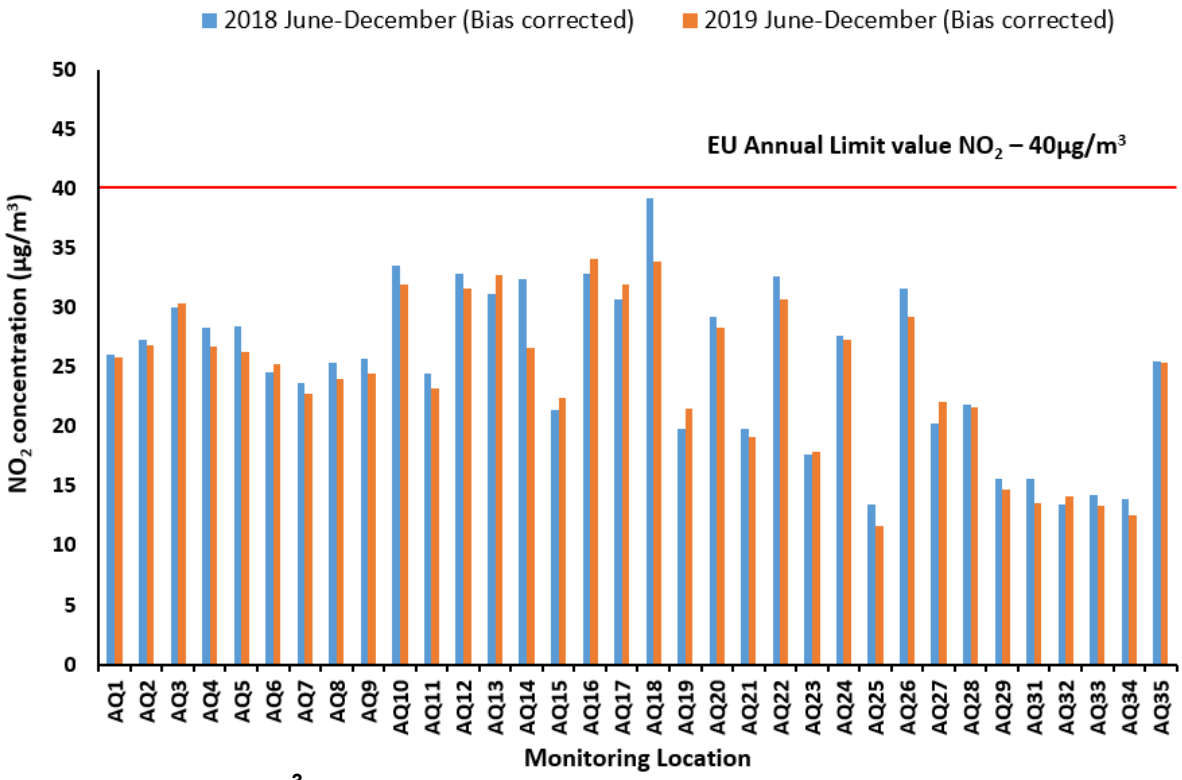


Figure 6: NO_2 ($\mu g/m^3$) concentrations (bias corrected) for June - December 2018 vs June - December 2019

Indicative NO_2 monitoring at eight locations (DT1–DT8) in the environs of the Dublin Tunnel commenced in July 2019. In order to assess NO_2 concentrations at the tunnel entrances and exits, four "roadside" monitoring stations (DT1–DT4) were set up within 100m of the portal entrances/exits and approximately 3m from the roadside. Average concentrations for the period July–December 2019 ranged from 61.6–109.4µg/m^3.

Four additional NO_2 monitoring stations (DT5–DT8) were set up at nearby sensitive residential receptors in order to ascertain whether the ambient concentrations of NO_2 complied with the limit value for the protection of human health. The average NO_2 concentrations measured from July–December 2019 ranged from 26.1–36.9µg/m^3 and all values recorded are below the annual average NO_2 limit value of 40µg/m^3 for the protection of human health.

All NO_2 monitoring data is available to the general public and other stakeholders through a dedicated website, https://tii.sonitussystems.com/, launched by TII in August 2019.

4.2.2 Particulate Matter Monitoring

TII is currently undertaking PM monitoring at two locations adjacent to the M50. PM concentrations are being determined using real-time continuous nephelometers.

Particulate monitoring commenced in February 2014 at the same two initial NO_2 monitoring stations at the eastern quadrant of the N4/M50 interchange and the western quadrant of the Sandyford interchange. The PM monitoring results are presented in Table 1.

Table 1. PM Monitoring Results (µg/m^3) 2014–2019

Location	Daily PM_{10} Averages	Annual PM_{10} Averages	Annual $PM_{2.5}$ Averages
Palmerstown	1.6 – 21.2	8.7–13.0	1.8–6.5
Sandyford	2.5 – 13.5	9.5–13.2	4.4–7.2

The concentrations of measured PM_{10} and $PM_{2.5}$ are low and are significantly below the limits set out within the Air Quality Standards Regulations (S.I. No. 180 of 2011).

The Air Quality Standards Regulations specify daily and annual average limit values for PM_{10} of 50 and 40µg/m^3, respectively. All daily and annual PM_{10} concentrations recorded on the M50 comply with these limit values. In addition, the annual average concentrations of $PM_{2.5}$ is significantly less than the new annual average limit value of 20µg/m^3 which came into force on the 1st January 2020.

4.3 Options for Improving Air Quality along the M50

4.3.1 Future Air Quality Trends with Less Polluting Vehicles

Over the past two decades, EU vehicle emission standards in relation to carbon dioxide (CO_2), NO_2, PM, etc. have significantly improved. Therefore, together with the National Car Test (NCT), this has resulted in cleaner vehicles travelling on the road network. It is further anticipated that as the penetration of ULEVs such as electric/hybrid vehicles increases on the network, greater improvements in air quality emissions can be expected.

TII will continue to work with DTTAS, the Department of Communications, Climate Action and Environment (DCCAE) and local authority partners to provide a road network that will allow a more flexible approach to the adoption of ULEVs and new emerging vehicle technologies, e.g. TII is ensuring the installation of rapid charging points at all TII Motorway Service Areas to address a range of anxiety issues associated with ULEVs. In addition, TII in conjunction with DTTaS currently operates and administers an expanded Low Emissions Vehicle Toll incentive scheme on the M50. The scheme has been funded under the Carbon Reduction Programme, with the objective of reducing transport emissions and building a climate resilient low carbon transport sector by 2050. Although such a scheme is likely to be a minor consideration in terms of purchase of a new private vehicle, it forms part of a package of incentives aimed at expanding the low emissions fleet.

These initiatives support the Government's objective of bringing 950,000 electric vehicles onto Ireland's roads by 2030 to reduce carbon emissions.

In the longer term, there is a movement towards electric vehicles becoming autonomous. Such vehicles may have a positive impact on air quality by mitigating the human tendency for stop-start driving, as well as braking, and via vehicle platooning, where a number of vehicles travel closely together to improve aerodynamics (Quarmby *et al*., 2019).

4.3.2 Traffic and Demand Management

In the National Roads Traffic Management Study (2011) some key measures were identified for the management of traffic on the M50 e.g., Variable Speed Limits (VSL) and Fiscal intervention (multi-point tolling). In the absence of fiscal intervention it was recommended that a Public Transport Freight Toll, i.e. extension of the Dublin Port arrangements to the wider M50, be considered.

Within the M50 Demand Management Study (2014), proposals identified included:

- Fiscal Measures in the form of multi point distance based variable time tolling;
- Intelligent Transport Systems (ITS) / Traffic Control Measures in the form of VSL and Incident management.

- Traffic Control Centre.

4.3.2.1 Variable Speed Limits – M50 Traffic Flow Optimisation (MTFO)

Following the M50 Demand Management Study, TII is progressing the implementation of VSLs on the M50. TII established the M50 Traffic Flow Optimisation (MTFO) Project to implement a variable speed limit regime on the M50 which will improve the operational efficiency of the motorway by smoothing traffic flow, improving journey time reliability and reducing the number of traffic collisions. This will be achieved through the setting of mandatory reduced speed limits which are most appropriate to the prevailing traffic conditions, using electronic speed limit signs displayed overhead each lane. MTFO is a part of the wider enhancing Motorway Operation Services (eMOS) project. The first phase of this project will be implemented in 2021.

The consequent smoother traffic flows that will result from the VSL regime will reduce the number of shockwaves and breakdowns in traffic flows that occur thereby reducing increase in vehicle emissions.

Speed management has in places (e.g. the Netherlands) been complemented by “eco-driving” campaigns which educate the public on fuel-efficient forms of driving. In advance of implementing MVSL, TII is undertaking a comprehensive assessment of baseline concentrations of NO_2 at a range of residential sites in close proximity to the M50.

4.3.2.2 Dublin Tunnel

In 2019, approximately 24,000 vehicles per day were using the tunnel. Heavy Goods Vehicles comprise 39% of this tunnel traffic. While there are no capacity issues in the tunnel, congestion can be experienced on the surrounding road network on the city side which has the potential to negatively impacts ambient air quality in the City. When such congestion occurs, vehicle access to the tunnel can be temporarily withdrawn as for safety reasons, vehicle queueing in the tunnel is not permitted. This will then shift the standing traffic to the Northside of the tunnel and further north and around the M50 depending on severity of the incident.

Through the Dublin Tunnel Bye-Laws, TII does not have any means to prioritise trucks and buses other than to discourage tunnel use by non-exempt vehicles through raising the applicable toll. Currently non-exempt vehicles are subject to a €10.00 charge southbound during the morning peak / northbound during the evening peak while the charge is €3.00 at other times.

4.3.2.3 Park & Ride Strategy

The Governments Climate Action Plan 2019, the National Mitigation Plan and the NTA's Transport Strategy for the Greater Dublin Area all highlight the need to reduce emissions from the transport sector via a range of measures including the development of a Park & Ride Strategy and eventual provision of associated facilities.

Park and Ride may have potential in terms of serving existing M50 users and also reducing, or slowing, the growth in demand for car travel on the M50.

4.3.2.4 Regional Demand Management Measures

TII is the manager and operator of key urban motorway infrastructure. TII recognises that there is a need for regional management of existing and future travel demand to address congestion. This requires a multi-agency and multi-faceted approach and may include some or all of the following measures: enhanced public transport provision; embracing home/remote working; enhancing walking and cycling facilities and connectivity within the urban areas; alongside complementary demand management measures including potentially addressing road pricing, parking provisions and controls within city centres and suburban locations.

TII strongly supports the objectives of the "*5 Cities Demand Management Study*", currently being undertaken by the Department of Transport, Tourism and Sport, to identify demand management measures that would address congestion, reduce transport-related greenhouse house gas emissions and improve air quality in urban areas.

4.3.3 Propagation Measures

4.3.3.1 Air pollution barriers

Technologies designed to remove road traffic pollution from the air remain unproven. For example, substances which react with NO_2 have been applied to surfaces (e.g. noise barriers) in several countries including the Netherlands and the UK. However, the results of these initiatives remain inconclusive and everyday wear and tear can limit their effectiveness. The key difficulty with these initiatives is that only a small fraction of air ever comes into contact with the applied substances, meaning that the overall impact on air quality is often negligible.

4.3.3.2 Environmental noise barriers – a positive unintended consequence

Environmental noise barriers have effects on air quality without this being their original purpose. These barriers tend to lead to decreased pollution behind the barrier. Therefore, the 39km of environmental noise barrier along the M50 may also be considered to have air quality improvement capabilities.

4.3.3.3 Trees and vegetation

Trees and vegetation in general have been shown to have positive impacts on air quality. Leaves are capable of filtering out certain pollutants such as NO_2 and PM. Whilst data is not currently available, it is anticipated that the significant planting along the M50 can play a role in mitigating air quality impacts from vehicle emissions.

5 Concluding Comments

Currently, NO_2, PM_{10} and $PM_{2.5}$ levels recorded at residential locations on the M50 comply with the statutory ambient air quality standards specified for the protection of human health for these pollutants in the 2011 Air Quality Standards Regulations.

However, increasing vehicle related air emissions is an inevitable consequence of a society that has a significance reliance on motorised vehicles for the transport of people and goods. When managing air quality issues there has to be a recognition that many activities that emit air pollutants provide value to society, e.g. through employment, leisure, connectivity and cultural activities.

Therefore, air quality management policy must consider the economic and societal benefits of these activities and the impacts on human health and quality of life of minimising the effects of air pollution as well as the environmental dis-benefits of air emissions.

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