Portsmouth
CITY COUNCIL

Optimisation of Road Traffic Management Control Systems (ORTMCS)

For the Purpose of Local Air Quality Improvement 2015

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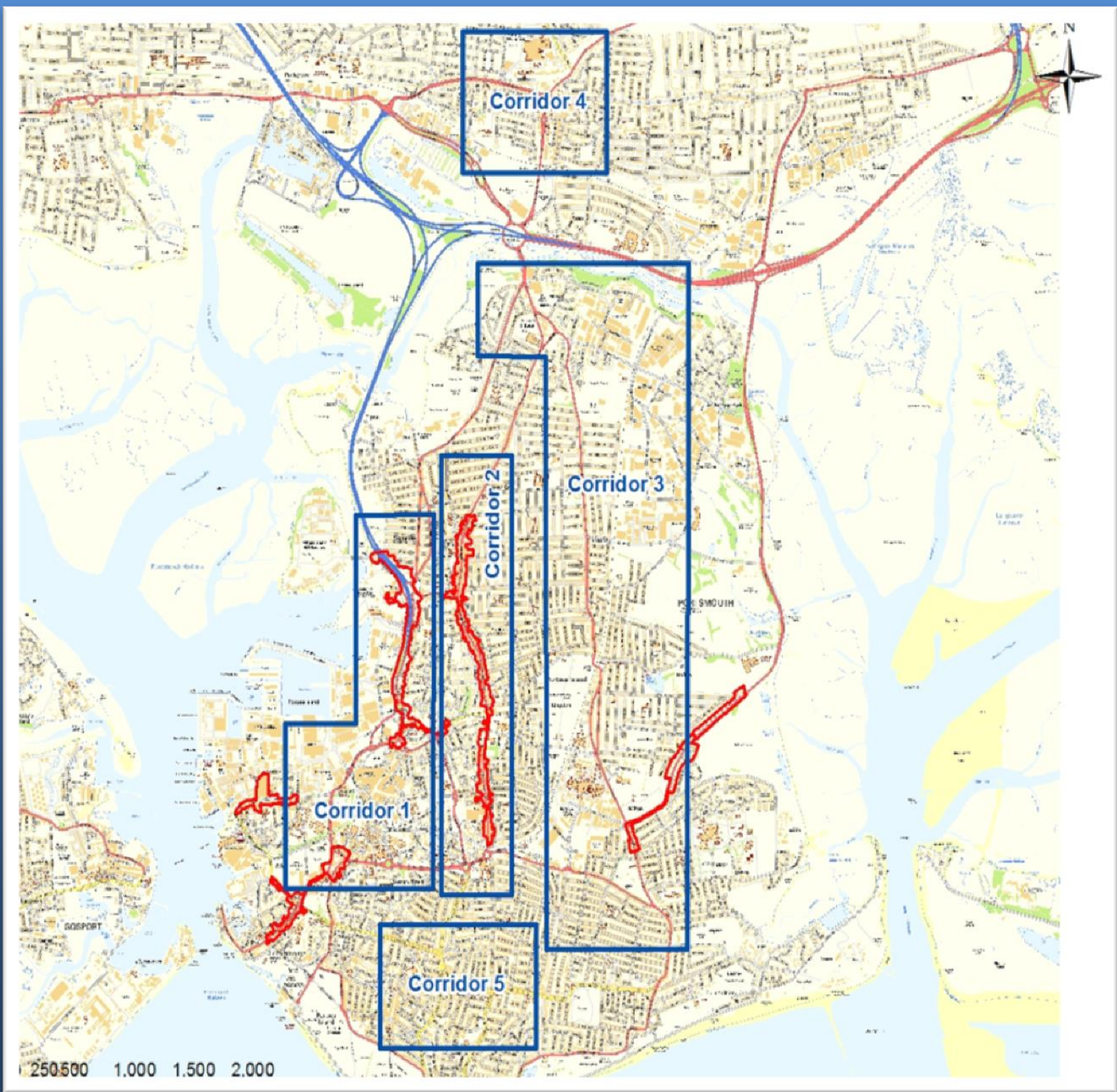

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1 Executive Summary

The "Optimisation of Road Traffic Management Control System(s)" (ORTMCS) is a desk top study, was set up by Portsmouth City Council (PCC) to explore possible improvements road traffic management controls for the purpose of achieving possible local air quality improvement.

This is a pioneering project in scale focusing on testing ways to regulate and improve road traffic flow management to achieve an improvement in local air quality without creating new air pollution hotspots.

A key measure adopted in the 2010 Air Quality Action Plan was to review the existing traffic management control systems in Portsmouth in order to ensure that road traffic is ‘maintained at maximum fluidity to keep transport-related pollution to a minimum’.

The project comprised three consecutive packages:

- ✓ To conduct extensive road traffic surveys at pre-selected junctions;
- ✓ To undertake a vehicle Micro-Simulation modelling based traffic impact assessment of each proposed scenario and to carry out Analysis of Instantaneous Road Emission (AIRE) modelling to produce estimates of road traffic emissions.
- ✓ To undertake an Air Quality Impact Assessment (AQIA) to test various proposed scenarios using more advanced dispersion modelling.

The domain study was confined to the road networks in five separate areas identified as corridors and were not confined to the five remaining Air Quality Management Areas (AQMA 6, 7, 9, 11, and 13).

The proposed scenarios consisted of a set of four models developed for each corridor. The first two model runs were considered as baseline models and the other two as scenarios put forward for assessment. Corridor 4 was an exception as one baseline model was considered followed with three proposed model runs:

- ✓ Base Year Scenario (BYS), 2013.
- ✓ Do-Minimum Scenario (DMS): includes all changes implemented or planned between the base year (2013) and assessment year (2015).
- ✓ Do-Something 1 Scenario (DS1S).
- ✓ Do-Something 2 Scenario (DS2S).
- ✓ Do-Something 3 Scenario (DS3S) (Only for corridor 4).

In general the conclusions of this ORTMCS study demonstrate a consistency throughout the three packages.

The performance analysis of various scenarios on the five corridors illustrates that:

- ✓ The annual mean NO_2 objective will not be exceeded at any modelled sensitive receptor location in 2013 or 2015 should additional traffic management measures not be implemented. However, the predicted annual mean NO_2 concentrations, particularly for the 2013 DMS, are close to the annual mean objective at several modelled receptor locations.

- ✓ Any revocation of Air Quality Management Area should consider both the predictions made throughout the corridors via the contour maps and local monitoring data.
- ✓ The proposed traffic management measure scenarios are unlikely to result in significant changes in ambient air quality in Portsmouth.
- ✓ The predicted changes in annual mean NO_2 concentrations at all modelled sensitive receptor locations are negligible.

It is therefore impossible to make any air quality based recommendation for any scenario, in any corridor, that would result in a significant improvement in local air quality. However, the ORTMCS recommends that should a decision be made to address road traffic congestion, air quality should be considered a material consideration regardless of significance determined by the AQIA:

- ✓ Corridor 1
  - **DMSc1:** To incorporate the following changes to the network, which have either already been implemented on site, or are due to be implemented shortly:
    - Signalisation of the Rudmore Roundabout, bus lane and bus gate along the SB offslip and alterations to lane allocations;
    - The merge of traffic from Rudmore Roundabout SB on slip with the M275 flyover has been altered so that the slip road traffic merges with the nearside lane of the flyover, resulting in a lane drop;
    - Extending the existing bus lane along Mile End Road southbound through the Church Street Roundabout, Commercial Road and Marketway Roundabout to join up with the current bus lane along Marketway, with lane alterations and signal time changes at the Church Street Roundabout;
    - Signalising Anglesea Road approach and opposing circulatory to allow pedestrian facilities, and altering the Cambridge Road triple crossings to run in isolation at St Michael's Gyratory.
  - **DS1Sc1:** To utilise the DMS model layout with alterations made to the Holbrook Road / Lake Road roundabout. Two flares have been introduced on the Church Street and Lake Road (E) approaches for left turning traffic only to provide more capacity for the ahead and right turning traffic.

- ✓ Corridor 2
  - **DMSc2:** To modify several signalised junctions throughout Corridor 2
  - **DS1Sc2:** To amend bus stops throughout the network (where possible)
  - **DS2Sc2:** To improve junction in line with the recommendations made within the South East Hampshire Bus Rapid Transit (BRT) Highway Design Priorities Study undertaken in February 2014.

- ✓ Corridor 3
  - **DMSc3:** This scenario consists of the following planned improvements
    - Signalisation of London Road / Northern Parade junction. This improvement includes prohibiting southbound to northbound U-turn manoeuvres. As a result, southbound vehicles originating from the Portsbridge roundabout or Military Road intending to go north along Northern Parade will be routed through the London Road/Copnor Road circulatory.
    - Geometric improvements and installation of MOVA at the Milton Road / Goldsmith Avenue junction. The geometric improvement includes reconfiguring of the northbound approach to provide one through lane and one left turn lane, along with provision of signalised pedestrian crossings.
    - Installation of MOVA at the Milton Road / Velder Avenue junction.
    - Optimisation of signal timing and stage sequence at the Milton Road / St. Mary's Hospital Entrance junction.
    - Optimisation of signal timing and stage sequence at the Copnor Road / Stubbington Avenue / Burrfields Road junction.
  - **DS1Sc3** This scenario included the following:
    - Replacement of on-street bus stops with laybys at the following locations:
      - Norway Road Eastbound, East of Copnor Road
      - Copnor Road Southbound, south of Stubbington Avenue / Burrfield Road
      - Milton Road Northbound, north of Locksway mini-roundabout
      - Milton Road Northbound, south of Priory Crescent
      - Milton Road Southbound, south of Priory Crescent
    - Additional parking/loading restrictions on the southbound section of Milton Road between Dover Road and St Mary's Roundabout.

  - **DS2Sc3:** To construct southbound right turn lane into the fuel station located approximately 50m north of the Copnor Road / Stubbington Avenue / Burrfields Road junction. Currently, traffic turning right into the fuel station blocks the southbound through traffic resulting in excessive delays for the southbound movement at this junction. The right turn lane will provide storage for the right turning traffic without blocking the southbound through traffic.

- ✓ Corridor 4
  - **DS3Sc4**: To alter the lane allocation to allow a double right turn to A3 Southampton Road. Therefore, the middle lane will be to travel right or ahead and the nearside will be a left or ahead lane as it has also been assumed that the widening of the approach has taken place as per DS1S. The bus gate has not been included in this scenario.

- ✓ Corridor 5
  - **DMSc5:** This scenario proposes the removal of stage 3 from the signalised junction of Victoria Road, Outram Road and Elm Grove, converting the right turn movement from Victoria Road South to Outram Road to gap seeking during stage 2, and reducing the number of northbound lanes to 1 to accommodate a cycle lane;
  - **DS1Sc5:** The conversion of the bus stops on the carriageway into bus laybys where it is considered feasible;
  - **DS2Sc5:** The removal of the on street parking provision at locations where it impedes two way traffic flows.

2 Introduction

2.1 Introduction

The "Optimisation of Road Traffic Management Control System(s)" (ORTMCS) is a desk top study, was set up by Portsmouth City Council (PCC) to explore the possibility (ies) to improve road traffic management controls for the purpose of achieving protential local air quality improvement.

This is a pioneering project in scale that took the form of a set of feasibility studies. These focused on testing ways to regulate and improve road traffic flow management to achieve an improvement in local air quality without creating new air pollution hotspots.

2.2 Background

In 2010, Portsmouth City Council (PCC) published their Air Quality Action Plan (AQAP)[1] in response to the declaration of several AQMAs across the city. A key measure adopted in the AQAP was to review the existing road traffic management systems in Portsmouth in order to ensure that road traffic is 'maintained at maximum fluidity so that road transport-related pollution is kept to a minimum'.

In 2013, PCC launched the ORTMCS for the purpose of local air quality improvement. This project was essentially a set of road traffic management feasibility studies which focused on a number of scenarios to improve traffic flow across the city.

This project was designed to explore the possibilities for improving road traffic flow management and thereby improve air quality within the existing and revoke Air Quality Management Areas (AQMAs), without either deteriorating or creating new air pollution hotspots elsewhere.

The project comprised three consecutive packages:

- ✓ To conduct extensive road traffic surveys at pre-selected junctions.
- ✓ To undertake a vehicle Micro-Simulation modelling based road traffic impact assessment of each proposed scenario and to carry out Analysis of Instantaneous Road Emission (AIRE) to produce estimates of road traffic emissions.
- ✓ To undertake an Air Quality Impact Assessment (AQIA) to test various proposed scenarios using more advanced air quality dispersion modelling.

2.3 Domain Study

The domain study addressed road networks in five separate areas. These were identified as corridors and were not confined immediately to the road network within the five remaining AQMAs (AQMA 6, 7, 9, 11, and 13).

[1] Portsmouth City Council (2010), Air Quality Action Plan, http://aqma.defra.gov.uk/action-plans/PCC%20AQAP%202010.pdf, Accessed March 2015

2.4 The First Stage

This stage was dedicated to road traffic information gathering process from various sources:

2.4.1 Commissioning of fresh extensive detailed road traffic surveys, both manual and automatic traffic counts (ATCs), to produce traffic data in a format that would meet the requirements of both transport and air quality modellers. The surveys were carried out by Traffic Survey Partners (TSP) on behalf of Arup covering 24 junctions (in Appendix D, Figure 8). They were designed to produce traffic data for each arm of a set of pre-selected junctions with in-depth specific details such as:

- ✓ Classified turning counts.
- ✓ Queue lengths.
- ✓ Pedestrian crossings surveys.
- ✓ Journey time surveys.

2.4.2 Signal specifications and bus services information, including bus stop and pedestrians crossing locations in each corridor, were sourced from Portsmouth City Council transport department. Where specifications were not available, observed timings for each junction were provided.

2.4.3 Similar road traffic information was sourced from transport assessment of committed developments.

2.5 Second Stage

This stage was a two phase process, delivered in two consecutive phases:

- ✓ Phase One: Vehicle micro-simulation modelling (using VISSIM).
- ✓ Phase Two: Vehicle emission calculator (using AIRE, Analysis of Instantaneous Road Emission).

This approach was designed to test the various proposed scenarios. It was an assessment and evaluation study that dealt with both the base year and the scenarios' predictions.

The combination of the Micro-simulation and the Emission Calculator provided the study with a platform for testing the proposed traffic management and the traffic signal optimisation strategies designed to reduce vehicle emissions.

2.5.1 Phase One: Vehicle micro-simulation modelling (using VISSIM)

Micro-simulation is a traffic flow modelling system for the analysis and design of urban and highway networks. It offered wide area vehicle routeing with dynamic feedback for accurate traffic flow modelling within a context of active urban traffic control. This tool was deployed in this project to focus on predicting ways to regulate and improve road traffic flows that include isolated, co-ordinated signals and the introduction of priority for public transport. This part of the project was sub-divided into two parts:

- ✓ **The First Part:** This covers primarily the development of a base traffic model. It is based on the pre collected data from the first package and covers the achievements in both road traffic congestion and air quality improvements as result of the installation of the new road traffic management systems and junction improvements since the publication of the 2010

Air Quality Action Plan and was dealt in the base model. All these would eventually constitute the input data for both micro-simulation road traffic and air quality dispersion models.

- ✓ **The Second Part:** This covered the predictions of various proposed scenarios for each corridor and their subsequent impact on both road congestion and air quality. These took a form of feasibility studies to generate, test and refine options based upon optimising current traffic signals and or the possibility of introducing traffic signals and removal of roundabouts in order to improve traffic flow conditions and eventually improve air quality.

2.5.2 Phase Two: Vehicle emission calculator (using AIRE, Analysis of Instantaneous Road Emission).

AIRE emissions modelling assessment software is an emission calculator, used in this context as a screening tool using predicted road traffic flows generated by vehicle micro-simulation modelling (using VISSIM) to determine if the proposals were predicted to reduce emissions and improve the air quality within the study area, in this study five corridors.

The emission calculator produces levels of oxides of nitrogen, particulate matter (PM10) and total carbon.

2.6 The Third Stage

This stage was a validation phase carried out as an Air Quality Impact Assessment (AQIA) of various proposed scenarios being considered by the vehicle micro-simulation modelling.

To determine the impact of each of these traffic management scenarios on local air quality, PCC commissioned AECOM to undertake air quality impact assessment studies for each of the scenarios produced from the traffic modelling study described above. This project was designed to explore the possibilities of improving road traffic flow management and thereby improve air quality within the AQMAs, without either deteriorating or creating new air pollution hotspots elsewhere.

The air quality impact assessments were undertaken in accordance with Defra's Technical Guidance LAQM.TG(09)[2] and used the AAQuIRE detailed dispersion modelling software to determine the annual mean NO_2 (nitrogen dioxide) concentrations within the study area for each traffic management scenario. The NO_2 impacts of each scenario were assessed at sensitive receptor locations and contour plots produced to illustrate the wider extent of the predicted impacts.

[2] Defra (2009). Local Air Quality Management Technical Guidance LAQM.TG(09), https://www.gov.uk/government/publications/local-air-quality-management-technical-guidance-laqm-tg-09, Accessed March 2015

3 Domain Study

3.1 Introduction

PCC defined the domain study of the ORTMCS project to address road traffic related air quality issues in a road network that includes 24 specific junctions (in Appendix D, Figure 8). These were identified and grouped in a set of five areas and were not confined immediately to the road network within the five remaining AQMAs (AQMA 6, AQMA 7, AQMA 9, AQMA 11, and AQMA 13).

The majority of these junctions focus on the main north - south corridors that connect the M27 / A27 to Portsea Island. These corridors are illustrated in Appendix D, Figure 8.

These were set up for the purpose of both vehicle simulation modelling and air dispersion modelling:

- ✓ Corridor 1: From Anglesea Road to M275, via Marketway, Commercial Road, and Mile End Road.
- ✓ Corridor 2: From Victoria Road North to Portsbridge roundabout, via Fratton road, Kingston Road, and London Road.
- ✓ Corridor 3: From Eastney Road to Norway Road, via Milton Road and Copnor Road.
- ✓ Corridor 4: A3 Southampton Road/A397 Northern Road, Cosham, located to the north of the M27.
- ✓ Corridor 5: B2154 Elm Grove and B2154 Albert Road, Southsea.

The choice of these 24 junctions across the city was based on two main reasons:

- ✓ Most of these junctions are located within existing or revoked AQMAs.
- ✓ At these 24 junctions significant changes in traffic flow were anticipated due to the proposed road traffic management control improvement scenarios. These include areas where detrimental effects may be experienced due to the rerouting of traffic as a result of the proposed scenarios.

Three of the corridors were set as traffic corridor models (Corridors 1 to 3) and two as junction corridor models (Corridors 4 and 5). The junctions included in each of the five corridors (models) are described in Table 8.

Table 1: Junctions included in each of the Corridor Models

Corridor	Junctions
1	- Junction 1: M27 Flyover and roundabout with the A3, A2017 (Kingston Crescent) and Wharf Road. - Junction 2: Mile End Road and Prospect Road. - Junction 3: Roundabout with Commercial Road, Hope Street, Church Street and Mile End Road. - Junction 4: Roundabout with Lake Road, Commercial Road and Marketway. - Junction 5: Cambridge Road, Hampshire Terrace, A2030 and Anglesea Road. - Junction 6: Alfred Road, Queen Street and Anglesea Road.
2	- Junction 7: Winston Churchill Avenue, Victoria Road North and Holbrook Road. - Junction 8: Victoria Road North, Fratton Road, Fawcett Road. - Junction 9: Fratton Road and Arundel Street. - Junction 10: Fratton Road and St Mary's Road. - Junction 11: Fratton Road and Lake Road. - Junction 12; Kingston Road and New Road. - Junction 13: London Road and Chichester Road.
3	- Junction 14: London Road, Old London Road, Copnor Road. - Junction 15: Copnor Road and Stubbington Avenue. - Junction 16: Baffins Road, St Mary's Road, Langston Road and Milton Road. - Junction 17: Milton Road, Velder Avenue, Rodney Road and Alverstone Road. - Junction 18: Milton Road, Goldsmith Road and Eastney Road. - Junction 19: Northern Parade and London Road.
4	- Junction 20: Southampton Road, Northern Road and Spur Road. - Junction 21: Northern Road, Medina Road and Wayte Street.
5	- Junction 22: Elm Grove, Grove Road south and Grove Road north. - Junction 23: Elm Grove, Victoria Road North, Albert Road and Outram Road. - Junction 24: Albert Road, Waverley Road and Lawrence Road.

4 Proposed Road Traffic Management Control Improvements

4.1 Introduction

In order to address both road traffic congestion and air quality issues within the city a set of measures were proposed by both our traffic management unit and Atkins.

These measures are corridor specific and were set up as individual corridor model runs. For each corridor a set of four model runs were developed.

For each corridor, the two first model runs were considered as baseline models and the other two as scenarios to be put forward for assessment. Corridor 4 was the exception, as one base year was considered followed with three proposed model runs:

- ✓ Base Year Scenario (BYS), 2013: Based on pre-collected traffic data from package one of the ORTMCS project.
- ✓ Do-Minimum Scenario (DMS): Includes all changes implemented or planned between the base year (2013) and assessment year (2015).
- ✓ Do-Something 1 Scenario (DS1S).
- ✓ Do-Something 2 Scenario (DS2S).
- ✓ Do-Something 3 Scenario (DS3S) (Only for corridor 4).

Details regarding the proposed road traffic management control improvements included in the DMS, DS1S and DS2S are provided below in Table 8 for each corridor. It should be noted that DS1S and DS2S also include all road traffic control improvements described in the DMS, with the exception of DS3S where no DMS was anticipated.

These set of proposed road traffic management was subjected to a road traffic assessment followed by and air quality assessment.

Table 2: Proposed Road Traffic Management Improvement Scenarios

Corridor	Scenario	Traffic Improvement
Corridor 1	DMSc1	- Signalised improvements at the Rudmore Roundabout; - Mile End Road/ Church Street Roundabout/Marketway Roundabout improvements, including the extension of the bus lane southbound to Marketway; and - St Michael's Gyratory improvements, including the signalisation of the Anglesea Road approach with pedestrian facilities and Cambridge Road triple crossing to run in isolation.
	DS1Sc1	- Improvements to the Holbrook/ Lake Road Roundabout, including the introduction of a 40 m flare on Church Street for left turns only and the introduction of a 35 m flare on Lake Road east for left turns only utilising the existing cross-hatched carriageway.
	DS2Sc1	- Improvements to the Church Street roundabout, including allowing 3 lanes from the merge with Rudmore Roundabout and the introduction of a bus gate upstream of the Mile End Road approach signals.
Corridor 2	DMSc2	- Modifications made to the following junctions: - Kingston Road/New Road; - Fratton Road/Arundel Street: Fratton Road including moving the northbound stop line; and - Kingston Road/Kingston Crescent: updated with revised staging to allow staggered pedestrian crossing over Kingston Crescent and allowing south-bound right turn filter phase.
	DS1Sc2	- Alterations to bus stop locations and parking/loading restrictions on Kingston Road southbound, south of Queens Road.
	DS2Sc2	- Kingston Road/New Road: relocation of the Kingston Road northbound stop line closer to the junction to reduce inter-green traffic signal times; and - Kingston Road/Kingston Crescent: reconfiguration of the existing road space on Kingston Road between Kingston Crescent and Clydebank Road to facilitate two lanes northbound.
Corridor 3	DMSc3	- Modifications were made to the following junctions: - London Road/Northern Parade junction: signalisation (includes prohibiting southbound U-turn movement); - A288/Goldsmith Avenue junction: installation of MOVA and geometric improvements includes reconfiguring the northbound approach to provide one through lane and one left turn lane, along with provision of signalised pedestrian crossings. - A288 / Velder Avenue junction: installation of MOVA. - A288 / St. Mary's Hospital Entrance junction: installation of MOVA. - A288 / Stubbington Avenue / Burrfields Road junction: optimisation of signal timings and the stage sequence. Revised stage sequence

Corridor	Scenario	Traffic Improvement
		introducing a break in the flow of traffic into the southbound receiving lane of Copnor Road to prevent the queueing traffic back into the junction.
	DS1Sc3	- Alterations to bus stop locations at the following locations: - Norway Road Eastbound, East of Copnor Road; - Copnor Road Southbound, south of Stubbington Avenue / Burrfield Road; - Milton Road Northbound, north of Locksway mini-roundabout; - Milton Road Northbound, south of Priory Crescent; and - Milton Road Southbound, south of Priory Crescent. - Parking/loading restrictions on the southbound section of Milton Road between Dover Road and St Mary's Roundabout.
	DS2Sc3	- Improvements at the Copnor Road/Stubbington Avenue/Burrfield Road Junction to provide dedicated right turn lane into the petrol station.
Corridor 4	DS1Sc4	- Improvements as recommended in the SEHBRT study of February 2014
	DS2Sc4	- Shortening the existing bus lane on the southbound approach to the Spur Road Roundabout by 50 m and introduction of a bus gate to provide priority to buses; and - Allow more weaving distance for traffic to merge to the nearside lane
	DS3Sc4	- Changes to the lane allocations to allow a double right turn to A3 Southampton Road at the Spur Road Roundabout. Traffic in the middle lane can travel ahead or right.
Corridor 5	DMSc5	- Removal of stage 3 from the Victoria Road / Outram Road / Elm Grove junction (Phase B becomes gap seeking) - The additional carriageway has been assigned to a cycle lane
	DS1Sc5	- Improvements to bus stops
	DS2Sc5	- Introduction of parking restrictions

5 Vehicle Micro-Simulation Modelling (Second Stage- Phase One)

5.1 Introduction

Atkins was commissioned by PCC to develop five existing conditions micro-simulation models of various road traffic control improvement schemes along key routes within Portsmouth boundary, and to carry their transport assessment with a view to improving both road traffic fluidity and air quality within each of the five pre-identified study areas, named "Corridor" (in Appendix D, Figure 8).

This section of the report documents the calibration and validation results of the each corridor's existing conditions model and assessment of proposed schemes developed using VISSIM, which is part of the PTV Vision Transport modelling suite. VISSIM is a microscopic traffic flow simulation model based on car following and lane change logic. VISSIM can analyse vehicular traffic including bus / tram, pedestrian and bicycle operations under constraints such as lane configuration, traffic composition, traffic signals, and bus/tram stops. VISSIM does not follow the conventional link / node modelling system, but utilises a link / connector system that enables complex geometry to be modelled. The link / connector system also permits different traffic controls (signal, give way or stop) to be utilised anywhere in the model. VISSIM is also capable of modelling vehicle actuation traffic control utilising the Vehicle Actuated Programming (VAP) module as well as MOVA using the PCMOVA module from TRL. Therefore, it is an appropriate tool for the evaluation of the combination of complex geometry and traffic controls (give way and traffic signal) operations that will be assessed within the study area.

The vehicle record outputs from the VISSIM model will be utilised by the AIRE emissions modelling assessment software to determine if the proposals are predicted to reduce emissions and improve the air quality within the study area.

A full data collection programme was commissioned in order to provide data for the model and included manual classified turning movement surveys at the key junctions throughout the study area and Automatic Number Plate Recognition (ANPR) cameras for journey time analysis.

All traffic signal controllers have been coded in Visual Vehicle Actuated Programming (VisVAP) using the signal specifications in order to replicate the average SCOOT green times, Cableless Linked Fixed time plans (CLF) or Vehicle Actuated (VA) control.

The models have been constructed to represent the morning peak period from 07:00 to 10:00, an Inter peak from 12:00 to 14:00 and an evening peak period from 16:00 to 19:00 each with a 30 minute seed period, prior to each peak to populate the network before analysis is undertaken.

A site visit was undertaken during the AM, IP and PM peaks to observe traffic conditions along the network at each corridor.

5.2 Domain Study

PCC identified a domain study to address a total of 24 junctions across the city where significant changes in traffic flow were anticipated due to the proposed traffic management scenarios. The selected 24 junctions include areas where detrimental effects may be experienced due to the rerouting of traffic as a result of the proposed scenarios.

The majority of these junctions focus on the main north - south corridors that connect the M27 / A27 to Portsea Island and are illustrated in in Appendix D, Figure 8.

5.3 Data Collection

A data collection programme was undertaken by Traffic Survey Partners (TSP) on behalf of Arup throughout October 2013, with the main day of traffic surveys being undertaken on Tuesday 1st October 2013. The data collection is described below by category.

5.3.1 Turning Counts

Manual classified counts (MCC) (car, taxi, light goods vehicles (LGV), other goods vehicles (OGV1 and OGV2), motorbike, bus and coach classifications) were conducted between 07:00 in the morning to 19:00 in the evening. The survey video files were also been received.

5.3.2 Automated Traffic Counts (ATC)

The ATC loops were placed and covered a period of 4 weeks from Monday 30th September to Sunday 27th October 2013 in order to avoid half term holidays.

5.3.3 Travel Times

Journey time surveys were conducted using the moving observer method on Tuesday 1st October 2013, between 07:00 to 10:00, 12:00 to 14:00 and 16:00 to 19:00.

5.3.4 Queue Lengths

Manual queue length surveys were collected for all approaches at each junction on Tuesday 1st October 2013 between 07:00 to 10:00, 12:00 to 14:00 and 16:00 to 19:00. The queue lengths were collated per lane with spot observations undertaken every 5 minutes. All observations were undertaken at the appropriate give way lines.

5.3.5 Pedestrians Surveys

The surveys were undertaken on Tuesday 1st October 2013 and counted the number of pedestrians crossing in each direction at signalised crossing at or adjacent to the surveyed junctions.

For the remainder of the crossings within the network where the data was unavailable, assumptions were made per 15 minute interval.

5.3.6 Bus Services.

The network contains several bus stops so it was necessary to isolate the bus services running through the network from the traffic count data and code these separately to the main traffic counts in order to model the correct traffic conditions.

The main bus operator in Portsmouth is First Hampshire and Dorset with a few services operated by Stagecoach Coastline.

All timetables for the services which operate in the network during the weekday AM, Inter and PM peak periods were collated from the Travel Line internet site (http://traveline.info/). The routes of the individual services through the network were given the corresponding service numbers as their route number and given separate inbound and outbound routes.

In order to calculate when the bus service would appear in the network, the nearest stop on the edge of the network was selected for the start time of the service, or where this information was missing, the nearest stop outside of the network was adopted and the time taken by the bus between this stop and when it appeared in the network was calculated and added to the start time.

Once the bus times were calculated for each 15 minute interval, the buses were then entered into VISSIM separately using Public Transport inputs.

The dwell times for all bus stops within the network have been set to the default value of 20 seconds with a 2 second standard deviation. All buses have been coded to stop at every stop along their route, to provide a robust assessment.

5.4 Traffic Signal Data

The traffic signal specifications for all signalised junctions within the study area were provided by PCC' road traffic management unit. Where specifications were not available, observed timings for each junction were provided.

5.5 Model Development

The VISSIM model is comprised of five basic components:

- ✓ Highway network (links and connectors).
- ✓ Traffic control systems (signal, stop and give-way control).
- ✓ Traffic inputs.
- ✓ Vehicle type and compositions.
- ✓ Vehicle routes.

VISSIM version v5.40-09 has been used to construct and run the model.

5.5.1 Balanced Turning Movements

Within VISSIM the traffic flows needed to be balanced so the same amount of traffic enters and exits each junction within the network. The MCC data was utilised to produce a network of unbalanced turning movement flows in 15 minute intervals.

The SATURN flows were then used to create turning proportions which were used to balance the remaining junctions back to the surveyed roundabouts in 15 minute intervals.

A seed period of 30 minutes was utilised to populate each peak, however, where traffic data for the 30 minute interval of 06:30-07:00 was not available therefore, the 07:00-07:15 flows were utilised and appropriate correction is applied based upon observations from the survey video footage.

5.5.2 Highway Network

The base road network for the existing conditions VISSIM models was constructed for both peaks based upon an Ordinance Survey CAD background.

In order to facilitate realistic queuing and vehicle behaviour the main link type utilised on the dual carriageway sections was Urban Free Lane Selection (Motorised) and on the signal lane sections Urban Left-Side Rule (Motorised) utilised, both Wiedemann 74.

5.5.3 Traffic Control System

Priority rules were placed at all give-way locations, with separate rules for lights and heavy vehicles to account for differing gap acceptance values at roundabouts.

5.5.4 Vehicles Types and Classes

VISSIM uses individual vehicle models that are grouped into vehicle types which are then grouped into vehicle classes. Vehicle classes for car, taxi, LGV, HGV, bus and motorcycle were used within the model. The car class was further split into small and large cars. HGV was further split into OGV1 and OGV2. All other vehicle classes contained a single vehicle type.

5.5.5 Vehicle Inputs and Composition

The balanced traffic flow networks for the AM and PM peak periods were used to determine the total vehicle inputs at all entries into the network in 15 minute intervals.

The survey data was used to calculate the vehicle type compositions at the entry points to the network in 15 minute intervals.

The light vehicles in VISSIM were split into vehicle types of small cars and large cars in the assumed proportions of 75% and 25% respectively.

5.5.6 Vehicle Routes

The balanced traffic flow networks for the AM and PM peaks were used to determine the total vehicle routes throughout the network in 15 minute intervals.

5.5.7 Traffic Signal Data

The traffic signal specifications provided by PCC were interrogated in order to code in the most applicable signal control method at each junction. All junctions were coded in Vehicle Actuated Programming (VAP) using the VisVAP module of VISSIM regardless of the specific control method. Using VAP allows Vehicle Actuation (VA) to be replicated in the model using detector loops in VISSIM, provide demand dependant phases and stages to be introduced as well as the ability to apply different time plans mid-way through a simulation. In the case of the Portsmouth model, VisVAP has been used to change the programme times to match the master clock settings within the specifications.

5.5.8 Model Output

Measures of effectiveness have been coded and output from VISSIM including the following:

- General network performance statistics.
- Junction analysis (including demand and supply volumes, average and maximum queue lengths).
- Journey times; and
- Vehicle record (for use in AIRE).

5.6 Model Calibration and Validation

In order to confirm that the model is fit for the purpose of the evaluation of proposed improvement measures and to provide credibility to results it was necessary to calibrate and validate the model.

The calibration process involved changing the network set up and behavioural characteristics to achieve a match between observed and modelled data.

Model validation assessed the accuracy of the model by comparing traffic data from the model with independent traffic data not used in the model building process. Validation is directly linked to the calibration process as adjustments in calibration are needed to improve the models ability to replicate field measured traffic conditions.

The calibration and validation of each corridor existing conditions model and assessment of proposed schemes developed used VISSIM, which is part of the PTV Vision Transport modelling suite. VISSIM is a microscopic traffic flow simulation model based on car following and lane change logic. VISSIM can analyse vehicular traffic including bus / tram, pedestrian and bicycle operations under constraints such as lane configuration, traffic composition, traffic signals, and bus/tram stops. VISSIM does not follow the conventional link /node modelling system, but utilises a link / connector system that enables complex geometry to be modelled. The link / connector system also permits different traffic controls (signal, give way or stop) to be utilised anywhere in the model. VISSIM is also capable of modelling vehicle actuation traffic control utilising the Vehicle Actuated Programming (VAP) module as well as MOVA using the PCMOVA module from TRL. Therefore, it was an appropriate tool for the evaluation of the combination of complex geometry and traffic controls (give way and traffic signal) operations that were assessed within the study area.

The models runs were constructed to represent the morning peak period from 07:00 to 10:00, an Inter peak period from 12:00 to 14:00 and an evening peak period from 16:00 to 19:00 with a 30 minute seed period prior to each peak to populate the network before analysis was undertaken.

5.6.1 Corridor 1

5.6.1.1 Location

This corridor is located partly within the area of Portsmouth City Centre, situated south of the M275. This study area includes three major roundabouts, one gyratory and four major signalised junctions. It includes the motorway M275 which is the principal route for traffic entering and leaving Portsmouth. It further continues as the A3 into Portsmouth and together they form the main routes through Portsmouth City centre area. The A3 forms a key link road between the M275, A288 and A2030 (Appendix D, Figure 8)

The area of assessment is shown bounded by the blue line and includes all junctions from the Rudmore Roundabout in the north through to St Michael's Gyratory in the south and Lake Road/A2030 roundabout to the east. In the middle of the network is the Mile End Road roundabout and the Marketway roundabout which has recently been converted from a roundabout to a signalised junction.

5.6.1.2 Model Validation

As VISSIM is a stochastic model, the results differ slightly depending on the random seed assigned to each simulation run. Therefore, in order to obtain statistically significant results, the models were simulated 16 times with different random seeds.

All peaks validated very well in terms of flow throughput, with the AM peak achieving 99% GEH and the PM and Inter achieving 100% GEH.

The network operates within capacity with an overall LOS of D in the AM peak, C in the PM peak and B in the Inter peak.

In the AM peak, the Holbrook Road / Lake Road roundabout operates over capacity and the Church Street Roundabout operates at capacity during the last two hours.

In the PM peak the Holbrook Road roundabout operates at capacity in the first two hours. The Inter peak shows no capacity issues, although several individual turning movements are operating at capacity.

The AM peak modelled travel times were validated with 74% of modelled travel times within the lower and upper ranges, however, the cumulative travel times validated to 95%. Travel times for the PM peak validate with 93% of modelled times within the upper and lower ranges, and 100% for cumulative times. In the Inter peak, 89% of modelled travel times validate to the observed times, along with 79% of cumulative times. This was due to the fact that during the survey day, traffic management was in place along Commercial Road and at the Church Street Roundabout, which closed lanes and thus reducing capacity around this junction.

The queue lengths throughout all peaks did not validated particularly well to the observed queues, with much lower modelled average queues and much higher maximum queues.

However, comparisons between the videos and VISSIM showed similar queues and therefore, the queue lengths were deemed to be validated to acceptable levels and more importantly, the travel times in the model match well to the observed journey times.

The VISSIM models were deemed to have been calibrated and validated to within acceptable levels and were therefore fit for purpose and used as an evaluation tool for potential improvement schemes within the study area to improve air quality.

5.6.1.3 Proposed Scenarios

Three proposed scenarios were identified and assessed and are named DMSc1, DS1Sc1, and DS2Sc1. The proposed changes for each scenario are detailed below:

- **DMSc1**

  To incorporate the following changes to the network, which had either already been implemented on site, or were due to be implemented shortly:

  - Signalisation of the Rudmore Roundabout, bus lane and bus gate along the SB off-slip and alterations to lane allocations;
  - The merge from Rudmore Roundabout SB on slip with the M275 flyover traffic was altered so that the slip road traffic merges with the nearside lane of the flyover, resulting in a lane drop;
  - Extending the existing bus lane along Mile End Road southbound through the Church Street Roundabout, Commercial Road and Marketway Roundabout to join up with the current bus lane along Marketway, with lane alterations and signal time changes at the Church Street Roundabout; and,
  - Signalising Anglesea Road approach and opposing circulatory to allow pedestrian facilities, and altering the Cambridge Road triple crossings to run in isolation at St Michael's Gyratory.

- **DS1Sc1**

  To utilise the DMS model layout with alterations made to the Holbrook Road / Lake Road roundabout. Two flares were introduced on the Church Street and Lake Road (E) approaches for left turning traffic only to provide more capacity for the ahead and right turning traffic.

- **DS2Sc1**

  To incorporate a bus gate upstream of the Mile End Road approach signals to allow buses clear access to merge with the nearside lane. It also retained the existing 3 lanes from the Rudmore on slip and shortens the right turn flare.

5.6.1.4 Results Summary and Recommendations

Network performance and junction performance measures were analysed and compared for the existing conditions, DMSc1, DS1Sc1 and DS2Sc1 scenarios.

Traffic management was in place at the Rudmore Roundabout throughout all peaks, with lane closures and speed restrictions in force. An earlier traffic count was undertaken at the Rudmore Roundabout in March 2013 and a comparison of the traffic flows showed little difference in the PM and Inter peaks, however, the AM peak comparison showed some significant differences on the M275 southbound off-slip and the London Road approaches where the March flows were much larger than the October flows.

Given the large discrepancy in the AM peak flows the proposed scenarios utilised revised flows in the AM peak. The March 2013 traffic flows were used directly at the Rudmore roundabout and Church Street roundabout and then the resulting differences downstream were balanced through in the proportion of the existing October 2013 turning movement.

The AM peak comparison results indicated that all three proposed scenarios result in capacity problems around the Church Street Roundabout and Holbrook Road roundabout as a result of the gating strategy and the reduction in green time that the Church Street approach receives.

The queues along Church Street extend back to the Holbrook roundabout blocking entry from Holbrook Road. The congestion along Holbrook Road results in a high unmet demand.

As a result of the congestion from Church Street, the Holbrook Road roundabout was predicted to operate over capacity in all scenarios throughout the AM peak, although some benefits are evident in the DS1Sc1 as a result of the proposed changes to two approaches.

The PM comparison results predict that the Rudmore Roundabout would operate better by introducing the signals and the changes to the SB off-slip, resulting in fewer delays. Northbound travel times to the Rudmore Roundabout decrease by almost 30 seconds in the middle peak hour.

The Holbrook roundabout performs better in the DS1Sc1, although it is still predicted to operate at capacity in the first two hours with the Lake Road (W) arm over capacity, as no changes can be made due to highway restrictions. As in the AM peak, the Church Street approach is also congested with the queue extending back to this junction.

Due to the improvements at the Holbrook Road roundabout, the DS1Sc1 is predicted to be the optimum performer in terms, travel times and network speed, although the differences in the results are marginal.

The Inter peak results showed that overall; the DS1Sc1 performs better in terms of travel times and network speed, but that the base has lower delays. At the Rudmore Roundabout, the A3 and Wharf Road approaches operated close to or over capacity as a result of introducing the traffic signals.

The Holbrook Road roundabout performed much better in the DS1Sc1 with delays almost halved in the last hour.

Therefore, it is recommended that the improvements to the Holbrook Road / Lake Road roundabout should be taken forward as the preferred scenario once the DMSc1 network changes have been concluded and that amendments to the Church Street Roundabout signals be reviewed due to the congestion observed along Church Street as a result of reducing the green time in the AM and PM peaks.

5.6.2 Corridor 2

5.6.2.1 Location

This corridor is located within the area of Portsmouth City Centre and Fratton. The study area includes two give way controlled roundabouts, and five signalised junctions (Appendix D, Figure 8).

5.6.2.2 Model Validation

All peaks validated very well in terms of flow throughput, with AM peak achieving 99.8% GEH, PM peak achieving 99.2% GEH and the Inter peak achieving 99.6% GEH.

The queue lengths throughout all peaks were validated particularly well to the observed queues, with lower modelled average queues and higher maximum queues. However, as the majority of the junctions with observed queue lengths are signalised, queue length validation was not considered to an appropriate measure (as the recording methodology is very different between observed and modelled), therefore, greater emphasis was based on the journey time validation.

The AM peak modelled travel times were validated well, with the cumulative travel time validated to 100% of modelled travel times. The cumulative travel times for the PM peak and Inter peak validated to 73% and 95% respectively.

The VISSIM models were deemed to have been calibrated and validated to within acceptable levels and are therefore, fit for purpose and used as an evaluation tool for potential improvement schemes within the study area to improve air quality

5.6.2.3 Proposed Scenarios

Three proposed scenarios were identified and assessed and are named DMSc2, DS1Sc2, and DS2Sc2. The proposed changes for each scenario are detailed below:

- **DMSc2 (already identified improvements)**

  To modify several signalised junctions throughout Corridor 2.

- **DS1Sc2**

  To amend bus stops throughout the network (where possible).

- **DS2Sc2**

  To improve junction in line with the recommendations made within the South East Hampshire Bus Rapid Transit (BRT) Highway Design Priorities Study undertaken in February 2014.

5.6.2.4 Results Summary and Recommendations

Network performance and junction performance measures were analysed and compared for the existing conditions, DMSc2, DS1Sc2 and DS2Sc2 scenarios.

The DS1Sc2 was the best performing of the three scenarios tested in the AM peak, with a negligible impact when compared to the existing conditions. The LOS at each junction generally remained the same throughout each of the modelled options except for the section between Hanway Road and Kingston Crescent, where it tended to reduce slightly in the DMSc2, DS1Sc2 and DS2Sc2.

Testing of the three potential scenarios in both the PM and Inter peaks revealed that the DS1Sc2 was the optimum performing scenario on nearly all measures at a junction and network wide level.

The DMS offers an improvement over the existing conditions, and these were enhanced even further by the proposals in the DS1Sc2. The DS2Sc2 appeared to have a negative impact on the benefits achieved in the DMSc2.

Testing also showed that the changes made to the signal control at the Kingston Road / Kingston Crescent junction in the DMSc2 improved the junction's performance throughout the PM peak, improving it from a LOS from a E in the first two hours and a LOS D in the final hour of the existing conditions scenario, to a LOS C throughout the DMSc2, DS1Sc2 and DS2Sc2.

The removal of the on street bus stops in the DS1Sc2 reduced the number of stops by nearly 9,300 instances across the entire modelled period compared to the base scenario in the PM peak.

The summary of impacts for the Inter peak and PM Peak confirmed that on many measures, the benefits realised by the DMSc2 were compromised by the proposals made in the DS2Sc2, but were enhanced by the DS1Sc2.

Therefore, it is recommended that the DS1Sc2 is considered further as the preferred scenario as the operational assessment of three potential scenarios has shown that the DS1Sc2 results in the optimal performance during all peak periods.

5.6.3 Corridor 3

5.6.3.1 Location

This corridor extends from Highland Avenue to M27 across the city. The study area includes one give-way controlled roundabout, one approach of a give-way controlled roundabout, two give-way controlled priority junctions, and four signalised junctions (Appendix D, Figure 8) bounded by the blue line.

5.6.3.2 Model Validation

All peaks validated very well in terms of flow throughput, with each peak meeting the GEH threshold in 100% of the cases for the PM and Inter-Peak periods, and 99.6% of the cases for the PM periods.

The AM, Inter-Peak and PM peak results for junction performance indicated that several junctions operate at unacceptable LOS during at least one of the peak hours. The Stubbington Avenue / Burrfields Road junction was the most critical junction which operated at LOS E or F during 7 of the 8 hours analysed. The A288 / Goldsmith Avenue operated at an unacceptable LOS for 4 of the 8 hours, while the junctions of A288 (Copnor Road) / Rodney Avenue, and A288 (Copnor Road) / Old London Road operated at an unacceptable LOS for 3 of the 8 hours analysed.

The modelled travel times for the PM, Inter-Peak and PM peak periods were validated adequately with 100% of modelled travel times meeting the 95% confidence level threshold. In addition, all the models were also validated to meet the DMRB criteria of ±15% (or 1-minute if higher) for more than 85% of the cases. The cumulative end-to-end travel times met the ±15% criteria in 100% of the cases for all peak hour directions except the southbound direction during the 13:00 to 14:00 Inter-Peak hour.

The average modelled queue lengths throughout all peaks were reasonably close to the observed queues, with less than 10% of cases where the difference between modelled and observed queues exceeded 10 vehicles. In addition, a visual validation of queues showed similar queuing patterns. Therefore, the queue lengths were considered to be satisfactory especially since both the travel times and volumes in the model match very well to the observed travel times and volumes, respectively.

The VISSIM models were deemed to have been calibrated and validated to within acceptable levels and were therefore, fit for purpose and used as an evaluation tool for potential improvement schemes within the study area to improve air quality.

5.6.3.3 Proposed Scenarios

Three proposed scenarios were identified and assessed and are named DMSc3, DS1Sc3, and DS2Sc3. The proposed changes for each scenario are detailed below:

- **DMSc3**

  This scenario consisted of the following planned improvements

  - Signalisation of London Road / Northern Parade junction. This improvement included prohibiting southbound to northbound U-turn manoeuvres. As a result, southbound vehicles originating from the Portsbridge roundabout or Military Road intending to go north along Northern Parade will be routed through the London Road/Copnor Road circulatory.
  - Geometric improvements and installation of MOVA at the Milton Road / Goldsmith Avenue junction. The geometric improvement included reconfiguring of the northbound approach to provide one through lane and one left turn lane, along with provision of signalised pedestrian crossings.

  - Installation of MOVA at the Milton Road / Velder Avenue junction.
  - Optimisation of signal timing and stage sequence at the Milton Road / St. Mary's Hospital Entrance junction.
  - Optimisation of signal timing and stage sequence at the Copnor Road / Stubbington Avenue / Burrfields Road junction.

- **DS1Sc3**

  This scenario included the following:

  - Replacement of on-street bus stops with laybys at the following locations:
    - Norway Road Eastbound, East of Copnor Road.
    - Copnor Road Southbound, south of Stubbington Avenue / Burrfield Road.
    - Milton Road Northbound, north of Locksway mini-roundabout.
    - Milton Road Northbound, south of Priory Crescent.
    - Milton Road Southbound, south of Priory Crescent.
  - Additionally, it was assumed that parking, loading and waiting restrictions will be enforced along the southbound section of Milton Road between Dover Road and St. Mary's roundabout during the PM, IP, and PM peak periods. As stated previously, a wider speed range (20-35 mph) was used for this section between Dover Road and the St. Marys Road / Langstone Road roundabout to replicate driver behaviour along this dense urban section which includes on-street parallel parking and a bicycle lane. This special speed limit range was eliminated as part of DS1S to account for the expected increase in travel speeds along this section due to the proposed parking, loading and waiting restrictions

- **DS2Sc3**

  This scenario incorporated construction of a southbound right turn lane into the fuel station located approximately 50m north of the Copnor Road / Stubbington Avenue / Burrfields Road junction. Currently, traffic turning right into the fuel station blocks the southbound through traffic resulting in excessive delays for the southbound movement at this junction. The right turn lane will provide storage for the right turning traffic without blocking the southbound through traffic.

5.6.3.4 Results Summary and Recommendations

Network performance and junction performance measures were analysed and compared for the existing conditions, DMSc3, DS1Sc3 and DS2Sc3.

The analysis indicates that DS1Sc3 performs better than the DS2Sc3 in terms of reduction in average queue lengths, delays and travel times in all peaks.

The benefits associated with DS1Sc3 could be increased further by addressing capacity constraints at the Portsbridge roundabout. This roundabout is expected to deteriorate further after the implementation of the improvements associated with DS1Sc3.

The DS2S is also predicted to operate better than the base and DMSc3 in most scenarios.

Based on the results of this study, DS1Sc3 is the optimal scheme but DS2Sc3 also showed benefits.

Therefore, it was recommended to pursue the feasibility of implementing a combined DS1Sc3 and DS2Sc3 scheme as the preferred scenario, given that both the operational assessment of 3 potential scenarios has shown that the DS1Sc3 results in the optimal performance over the 3 peak periods assessed and that the DS2Sc3 also offers benefits.

5.6.4 Corridor 4

5.6.4.1 Location

This corridor is located within the area of Cosham, situated to the north of the M27 of the city (Appendix D, Figure 8). The study area includes two give way controlled roundabouts along the A397 and A3, all approaches and exits, and three signalised junctions.

5.6.4.2 Model Validation

All peaks validated very well in terms of flow throughput, with each peak achieving 100% GEH.

The AM and PM peak results for junction performance indicated that the network operates within capacity with an overall LOS of C. However, the middle peak hour for both peaks the network was operating with an overall LOS of D, with the hospital junction operating close to capacity with an overall LOS of D. Several individual movements are operating at or over capacity in the last two hours of the AM peak and throughout the entire PM peak. The Inter peak junction performance indicates no capacity issues with the network operating with an overall LOS of B.

The AM peak modelled travel times have validated well, with 96% of modelled travel times within the lower and upper ranges, however, the cumulative travel times validated to 100%. Travel times for the PM and Inter peaks validated extremely well with 100% of modelled times within the upper and lower ranges, along with 100% cumulative times validating.

The queue lengths throughout all peaks did not validate particularly well to the observed queues, with much lower modelled average queues and much higher maximum queues. As a result, visual validation of queues was undertaken for each peak and screenshots provided showing comparisons of the survey video footage compared with the VISSIM model at the same time. The comparisons showed similar queues and therefore, the queue lengths were deemed to be validated to acceptable levels and more importantly, the travel times in the model matched very well to the observed journey times.

The existing conditions VISSIM models were deemed to have been calibrated and validated to within acceptable levels and were therefore, fit for purpose and used as an evaluation tool for potential improvement schemes within the study area to improve air quality.

5.6.4.3 Proposed Scenarios

Three proposed scenarios were identified and assessed and are named DS1Sc4, DS2Sc4 and DS3Sc4. The proposed changes for each scenario are detailed below:

- **DS1Sc4**

  This scenario proposed widening of the carriageway on the southbound approach to provide suitable lane widths for buses to manoeuvre the roundabout and reduce conflicts with general traffic resulting in buses being able to utilise the existing bus lane to its full potential;

- **DS2Sc4**

  This scenario proposed shortening the existing bus lane on the southbound approach to the Spur Road Roundabout and introduced a bus gate to provide priority to buses. The bus lane was moved back 50m upstream of the approach to allow a greater distance for general traffic to merge into the nearside lane to either turn left or to travel straight ahead. The widening of the approach as per DS1S was also included.

- **DS3Sc4**

This scenario altered the lane allocation to allow a double right turn to A3 Southampton Road. Therefore, the middle lane was used to travel right or ahead and the nearside lane to travel left or ahead as it was also assumed that the widening of the approach had taken place as per DS1S. The bus gate was not included in this scenario.

5.6.4.4 Results Summary and Recommendations

Network performance and junction performance measures were analysed and compared for the existing conditions, DMSc4, DS1Sc4 and DS2Sc4.

The comparison results have shown that in all three peak models, the DS3Sc4 is predicted to be the optimum performer with the biggest benefits around the Spur Road roundabout as a result of introducing the double right turn and widening the approach to enable buses to manoeuvre the roundabout.

The DS3Sc4 lowers delays, reduces average queues, and in the more congested AM and PM peaks lowers travel times and increases capacity at roundabout.

The remaining proposed scenarios also offered benefits to the network compared with the BYS, but the more notable benefits were with the DS3Sc4.

Therefore, it was recommended to pursue the feasibility of implementing DS3Sc4 as the preferred scenario given that the operational assessment of 3 potential scenarios has shown that the DS3Sc4 results in the optimal performance over the 3 peak periods assessed.

5.6.5 Corridor 5

5.6.5.1 Location

This corridor is located within the area of Southsea, situated to the south of the A2030 (Appendix D, Figure 8). The study area includes three signalised junctions, two priority junctions and several pedestrian crossings. The study area is shown bounded by the blue line.

5.6.5.2 Model Validation

All peaks validated very well in terms of flow throughput, with each peak achieving 100% GEH.

The AM Peak results indicated that the network operated within capacity with an overall LOS of C. Although during the middle peak hour the Victoria Road / Elm Grove junction operated close to capacity with a LOS of D and several individual movements at the junction operating at capacity with a LOS of E.

During the PM Peak the network operates within capacity with an overall LOS of C for the PM peak. Throughout the entire PM peak the Victoria Road / Outram Road junction operated close to capacity with a LOS of D for all peak hours and with some individual movements operating at or over capacity.

The Inter peak junction performance indicated no capacity issues with the network operating with an overall LOS of B.

The AM peak modelled travel times validated extremely well, with 100% of modelled travel times within the lower and upper ranges. Travel times for the PM and Inter peaks also validated well with 95.8% (PM Peak) and 93.8% (Inter Peak) of modelled times within the upper and lower ranges, along with and 91.7% (PM Peak) and 100% (Inter Peak) cumulative times validating.

The queue lengths throughout all peaks were not used to validate the model as the manner and frequency with which they are recorded on site are not considered to be robust or comparable to the output of queue length data from VISSIM.

The travel times in the model matched very well to the observed journey times.

The VISSIM models were deemed to have been calibrated and validated to within acceptable levels and are therefore, fit for purpose and used as an evaluation tool for potential improvement schemes within the study area to improve air quality.

5.6.5.3 Proposed Scenarios

Three proposed scenarios were identified and assessed and are named DMSc5, DS1Sc5, and DS2Sc5. The proposed changes for each scenario are detailed below:

- **DMSc5**

  This scenario proposed the removal of stage 3 from the signalised junction of Victoria Road, Outram Road and Elm Grove, converting the right turn movement from Victoria Road South to Outram Road to gap seeking during stage 2, and reducing the number of northbound lanes to 1 to accommodate a cycle lane;

- **DS1Sc5**

  This scenario proposed the conversion of the bus stops on the carriageway into bus laybys where it is considered feasible;

- **DS2Sc5**

This scenario proposed the removal of the on street parking provision at locations where it impedes two way traffic flows.

5.6.5.4 Results Summary and Recommendations

Network performance and junction performance measures were analysed and compared for the existing conditions, DMSc5, DS1Sc5 and DS2Sc5.

To replicate the introduction of parking and loading restrictions in the DS2Sc5, reduced speed areas which had been added to the model to replicate vehicles slowing or stopping to allow oncoming traffic to pass, were removed from the sections identified for implementation of the restrictions, enabling vehicles to travel freely in both directions again.

The DMSc5 changes improved the operation of the Victoria Road / Elm Grove / Outram Road junction in all peaks.

The DS1Sc5 was the optimum performing scenario during all peak periods, AM, PM and Inter peaks, however, the DS2Sc5 was only marginally worse than the DS1Sc5. The predicted benefits of the schemes were small; however, the costs were also likely to be low and were considered worthy of consideration.

Therefore, it is recommended to pursue the feasibility of implementing both the DS1Sc5 to introduce bus laybys at several locations along Elm Grove and Victoria Road North and the DS2Sc5 to remove on street parking provision where it impedes two way traffic flow; given that both the operational assessment of 3 potential scenarios has shown that the DS1Sc5 results in the optimal performance over the 3 peak periods assessed, and the DS2Sc5 also offers benefits.

5.7 Conclusions and Recommendations

In general the result summary and recommendations of the VISSIM vehicle modelling for all individual five corridors are as follows:

- ✓ Corridor 1

  The improvements to the Holbrook Road / Lake Road roundabout should be taken forward as the preferred scheme once the DMSc1 network changes have been concluded and that amendments to the Church Street Roundabout signals be reviewed due to the congestion observed along Church Street as a result of reducing the green time in the AM and PM peaks.

- ✓ Corridor 2

  Due to the optimal performance during all peak periods; DS1Sc2 should be considered further as the preferred Scheme.

- ✓ Corridor 3

  Due to the optimal performance during all peak periods; DS1Sc3 should be considered further as the preferred Scheme. In the meantime DS2Sc3 also offers benefits. Therefore, it is recommended to pursue the feasibility of implementing a combined DS1Sc3 and DS2Sc3 scheme as the preferred option.

- ✓ Corridor 4

Due to the optimal performance during all peak periods; DS3Sc4 should be considered further as the preferred Scheme.

✓ Corridor 5

Due to the optimal performance during all peak periods; DS1Sc5 should be considered further as the preferred Scheme. In the meantime DS2Sc5 also offers benefits. Therefore, it is recommended to pursue the feasibility of implementing both the DS1Sc5 to introduce bus laybys at several locations along Elm Grove and Victoria Road North and the DS2Sc5 to removal on street parking provision where it impedes tow way traffic flow DS1Sc5 and DS2Sc5 scheme as the preferred option.

6 Vehicle Emissions Modelling (Second Stage- Phase One)

6.1 Introduction

Vehicle emissions modelling has been undertaken using the Analysis of Instantaneous Road Emissions (AIRE) model software version 1.0.24115.0, developed for Transport Scotland by SIAS Limited in collaboration with TRL1.

AIRE is a tool chosen to evaluate and assess the environmental impact of various proposed road traffic management control improvement scenarios being considered in the vehicle micro-simulation modelling undertaken using VISSIM. The results from such modelling will be used to validate to certain degree the outcome of the micro-simulation study.

Data generated from such vehicle emission modelling airs on conservative scale.

6.2 Approach

AIRE incorporates a detailed vehicle emissions database compiled from Passenger car and Heavy duty Emissions Model (PHEM)2 runs undertaken by TRL. It can be used with vehicle trajectory data output from any micro-simulation model, although it requires the data to be in S-Paramics3 file format. For this project, micro-simulation modelling has been undertaken using VISSIM4. The VISSIM models have been run for weekday AM and PM peak periods - each comprising 3 hours, and the Inter Peak period – comprising 2 hours.

The AIRE model generates emissions data (given in milligrams) for oxides of nitrogen (NOx), PM10 (particulate matter generally less than 10 micrometres in diameter) and total carbon (TC) that would otherwise be produced by the road traffic volume as modelled by AIRE.

Emissions of carbon dioxide (CO2) have been derived by multiplying values for TC by 44/12. For each run of AIRE, outputs are generated in detailed and link summary formats. The detailed format is as a modified ‘carpositions’ file that includes columns for NOx, PM10 and TC. For the modelling undertaken, the data are given for each individual vehicle on a 0.4 second (i.e. 0.4 hertz, Hz) basis. The link summary file provides totals of NOx, PM10 and TC emissions for each link broken down by vehicle type and fuel type for the modelled period.

6.3 Results

The AIRE numerical results for the modelled vehicle emissions is expressed as totals of NOx, PM10 and TC for each link broken down by vehicle type and fuel type for the modelled period. They are collated for the individual five corridors, and are summarised in the following tables:

Table 3: AIRE emission results for Corridor 1

Vehicle	Fuel	BYSc1			DMSc1			DS1Sc1			DS2Sc1		
		NOx (g)	PM10 (g)	CO2 (kg)	NOx (g)	PM10 (g)	CO2 (kg)	NOx (g)	PM10 (g)	CO2 (kg)	NOx (g)	PM10 (g)	CO2 (kg)
Cars & MC	petrol	10,038.3	432.2	26,612.2	11,355.7	482.3	29,985.9	11,459.0	486.0	29,949.5	11,502.3	483.9	29,805.3
Cars	diesel	55,245.3	2,300.0	15,787.1	63,394.1	2,544.5	17,685.9	62,327.3	2,552.3	17,480.0	63,474.5	2,578.9	17,816.6
LGV	petrol	4.0	0.2	13,763.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LGV	diesel	99,081.0	2,117.6	18,128.1	115,464.9	2,411.1	20,932.6	111,330.3	2,298.5	20,516.5	113,746.0	2,395.6	20,673.5
Rigid HGV	diesel	15,972.7	295.4	2,803.6	16,961.2	313.1	2,915.5	16,952.3	330.9	2,890.9	16,671.5	312.9	2,867.8
Artic HGV	diesel	1,461.6	60.8	464.3	1,565.5	66.5	496.5	1,541.7	61.1	496.3	1,512.0	59.9	493.3
Buses & coaches	diesel	28,922.4	361.6	7,414.2	33,486.6	415.0	8,583.4	33,479.7	422.0	8,496.0	33,965.5	438.4	8,624.6
Totals		210,725.3	5,567.7	84,973.3	242,228.0	6,232.6	80,599.9	237,090.3	6,150.8	79,829.2	240,871.9	6,269.6	80,281.2
% of base c1					114.95%	111.94%	94.85%	112.51%	110.47%	93.95%	114.31%	112.61%	94.48%
% of DMSc1								97.88%	98.69%	99.04%	101.59%	101.93%	100.57%

Table 4: AIRE emission results for Corridor 2

Vehicle	Fuel	BYSc2			DMSc2			DS1Sc2			DS2Sc2		
		NOx (g)	PM10 (g)	CO2 (kg)	NOx (g)	PM10 (g)	CO2 (kg)	NOx (g)	PM10 (g)	CO2 (kg)	NOx (g)	PM10 (g)	CO2 (kg)
Cars & MC	petrol	2,748.2	103.6	7,372.2	2,694.3	103.1	7,233.0	2,638.6	102.7	7,150.7	2,698.7	103.5	7,230.2
Cars	diesel	14,104.7	529.3	4,415.2	13,722.6	526.8	4,345.6	13,340.3	516.5	4,237.9	13,565.9	520.1	4,328.8
LGV	petrol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LGV	diesel	35,531.9	738.5	5,744.3	33,352.0	710.0	5,493.6	32,334.6	696.7	5,388.5	34,313.4	722.9	5,636.2
Rigid HGV	diesel	3,242.0	65.6	502.6	3,265.2	67.0	501.9	3,153.8	64.6	495.6	2,954.6	61.7	456.7
Artic HGV	diesel	50.7	2.0	21.0	54.3	2.3	21.4	57.1	2.6	19.8	49.3	2.1	21.8
Buses & coaches	diesel	7,750.3	106.5	1,959.9	7,711.7	106.6	1,909.1	7,699.9	105.8	1,909.1	7,654.2	100.1	1,963.1
Totals		63,427.8	1,545.4	20,015.2	60,800.2	1,515.8	19,504.6	59,224.3	1,488.9	19,201.6	61,236.3	1,510.5	19,636.6
% of base c2					95.86%	98.09%	97.45%	93.37%	96.34%	95.94%	96.54%	97.74%	98.11%
% of Base c2								97.41%	98.22%	98.45%	103.40%	101.45%	102.27%

Table 5: AIRE emission results for Corridor 3

Vehicle	Fuel	BYSc3			DMSc3			DS1Sc3			DS2Sc3		
		NOx (g)	PM10 (g)	CO2 (kg)	NOx (g)	PM10 (g)	CO2 (kg)	NOx (g)	PM10 (g)	CO2 (kg)	NOx (g)	PM10 (g)	CO2 (kg)
Cars & MC	petrol	5,382.9	215.9	14,876.9	5,380.9	216.5	14,660.1	5,261.1	214.7	14,482.0	5,336.5	216.5	14,862.2
Cars	diesel	26,475.3	1,112.7	8,871.0	26,221.9	1,119.5	8,820.5	25,758.5	1,111.6	8,739.2	26,632.4	1,129.6	8,937.4
LGV	petrol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LGV	diesel	99,641.0	2,178.3	16,564.4	98,657.4	2,144.7	16,397.9	96,613.6	2,106.8	16,130.2	100,608.9	2,201.4	16,694.2
Rigid HGV	diesel	11,992.8	235.6	1,933.4	11,728.9	226.2	1,927.7	11,921.7	244.8	1,930.5	12,927.5	262.0	2,056.4
Artic HGV	diesel	605.2	27.3	255.4	542.2	24.8	225.5	558.1	25.7	229.0	611.2	28.1	242.2
Buses & coaches	diesel	14,743.9	203.2	3,636.9	14,203.2	193.2	3,598.8	14,532.5	196.1	3,581.0	14,983.5	202.8	3,615.4
Totals		158,841.0	3,972.9	46,138.0	156,734.6	3,924.9	45,630.5	154,645.5	3,899.7	45,091.9	161,100.2	4,040.4	46,407.8
% of base c3					98.67%	98.79%	98.90%	97.36%	98.16%	97.73%	101.42%	101.70%	100.58%
% of DMSc3								98.67%	99.36%	98.82%	104.17%	103.61%	102.92%

Table 6: AIRE emission results for Corridor 4

Vehicle	Fuel	BYSc4			DS1Sc4			DS2Sc4			DS3Sc4		
		NOx (g)	PM10 (g)	CO2 (kg)	NOx (g)	PM10 (g)	CO2 (kg)	NOx (g)	PM10 (g)	CO2 (kg)	NOx (g)	PM10 (g)	CO2 (kg)
Cars & MC	petrol	2,679.4	103.0	6,736.7	2,713.8	104.3	6,788.1	2,712.6	104.1	6,762.7	2,694.0	103.7	6,727.2
Cars	diesel	12,597.2	505.0	3,987.1	12,626.6	505.5	3,970.3	12,547.3	502.9	3,957.1	12,509.2	502.6	3,959.7
LGV	petrol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LGV	diesel	33,623.1	705.1	5,555.5	33,717.9	728.4	5,558.5	33,565.9	714.3	5,575.1	33,429.3	715.1	5,566.6
Rigid HGV	diesel	3,499.9	69.8	561.0	3,620.5	72.1	577.9	3,632.0	74.0	566.6	3,501.5	71.8	555.0
Artic HGV	diesel	57.9	2.7	23.9	60.7	2.8	25.4	60.1	2.8	24.0	59.6	2.7	24.5
Buses & coaches	diesel	9,050.3	131.6	2,295.8	9,005.5	130.6	2,281.2	9,222.9	133.3	2,297.9	8,956.4	126.6	2,269.1
Totals		61,507.8	1,517.2	19,159.9	61,745.0	1,543.6	19,201.3	61,740.9	1,531.5	19,183.4	61,150.0	1,522.5	19,102.1
% of base c4					100.39%	101.74%	100.22%	100.38%	100.94%	100.12%	99.42%	100.35%	99.70%

Table 7: AIRE emission results for Corridor 5

Vehicle	Fuel	BYSc5			DMSc5			DS1Sc5			DS2Sc5		
		NOx (g)	PM10 (g)	CO2 (kg)	NOx (g)	PM10 (g)	CO2 (kg)	NOx (g)	PM10 (g)	CO2 (kg)	NOx (g)	PM10 (g)	CO2 (kg)
Cars & MC	petrol	981.5	33.8	2,414.4	924.8	32.4	2,345.8	954.5	33.4	2,343.3	926.6	32.6	2,303.1
Cars	diesel	4,091.9	155.5	1,391.9	4,060.8	155.0	1,379.4	3,951.1	153.1	1,358.6	3,845.0	152.8	1,343.2
LGV	petrol	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LGV	diesel	11,549.0	238.3	1,757.9	11,457.9	243.6	1,756.8	11,451.0	243.4	1,731.2	11,291.0	246.5	1,688.7
Rigid HGV	diesel	1,103.9	21.6	168.9	930.2	20.1	136.6	880.5	18.8	131.9	880.3	18.8	128.8
Artic HGV	diesel	7.4	0.3	3.8	7.0	0.3	3.7	8.0	0.4	4.0	10.6	0.6	3.9
Buses & coaches	diesel	3,777.8	54.2	939.6	3,751.8	54.4	921.5	3,621.4	51.1	906.6	3,596.1	53.0	896.4
Totals		21,511.5	503.7	6,676.5	21,132.4	505.9	6,543.9	20,866.6	500.0	6,475.7	20,549.5	504.4	6,364.1
% of base c5					98.24%	100.45%	98.01%	97.00%	99.28%	96.99%	95.53%	100.13%	95.32%
% of DMSc5								98.74%	98.84%	98.96%	98.48%	100.86%	98.28%

Totals for NOx and PM10 emissions are given in grams (g) and the totals for CO2 are given in kilograms (kg).

6.4 Conclusion and Recommendations

In general the summary results of the AIRE modelling for all five corridors are consistent with the findings of the VISSIM modelling. For all corridors differences in emissions between Do Minimum and Do Something scenarios are subtle and the findings of the AIRE modelling generally support the findings of the corresponding VISSIM modelling:

- ✓ Corridor 1

  AIRE results for Corridor 1 are illustrated in Table 8:

  - ✓ Emissions of NOx and PM10 in the DMSc1 are higher than in the BYSc1.
  - ✓ DS1Sc1 would also have lower CO2 emissions than the base and do-minimum scenarios.
  - ✓ DS2Sc1 is the least favourable.
  - ✓ However BYSc1 remains the most environmental friendly scenario.
  - ✓ **The most favourable proposed scenario is DS1Sc1, which would result in higher NOx and PM10 emissions than in the BYSc1 but slightly lower than in the DMSc1**.

- ✓ Corridor 2

  AIRE results for Corridor 2 are illustrated in Table 8:

  - ✓ Emissions in the DMSc2 are lower than in the BYSc2.
  - ✓ DS2Sc2 is the least favourable.
  - ✓ **The most favourable scenario is DS1Sc2, which would result in lower NOx, PM10 and CO2 emissions than in the BYSc2 and DMSc2.**

- ✓ Corridor 3

  AIRE results for Corridor 3 are illustrated in Table 8:

  - ✓ Emissions in the DMSc3 are lower than in the BYSc3.
  - ✓ DS2Sc3 is the least favourable.
  - ✓ **The most favourable scenario is DS1Sc3, which would result in lower NOx, PM10 and CO2 emissions than in the BYSc3 and DMSc3**.

- ✓ Corridor 4

  AIRE results for Corridor 4 are illustrated in Table 8:

  - ✓ Emissions of NOx, PM10 and CO2 with DS1Sc4 and DS2Sc4 are marginally higher than in the BYSc4.

  - ✓ **By a very small margin DS3Sc4 is the most favourable.**
- ✓ Corridor 5

  AIRE results for Corridor 5 are illustrated in Table 8:

  - ✓ Emissions of NOx, PM10 and CO2 with DS1Sc4 and DS2Sc4 are marginally higher
  - ✓ With the exception of PM10, emissions in the DMSc5 are lower than in the BYSc5.
  - ✓ The differences between DS1Sc5 and DS2Sc5 are very slight.
  - ✓ **The D2Sc5 is most favourable in terms of NOx and CO2 emissions and DS1Sc5 is most favourable in terms of PM10 emissions.**

7 Air Quality Impact Assessment (Third Stage)

7.1 Introduction

In 2010, Portsmouth City Council (PCC) published their Air Quality Action Plan (AQAP)[3] in response to the declaration of several Air Quality Management Areas (AQMAs) across the city. A key measure adopted in the Action Plan was to review the existing traffic management systems in Portsmouth in order to ensure that road traffic is 'maintained at maximum fluidity and that transport-related pollution is kept to a minimum'.

In 2013, PCC launched the 'Optimisation of Road Traffic Management Control Systems (ORTMCS) for the purpose of local air quality improvement traffic modelling' project. This project was essentially a set of traffic management feasibility studies which focused on a number of scenarios to improve road traffic flow across the city. The project comprised three packages:

- ✓ The first package was to conduct extensive road traffic surveys at pre-selected junctions;
- ✓ The second package was to undertake road traffic modelling of each proposed scenario and to produce estimates of road traffic emissions;
- ✓ The third package was to undertake Air Quality Impact Assessment (AQIA) or the proposed scenarios.

To determine the impact of each of these proposed road traffic management scenarios on local air quality, PCC commissioned AECOM to undertake AQIA studies for each of the scenarios produced from the traffic modelling study described above. This project was designed to explore the possibilities of improving road traffic flow management and thereby improve air quality within the AQMAs, without either deteriorating or creating new air pollution hotspots elsewhere.

The AQIAs were undertaken in accordance with Defra's Technical Guidance LAQM.TG(09)[4] and used the AAQuIRE detailed dispersion modelling software to determine the annual mean NO_2 (nitrogen dioxide) concentrations within the study area for each traffic management scenario. The NO_2 impacts of each scenario were assessed at sensitive receptor locations and contour plots produced to illustrate the wider extent of the predicted impacts.

[3] Portsmouth City Council (2010), Air Quality Action Plan, http://aqma.defra.gov.uk/action-plans/PCC%20AQAP%202010.pdf, Accessed March 2015

[4] Defra (2009). Local Air Quality Management Technical Guidance LAQM.TG(09), https://www.gov.uk/government/publications/local-air-quality-management-technical-guidance-laqm-tg-09, Accessed March 2015

7.2 Legislation and Policy

7.2.1 European Air Quality Directives

The Air Quality Framework Directive (96/62/EC)[5] on ambient air quality assessment and management defines the policy framework for 12 air pollutants known to have a harmful effect on human health and the environment. Ambient concentration limit values for the specific pollutants are set through a series of daughter directives.

Following the daughter directives, Council Directive 2008/50/EC[6] on ambient air quality and cleaner air for Europe came into force in 2008, and was transposed into national legislation in 2010[7]. It consolidated existing air quality legislation and made provisions for Member States to postpone Limit Value attainment deadlines and allow an exemption from the obligation to meet Limit Values for certain pollutants, subject to strict conditions and assessment by the European Commission (EC).

7.2.2 National Air Quality Legislation

The provisions of Part IV of the Environment Act 1995 establish a national framework for air quality management, which requires all local authorities to conduct local air quality reviews. Section 82(1) of the Act requires these reviews to include an assessment of the current air quality in the area and the predicted air quality in future years. Should the reviews indicate that the objectives prescribed in the UK Air Quality Strategy[8] (AQS) and the Air Quality Standards Regulations 2010 will not be met, the local authority is required to designate an AQMA. Action must then be taken at a local level to ensure that air quality in the area improves.

The UK AQS identifies nine ambient air pollutants that have the potential to cause harm to human health. These pollutants are associated with local air quality problems, with the exception of ozone, which is instead considered to be a regional problem. Similarly, the Air Quality Regulations 2010 set objectives, but for just seven of the pollutants that are associated with local air quality. These objectives aim to reduce the health effects of the pollutants to negligible levels.

The air quality objectives and limit values currently applicable to the UK can be split into two groups. Each has a different legal status and is therefore handled differently within the framework of UK air quality policy. These are:

- ✓ UK air quality objectives set down in regulations for the purposes of local air quality management; and

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5 Air Quality Framework Directive (96/62/EC) on ambient air quality assessment and management
6 Council Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe
7 The Air Quality Standards Regulations 2010 Statutory Instrument 2010 No. 64
8 Defra (2007) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland

✓ European Union (EU) limit values transcribed into UK legislation for which compliance is mandatory.

7.2.3 Pollutants of Concern: Nitrogen Dioxide

The Government and the devolved administrations adopted two air quality objectives for nitrogen dioxide (NO_2) which were to be achieved by the end of 2005. In 2010, mandatory EU air quality limit values on pollutant concentrations were to apply in the UK, however the UK government applied for derogation. For some parts of the UK the application has been refused, and for major cities a decision has yet to be reached. The EU Limit Values for NO_2 in relation to human health are the same as the national objectives:

- An annual mean concentration of 40 µg/m^3 (micrograms per metre cubed); and
- An hourly mean concentration of 200 µg/m^3, to be exceeded no more than 18 times per year.

In practice, meeting the annual mean objective has been and is expected to be considerably more demanding than achieving the 1-hour objective. The annual mean objective of 40 µg/m^3 is currently widely exceeded at roadside sites throughout the UK, with exceedances also reported at urban background locations in major conurbations. Exceedances are associated almost exclusively with road emissions.

There is considerable year-to-year variation in the number of exceedances of the hourly objective, driven by meteorological conditions which give rise to winter episodes of poor dispersion and summer oxidant episodes. Analysis of the relationship between 1-hour and annual mean NO_2 concentrations[2] at roadside and kerbside monitoring sites indicate that exceedances of the 1-hour objective are unlikely where the annual mean concentrations are less than 60 µg/m^3.

NO_2 and nitric oxide (NO) are both oxides of nitrogen, and are collectively referred to as NO_X. All combustion processes produce NO_X emissions, largely in the form of NO, which is then converted to NO_2, mainly as a result of its reaction with ozone in the atmosphere. Therefore, the ratio of NO_2 to NO is dependent on the concentration of ozone and the distance from the emission source.

7.2.4 Portsmouth City Council Air Quality Action Plan (AQAP)

As part of the 2004 Detailed Assessment (DA), PCC modelled NO_2 concentrations across Portsmouth. The results indicated that the annual mean NO_2 objective would be exceeded at 13 hotspot areas across the city. In accordance with the Air Quality Strategy and Air Quality Regulations described above, PCC declared 13 AQMAs.

In 2007, PCC developed the first draft of their AQAP and although not formally adopted, many of the proposed actions were implemented as part of the Local Transport Plan (LTP). In 2009, PCC undertook a Further Assessment (FA), which indicated that air quality in Portsmouth had improved sufficiently to enable the revocation of 8 of the 13 AQMAs.

In 2010, PCC reviewed the 2007 draft AQAP to target the remaining 'hotspot' areas. The revised AQAP set out measures in pursuit of achieving the national objectives to deliver cleaner ambient air. Although aiming to deliver city wide improvements in air quality, the primary purpose of the AQAP was to explore measures, which would combat the areas of poor air quality within Portsmouth's remaining five AQMAs. As part of the 2009 FA, a source apportionment study was undertaken. This concluded that:

- In 2007, the predominant source of NO_x emissions was determined to be heavy goods vehicles (HGVs), closely followed by car emissions; and
- In 2010, the influence of cars and background concentrations was greater than those of 2007 but HGVs remained the highest polluter comparatively when considering the number of each type of vehicle.

The results of the source apportionment study enabled PCC to identify the sources that cause the highest level of pollution and those upon which the AQAP should focus and prioritise.

The following were considered to be priorities of the AQAP:

Priority 1:

- **HGVs:**
  In 2010, HGVs were predicted to contribute between 23.2% and 24.5% of the NO_X within AQMAs 6 and 11. Therefore any percentage decrease in HGVs passing through these areas will have a significant beneficial impact upon local air quality. Another factor to address is the implications of HGVs' reduced speed, as the very lowest speeds are disproportionately more polluting. Congestion impairing HGV movement is therefore highly significant and needs to be reduced. Furthermore, HGVs contribute directly to the problem of congestion when making deliveries. This is particularly relevant on the London Road / Kingston Road / Fratton Road corridor (AQMA 6).
- Measures:
  - Applying a weight restriction to prevent HGV's entering London Road, south of Stubbington Road, to ensure that Stamshaw Avenue is not used as an alternative route by HGVs;
  - Improving traffic light signals to speed traffic movement at the junction of Kingston Crescent and London Road. These would be more responsive to vehicle demand and be able to immediately react to changing vehicle flows, reducing queuing and congestion and leading to an improvement in air quality;
  - Removing the on-street parking bays to the north of the junction with Kingston Crescent to improve the movement of traffic; and

    - Improving signage to car parks. Currently Stubbington Avenue car park is only operating at around 40%–50% capacity. A review of pricing policies, improve signage, lighting and security should be undertaken in order to increase take up of this underused facility.

Priority 2:

- **Car traffic:**
  In 2010, cars were predicted to contribute between 24.3% and 32.0% of NO_x emissions within AQMAs 6 and 11. Reducing congestion across the road network is essential if air quality is to improve.
- Measures:
    - Introduction of new traffic management systems at key locations to reduce congestion and pollution, such as the use of MOVA (Microprocessor Optimised Vehicle Actuation);
    - Junction improvements on the St Michael's Gyratory as during the afternoon peak hour, large queues form on Hampshire Terrace due to the large quantities of vehicles exiting Portsmouth and the pedestrian crossing signals. Traffic signal control should be introduced to improve traffic flow on Hampshire Terrace; and
    - Introduction of a Park-and-Ride scheme and a review of parking charges.

Priority 3:

- **Buses**
  In 2010, buses were predicted to contribute between 4.9% and 14.4% of the NO_x emissions within AQMA 6 and 11. The continued introduction of bus priority measures and introduction of improved bus exhaust technology therefore plays an important part in ensuring public transport can offer a realistic and sustainable alternative to the private car.
- Measures:
    - Targeted schemes to improve bus services, to increase usage and reduce emission levels in co-ordination with bus operators and partner authorities.

Priority 4:

- **Domestic, commercial and background sources**
  As background concentrations are influenced by pollution generated from outside Portsmouth's boundaries, emissions are difficult to specify or control. The AQAP states that wherever possible, PCC needs to encourage a reduction

of unnecessary discharges from residential and industrial premises and encourage the use of more efficient heating systems.

Priority 5:

- **Shipping sources**
  The Further Assessment confirmed that the emissions from shipping did not exceed 10% of the total NO_X contribution in AQMA 11. This contribution is relatively small given the economic importance of shipping to Portsmouth.

Priority 6:

- **Industrial sources**
  In 2007, industrial sources were found to contribute between 0.2% and 0.4% to the NO_X levels in AQMA 6 and 11.

Priority 7:

- **Continuous improvement**
  Although the current legal limits on ambient air quality are now met across the majority of Portsmouth, the remaining NO_2 'hotspots' within the 5 AQMAs mean that exposure in these areas is still highly significant. However, even where the objectives have been achieved, effort is needed to maintain air quality given pressures from Portsmouth's increasing population and demands on transport and land use.

7.3 Assessment and Methodology

The air quality assessment comprises the following three tasks:

- Development of a Base Year Scenario (BYS) air quality dispersion model using the pre-collected road traffic data from package one of the ORTMCS project. The BYS model was developed for 2013 and used for model verification purposes.
- Dispersion modelling to predict the annual mean NO_2 concentrations for each of the three proposed traffic management scenarios for each corridor as identified in the Vehicle Micro-simulation Modelling package of the ORTMCSs project. Concentrations were predicted at sensitive receptor locations and contour plots of NO_2 concentrations were produced to assess the air quality impacts of the traffic management options on local air quality.

7.3.1 Study Area

PCC identified a total of 24 junctions across the city where significant changes in traffic flow were anticipated due to the proposed traffic management scenarios. The selected 24 junctions include areas where detrimental effects may be experienced due to the rerouting of traffic as a result of the proposed scenarios. The majority of these junctions focus on the main north - south corridors that connect the M27 / A27 to Portsea Island. This is covered in "Chapter 3".

7.3.2 Scenarios

In order to address both road traffic congestion and air quality issues within the City a set of measures were proposed by both PCC traffic management unit and Atkins. These are covered in "Chapter 4".

7.3.3 AAQuIRE

The AAQuIRE dispersion modelling software, developed by AECOM, was used to predict the annual mean NO_2 concentrations for each scenario. AAQuIRE uses the CALINE4 model for the dispersion of road-traffic emissions. The model is fully validated and has been extensively used worldwide. Further details are provided in Appendix B.

The modelling study uses the most recent version of the Emission Factor Toolkit (EFT) published by Defra[9]. The EFT takes into consideration the following information derived from the National Atmospheric Emission Inventory:

- Fleet composition data for motorways, urban and rural roads;
- Fleet composition based on European emission standard from pre-Euro 1 to Euro 6;
- Scaling factors reflecting improvements in the quality of fuel and some degree of retrofitting; and
- Technology conversions in the national fleet.

The EFT specifically incorporates updated NO_X emissions factors and the latest vehicle fleet information based on measurements and projections, and was the most recent version available at the time the assessment was undertaken.

7.3.4 Conversion of NO_X to NO_2

The proportion of NO_2 in NO_X varies greatly with location and time according to a number of factors including the amount of oxidant available and the distance from the emission source. Due to projected future-year reductions in NO_X concentrations it is expected that NO_2 concentrations will not be limited as much by ozone. This would result in an increase in the NO_2/NO_X ratio. In addition, a trend has been noted in recent years whereby roadside NO_2 concentrations have been increasing at certain roadside monitoring sites, despite emissions of NO_X falling. The 'direct NO_2' phenomenon has had an increasingly marked effect in many urban locations throughout the UK and must be considered when undertaking modelling studies.

9 Defra (2014). Emission Factors Toolkit Version 6.0.2. http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#eft

In this study modelled NO_X values were converted to NO_2 using the 'NO_X to NO_2' calculator Version 4.1[10], released in June 2014. The "All other UK Urban Traffic" vehicle fleet mix, the appropriate year (2013 or 2015) and local authority (Portsmouth City Council) were specified for the conversion of modelled NO_X concentrations to NO_2 concentrations.

7.3.5 Traffic Data

Traffic data for each proposed road traffic management scenario in the form of annual average daily traffic (AADT) flows, HGV percentages and vehicle speeds were required as inputs to the dispersion model.

7.3.5.1 Base Year

As part of the first package of the ORTMCS, ARUP were commissioned to undertake traffic surveys at 24 junctions. Traffic surveys were undertaken between the 30th September 2013 and 27th October 2013 using Automatic Traffic Counters (ATCs), which provided the number of vehicles, speed and category of the vehicles for each hour of the day. These data were converted to AADT flows using PCC's four ATCs located across Portsmouth. For each of the four ATCs, an average ratio was determined between the October survey data and the average for the year. The ratio was applied to the project-specific survey data to derive the corresponding AADT flows.

It should be noted that due to road works being undertaken at the time of the traffic surveys, site 1 was resurveyed between 11th January and 13th February 2014. The same methodology was used to derive the AADT flows as discussed above.

The ATC installed by ARUP also provided 24 hour vehicle speed data, which was applied to the model to reflect the diurnal variation in vehicle speeds. It was assumed that the traffic speeds recorded during the ARUP survey periods were representative of the whole year.

7.3.5.2 Proposed Road Traffic Management Control Scenarios

As part of the second package of the ORTMCS project, Atkins was commissioned to model traffic flows for the three traffic management scenarios for each Corridor:

- Do-Minimum(DM), Do-Something 1 (DS1S), and Do-Something 2(DS2S) for Corridors 1, 2, 3 and 5
- DS1S, DS2S and DS3S for Corridor 4

[10] Defra (2014). NO_X to NO_2 Calculator. Version 4.1. http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc

As discussed in Chapter 4, the DMS includes all changes implemented or planned on site since base year (BY) model was developed, while the DS1S, DS2S and DS3S include various traffic improvements as described Table 25.

From the traffic modelling Atkins provided AADT data and HGV proportions, and speed data for the AM peak (7:00 to 10:00), PM peak (16:00 to 19:00) and inter-peak periods. These data were used in the air quality impact assessment to predict NO_2 concentrations and air quality impacts associated with the proposed scenarios.

The traffic data used in the detailed dispersion modelling are summarised in Appendix C, Table 25. It should be noted that the speed data presented in Table 25 represent daily average speed

For modelling purposes the diurnal speed variation function was used to simulate changes in vehicle speeds throughout the day.

7.3.6 Receptors

Air quality receptors susceptible to changes in air quality typically include residential properties, schools, care homes, hospitals and designated ecological sites.

A total of 89 sensitive receptors were selected across the study areas covered by the five route corridors. Annual mean NO_2 concentrations at these receptor locations were predicted for each of the traffic management scenarios to assess the potential air quality impacts associated with those scenarios:

- ✓ Corridor 1: 19 receptors;
- ✓ Corridor 2: 10 receptors;
- ✓ Corridor 3: 35 receptors;
- ✓ Corridor 4: 9 receptors;
- ✓ Corridor 5: 16 receptors

The receptors were chosen to represent worst-case locations where the largest air quality impacts associated with each scenario might be anticipated, based on the projected changes in traffic flow and proximity to the road. The locations of all the modelled receptors are illustrated in Appendix D, Figure 8.

In addition to the discrete receptor locations, NO_2 concentrations were predicted over Cartesian grids of 10 metre resolution, covering each of the model study areas. The Cartesian grids were used to create contour plots of NO_2 concentrations to indicate the potential wider impacts of each traffic management scenario on local air quality. Concentrations were predicted at a height of 1.5 m to represent typical human exposure.

7.3.7 Meteorological Data

The meteorological dataset used in the assessment was derived from Thorney Island meteorological station for 2013. This meteorological station is located approximately 12 km away from Portsmouth and considered to be most representative of the meteorological conditions in Portsmouth.

The wind rose for this site and further details of the preparation of meteorological data for use in dispersion modelling are provided in Figure 12 in Appendix E.

7.3.8 Model Verification

For any air quality assessment it is necessary to consider and account for errors in the modelling process. Systematic errors in modelling results can arise from many factors, such as uncertainties in vehicle flows, speeds and the composition of the vehicle fleet. Such errors can be addressed and corrected for by making comparisons with monitoring data. The modelling results presented in this report were verified by comparing model predictions against monitored pollutant concentrations in the study areas and adjusting model predictions where necessary.

The accuracy of the future year modelling results is relative to the accuracy of the base year results, therefore greater confidence can be placed in the future year concentrations if good agreement is found for the base year.

PCC undertakes NO_2 monitoring using passive diffusion tubes and continuous monitors across the city. Twenty one of these sites were located within the study area and suitable for model verification purposes. Comparison of the modelled and monitored 2013 concentrations using the methodology defined in LAQM.TG(09) determined that an adjustment factor of 1.43 should be applied to the model outputs. Further details of the verification procedure are provided in Appendix F; the monitoring site locations are indicated in Figure 12 in Appendix G.

7.3.9 Significance Criteria

Air quality impacts may be considered to be significant if air quality objectives are predicted to be breached or if the development leads to significant impacts on air quality at sensitive receptors. Updated guidance published by Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM)[11] (EPUK, 2015) concludes that a two-stage approach should be adopted to determine whether a proposed development will have a significant impact on local air quality, comprising:

- ✓ A qualitative or quantitative description of the impacts on local air quality; and
- ✓ A judgement on the overall significance of the effects of any identified impacts

[11] EPUK (2015). Land-Use Planning & Development Control: Planning for Air Quality. Final Draft April 2015. http://www.iaqm.co.uk/text/guidance/iaqm-planning-development.pdf

In order to assess the potential impacts of a proposed development on local air quality EPUK suggests assigning a description of the impact based on the magnitude of change as a percentage of a relevant Air Quality Assessment Level (AQAL). Account also needs to be taken of predicted pollutant concentrations and their relationship to the AQAL. In most assessments the AQAL will correspond to the Air Quality Objective / EU Limit Value for the pollutant(s) of concern.

Table 8 summarises the approach detailed by EPUK and is intended primarily for assessment of changes in long-term average concentrations i.e. annual mean concentrations, or numbers of days of exceedence per annum. It should also be noted that the impact descriptors may be adverse or beneficial depending upon whether concentrations are predicted to increase or decrease.

Table 8: Air Quality Impact Descriptors for Sensitive Receptors (Adapted from EPUK, 2015)

Long-Term Average Concentration at Receptor in Assessment Year	**% Change in Concentration Relative to AQAL**				
	0	1	2 – 5	6 – 10	>10
75% or Less of AQAL	Negligible	Negligible	Negligible	Slight	Moderate
76% – 94% of AQAL	Negligible	Negligible	Slight	Moderate	Moderate
95% – 102% of AQAL	Negligible	Slight	Moderate	Moderate	Substantial
103% – 109% of AQAL	Negligible	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Negligible	Moderate	Substantial	Substantial	Substantial

This table is designed for use only with long-term average concentrations, i.e. annual means.

AQAL = Air Quality Assessment Level, which will usually be an Air Quality Objective or EU Limit Value. e.g. for NO_2 (annual mean) the AQAL = 40 µg/m^3.

It is intended that percentage changes in pollutant concentrations are calculated and rounded to the nearest whole number to make it clearer which column the impacts fall within. Changes of less than 0.5% will be rounded down to zero and therefore be described as Negligible.

When defining the total concentration as a percentage of the AQAL, the 'without scheme' (Do-Minimum) concentration should be used where there is a predicted decrease in pollutant concentration and the 'with scheme' (Do-Something) should be used in situations

where concentrations are predicted to increase.

The descriptors presented in Table 8 should be ascribed to individual sensitive receptor locations. However, to define the overall significance of air quality impacts resulting from a proposed development one must take into account, not only the impacts at individual receptors but a range of additional factors, including but not limited to:

- ✓ The existing and future air quality in the absence of the proposed development.
- ✓ The extent of current and future population exposure to the air quality impacts.
- ✓ The influence and validity of any assumptions made when undertaking the prediction of impacts.
- ✓ Uncertainty and the extent to which worst-case assumptions have been made.
- ✓ The potential for cumulative impacts to occur.

7.4 Baseline

7.4.1 Local Air Quality Management

In 2005, PCC designated 13 AQMAs across the city, in response to the findings of the 2004 Detailed Assessment. In 2010, PCC revoked 8 of these AQMAs, retaining AQMAs 6, 7, 9 and 12, and re-designating AQMA 11.

Descriptions of the five remaining AQMAs are given below, and all are designated for exceedances of the annual mean NO_2 objective:

- ✓ AQMA 6: Extending north from along Fratton Road from Fratton Bridge into Kingston Road, continuing into London Road until the roundabout junction with Stubbington Road and Gladys Avenue.
- ✓ AQMA 7: Focusing on Hampshire Terrace and St Michaels Road Gyratory.
- ✓ AQMA 9: Focusing on the southernmost section of Eastern Road from Sword Sands Road south into Velder Avenue and it’s junction with Milton Road.
- ✓ AQMA 11: The redesigned AQMA extends from Rudmore Roundabout south to Church Street Roundabout.
- ✓ AQMA 12: Encompassing the greater part of Queen Street from The Hard to St James’s Road. This area is retained as there is a lack of enough historical monitoring data to justify the revocation at this stage.

7.4.2 Pollutant Monitoring

PCC monitors NO_2 using both continuous monitors and passive diffusion tubes.

7.4.2.1 Continuous Monitoring

PCC operates three continuous monitors across the city; London Road, Burrfield and Mile End Road, all of which are located in Roadside locations and within the declared AQMAs. A map showing the locations of the monitoring stations is provided in Figure 12 in Appendix G.

The results of recent years' continuous monitoring are presented in Table 9. Generally, annual mean NO_2 concentrations have decreased between 2010/11 and 2013 or remained stable. In 2013, all monitoring sites recorded annual mean NO_2 concentrations below the objective.

Table 9: Continuous Monitoring of NO_2, 2010 – 2013

Location		Type	Within AQMA?	Annual Mean NO_2 ($\mu g/m^3$)			
				2010	**2011**	**2012**	**2013**
R1	London Road	Roadside	Yes	**52.1**	**46.0**	**43.9**	39.7
R4	Burrfield Road	Roadside	Yes	38.4	31.5	36.1	33.5
R5	Mile End Road	Roadside	Yes	-	35.0	36.9	35.9

NB exceedances of the objective are emboldened.

7.4.2.2 Diffusion Tube Monitoring

PCC undertakes monitoring of NO_2 concentrations using passive diffusion tubes at 22 locations across Portsmouth. The locations of these sites are illustrated in Figure 12 in Appendix G and recent years' results are shown in Table 10. Generally, concentrations have decreased or remained stable between 2010 and 2013. In 2010, nine sites exceeded the national objective compared to three in 2013. The three sites to exceed the annual mean NO_2 objective in 2013 are located on Fratton Road (AQMA 6), London Road (AQMA 6) and Lord Montgomery Way (AQMA 7).

Table 10: NO_2 Diffusion Tube Monitoring, 2010 – 2013

Location		Type	Within AQMA?	Annual Mean NO_2 ($\mu g/m^3$)			
				2010	2011	2012	2013
1	Lord Montgomery Way	Roadside	Yes	**49.3**	39.5	**42.5**	**41.3**
3	High Street	Roadside	Yes	32.9	26.2	26.6	22.1
4	Queen Street	Roadside	Yes	37.8	32.9	36.3	30.4
5	119 Whale Island Way	Roadside	Yes	33.9	28.9	28.6	27.5
6	88 Stanley Road	Roadside	Yes	35.9	34.8	35.6	38.6
7	138 Lower Derby	Roadside	Yes	29.4	27.2	29.8	30.0
9	6 Northern Road	Roadside	Yes	**41.0**	36.1	35.1	32.0
11	Anchorage Road	Roadside	Yes	29.4	32.7	31.8	29.5
14	4 Merlyn Drive	Roadside	Yes	26.8	21.7	22.7	21.6
15	29 Milton Road	Roadside	Yes	34.6	28.5	28.8	28.2
16	Parade Court, London Road	Roadside	Yes	35.2	35.0	36.4	34.1
18	4 Milton Road	Roadside	Yes	32.0	27.8	29.5	27.8
19	7 Velder Avenue	Roadside	Yes	**43.2**	**44.7**	34.5	30.7
20	136 Eastney Rd	Roadside	Yes	34.2	28.7	26.1	27.4
21	116 Albert Road	Roadside	Yes	**43.4**	38.6	35.8	34.0
22	2 Victoria Road North	Roadside	Yes	34.6	29.0	31.6	28.7
23	106 Victoria Road North	Roadside	Yes	**43.4**	35.8	**41.1**	32.2
24	221 Fratton Road	Roadside	Yes	**44.8**	38.3	39.1	**42.5**
25	117 Kingston Road	Roadside	Yes	**45.2**	**41.4**	**44.6**	38.7
26	The Tap London Road	Roadside	Yes	**56.6**	**48.8**	**50.5**	**51.7**
30	Market Tavern (Mile End Rd)	Roadside	Yes	**43.7**	**43.2**	38.0	37.7
32	Larch Court, Church Rd	Roadside	Yes	36.5	33.6	36.0	31.1

NB exceedances of the objective are emboldened.

7.4.3 Background Concentrations

A large number of sources of air pollutants exist which individually may not be significant, but collectively, over a large area, need to be considered. The concentrations calculated by the model due to vehicle emissions can then be added to these background concentrations to give the total concentration.

7.4.3.1 Monitored Background Concentrations

As part of the diffusion tube network operated by PCC, three monitoring sites are situated in background locations (2, 8 and 10). In addition, a background monitoring site operated by Defra as part of the Automatic Urban Rural Network (AURN) is located at Gatcombe Park, Portsmouth.

These sites were considered for their use to provide background NO_2 concentrations for use in the air quality assessment.

The use of Gatcombe Park AURN site was excluded due to the slightly low data capture at this site in 2013 (84%). Similarly, the use of Hawthorn Crescent diffusion tube site was ruled out as the site is located in close proximity to a busy section of the A27 and may therefore be influenced by road traffic emissions, and as such cannot be considered a background site.

Table 11: Background Monitoring Sites

Location		Monitoring Type	Within AQMA?	Annual Mean NO_2 (µg/m^3)			
				2010	2011	2012	2013
C4	Gatcombe Park AURN	CM	No	21.9	19.0	21.2	20.3
2	12 Chadderton Gardens	DT	No	23.3	17.4	17.5	16.5
8	492 Hawthorn Crescent	DT	No	30.0	28.6	28.8	27.2
10	20 Stroudley Avenue	DT	No	21.5	18.5	17.9	17.7

7.4.3.2 Modelled Background Concentrations

Modelled estimations of background air quality concentrations are provided by Defra[12] for each 1 km grid square in the UK for each year between 2010 and 2030. Road sources were discounted from the total background pollutant concentrations to avoid double-counting, to give ‘adjusted’ values. Average background NO_X and NO_2 concentrations for the grid squares that cover the whole of Portsmouth are presented in Table 12 for 2013 and 2015.

Table 12: Forecast Annual Mean Background Pollutant Concentrations (µg/m^3)

Pollutant	2013		2015	
	Total	Adjusted	Total	Adjusted
NO_x	36.9	31.0	33.0	29.0
NO_2	25.4	21.9	23.1	20.6

7.4.3.3 Summary

While it is preferential to use actual monitored rather than modelled background concentrations in modelling, it was concluded that the results of monitoring at local background sites were

[12] Defra (2014). Air Pollution Background Concentration Maps. http://uk-air.defra.gov.uk/data/laqm-background-home

unsuitable for use in the modelling due. It was considered more appropriate to use the Defra modelled air pollution background concentrations due to the scales of the modelled areas and the small number of background monitoring locations from which to determine suitable monitored background concentrations. .

It should be noted that for sensitive receptor modelling the background concentrations used are taken from the 1 km square within which the modelled receptor is located. For the Cartesian grid modelling (for the production of contour plots) the background concentrations used represent an average of all the grid squares covering the model domain.

Further details of the background concentrations used in the air quality assessment are included in Appendix H.

7.5 Results

7.5.1 Introduction

Annual mean NO_2 concentrations have been predicted for the following scenarios:

- ✓ 2013 Base Year (BYS)
- ✓ Do-Minimum (DMS)
- ✓ Do-Something 1 Scenario (DS1S)
- ✓ Do-Something 2 Scenario (DS2S)
- Do-Something 3 Scenario (DS3S)(Corridor 4 only)

The assessment results are presented and discussed by route corridor. NO_2 concentrations for the DMS, DS1S, DS2S and DS3S have been predicted using background concentrations and emission factors for both 2013 and 2015. The use of 2013 background concentrations and emission factors serves as a sensitivity test, providing a worst-case assessment that effectively assumes no improvement in vehicle emissions or reductions in background pollution between the base year and implementation year.

The air quality impacts of each Do-Something Scenario are assessed by comparisons with the DMS predictions, except for Corridor 4 where there is no DMS. In this case impacts are quantified by comparison to the BYS.

7.5.2 Corridor 1

Corridor 1 encompasses Junctions 1 to 6 (Appendix D, Figure 8).

7.5.2.1 Air quality predictions for 2013

The predicted annual mean NO_2 concentrations for the 19 sensitive receptors located in Corridor 1 in 2013 are presented in Table 13.

Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2013 at all modelled receptors in all modelled scenarios. The predicted changes in concentrations for many of the modelled receptors between the BYSc1 and the DMSc1 reflect the effects of traffic management interventions implemented to date.

At receptors 12, 13, 63 and 66, NO_2 concentrations are predicted to decrease between the BYSc1 and DMSc1 by up to 0.9 $\mu g/m^3$; at all other receptors, increases in NO_2 concentrations of up to 1.1 $\mu g/m^3$ are predicted between the BYSc1 and DMSc1.

The maximum predicted annual mean NO_2 concentrations in all modelled scenarios occur at Receptor 15: the highest predicted NO_2 concentration is 39.3 $\mu g/m^3$ in the DS2Sc1. The predicted concentration at Receptor 15 in the BYSc1 is 38.4 $\mu g/m^3$, 39.1 $\mu g/m^3$ in the DMSc1 and 39.2 $\mu g/m^3$ in the DS1Sc1.

Comparisons between the DMSc1 and DS1Sc1 suggest that the proposed traffic management measures within the DS1Sc1 are likely to result in changes in annual mean NO_2 concentrations ranging from -0.4 $\mu g/m^3$ to less than +0.1 $\mu g/m^3$. Four receptors (Receptors 12, 13, 66 and 67) are predicted to experience decreases in annual mean NO_2 concentrations of between -0.2 $\mu g/m^3$ and -0.4 $\mu g/m^3$. According to EPUK Guidance (2015) impacts of this magnitude (i.e. 1% of the annual mean NO_2 objective) can be described as Slight Beneficial. Elsewhere predicted changes in annual mean NO_2 concentrations between the DMSc1 and DS1Sc1 are less than 0.5% of the annual mean NO_2 objective and are therefore considered to be Negligible.

Comparisons between the DMSc1 and DS2Sc1 indicate that annual mean NO_2 concentrations are predicted to decrease by 0.1 $\mu g/m^3$ at four of the modelled receptor locations in Corridor 1 (Receptors 62, 64, 67 and 86).

Increases in annual mean NO_2 concentrations are predicted to be 0.2 $\mu g/m^3$ or less at all other modelled receptors.

The maximum predicted increase in annual mean NO_2 concentration in the DS2Sc1 is 0.2 $\mu g/m^3$ at Receptor 15. According to EPUK Guidance (2015), impacts of the magnitude predicted at Receptor 15 can be described as Slight Adverse. The magnitudes of predicted impacts at all other modelled receptor locations can be described as Negligible.

The DS2Sc1 contains a range of traffic intervention measures that aim to alleviate congestion in the vicinity of the Church Road roundabout and along Mile End Road. The predicted changes in annual mean NO_2 concentrations at Receptor 16, located near to the junction of Mile End Road and the Church Road roundabout, and Receptors 17 and 87, located further along Mile End Road, indicate that the proposed traffic management measures contained within DS2Sc1 are unlikely to deliver significant air quality benefits or disbenefits.

The changes in local air quality at receptor locations in Corridor 1 with the implementation of traffic management measures are likely to be Slight to Negligible.

Of the two proposed options, the dispersion modelling results suggest that the DS1Sc1 is preferable to DS2Sc1; however, overall, the magnitudes of the changes in concentrations are small and neither scenario is likely to result in significant changes to existing air quality in the local area.

Table 13: Corridor 1, Annual Mean NO_2 Concentrations, 2013

Receptor ID	2013					
	BYSc1	DMSc1	DS1Sc1	DS2Sc1	DS1Sc1 Impact	DS2Sc1 Impact
12	35.3	34.4	34.0	34.5	-0.4	0.1
13	34.9	34.5	34.2	34.5	-0.3	0.0
15	38.4	39.1	39.2	39.3	0.0	0.2
16	36.2	37.1	37.1	37.2	0.0	0.1
17	32.6	32.9	32.9	32.9	0.0	0.0
18	29.2	30.4	30.3	30.4	0.0	0.0
19	27.5	28.4	28.3	28.4	-0.1	0.0
62	32.0	32.7	32.6	32.6	-0.1	-0.1
63	33.1	33.1	33.2	33.2	0.0	0.1
64	33.6	33.9	33.8	33.8	-0.1	-0.1
65	31.3	32.1	32.1	32.1	0.0	0.0
66	35.3	34.5	34.1	34.5	-0.4	0.0
67	38.0	38.5	38.3	38.4	-0.2	-0.1
68	31.1	31.3	31.3	31.3	0.0	0.0
69	32.4	32.5	32.5	32.5	0.0	0.0
70	29.2	29.4	29.4	29.4	0.0	0.0
85	36.8	37.4	37.4	37.4	0.0	0.0
86	33.7	34.0	33.9	33.9	0.0	-0.1
87	36.4	37.2	37.1	37.2	-0.1	0.0

Note: All results are rounded to 1 decimal place. Impacts of between greater than -0.1 $\mu g/m^3$ and less than +0.1 $\mu g/m^3$ are reported as 0.0.

7.5.3 Predicted Concentrations in 2015

The predicted annual mean NO_2 concentrations for the 19 sensitive receptors located in Corridor 1 in 2015 are presented in Table 14.

Table 14: Corridor 1, Annual Mean NO_2 Concentrations, 2015

Receptor ID	2015				
	DMSc1	DS1Sc1	DS2Sc1	DS1Sc1 Impact	DS2Sc1 Impact
12	33.6	33.2	33.6	-0.4	0.0
13	33.6	33.1	33.6	-0.4	0.1
15	37.8	37.6	37.8	-0.2	0.0
16	35.9	35.8	35.9	-0.1	0.0
17	31.8	31.8	31.8	0.0	0.0
18	29.1	29.2	29.2	0.0	0.0
19	27.5	27.5	27.5	0.0	0.0
62	31.6	31.8	31.7	0.2	0.1
63	32.0	32.0	32.0	0.0	0.0
64	32.7	32.7	32.7	0.0	0.0
65	31.0	31.0	31.1	0.0	0.0
66	33.7	33.2	33.6	-0.5	-0.1
67	36.2	36.4	36.2	0.2	0.0
68	30.4	30.4	30.4	0.0	0.0
69	31.6	31.6	31.6	0.0	0.0
70	28.6	28.6	28.6	0.0	0.0
85	36.1	36.0	36.0	-0.1	-0.1
86	32.7	32.6	32.6	0.0	-0.1
87	35.9	35.7	35.9	-0.1	0.0

Note: All results are rounded to 1 decimal place. Impacts of between greater than -0.1 $\mu g/m^3$ and less than +0.1 $\mu g/m^3$ are reported as 0.0.

Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2015 at all modelled receptors in the DMSc1, DS1Sc1 and DS2Sc1. The maximum predicted annual mean NO_2 concentration is 37.8 $\mu g/m^3$ at Receptor 15 in the DMSc1 and DS2Sc1. The maximum predicted concentration in the DS1Sc1 is also at Receptor 15 (37.6 $\mu g/m^3$).

Comparisons between the DMSc1 and DS1Sc1 indicate that the proposed traffic management measures within the DS1 scenario are likely to result in changes in annual mean NO_2 concentrations of -0.5 $\mu g/m^3$ to +0.2 $\mu g/m^3$ at modelled receptor locations in Corridor 1. The largest reductions in annual mean NO_2 concentrations are predicted to occur at Receptor 66 (-

0.5 µg/m^3) and Receptors 12 and 13 (-0.4 µg/m^3). According to EPUK Guidance (2015), impacts of this magnitude (1% of the annual mean NO_2 objective) can be described as Negligible because the predicted annual mean NO_2 concentrations are in the range of 76% - 94% of the AQAL.

Increases in annual mean NO_2 concentrations in the DS1Sc1 are predicted at Receptors 62 and 67 (0.2 µg/m^3). This increase represents a change relative to the AQAL of less than 0.5% and according to EPUK Guidance (2015) can be described as Negligible.

Comparisons between the DMSc1 and DS2Sc1 indicate that annual mean NO_2 concentrations are predicted to decrease slightly at three of the modelled receptor locations in Corridor 1 and increase at two receptor locations. Increases in annual mean NO_2 concentrations of up to 0.1 µg/m^3 are predicted at Receptors 13 and 62 in DS2Sc1. The maximum predicted reduction in annual mean NO_2 concentration in the DS2Sc1 is -0.1 µg/m^3 (at Receptors 66, 85 and 86). According to EPUK Guidance (2015) impacts of the magnitudes predicted in scenario DS2Sc1 at all modelled receptor locations can be described as Negligible.

The changes in local air quality at receptor locations in Corridor 1 with the implementation of traffic management measures are likely to be Negligible.

Of the two proposed scenarios, the dispersion modelling results suggest that the DS1Sc1 is preferable to DS2Sc1; however, overall, the magnitudes of the changes in concentrations are small and neither scenario is likely to result in significant changes to existing air quality in the local area.

7.6 Corridor 2

Corridor 2 encompasses Junctions 7 to 13 (Appendix D, Figure 8), and is oriented north-south running through central Portsmouth.

7.6.1 Predicted Concentrations in 2013

The predicted annual mean NO_2 concentrations for the ten sensitive receptors located in Corridor 2 in 2013 are presented in Table 15.

Table 15: Corridor 2, Annual Mean NO_2 Concentrations, 2013

Receptor ID	2013					
	BYSc2	DMSc2	DS1Sc2	DS2Sc2	DS1Sc2 Impact	DS2Sc2 Impact
6	30.4	32.0	32.0	32.3	0.0	0.2
7	27.6	28.8	28.7	29.0	-0.1	0.1
8	33.9	34.2	34.1	34.2	0.0	0.0
9	32.4	32.3	32.3	32.3	0.0	0.0
10	31.4	30.8	30.9	30.8	0.0	0.0
11	27.9	27.9	27.9	27.9	0.0	0.0

82	33.1	33.3	33.3	33.3	0.0	0.0
83	30.7	33.1	33.0	33.3	0.0	0.3
84	36.7	37.0	37.0	37.0	0.0	0.0
89	30.9	30.9	30.9	30.9	0.0	0.0

Note: All results are rounded to 1 decimal place. Impacts of between greater than -0.1 µg/m^3 and less than +0.1 µg/m^3 are reported as 0.0.

Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2013 at all modelled receptors in the BYSc2. All receptors in Corridor 2 are also predicted to achieve the annual mean NO_2 objective in the DMSc2, DS1Sc2 and DS2Sc2. The maximum predicted annual mean NO_2 concentration is 37.0 µg/m^3 at Receptor 84 in the DMSc2, DS1Sc2 and DS2Sc2; the highest concentration in the BYSc2 is also predicted to occur at Receptor 84. Between the BYSc2 and the DMSc2, annual mean NO_2 concentrations are predicted to increase by up to 2.4 µg/m^3 (Receptor 83); smaller increases in concentration between the BYSc2and DMSc2 are predicted at five other modelled locations. At the three remaining receptors concentrations are predicted to be unchanged or decrease slightly.

Comparisons between the DMSc2 and DS1Sc2 indicate that the proposed traffic management measures within the DS1Sc2 are likely to result in changes in annual mean NO_2 concentrations of -0.1 µg/m^3 to less than +0.1 µg/m^3 at modelled receptor locations in Corridor 2. According to EPUK Guidance (2015) impacts of this magnitude (less than 0.5% of the annual mean NO_2 objective) can be described as Negligible.

Annual mean NO_2 concentrations are not predicted to increase at any receptor location in the DS1Sc2. A reduction in annual mean NO_2 concentration of up to 0.1 µg/m^3 is predicted at Receptor 7. Changes to bus stop locations and parking and loading restrictions on Kingston Road may account for this small improvement in air quality at this location.

Comparisons between the DMSc2 and DS2Sc2 indicate that annual mean NO_2 concentrations are predicted to increase at three modelled receptor locations in Corridor 2 and remain unchanged at all other receptor locations. Increases in annual mean NO_2 concentrations of up to 0.3 µg/m^3 are predicted at Receptors 6, 7 and 83 in DS2Sc2. According to EPUK Guidance (2015), impacts of this magnitude (1% of the annual mean NO_2 objective) can be described as Negligible.

The changes in local air quality at receptor locations in Corridor 2 with the implementation of traffic management measures are likely to be Negligible. Of the two proposed scenarios, the dispersion modelling results suggest that the DS1Sc2 has the potential to deliver slightly greater local air quality benefits. However, the magnitudes of the changes in concentrations at all receptor locations are small and neither scenario is likely to result in significant changes to existing air quality in the local area.

7.6.2 Predicted Concentrations in 2015

The predicted annual mean NO_2 concentrations for the 10 sensitive receptors located in Corridor 2 in 2013 are presented in Table 16.

Table 16: Corridor 2, Annual Mean NO_2 Concentrations, 2015

Receptor ID	2015				
	DMSc2	DS1Sc2	DS2Sc2	DS1Sc2 Impact	DS2Sc2 Impact
6	31.1	31.1	31.2	0.0	0.1
7	28.0	27.9	28.0	-0.1	0.1
8	33.1	33.0	33.2	-0.1	0.0
9	31.5	31.4	31.4	0.0	0.0
10	30.0	30.1	30.1	0.1	0.1
11	27.2	27.2	27.2	0.0	0.0
82	32.3	32.3	32.3	0.0	0.0
83	32.2	32.1	32.3	-0.1	0.1
84	35.7	36.0	35.7	0.3	0.0
89	29.9	30.1	29.9	0.2	0.0

Note: All results are rounded to 1 decimal place. Impacts of between greater than -0.1 µg/m^3 and less than +0.1 µg/m^3 are reported as 0.0.

Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2015 at all modelled receptors in Corridor 2 in the DMSc2, DS1Sc2 and DS2Sc2.

The maximum predicted annual mean NO_2 concentration is 36.0 µg/m^3 at Receptor 84 in the DS1Sc2, and the maximum predicted concentration in the DS2Sc2 is 35.7 µg/m^3, also at Receptor 84.

Comparisons between the DMSc2 and DS1Sc2 indicate that the proposed traffic management measures within the DS1 scenario are likely to result in changes in annual mean NO_2 concentrations of -0.1 µg/m^3 to +0.3 µg/m^3 at modelled receptor locations in Corridor 2.

Increases in annual mean NO_2 concentrations in the DS1Sc2 are predicted at Receptor 10 (0.1 µg/m^3), Receptor 84 (0.3 µg/m^3) and Receptor 89 (0.2 µg/m^3). Reductions in annual mean NO_2 concentrations of up to 0.1 µg/m^3 are predicted at Receptors 7, 8 and 83. According to EPUK Guidance (2015), the predicted impact on annual mean NO_2 concentration at all receptors can be described as Negligible.

Comparisons between the DMSc2 and DS2Sc2 indicate that annual mean NO_2 concentrations are predicted to increase at four modelled receptor locations in Corridor 2. Increases in annual mean NO_2 concentrations of up to 0.1 µg/m^3 are predicted at Receptors 6, 7, 10 and 83 in DS2.

According to EPUK Guidance (2015) the predicted impact on annual mean NO_2 concentrations at all modelled receptor locations in DS2Sc2 can be described as Negligible.

The changes in local air quality at receptor locations in Corridor 2 with the implementation of traffic management measures are likely to be Negligible. Of the two proposed options, the dispersion modelling results suggest that the DS1Sc2 is slightly more beneficial than DS2Sc2. The largest predicted adverse impact in the DS1Sc2 occurs at a receptor location that is close to the annual mean NO_2 objective; any worsening of air quality in such locations is undesirable. Despite this it should be noted that the magnitudes of the changes in concentrations at all receptor locations are small and neither scenario is likely to result in significant changes to existing air quality in the local area.

7.7 Corridor 3

Corridor 3 encompasses Junctions 14 to 19, and runs north-south in the east of Portsmouth (Appendix D, Figure 8).

7.7.1 Predicted Concentrations in 2013

The predicted annual mean NO_2 concentrations for the modelled sensitive receptors located in Corridor 3 in 2013 are presented in Table 17.

Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2013 at all modelled receptors in all modelled scenarios. The maximum predicted annual mean NO_2 concentration is 35.5 $\mu g/m^3$ at Receptor 72 in the BYSc3.

The maximum predicted concentrations in the DMSc3, DS1Sc3 and DS2Sc3 are also predicted to occur at Receptor 72.

Increases in annual mean NO_2 concentrations of 1.2 $\mu g/m^3$ at Receptors 74 and 76 are predicted between the BYSc3 and DMSc3. It appears that these increases are due to projected increases in traffic flows along this section resulting from traffic management measures already introduced.

Comparisons between the DMSc3 and DS1Sc3 indicate that the proposed traffic management measures within the DS1Sc3 are likely to result in changes in annual mean NO_2 concentrations of -0.3 $\mu g/m^3$ to +0.1 $\mu g/m^3$ at modelled receptor locations in Corridor 3. According to EPUK Guidance (2015), impacts of this magnitude can be described as Negligible.

An increase in annual mean NO_2 concentration of 0.1 $\mu g/m^3$ is predicted at Receptor 75 in Corridor 3 in the DS1Sc3. This is the only receptor predicted to experience an increase in concentration. Annual mean NO_2 concentrations are predicted to decrease by up to 0.3 $\mu g/m^3$ at 25 modelled receptor locations in the DS1Sc3. The largest reductions are predicted to occur at Receptors 38, 41 and 88 (0.3 $\mu g/m^3$).

Comparisons between the DMSc3 and DS2Sc3 indicate that annual mean NO_2 concentrations are predicted to decrease at 17 of the modelled receptor locations in Corridor 3, increase at one location and remain unchanged at all other receptor locations. An increase in annual mean NO_2 concentration of 0.1 $\mu g/m^3$ is predicted at Receptor 75 in the DS2Sc3. A reduction in annual mean NO_2 concentration of 0.3 µg/m^3 is predicted at Receptor 41, and of 0.2 µg/m^3 at Receptors 45 and 61. According to EPUK Guidance (2015) impacts, these magnitudes can be described as Negligible.

The changes in local air quality at sensitive receptor locations in Corridor 3 as a result of proposed traffic management measures are likely to be Negligible.

Of the two proposed scenarios, the dispersion modelling results indicate that the DS1Sc3 is slightly more beneficial than the DS2Sc3 as more receptors are predicted to experience reductions in annual mean NO_2 concentrations. However, the magnitudes of changes in concentrations at all receptors in Corridor 3 in both the DS1Sc3 and DS2Sc3 are small and unlikely to result in significant changes to local air quality.

Table 17: Corridor 3, Annual Mean NO_2 Concentrations, 2013

Receptor ID	2013					
	BYSc3	DMSc3	DS1Sc3	DS2Sc3	DS1Sc3 Impact	DS2Sc3 Impact
1	29.1	29.0	28.9	28.9	-0.1	-0.1
2	31.8	31.5	31.5	31.4	0.0	-0.1
3	31.9	31.2	31.1	31.2	-0.1	0.0
4	29.8	29.4	29.4	29.4	0.0	0.0
5	30.1	29.9	29.9	29.9	0.0	0.0
20	28.1	27.8	27.7	27.7	-0.1	-0.1
21	28.4	27.8	27.8	27.8	0.0	0.0
22	26.8	26.5	26.5	26.5	0.0	0.0
23	30.7	29.6	29.6	29.6	0.0	0.0
32	30.7	29.7	29.5	29.7	-0.2	0.0
33	27.8	27.8	27.8	27.8	0.0	0.0
34	28.3	28.5	28.4	28.4	0.0	0.0
35	28.3	28.4	28.3	28.3	-0.1	-0.1
36	30.3	30.4	30.3	30.3	-0.1	-0.1
37	28.4	29.0	28.9	29.0	-0.1	-0.1
38	26.9	27.4	27.1	27.3	-0.3	0.0
39	28.1	28.2	28.0	28.1	-0.2	-0.1
40	23.8	23.6	23.5	23.6	-0.1	0.0
41	26.5	26.8	26.5	26.5	-0.3	-0.3
42	31.6	30.6	30.4	30.5	-0.2	-0.1
43	30.3	29.3	29.2	29.3	-0.2	0.0
44	25.1	24.0	23.9	23.9	-0.1	-0.1
45	25.8	25.2	25.0	25.0	-0.2	-0.2
46	23.2	22.4	22.4	22.4	0.0	0.0
47	25.7	25.0	24.9	25.0	-0.2	-0.1
60	25.8	25.3	25.2	25.3	-0.1	0.0
61	30.5	29.4	29.2	29.2	-0.2	-0.2
72	35.5	35.0	34.8	35.0	-0.2	-0.1
73	35.3	34.9	34.8	34.8	-0.1	0.0
74	25.8	27.0	26.9	27.0	-0.1	0.0
75	31.3	30.8	30.9	30.8	0.1	0.1
76	25.5	26.6	26.5	26.6	-0.1	0.0

Receptor ID	2013					
	BYSc3	DMSc3	DS1Sc3	DS2Sc3	DS1Sc3 Impact	DS2Sc3 Impact
77	30.0	29.0	28.8	28.8	-0.2	-0.1
78	25.9	25.1	24.9	25.0	-0.2	-0.1
88	32.3	32.5	32.2	32.3	-0.3	-0.1

Note: All results are rounded to 1 decimal place. Impacts of between greater than -0.1 µg/m^3 and less than +0.1 µg/m^3 are reported as 0.0.

7.7.2 Predicted Concentrations in 2015

The predicted annual mean NO_2 concentrations for the 35 sensitive receptors located in Corridor 3 in 2015 are presented in Table 18.

Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective at all modelled receptor locations in Corridor 3 in all modelled scenarios for 2015. The maximum predicted NO_2 concentration is 33.0 µg/m^3 in the DMSc3 and DS2Sc3 at Receptor 72. The highest concentration in the DS1Sc3 (32.9 µg/m^3) is also predicted at this receptor.

Comparisons between the DMSc3 and DS1Sc3 indicate that the proposed traffic management measures within the DS1Sc3 are likely to result in changes in annual mean NO_2 concentrations of -0.3 µg/m^3 to +0.1 µg/m^3 at modelled receptor locations in Corridor 3. There are predicted increases in annual mean NO_2 concentrations of up to 0.1 µg/m^3 at Receptors 3, 4, 5 and 22. Reductions in annual mean NO_2 concentrations are predicted at 19 modelled receptors. The maximum reductions in annual mean NO_2 concentrations (0.3 µg/m^3) are predicted at Receptors 1, 2, 38, 43 and 88 whilst a further six receptors are predicted to experience decreases of 0.2 µg/m^3 in the DS1Sc3. According to EPUK Guidance (2015), impacts of these magnitudes can be described as Negligible.

Comparisons between the DMSc3 and DS2Sc3 indicate that annual mean NO_2 concentrations are predicted to decrease at 12 of the modelled receptor locations in Corridor 3 and remain unchanged at all other modelled locations. The greatest reduction in annual mean NO_2 concentration in the DS2Sc3 is predicted to be 0.2 µg/m^3 at Receptor 1. According to EPUK Guidance (2015), impacts of these magnitudes can be described as Negligible.

The changes in local air quality at sensitive receptor locations in Corridor 3 as a result of proposed traffic management measures are likely to be Negligible. Of the two proposed scenarios, the dispersion modelling results indicate that the DS1Sc3 is considered to be slightly more beneficial than the DS2Sc3 as more receptors are predicted to experience reductions in annual mean NO_2 concentrations and the magnitudes of those reductions are slightly larger. However, predicted changes in concentrations at all receptors in Corridor 3 in both the DS1Sc3 and DS2Sc3 are small and unlikely to amount to significant changes to local air quality.

Table 18: Corridor 3, Annual Mean NO_2 Concentration, 2015

Receptor ID	2015				
	DMSc3	DS1Sc3	DS2Sc3	DS1Sc3 Impact	DS2Sc3 Impact
1	28.2	28.0	28.0	-0.3	-0.2
2	30.4	30.0	30.2	-0.3	-0.1
3	29.9	30.1	29.9	0.1	0.0
4	28.5	28.5	28.5	0.1	0.0
5	28.9	29.0	28.9	0.1	0.0
20	27.2	27.2	27.2	0.0	0.0
21	27.0	27.0	27.0	0.0	0.0
22	25.7	25.8	25.7	0.1	0.0
23	28.6	28.5	28.5	-0.1	0.0
32	28.8	28.6	28.8	-0.2	0.0
33	26.9	26.9	26.9	0.0	0.0
34	27.6	27.6	27.6	0.0	0.0
35	27.7	27.6	27.6	-0.1	-0.1
36	29.7	29.5	29.6	-0.2	-0.1
37	28.2	28.0	28.2	-0.2	0.0
38	26.6	26.3	26.5	-0.3	0.0
39	27.2	27.1	27.2	0.0	0.0
40	22.9	22.9	22.9	0.0	0.0
41	26.0	25.9	25.9	-0.1	0.0
42	29.6	29.5	29.5	-0.2	-0.1
43	28.4	28.2	28.4	-0.3	-0.1
44	23.4	23.4	23.4	0.0	0.0
45	24.3	24.2	24.2	0.0	0.0
46	21.8	21.9	21.8	0.0	0.0
47	24.3	24.1	24.2	-0.2	-0.1
60	24.7	24.8	24.7	0.0	-0.1
61	28.5	28.4	28.4	0.0	-0.1
72	33.0	32.9	33.0	-0.1	0.0
73	32.9	32.7	32.9	-0.2	0.0
74	25.9	25.8	25.9	-0.1	0.0
75	29.6	29.6	29.6	-0.1	0.0
76	25.5	25.5	25.5	0.0	0.0

Receptor ID	2015				
	DMSc3	DS1Sc3	DS2Sc3	DS1Sc3 Impact	DS2Sc3 Impact
77	28.1	28.0	28.0	-0.1	-0.1
78	24.3	24.2	24.2	-0.1	-0.1
88	31.3	31.1	31.3	-0.3	-0.1

Note: All results are rounded to 1 decimal place. Impacts of between greater than -0.1 µg/m^3 and less than +0.1 µg/m^3 are reported as 0.0.

7.8 Corridor 4

Corridor 4 encompasses Junctions 20 and 21, located to the north of Portsmouth (Appendix D, Figure 8).

7.8.1 Predicted Concentrations in 2013

The predicted annual mean NO_2 concentrations for the nine sensitive receptors located in Corridor 4 in 2013 are presented in Table 19.

Table 19: Corridor 4, Annual Mean NO_2 Concentrations, 2013

Receptor ID	2013						
	BYSc4	DS1Sc4	DS2Sc4	DS3Sc4	DS1Sc4 Impact	DS2Sc4 Impact	DS3Sc4 Impact
24	34.2	34.0	34.0	33.9	-0.3	-0.3	-0.3
25	31.8	31.6	31.6	31.6	-0.2	-0.2	-0.2
26	29.2	29.5	29.4	29.4	0.3	0.2	0.2
27	32.0	31.5	31.5	31.5	-0.5	-0.5	-0.5
28	27.0	26.9	26.9	26.9	-0.1	-0.1	-0.1
29	28.3	28.1	28.1	28.1	-0.2	-0.2	-0.2
30	25.2	25.3	25.3	25.3	0.1	0.1	0.1
31	26.2	25.9	25.9	25.9	-0.2	-0.2	-0.2
71	34.4	34.0	34.0	34.0	-0.4	-0.4	-0.4

Note: All results are rounded to 1 decimal place. Impacts of between greater than -0.1 µg/m^3 and less than +0.1 µg/m^3 are reported as 0.0. * There is no DM scenario for Corridor 4; impacts are calculated by comparison to the base year scenario.

Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2013 at all modelled receptors in all modelled scenarios.

The maximum predicted annual mean NO_2 concentration is 34.4 µg/m^3 at Receptor 71 in the BYSc4, and the maximum predicted concentrations in all other modelled scenarios are also predicted to occur at Receptor 71.

It should be noted that the predicted annual mean NO_2 concentrations at receptor locations in Corridor 4 for the DSSs are compared with BYSc4 concentrations because there is no DMS for Corridor 4.

Model results for the DS1Sc4 indicate that the proposed traffic management measures have the potential to result in changes in annual mean NO_2 concentrations of between -0.5 μg/m^3 and +0.3 μg/m^3.

The largest reduction in annual mean NO_2 concentration in the DS1Sc4 is predicted to occur at Receptor 27. The largest increase in concentration in this scenario is predicted at Receptor 26.

All of the predicted annual mean NO_2 impacts in the DS1Sc4 are less than ±2%, and the predicted annual mean NO_2 concentrations in the BYSc4 and DS1Sc4 are 34.4 μg/m^3 and less. According to EPUK Guidance (2015) impacts of this magnitude can therefore be described as Negligible.

Comparisons between the BYSc4 and DS2Sc4 indicate that the proposed traffic management measures within the DS2Sc4 are likely to result in changes in annual mean NO_2 concentrations of between -0.5 μg/m^3 and +0.2 μg/m^3. The largest reduction in annual mean NO_2 concentration in the DS2Sc4 is predicted to occur at Receptor 27. The largest increase in concentration in this scenario is predicted at Receptor 26. All of the predicted annual mean NO_2 impacts in the DS2Sc4 are less than ±2%, and the predicted annual mean NO_2 concentrations in BYSc4 and DS2Sc4 are 34.4 μg/m^3 and less. According to EPUK Guidance (2015) impacts of this magnitude can therefore be described as Negligible.

Results for the DS3Sc4 display similar patterns with predicted impacts upon annual mean NO_2 concentrations at receptor locations of -0.5 μg/m^3 to +0.2 μg/m^3. The greatest increase in annual mean NO_2 concentration is predicted to occur at Receptor 26, whilst the greatest reduction is predicted to occur at Receptor 27. All of the predicted annual mean NO_2 impacts in the DS3Sc4 are ±1% and less, and the predicted annual mean NO_2 concentrations in the BYSc4 and DS3Sc4 are 34.4 μg/m^3 and less. According to EPUK Guidance (2015), impacts of this magnitude can therefore be described as Negligible.

The changes in local air quality at sensitive receptor locations in Corridor 4 as a result of proposed traffic management measures are likely to be Negligible. The dispersion modelling results indicate that the two proposed scenarios have the potential to deliver small changes in concentrations of similar magnitudes at modelled receptor locations in Corridor 4. Consequently none of the three DSSc4 are considered likely significantly affect local air quality.

7.8.2 Predicted Concentrations in 2015

The predicted annual mean NO_2 concentrations for the nine sensitive receptors located in Corridor 4 in 2015 are presented in Table 20.

Table 20: Corridor 4, Annual Mean NO_2 Concentration, 2015

Receptor ID	2015						
	DM*Sc4	DS1Sc4	DS2 Sc4	DS3Sc4	DS1Sc4 Impact	DS2Sc4 Impact	DS3Sc4 Impact
24	33.0	32.9	32.9	32.9	-0.1	-0.1	-0.1
25	30.6	30.6	30.7	30.4	0.0	0.1	-0.2
26	28.4	28.7	28.7	28.6	0.2	0.3	0.2
27	30.8	30.6	30.6	30.6	-0.2	-0.2	-0.2
28	26.3	26.3	26.3	26.3	0.0	0.0	0.0
29	27.6	27.3	27.3	27.3	-0.3	-0.3	-0.3
30	24.7	24.7	24.7	24.7	-0.1	-0.1	-0.1
31	25.4	25.2	25.3	25.2	-0.2	-0.1	-0.2
71	33.2	33.0	33.0	33.0	-0.3	-0.3	-0.3

Note: All results are rounded to 1 decimal place. Impacts of between greater than -0.1 µg/m^3 and less than +0.1 µg/m^3 are reported as 0.0. * There is no DMS for Corridor 4; results for DMS are based on base year traffic data modelled with 2015 emission rates and background concentrations.

Annual mean NO_2 concentrations are predicted to be below the objective in 2015 at all modelled receptors in all scenarios. The highest NO_2 concentrations are predicted to occur at Receptor 71 in the DMSc4 (33.2 µg/m^3). Receptor 71 is located adjacent to Northern Road, near the roundabout with Wayte Street.

The results for the DS1Sc4 indicate that annual mean NO_2 concentrations are predicted to increase by 0.2 µg/m^3 at Receptor 26 and remain unchanged or decrease slightly at other modelled receptor locations. Reductions of 0.3 µg/m^3 are predicted at receptors 29 and 71. According to EPUK Guidance (2015), impacts of these magnitudes can be described as Negligible.

Comparisons between the DMSc4 and DS2Sc4 indicate that two modelled receptors in Corridor 4 are predicted to experience an increase in annual mean NO_2 concentration in the DS2Sc4 (0.3 µg/m^3 at Receptor 26 and 0.1 µg/m^3 at Receptor 25). According to EPUK Guidance (2015), impacts of these magnitudes can be classified as Negligible.

At six modelled receptor locations, annual mean NO_2 concentrations are predicted to decrease slightly in the DS2Sc4.

The largest predicted reduction in concentration is -0.3 µg/m^3 (Receptors 29 and 71). According to EPUK Guidance (2015), impacts of these magnitudes are classified as Negligible.

The proposed traffic improvements within Corridor 4 as part of the DS2Sc4 include the shortening of the existing bus lane on the approach to the Spur Road roundabout and the introduction of a bus gate to provide priority to buses. The results of the air quality modelling assessment indicate that these traffic improvements will have little impact on local air quality over annual timescales.

Comparisons between the DMSc4 and DS3Sc4 indicate that the implementation of the DS3Sc4 is predicted to results in changes in annual mean NO_2 concentrations of -0.3 µg/m^3 to +0.2 µg/m^3. Receptors 29 and 71 are predicted to experience reductions in annual mean NO_2 concentration of 0.3 µg/m^3 whilst an increase of 0.2 µg/m^3 is predicted at Receptor 26. According to EPUK Guidance (2015), the predicted changes in concentrations associated with the DS3Sc4 can be described as Negligible.

The changes in local air quality at sensitive receptor locations in Corridor 4 as a result of proposed traffic management measures are likely to be Negligible. The dispersion modelling results suggest that the DS3Sc4 is slightly more beneficial than the DS1Sc4 and DS2Sc4; however, predicted changes in concentrations at all receptors in Corridor 4 in all DSSc4 are small and unlikely to account for significant changes to local air quality.

7.9 Corridor 5

Corridor 5 encompasses Junctions 22 to 24, located to the south of Portsmouth (Appendix D, Figure 8).

7.9.1 Predicted Concentrations in 2013

The predicted annual mean NO_2 concentrations for the 16 sensitive receptors located in Corridor 5 in 2013 are presented in Table 21.

Table 21: Corridor 5, Annual Mean NO_2 Concentrations, 2013

Receptor ID	2013					
	BYSc5	DMSc5	DS1Sc5	DS2Sc5	DS1Sc5 Impact	DS2Sc5 Impact
14	28.0	28.2	28.1	28.3	-0.1	0.1
48	22.6	23.2	23.1	23.1	-0.1	-0.1
49	25.3	26.1	26.1	26.1	0.0	0.0
50	23.0	23.7	23.7	23.7	-0.1	0.0
51	26.5	28.0	27.9	28.0	0.0	0.0
52	24.1	24.4	24.3	24.3	0.0	0.0
53	22.6	23.5	23.5	23.4	0.0	-0.1
54	26.0	26.6	26.6	26.6	0.0	0.0
55	32.3	34.2	34.2	34.0	-0.1	-0.2
56	30.3	30.9	30.9	30.9	0.0	0.0
57	27.2	27.6	27.6	27.6	0.0	0.0
58	27.0	27.7	27.6	27.6	-0.1	-0.1

Receptor ID	2013					
	BYSc5	DMSc5	DS1Sc5	DS2Sc5	DS1Sc5 Impact	DS2Sc5 Impact
59	28.4	28.7	28.5	28.7	-0.2	-0.1
79	28.3	29.8	29.8	29.8	-0.1	-0.1
80	29.9	30.7	30.6	30.6	-0.1	-0.1
81	31.0	30.9	31.0	31.0	0.1	0.1

Note: All results are rounded to 1 decimal place. Impacts of between greater than -0.1 $\mu g/m^3$ and less than +0.1 $\mu g/m^3$ are reported as 0.0.

Annual mean NO_2 concentrations are predicted to be below the annual mean NO_2 objective in 2013 at all modelled receptors in all scenarios.

The highest predicted concentration is 34.2 $\mu g/m^3$ at Receptor 55 in the DMSc5 and DS1Sc5. The highest concentrations in the DMSc5 and DS2Sc5 are also predicted at this receptor location. At all modelled receptors except Receptor 81 annual mean NO_2 concentrations are predicted to increase between the BYSc5 and DMSc5. The largest increase between the BYSc5 and DMSc5 is 1.9 $\mu g/m^3$ at Receptor 55.

Comparisons between the DMSc5 and DS1Sc5 indicate that the proposed traffic management measures within the DS1Sc5 could result in changes in annual mean NO_2 concentrations of -0.2 $\mu g/m^3$ to +0.1 $\mu g/m^3$ at modelled receptor locations in Corridor 5. The largest impact on annual mean NO_2 concentration is predicted to occur at Receptor 81 (+0.1 $\mu g/m^3$). According to EPUK Guidance (2015), this impact is defined as Negligible.

Eight receptors are predicted to experience decreases in annual mean NO_2 concentrations in the DS1Sc5. A change in annual mean NO_2 concentration of -0.2 $\mu g/m^3$ is predicted at Receptor 59; according to EPUK Guidance (2015), this change is described as Negligible.

Comparisons between the DMSc5 and DS2Sc5 indicate that annual mean NO_2 concentrations are predicted to decrease at seven of the modelled receptor locations in Corridor 5, remain unchanged at seven locations, and increase slightly at two modelled locations. The maximum increase in annual mean NO_2 concentration in the DS2Sc5 is 0.1 $\mu g/m^3$ at Receptors 14 and 81. According to EPUK Guidance (2015), the impacts at Receptors 14 and 81 are defined as Negligible.

A reduction in annual mean NO_2 concentrations of 0.2 $\mu g/m^3$ is predicted at Receptor 55 in the DS2Sc5. As this predicted change in concentration is less than 0.5% of the annual mean NO_2 objective the impact can be described as Negligible according to EPUK Guidance (2015).

Overall, the changes in local air quality at sensitive receptor locations in Corridor 5 as a result of proposed traffic management measures are likely to be Negligible. The proposed DS1Sc5 is predicted to result in small deterioration in local air quality at one receptor location, whilst the

DS2Sc5 may result in slight increases in concentrations at two receptors. The dispersion modelling results indicate that the DS1Sc5 and DS2Sc5 are likely to result in similar overall air quality effects at receptor locations in Corridor 5. The predicted changes in concentrations in both the DS1Sc5 and DS2Sc5 are small and are considered unlikely to result in widespread significant impacts on local air quality.

7.9.2 Predicted Concentrations in 2015

The predicted annual mean NO_2 concentrations predicted for the 16 sensitive receptors located in Corridor 5 in 2015 are presented in Table 22.

Table 22: Corridor 5, Annual Mean NO_2 Concentrations, 2015

Receptor ID	2015				
	DMSc5	DS1Sc5	DS2Sc5	DS1Sc5 Impact	DS2Sc5 Impact
14	27.8	27.7	27.8	-0.1	0.0
48	22.5	22.5	22.5	0.0	0.0
49	25.4	25.4	25.4	0.0	0.0
50	23.1	23.1	23.1	0.0	0.0
51	27.2	27.3	27.2	0.1	0.0
52	23.8	23.8	23.8	0.0	0.0
53	22.8	22.8	22.8	0.0	0.0
54	26.1	26.1	26.1	-0.1	0.0
55	33.3	33.3	33.1	0.0	-0.3
56	30.2	30.2	30.2	0.0	0.0
57	27.1	27.1	27.1	0.0	0.0
58	26.9	26.9	26.9	0.0	0.0
59	28.0	27.9	28.0	-0.2	0.0
79	29.0	29.0	28.9	0.0	-0.1
80	30.0	30.0	30.0	0.0	0.0
81	30.2	30.3	30.3	0.0	0.0

Note: All results are rounded to 1 decimal place. Impacts of between greater than -0.1 $\mu g/m^3$ and less than +0.1 $\mu g/m^3$ are reported as 0.0.

Annual mean NO_2 concentrations were predicted to be below the annual mean NO_2 objective in 2015 at all modelled receptors in all scenarios. The highest predicted concentration is 33.3 $\mu g/m^3$ at Receptor 55 in the DMSc5 and DS1Sc5. The highest concentration in the DS2Sc5 is also predicted at this receptor location.

Comparisons between the DMSc5 and DS1Sc5 indicate that the proposed traffic management measures within the DS1Sc5 could result in changes in annual mean NO_2 concentrations of -0.2

μg/m^3 to +0.1 μg/m^3 at modelled receptor locations in Corridor 5. The largest increase in annual mean NO_2 concentration is predicted to occur at Receptor 51 (0.1 μg/m^3). This is the only receptor location where there is a predicted increase in annual mean NO_2 concentration. According to EPUK Guidance (2015), an impact of this magnitude is defined as Negligible.

Three receptors are predicted to experience decreases in annual mean NO_2 concentrations in the DS1Sc5. Changes in annual mean NO_2 concentrations of -0.1 μg/m^3 are predicted at Receptors 14 and 54; the largest predicted decrease is -0.2 μg/m^3 at Receptor 59. According to EPUK Guidance (2015), changes of these magnitudes are described as Negligible.

Comparisons between the DMSc5 and DS2Sc5 indicate that annual mean NO_2 concentrations are predicted to decrease at two modelled receptors and remain unchanged at all other modelled locations in Corridor 5. The maximum reduction in annual mean NO_2 concentration in the DS2Sc5 is 0.3 μg/m^3 at Receptor 55. According to EPUK Guidance (2015), the air quality impacts associated with DS2Sc5 are defined as Negligible.

The predicted changes in local air quality at sensitive receptor locations in Corridor 5 as a result of proposed traffic management measures are likely to be Negligible. The dispersion modelling results indicate that both of the proposed scenarios are likely to result in similar changes in concentrations at sensitive receptor locations. Overall, any changes are likely to be very small and are considered unlikely to result in widespread significant impacts on local air quality.

7.10 Summary and Conclusions

Annual mean NO_2 concentrations for 2013 and 2015 have been predicted for each of the model scenarios using the AAQuIRE regional dispersion model and the potential impacts associated with each of the Do-Something scenarios assessed.

The main conclusions from the detailed dispersion modelling exercise are summarised in the 8.3 sub-sections below and in tabulated form in Table 23.

7.10.1Existing and Future Air Quality Without Additional ORTMCS Measures

The first task of the AQIA was to predict annual mean NO_2 concentrations at sensitive receptor locations within each of the five individual route corridors for the 2013 and 2015 DMSs.

The aim of this task was to determine whether the annual mean NO_2 objective is likely to be achieved without the implementation of any additional traffic management measures. The results are summarised as follows:

- ✓ There are no predicted exceedences of the annual mean NO_2 objective at any modelled receptor location in any of the five route corridors in the 2013 or 2015 DMSs.
- ✓ The maximum predicted annual mean NO_2 concentration in the 2013 DMS is 39.1 μg/m^3 at Receptor 15.
- ✓ The maximum predicted annual mean NO_2 concentrations in the 2013 DMS by route corridor are:
  - Corridor 1: 39.1 μg/m^3 at Receptor 15.
  - Corridor 2: 37.0 μg/m^3 at Receptor 84.
  - Corridor 3: 35.0 μg/m^3 at Receptor 72.
  - Corridor 4: 34.4 μg/m^3 at Receptor 71 (BY result as there is no DMS for Corridor 4)
  - Corridor 5: 34.2 μg/m^3 at Receptor 55..
- ✓ The maximum predicted annual mean NO_2 concentration in the 2015 DMS is 37.8 μg/m^3 at Receptor 15.
- ✓ The maximum predicted annual mean NO_2 concentrations in the 2015 DM by route corridor are:
  - Corridor 1: 37.8 μg/m^3 at Receptor 15.
  - Corridor 2: 35.7 μg/m^3 at Receptor 84.
  - Corridor 3: 33.0 μg/m^3 at Receptor 72.
  - Corridor 4: 33.2 μg/m^3 at Receptor 71 (Projected base year result).
  - Corridor 5: 33.3 μg/m^3 at Receptor 55.

The results of the AQIA indicate that the annual mean NO_2 objective will not be exceeded at any modelled sensitive receptor location in 2013 or 2015 should additional traffic management measures not be implemented. However, the predicted annual mean NO_2 concentrations, particularly for the 2013 DMS, are close to the annual mean objective at several modelled receptor locations.

Due to inherent uncertainties within the dispersion modelling process, where predicted concentrations are within 10% of the annual mean objective it is possible that exceedence of the objective may occur. At Receptors 15 (39.1 µg/m^3), 16 (37.1 µg/m^3), 67 (38.5 µg/m^3), 84 (37.0 µg/m^3), 85 (37.4 µg/m^3) and 87 (37.2 µg/m^3) annual mean NO_2 concentrations are predicted to be within 10% of the annual mean objective.

Any revocation of an Air Quality Management Area should consider both the predictions made throughout the corridors via the contour maps and local monitoring.

7.10.2 Future Air Quality With the Implementation of Additional ORTMCS Measures

Annual mean NO_2 concentrations for 2013 and 2015 have been predicted using the AAQuIRE regional dispersion model to assess the potential impacts associated with the implementation of traffic management measures proposed as part of the ORTMCS project. Two Do-Something scenarios comprising different packages of measures have been assessed.

The main conclusions from this part of the AQIA are summarised in 8.3 sub-sections below and in tabulated form in Table 23.

- ✓ **Corridor 1**
    - There are no predicted exceedences of the annual mean NO_2 objective at any location in the DMSc1, DS1Sc1 or DS2Sc1 in 2013 and 2015.
    - The maximum predicted annual mean NO_2 concentration is 39.3 µg/m^3 at Receptor 15 in the 2013 DS2Sc1.
    - In the 2013 DS1Sc1, it is predicted that annual mean NO_2 concentrations will decrease at 8 receptors, with no change in concentration (less than 0.1 µg/m^3) at all other modelled receptors.
    - In the 2015 DS1Sc1, it is predicted that annual mean NO_2 concentrations will increase at 2 receptors and decrease at 7 receptors, with no change in concentration at all other modelled receptors.
    - The largest increases in annual mean NO_2 concentrations in the DS1Sc1 are less than 0.1 µg/m^3 in 2013 and 0.2 µg/m^3 in 2015.
    - The largest decreases in annual mean NO_2 concentrations in the DS1Sc1 are 0.4 µg/m^3 in 2013 and 0.5 µg/m^3 in 2015.

- In the 2013 DS2Sc1, it is predicted that annual mean NO_2 concentrations will increase at 4 receptors and will decrease at 4 receptors, with no change in concentration at all other modelled receptors.
- In the 2015 DS2Sc1, it is predicted that annual mean NO_2 concentrations will increase at 2 receptors and decrease at 3 receptors, with no change in concentration at all other modelled receptors.
- The largest increases in annual mean NO_2 concentration in the DS2Sc1 are 0.2 $\mu g/m^3$ and 0.1 $\mu g/m^3$ in 2013 and 2015, respectively.
- The largest decreases in annual mean NO_2 concentration in the DS2Sc1 are 0.1 $\mu g/m^3$ in both 2013 and 2015.

For both assessment years, the dispersion modelling results indicate that **DS1Sc1 is the preferred** scenario in Corridor 1 due to the potential for slightly greater reductions in annual mean NO_2 concentrations at modelled receptor locations.

- ✓ **Corridor 2**
  - There are no predicted exceedences of the annual mean NO_2 objective at any location in the DMSc2, DS1Sc2 or DS2Sc2 in 2013 and 2015.
  - The maximum predicted annual mean NO_2 concentration is 37.0 $\mu g/m^3$ at Receptor 84 in the 2013 DMSc2, 2013 DS1Sc2 and 2013 DS2Sc2.
  - In the 2013 DS1 scenario, it is predicted that annual mean NO_2 concentrations will not increase at any receptor location and will decrease at 1 receptor. No change in concentration is predicted at all other modelled receptors.
  - In the 2015 DS1Sc2, it is predicted that annual mean NO_2 concentrations will increase at 3 receptors and will decrease at 3 receptors, with no change in concentration at all other modelled receptors.
  - The largest increases in annual mean NO_2 concentration in the DS1Sc2 are less than 0.1 $\mu g/m^3$ and 0.3 $\mu g/m^3$ in 2013 and 2015, respectively.
  - The largest decreases in annual mean NO_2 concentration in the DS1Sc2 are 0.1 $\mu g/m^3$ in both the 2013 and 2015 assessment years.
  - In the 2013 DS2Sc2, it is predicted that annual mean NO_2 concentrations will increase at 3 receptors and will remain unchanged at all other modelled receptors.
  - In the 2015 DS2Sc2, it is predicted that annual mean NO_2 concentrations will increase at 4 receptors and will remain unchanged at all other modelled receptors.
  - The largest increases in annual mean NO_2 concentration in the DS2Sc2 are 0.3 $\mu g/m^3$ and 0.1 $\mu g/m^3$ in 2013 and 2015, respectively.
  - The largest decreases in annual mean NO_2 concentration in the DS2Sc2 are 0.1 $\mu g/m^3$ in 2013 and less than 0.1 $\mu g/m^3$ in 2015.

The dispersion modelling results for Corridor 2 indicate that **DS1Sc2 is the preferable** scenario. Neither of the two proposed scenarios is predicted to bring about significant changes in local air quality; however, the results for the DS2Sc2 suggest the potential for slight deterioration in local air quality.

- **Corridor 3**

  - There are no predicted exceedences of the annual mean NO_2 objective at any location in the DMSc3, DS1Sc3 or DS2Sc3 in 2013 and 2015.
  - The maximum predicted annual mean NO_2 concentration is 35.5 µg/m^3 at Receptor 72 in the 2013 BYSc3.
  - In the 2013 DS1Sc3, it is predicted that annual mean NO_2 concentrations will decrease at 25 receptors, increase at 1 location and remain unchanged elsewhere.
  - In the 2015 DS1Sc3, it is predicted that annual mean NO_2 concentrations will increase at 4 receptors and will decrease at 19 receptors, with no change in concentration at all other modelled receptors.
  - The largest increases in annual mean NO_2 concentration in the DS1Sc3 are 0.1 µg/m^3 in both 2013 and 2015.
  - The largest decreases in annual mean NO_2 concentration in the DS1Sc3 is 0.3 µg/m^3 in both the 2013 and 2015 assessment years.
  - In the 2013 DS2Sc3, it is predicted that annual mean NO_2 concentrations will increase at 1 receptor and will decrease at 17 receptors, with no change in concentration at all other modelled receptors.
  - In the 2015 DS2Sc3, it is predicted that annual mean NO_2 concentrations will decrease at 12 receptors, with no change in concentration at all other modelled receptors.
  - The largest increases in annual mean NO_2 concentration in the DS2Sc3 are 0.1 µg/m^3 and less than 0.1 µg/m^3 in 2013 and 2015, respectively.
  - The largest decreases in annual mean NO_2 concentration in the DS2Sc3 are 0.3 µg/m^3 and 0.2 µg/m^3 in 2013 and 2015, respectively.

For both the 2013 and 2015 assessment years the dispersion modelling results indicate that **DS1Sc3 is marginally the preferred** scenario with respect to Corridor 3. DS1Sc3 is predicted to result in slightly greater reductions in annual mean NO_2 concentrations and at a greater number of sensitive receptor locations than the DS2Sc3.

- **Corridor 4**
  - There are no predicted exceedences of the annual mean NO_2 objective at any location in the BYSc4, DS1Sc4, DS2Sc4 or DS3Sc4 in 2013 and 2015. The maximum predicted annual mean NO_2 concentration is 34.4 µg/m^3 at Receptor 71 in the 2013 BYSc4.
  - In the 2013 DS1Sc4, it is predicted that annual mean NO_2 concentrations will increase at two modelled receptor locations and decrease at all other receptors in Corridor 4. In the 2015 DS1Sc4, it is predicted that annual mean NO_2 concentrations will increase at one receptor, will remain unchanged at two receptors and decrease at all other modelled receptors.
  - The largest increases in annual mean NO_2 concentration in the DS1Sc4 are 0.3 µg/m^3 in 2013 and 0.2 µg/m^3 in 2015.
  - The largest decreases in annual mean NO_2 concentration in the DS1Sc4 are 0.5 µg/m^3 in 2013 and 0.3 µg/m^3 in 2015.
  - In the 2013 DS2Sc4, it is predicted that annual mean NO_2 concentrations will increase at two modelled receptor locations and decrease at all other receptors in Corridor 4.
  - In the 2015 DS2Sc4, it is predicted that annual mean NO_2 concentrations will increase at two receptors, will remain unchanged at one receptor and decrease at all other modelled receptors.
  - The largest increases in annual mean NO_2 concentration in the DS2Sc4 are 0.2 µg/m^3 in 2013 and 0.3 µg/m^3 in 2015.
  - The largest decreases in annual mean NO_2 concentration in the DS2Sc4 are 0.5 µg/m^3 in 2013 and 0.3 µg/m^3 in 2015.
  - In the 2013 DS3Sc4, it is predicted that annual mean NO_2 concentrations will increase at two modelled receptor locations and decrease at all other modelled locations.
  - In the 2015 DS3Sc4, it is predicted that annual mean NO_2 concentrations will increase at one receptor, remain unchanged at 1 receptor and decrease at all other modelled receptors.
  - The largest increases in annual mean NO_2 concentration in the DS3Sc4 are 0.2 µg/m^3 in both 2013 and 2015.
  - The largest decreases in annual mean NO_2 concentration in the DS3Sc4 are 0.5 µg/m^3 and 0.3 µg/m^3 in 2013 and 2015 respectively.

For both the 2013 and 2015 assessment years, the dispersion modelling results indicate that none of the three proposed scenarios are likely to result in widespread changes in local air quality. DS3Sc4 appears to offer some small potential reductions in NO_2 concentrations at receptor locations in Corridor 4 and is consequently considered to be the preferred option.

- **Corridor 5**
  - There are no predicted exceedences of the annual mean NO_2 objective at any location in the DMSc5, DS1Sc5 or DS2Sc5 in 2013 and 2015.
  - The maximum predicted annual mean NO_2 concentration is 34.2 $\mu g/m^3$ at Receptor 55 in the 2013 DMSc5 and DS1Sc5.
  - In the 2013 DS1Sc5, it is predicted that annual mean NO_2 concentrations will increase at one receptor location, decrease at eight locations, and remain unchanged at all other modelled receptors.
  - In the 2015 DS1Sc5, it is predicted that annual mean NO_2 concentrations will increase at one receptor, decrease at three receptors, and remain unchanged at all other modelled receptors.
  - The largest increases in annual mean NO_2 concentration in the DS1Sc5 is 0.1 $\mu g/m^3$ in both the 2013 and 2015 assessment years.
  - The largest decreases in annual mean NO_2 concentration in the DS1Sc5 are 0.2 $\mu g/m^3$ in both the 2013 and 2015 assessment years.
  - In the 2013 DS2Sc5, it is predicted that annual mean NO_2 concentrations will increase at two receptor locations, will decrease at seven receptors, and remain unchanged at all other modelled receptors.
  - In the 2015 DS2Sc5, it is predicted that annual mean NO_2 concentrations will not increase at any receptor and decrease at two receptors, with no change in concentration at all other modelled receptors.
  - The largest increases in annual mean NO_2 concentration in the DS2Sc5 are 0.1 $\mu g/m^3$ and less than 0.1 $\mu g/m^3$ in 2013 and 2015, respectively.
  - The largest decreases in annual mean NO_2 concentration in the DS2Sc5 are 0.2 $\mu g/m^3$ and 0.3 $\mu g/m^3$ in the 2013 and 2015 assessment years, respectively.

For both the 2013 and 2015 assessment years the dispersion modelling results indicate that **DS1Sc5 is the preferred** scenario with respect to Corridor 5. The predicted impacts associated with both scenarios are very small and unlikely to result in widespread changes to local air quality; however, DS1Sc5 is predicted to result in greater reductions in annual mean NO_2 concentrations at a greater number of modelled receptors than DS2Sc5.

8 ORTMCSs Conclusions and Recommendations

8.1 Vehicle Micro-Simulation Modelling

VISSIM vehicle modelling for all individual five corridors concluded the following:

- ✓ Corridor 1

  The improvements to the Holbrook Road / Lake Road roundabout should be taken forward as the preferred scheme once the DMSc1 network changes have been concluded and that amendments to the Church Street Roundabout signals be reviewed due to the congestion observed along Church Street as a result of reducing the green time in the AM and PM peaks.

- ✓ Corridor 2

  Due to the optimal performance during all peak periods; **DS1Sc2 should be considered further as the preferred scenario**.

- ✓ Corridor 3

  Due to the optimal performance during all peak periods; DS1Sc3 should be considered further as the preferred scenario. In the meantime DS2Sc3 also offers benefits. Therefore, it is recommended to pursue the feasibility of implementing **a combined DS1Sc3 and DS2Sc3 as the preferred scenario**.

- ✓ Corridor 4

  Due to the optimal performance during all peak periods; **DS3Sc4 should be considered further as the preferred scenario**.

- ✓ Corridor 5

  Due to the optimal performance during all peak periods; DS1Sc5 should be considered further as the preferred scenario. In the meantime DS2Sc5 also offers benefits. Therefore, it is recommended to pursue the feasibility of implementing both the DS1Sc5 to introduce bus laybys at several locations along Elm Grove and Victoria Road North and the DS2Sc5 to removal on street parking provision where it impedes tow way traffic flow. **DS1Sc5 and DS2Sc5 are the preferred scenarios**.

8.2 AIRE Emission Calculation

AIRE modelling for all five corridors are consistent with the findings of the VISSIM modelling. For all corridors differences in emissions between Do Minimum and Do Something scenarios are subtle and the findings of the AIRE modelling generally support the findings of the corresponding VISSIM modelling:

- ✓ Corridor 1

  AIRE results for Corridor 1 are illustrated in Table 8:

  - o Emissions of NOx and PM10 in the DMSc1 are higher than in the base.

- DS1Sc1 would also have lower CO2 emissions than the BYSc1 and DMSc1.
- DS2Sc1 is the least favourable.
- BYSc1 remains the most environmental friendly scenario.
- **The most favourable proposed scenario is DS1Sc1**, which would result in higher NOx and PM10 emissions than in the BYSc1 but slightly lower than in the DMSc1.

✓ Corridor 2

AIRE results for Corridor 2 are illustrated in Table 8:

- Emissions in the DMSc2 are lower than in the BYSc2.
- DS2Sc2 is the least favourable
- **The most favourable scenario is DS1Sc2, which would result in lower NOx, PM10 and CO2 emissions than in the BYSc2 and DMSc2.**

✓ Corridor 3

AIRE results for Corridor 3 are illustrated in Table 8:

- Emissions in the DMSc3 are lower than in the BYSc3.
- DS2Sc3 is the least favourable.
- **The most favourable scenario is DS1Sc3, which would result in lower NOx, PM10 and CO2 emissions than in the BYSc3 and DMSc3.**

✓ Corridor 4

AIRE results for Corridor 4 are illustrated in Table 8:

- Emissions of NOx, PM10 and CO2 with DS1Sc4 and DS2Sc4 are marginally higher than in the BYSc4.
- **By a very small margin DS3Sc4 is the most favourable.**

✓ Corridor 5

AIRE results for Corridor 5 are illustrated in Table 8:

- Emissions of NOx, PM10 and CO2 with DS1Sc4 and DS2Sc4 are marginally higher
- With the exception of PM10, emissions in the DMSc5 are lower than in the BYSc5.
- The differences between DS1Sc5 and DS2Sc5 are very slight.
- **The SD2Sc5 is most favourable in terms of NOx and CO2 emissions and DS1Sc5 is most favourable in terms of PM10 emissions.**

8.3 Air Quality Impact Assessment

The AQIA concludes that:

- ✓ There are no predicted exceedences of the annual mean NO_2 objective at any location in the DMS or any of the DSSs in 2013 and 2015.
- ✓ The maximum predicted annual mean NO_2 concentration is 39.3 μg/m^3 at Receptor 15 in the 2013 DS2S.
- ✓ In the 2013 DS1S, it is predicted that annual mean NO_2 concentrations will increase at 4 receptor locations, decrease at 49 locations, and remain unchanged at 36 modelled receptors.
- ✓ In the 2015 DS1S, it is predicted that annual mean NO_2 concentrations will increase at 11 receptors, decrease at 38 receptors, and remain unchanged at 40 modelled receptors.
- ✓ The largest increase in annual mean NO_2 concentration in the DS1S is 0.2 μg/m^3 in 2013 and 0.3 μg/m^3 in 2015.
- ✓ The largest decreases in annual mean NO_2 concentration in the DS1Ss are 0.5 μg/m^3 in both 2013 and 2015 assessment years.
- ✓ In the 2013 DS2S, it is predicted that annual mean NO_2 concentrations will increase at 12 receptor locations, will decrease at 35 receptors, and remain unchanged at 42 modelled receptors.
- ✓ In the 2015 DS2S, it is predicted that annual mean NO_2 concentrations will increase at 8 receptors and decrease at 23 receptors, with no change in concentration at 58 modelled receptors.
- ✓ The largest increases in annual mean NO_2 concentration in the DS2Ss are 0.3 μg/m^3 and 0.2 μg/m^3 in 2013 and 2015, respectively.
- ✓ The largest decreases in annual mean NO_2 concentration in the DS2 scenarios are 0.5 μg/m^3 in the 2013 assessment year and 0.3 μg/m^3 in the 2015 assessment year.
- ✓ The DS3S for Corridor 4 is predicted to increase annual mean NO_2 concentrations at 2 receptors and decrease concentrations at 7 modelled receptors in the 2013 assessment year. In the 2015 assessment year the DS3S is predicted to increase annual mean NO_2 concentrations at 1 receptor, decrease concentrations at 7 receptors and result in no change in concentration at 1 modelled receptor.
- ✓ The largest increases in annual mean NO_2 concentration in the DS3S are 0.2 μg/m^3 in both the 2013 and 2015 assessment years. The largest decreases in annual mean NO_2 concentration in the DS3S are 0.5 μg/m^3 and 0.3 μg/m^3 in the 2013 and 2015 assessment years respectively.

The results of the dispersion modelling indicate that the overall preferred traffic management scenario with respect to air quality is DS1S for the 2015 assessment year.

Taking the 2015 assessment year results, the sum of changes in NO_2 concentrations is lower in the DS1S than the DS2S, indicating that the DS1S may result in an overall greater reduction in concentrations at modelled receptor locations.

The total number of modelled receptors predicted to experience decreases in annual mean NO_2 concentrations in 2015 is higher in the DS1S than the DS2S. The total number of receptors predicted to see increased concentrations is lower in the DS2S (8) than the DS1S (11); however, the magnitudes of these increases in concentration in the DS1S are small and not considered to be significant, particularly when account is taken of the reductions in concentrations elsewhere.

The results of the dispersion modelling exercise illustrate that the proposed traffic management measures are unlikely to result in significant changes in ambient air quality in Portsmouth. The predicted changes in annual mean NO_2 concentrations at all modelled sensitive receptor locations are negligible.

As a consequence of the small changes in concentrations over annual timescales, the magnitudes of the predicted air quality impacts are quite sensitive to changes in background pollutant concentrations, vehicle NO_X emission rates and assumed changes in the fraction of primary NO_2 between assessment years.

Table 23: Summary of Predicted Impacts of Traffic Management Options on Local Air Quality, 2015

Route Corridor	Maximum Predicted NO_2 Concentration ($\mu g/m^3$)			Maximum Predicted NO_2 Impact ($\mu g/m^3$)			Number of Receptors Where Concentrations Increase			Number of Receptors Where Concentrations Decrease			Preferred Option
	DS1	DS2	DS3	DS 1	DS 2	DS 3	DS 1	DS 2	DS 3	DS 1	DS 2	DS 3	
1	37.6	37.8	-	0.2	0.1	-	2	2	-	7	3	-	DS1
2	36.0	35.7	-	0.3	0.1	-	3	4	-	3	0	-	DS1 / DS2
3	32.9	33.0	-	0.1	0	-	4	0	-	19	12	-	DS1
4	33.0	33.0	33.0	0.3	0.2	0.2	1	2	1	6	6	7	DS3
5	33.3	33.1	-	0.1	0	-	1	0	-	3	2	-	DS1 / DS2
Overall	**37.6**	**37.8**	**33.0**	**-5.5***	**-2.1***	**-1.2***	**11**	**8**	**1**	**38**	**23**	**7**	**DS1**

* These figures represent the sum of predicted impacts at all modelled receptor locations to give an indication of the overall changes in NO_2 concentrations associated with each scenario.

8.4 Overall Conclusion and Recommendations

In general the conclusions of this ORTMCs study demonstrate a consistency throughout the three packages.

The performance analysis of various scenarios on various corridors indicates that the results of the dispersion modelling exercise illustrate that:

- ✓ There are no predicted exceedances of the annual mean NO_2 objective at any modelled receptor location in any of the five route corridors in the 2013 or 2015 assessment years.
- ✓ The results of the AQIA indicate that the annual mean NO_2 objective will not be exceeded at any modelled sensitive receptor location in 2013 or 2015 should additional traffic management measures not be implemented. However, the predicted annual mean NO_2 concentrations, particularly for the 2013 DMS, are close to the annual mean objective at several modelled receptor locations.
- ✓ Any revocation of an Air Quality Management Area should consider both the predictions made throughout the corridors via the contour maps and local monitoring.
- ✓ The proposed traffic management measure scenarios are unlikely to result in significant changes in ambient air quality in Portsmouth.
- ✓ The predicted changes in annual mean NO_2 concentrations at all modelled sensitive receptor locations are negligible.

It is therefore impossible to make any air quality based recommendation for referral scenario at any corridor that would result into significant change to lead into an improvement in local air quality

However, the ORTMCS recommends that should a decision is made to address road traffic congestion within the City air quality should be considered as material consideration however insignificant was found in the AQIA:

- ✓ Corridor 1
  - **DMSc1:** To incorporate the following changes to the network, which have either already been implemented on site, or are due to be implemented shortly:
    - Signalisation of the Rudmore Roundabout, bus lane and bus gate along the SB offslip and alterations to lane allocations;
    - The merge from Rudmore Roundabout SB on slip with the M275 flyover traffic has been altered so that the slip road traffic merges with the nearside lane of the flyover, resulting in a lane drop;
    - Extending the existing bus lane along Mile End Road southbound through the Church Street Roundabout, Commercial Road and Marketway Roundabout to join up with the current bus lane along Marketway, with lane alterations and signal time changes at the Church Street Roundabout;
    - Signalising Anglesea Road approach and opposing circulatory to allow pedestrian facilities, and altering the Cambridge Road triple crossings to run in isolation at St Michael's Gyratory.
  - **DS1Sc1:** To utilise the DMS model layout with alterations made to the Holbrook Road / Lake Road roundabout. Two flares have been introduced on the Church Street and Lake Road (E) approaches for left turning traffic only to provide more capacity for the ahead and right turning traffic.

- ✓ Corridor 2
  - **DMSc2:** To modify several signalised junctions throughout Corridor 2
  - **DS1Sc2:** To amend bus stops throughout the network (where possible)
  - **DS2Sc2:** To improve junction in line with the recommendations made within the South East Hampshire Bus Rapid Transit (BRT) Highway Design Priorities Study undertaken in February 2014.

- ✓ Corridor 3
  - **DMSc3:** This scenario consists of the following planned improvements
    - Signalisation of London Road / Northern Parade junction. This improvement includes prohibiting southbound to northbound U-turn manoeuvres. As a result, southbound vehicles originating from the Portsbridge roundabout or

Military Road intending to go north along Northern Parade will be routed through the London Road/Copnor Road circulatory.

- Geometric improvements and installation of MOVA at the Milton Road / Goldsmith Avenue junction. The geometric improvement includes reconfiguring of the northbound approach to provide one through lane and one left turn lane, along with provision of signalised pedestrian crossings.
- Installation of MOVA at the Milton Road / Velder Avenue junction.
- Optimisation of signal timing and stage sequence at the Milton Road / St. Mary's Hospital Entrance junction.
- Optimisation of signal timing and stage sequence at the Copnor Road / Stubbington Avenue / Burrfields Road junction.

- **DS1Sc3** This scenario included the following:
  - Replacement of on-street bus stops with laybys at the following locations:
    - Norway Road Eastbound, East of Copnor Road
    - Copnor Road Southbound, south of Stubbington Avenue / Burrfield Road
    - Milton Road Northbound, north of Locksway mini-roundabout
    - Milton Road Northbound, south of Priory Crescent
    - Milton Road Southbound, south of Priory Crescent
  - Additional parking/loading restrictions on the southbound section of Milton Road between Dover Road and St Mary's Roundabout.

- **DS2Sc3:** To construct southbound right turn lane into the fuel station located approximately 50m north of the Copnor Road / Stubbington Avenue / Burrfields Road junction. Currently, traffic turning right into the fuel station blocks the southbound through traffic resulting in excessive delays for the southbound movement at this junction. The right turn lane will provide storage for the right turning traffic without blocking the southbound through traffic.

✓ Corridor 4

- **DS3Sc4**: To alter the lane allocation to allow a double right turn to A3 Southampton Road. Therefore, the middle lane will be to travel right or ahead and the nearside will be a left or ahead lane as it has also been assumed that the widening of the approach has taken place as per DS1S. The bus gate has not been included in this scenario.

✓ Corridor 5

- **DMSc5:** This scenario proses the removal of stage 3 from the signalised junction of Victoria Road, Outram Road and Elm Grove, converting the right turn movement from Victoria Road South to Outram Road to gap seeking during stage 2, and reducing the number of northbound lanes to 1 to accommodate a cycle lane;

- **DS1Sc5:** The conversion of the bus stops on the carriageway into bus laybys where it is considered feasible;
- **DS2Sc5:** The removal of the on street parking provision at locations where it impedes two way traffic flows.

Table 24: Summary of Preferred Proposed Scenarios by Package per Corridor and Preferred Proposed Scenario(s) Across the packages per Corridor.

Route Corridor	**Micro Simulation Modelling**			**AIRE**			**AQIA**			**Preferred Option**
	DS1	**DS2**	**DS3**	**DS1**	**DS2**	**DS3**	**DS1**	**DS2**	**DS3**	
1	DS1			DS1			DS1			DS1
2	DS1			DS1			DS1	DS2		DS1 / DS2
3	DS1	DS2		DS1			DS1			DS1 / DS2
4			DS3			DS3			DS3	DS3
5	DS1	DS2		DS1	DS2		DS1	DS2		DS1 / DS2

9 Appendices

Appendix A: Air Quality Management Areas and Corridors

Figure 1: Junction Locations Across the City

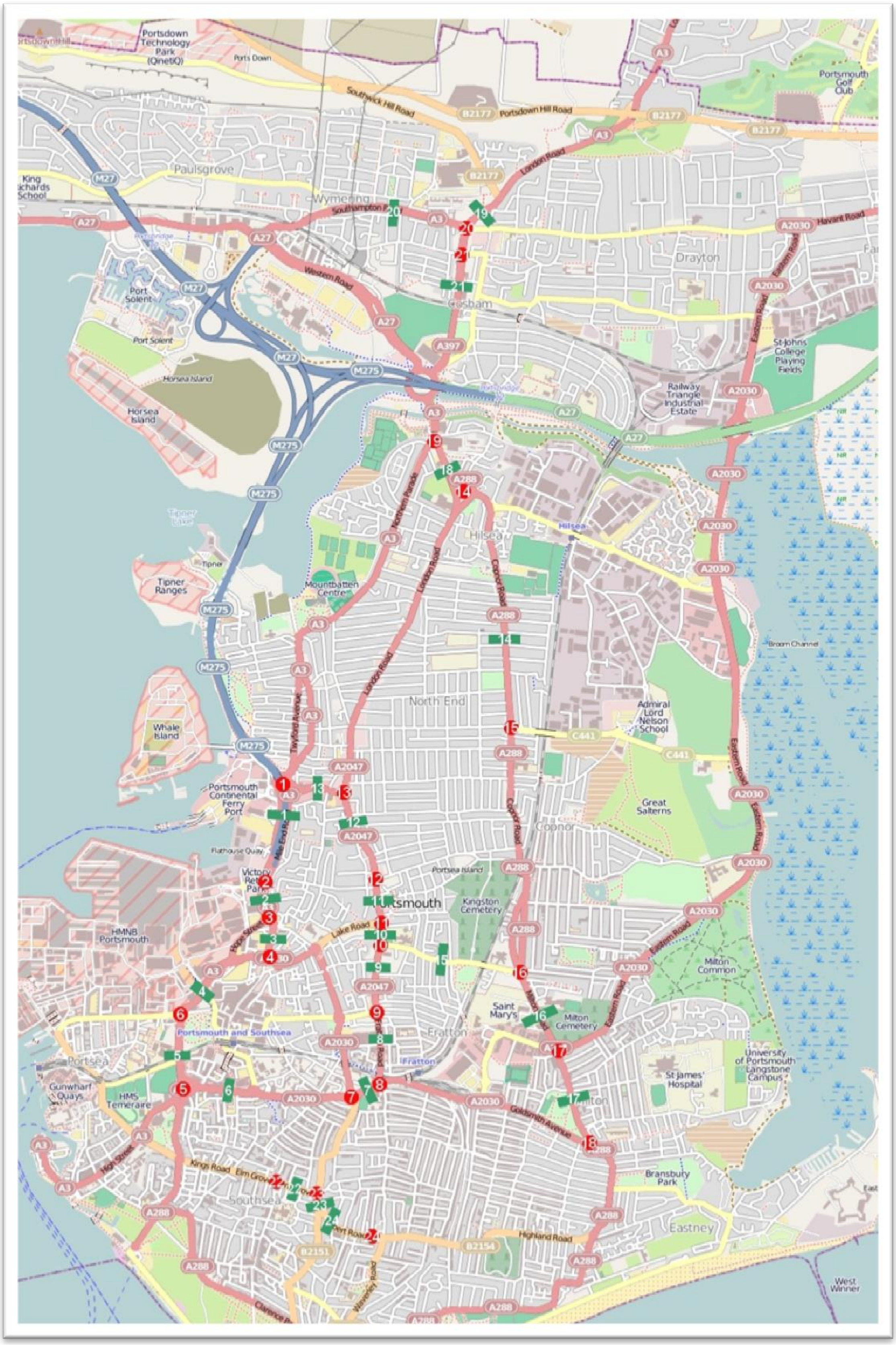


Figure 2: Air Quality Management Areas and Corridors Locations

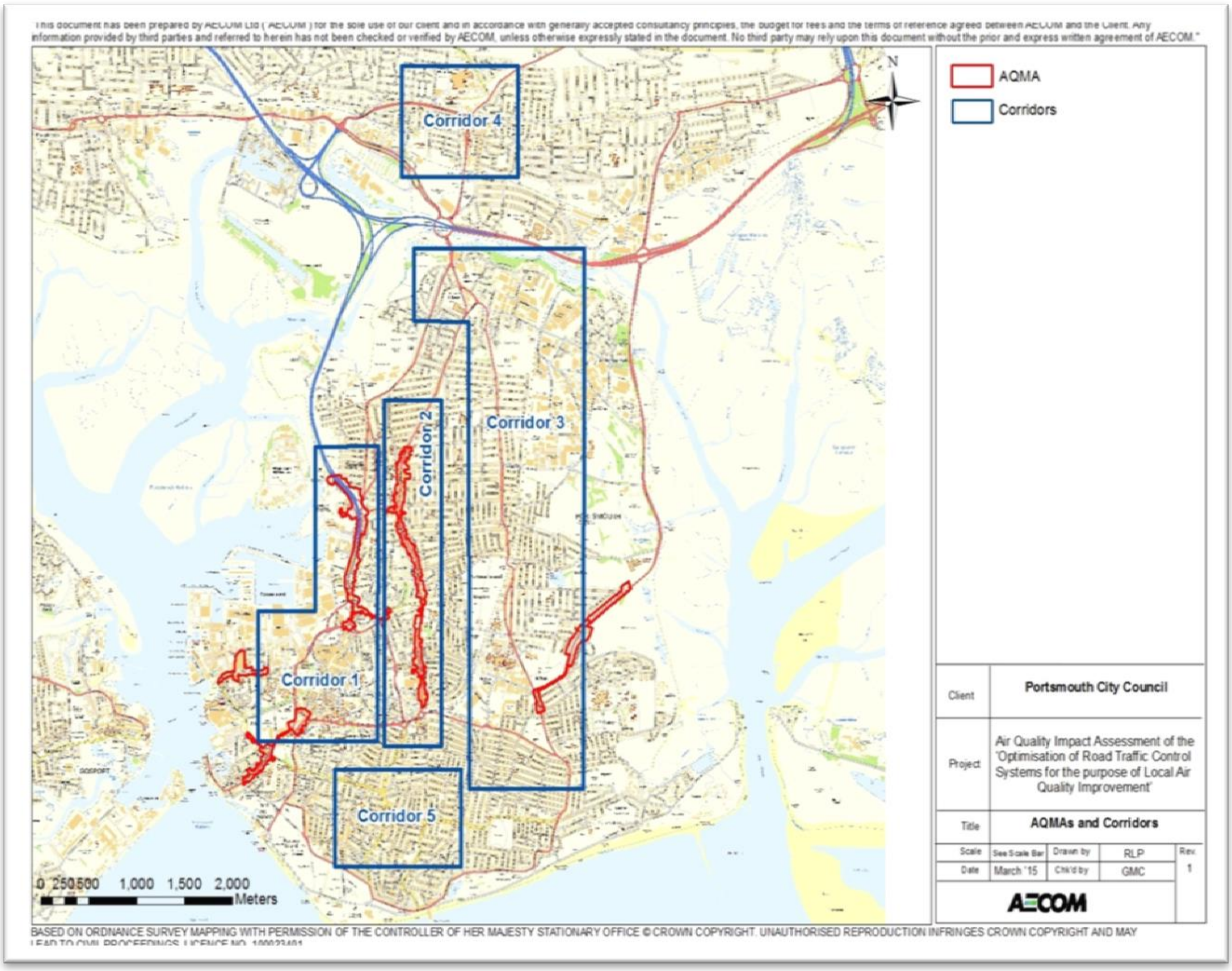


Figure 3: Extent of the Study Area of Corridor 1 (bounded in blue line)

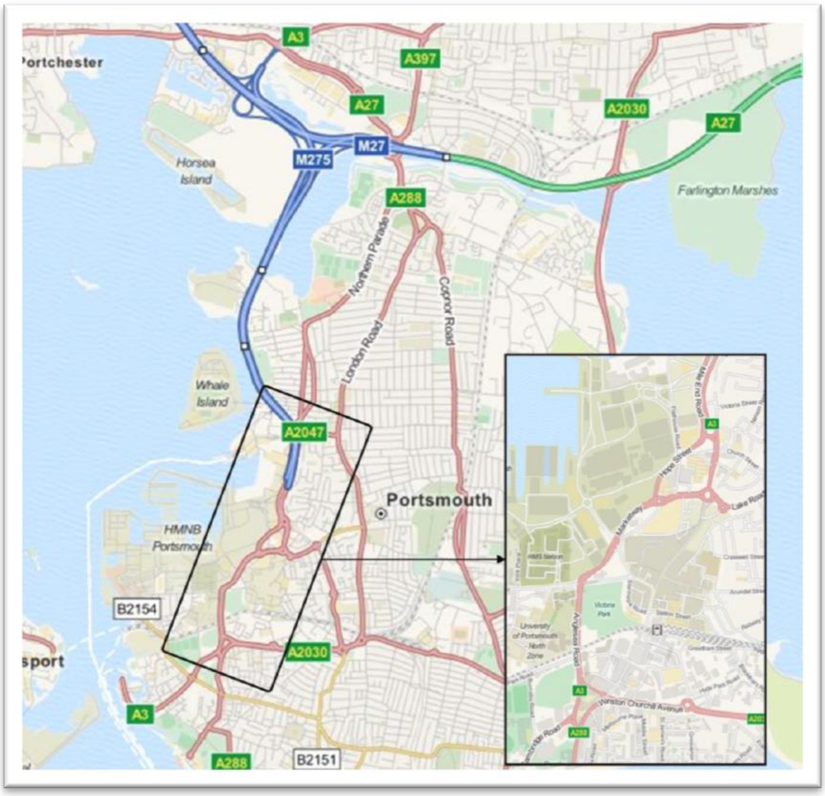


Figure 4: Extent of the Study Area of Corridor 2 (bounded in blue line)

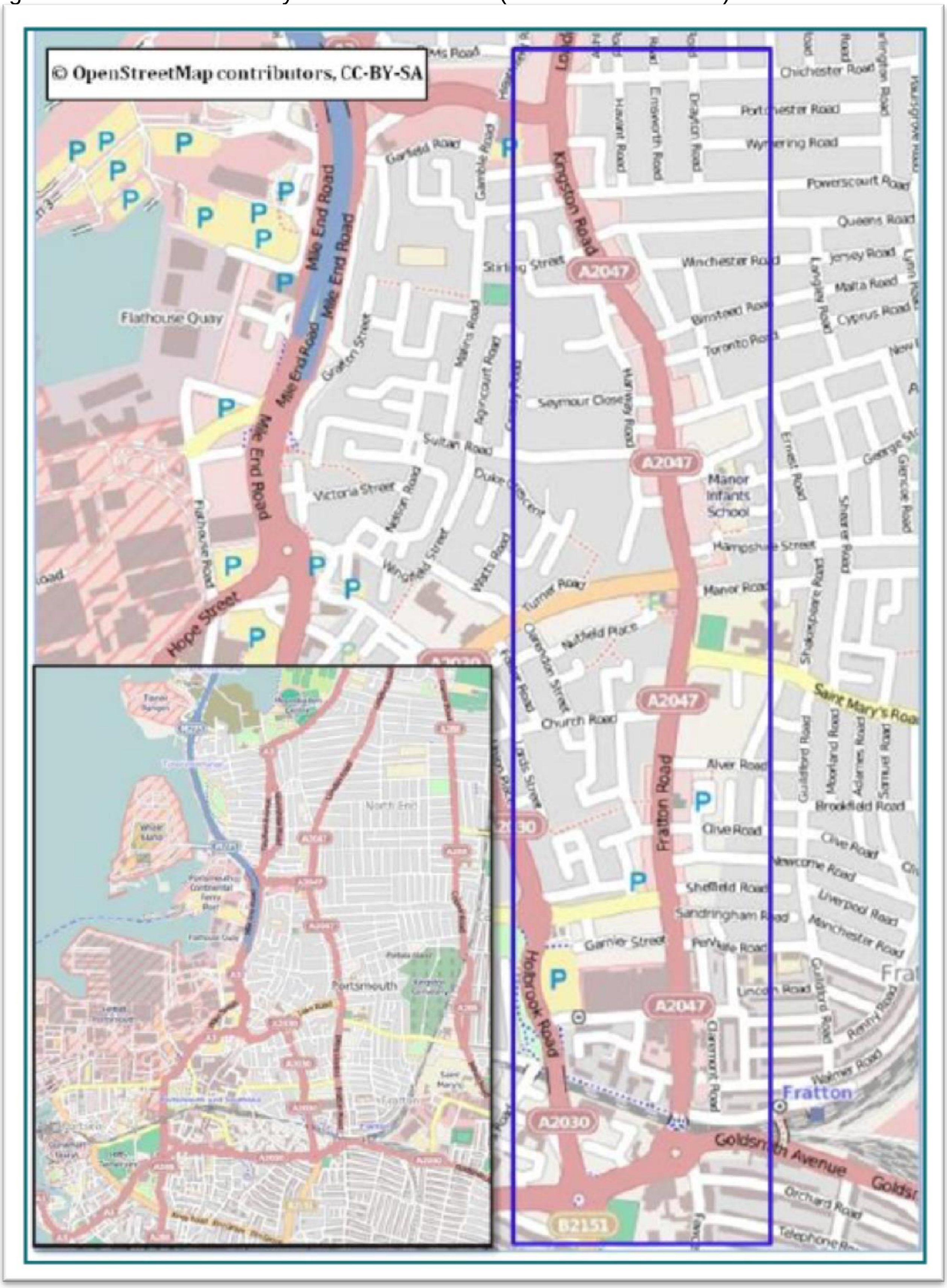


Figure 5: Extent of the Study Area of Corridor 3 (bounded in blue line)

Figure 6: Extent of the Study Area of Corridor 4 (bounded in blue line)

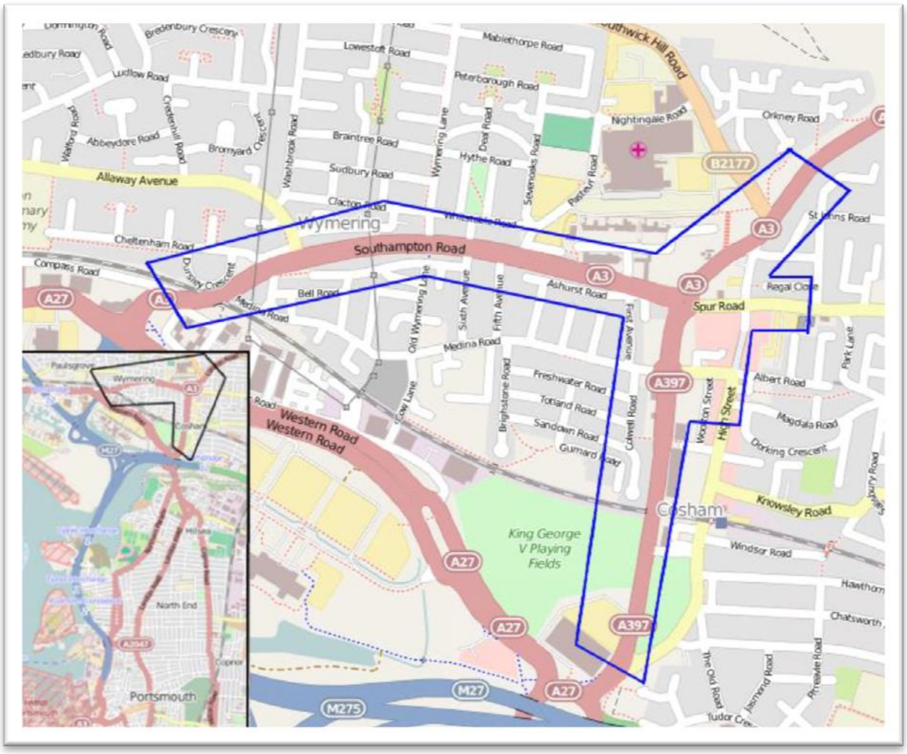
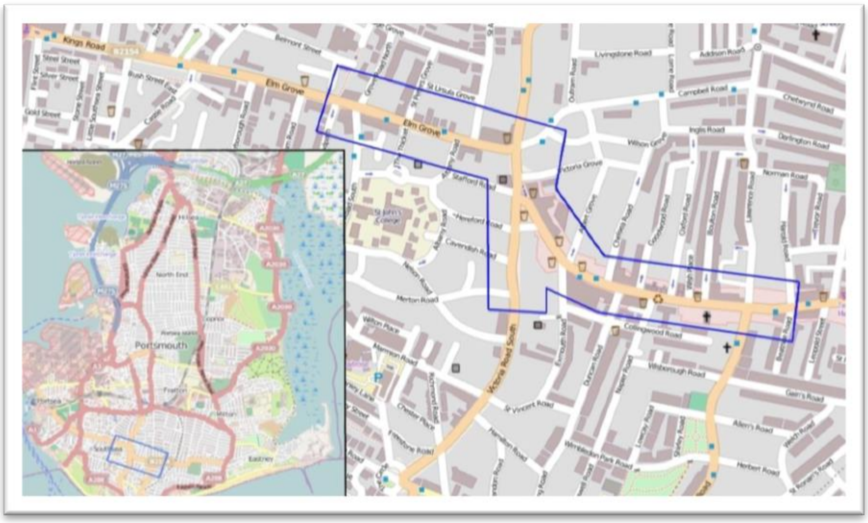


Figure 7: Extent of the study area of Corridor 5 (bounded in blue line



Appendix B: AAQuIRE

The AAQuIRE 6.2 software is a system that predicts Ambient Air Quality in Regional Environments and comprises a regional air quality model and statistical package. The latest version of the Emission Factors Toolkit, released in November 2014, has been incorporated into the AAQuIRE software.

AAQuIRE was developed by AECOM to meet three requirements in predictive air quality studies. The first requirement was an immediate need for a system that produced results that could be interpreted easily by non-air quality specialists to allow for proper informed inclusion of air quality issues in wider fora, the main example being to allow consideration of air quality issues in planning processes. This was achieved by allowing results to be generated over a sufficiently large study area, and at an appropriate resolution, for the issue being considered. The results are also presented in a relevant format, which is normally a statistic directly comparable with an air quality criterion or set of measured data being considered. For example, the AQS PM_{10} 24-hour objective level of 50 $\mu g/m^3$ is expressed as a 90^{th} percentile of hourly means. AAQuIRE can also produce results directly comparable with all ambient air quality standards.

The second requirement was for a system to be based, initially, on existing and well-accepted and validated dispersion models. This has two advantages. The primary one is that it avoids the need to prove a new model against the accepted models and therefore enhances acceptability. The second advantage is that when appropriate new models are developed they can be included in AAQuIRE and be compared directly with the existing models, and sets of measured data, using the most appropriate statistics.

The final primary requirement for AAQuIRE was a consideration of quality assurance and control. An important aspect of modelling is proper record keeping ensuring repeatability of results. This is achieved within AAQuIRE by a set of log files, which record all aspects of a study and allow model runs to be easily repeated. The ways in which AAQuIRE and the models currently available within it operate are discussed below.

The first step in operating AAQuIRE is to prepare the input data. The following data are needed for the year and pollutant to be modelled:

- meteorological data expressed as occurrence frequencies for specified combinations of wind speed, direction, stability and boundary layer height;
- road system layout and associated traffic data within and immediately surrounding the study area;
- industrial stack locations and parameters; and
- a grid of model prediction locations (receptors).

The modelling is always carried out to give annual average results from which appropriate shorter period concentrations can be derived.

The second stage is the generation of the model input files required for the study. All the data collated in the first stage can be easily input into AAQuIRE, using the worksheets, drop down boxes and click boxes in the Data Manager section of the software. Data from spreadsheets can be easily pasted into worksheets, so that any complicated procedures required for data manipulation can be achieved before entry into AAQuIRE. Several diurnal and seasonal profiles can be defined for each separate source. The relevant meteorological data can also be specified at this stage.

The third stage is executing the models. The study area will usually be divided up into manageable grids and run separately using the Run Manager in AAQuIRE. The results from the separate files can be combined at a later stage. Pollutant concentrations are determined for each receptor point and each meteorological category and are subsequently combined.

The fourth stage is the statistical processing of the raw dispersion results to produce results in the relevant averaging period. Traffic sources and industrial sources can be combined at this stage provided the same receptor grid has been used for both. Background concentrations should also be incorporated at this stage.

The final stage is presentation of results. The result files from the statistical interpretation are formatted to be used directly by the Surfer package produced by Golden Software Inc. However, the model outputs are more commonly imported into a GIS (e.g. ArcView and Map Info) for display and further data processing.

Appendix C: Traffic Data

Table 25: Road Traffic Data across the Domain Study (Five Corridors)

Link Description	AADT				HGV %				Speed (kph)			
	BY	DM	DS1	DS2	BY	DM	DS1	DS2	BY	DM	DS1	DS2
J1-NSLIPNB	10,917	11,258	11,259	11,260	5.9	7.2	7.2	7.2	40	75	75	75
J1-NSLIPSB	9,759	10,063	10,064	10,064	6.3	3.4	3.4	3.4	39	54	54	54
J1-ETAvNB	8,902	8,738	8,734	8,746	2.3	4.7	4.7	4.7	25	45	45	45
J1-ESRdSB	9,086	9,769	9,769	9,768	1.9	3.8	3.8	3.8	23	36	36	36
J1-EEB	7,884	7,868	7,867	7,863	2.0	4.1	4.0	4.0	25	52	52	52
J1-EWB	8,243	8,715	8,716	8,715	1.5	2.4	2.4	2.4	23	33	33	33
J1-EKC	15,688	16,957	16,957	16,952	2.0	3.4	3.3	3.3	24	42	42	42
J1-EB&T	214	46	46	46	12.8	64.9	64.9	64.9	23	37	37	37
J1-SSLIPSB	8,027	8,424	8,424	8,424	3.3	7.4	7.4	7.4	39	59	59	59
J1-Flyover	53,177	51,538	51,560	51,576	2.6	3.2	3.2	3.2	78	78	78	78
J1-SSLIPNB	8,625	7,880	7,886	7,891	4.5	5.9	6.0	6.0	40	58	58	58
J1-WCFP	8,013	7,910	7,922	7,907	14.8	12.8	12.8	12.8	24	42	42	42
J2-NNB	62,936	61,600	61,624	61,640	4.5	6.5	6.5	6.6	40	75	75	75
J2-SNB	64,094	62,795	62,819	62,836	4.2	10.4	10.4	10.4	39	54	54	54
J2-SSB	8,669	8,875	8,877	8,876	5.2	10.9	10.9	10.9	29	49	49	49
J2-W	36,386	33,850	33,890	33,887	3.1	4.1	4.1	4.1	27	62	62	62
J2-NWB	33,390	31,666	31,706	31,719	2.7	3.6	3.6	3.6	27	51	51	51
J3-NSB	30,876	30,918	30,917	30,924	2.5	4.0	4.0	4.0	26	50	51	49
J3-S	8,786	9,160	9,161	9,167	4.7	5.6	5.6	5.6	26	49	49	49
J3-E	33,764	33,900	33,900	33,904	2.7	3.9	4.0	3.9	26	55	56	57
J3-W	33,024	33,109	33,108	33,115	2.5	4.0	4.0	4.0	26	50	51	49
J3-NNB	30,579	30,587	30,627	30,610	2.8	4.2	4.2	4.2	25	34	35	34
J4-N	12,436	10,532	10,519	10,519	0.7	2.8	2.8	2.8	25	31	31	31
J4-S	16,766	15,967	15,965	15,972	3.1	3.8	3.9	3.8	25	39	39	39
J4-EEB	25,846	24,495	24,526	24,536	2.7	3.6	3.6	3.6	27	51	51	51
J4-EWB	32,455	32,532	32,545	32,543	2.7	4.1	4.1	4.1	25	47	47	47
J4-WEB	31,852	30,587	30,627	30,610	2.7	4.2	4.2	4.2	25	34	35	34
J4-WWB	485	541	546	540	73.9	58.5	58.7	58.7	25	29	29	29
J4-EEB2	6,379	6,056	6,056	6,057	9.6	10.8	10.8	10.8	24	33	34	34
J4-RBT	6,244	6,413	6,455	6,436	5.4	5.2	5.2	5.2	26	29	29	30
J5-NNB	4,580	4,330	4,333	4,335	7.8	11.3	11.4	11.4	22	35	34	34

Link Description	AADT				HGV %				Speed (kph)			
	BY	DM	DS1	DS2	BY	DM	DS 1	DS 2	B Y	D M	DS 1	DS 2
J5-NSB	22,653	22,354	22,361	22,358	3.9	5.2	5.2	5.2	26	35	36	36
J5-KRRD	12,623	12,469	12,511	12,493	7.5	8.0	7.9	7.9	25	31	31	32
J5-EEB	19,695	19,091	19,107	19,101	4.8	6.9	6.9	6.9	24	35	35	35
J5-EWB	13,038	12,117	11,873	12,119	2.3	2.5	2.1	2.5	23	39	39	39
J5-ESN	10,814	10,520	10,312	10,522	2.0	3.3	2.9	3.3	27	39	39	39
J5-ST P RD	15,213	14,400	14,120	14,403	3.8	4.2	3.7	4.1	27	39	39	38
J5-SNW	4,455	4,091	4,011	4,093	7.3	6.3	5.6	6.4	28	44	44	44
J5-S	5,894	6,019	5,814	6,019	6.7	7.1	6.0	7.1	23	38	38	38
J5-WS	16,651	14,523	14,207	14,518	3.9	4.9	4.3	4.8	25	36	36	36
J5-W	1,833	1,068	1,049	1,068	0.5	0.6	0.5	0.6	25	30	30	30
J5-WN	18,470	16,405	15,939	16,406	3.6	4.6	3.8	4.5	25	36	36	36
J6-SNB	13,454	13,995	13,650	13,992	2.3	3.1	2.6	3.1	25	38	37	37
J6-SSB	17,177	14,062	13,787	14,072	3.7	4.2	3.7	4.2	25	28	28	28
J6-E	11,264	11,157	10,861	11,161	6.9	6.0	5.0	6.0	25	41	41	41
J6-W	19,204	15,886	15,629	15,887	3.8	3.6	3.2	3.6	25	42	42	42
J6-NNB	16,588	15,480	15,480	15,477	2.3	2.9	2.9	2.9	23	22	22	22
J6-NSB	13,351	13,572	13,564	13,574	2.0	3.4	3.4	3.4	27	39	39	39
J7-N	1,434	1,643	1,641	1,641	78.5	66.7	66.7	66.7	25	32	32	32
J7-S	11,197	11,861	11,865	11,875	12.5	12.8	12.8	12.8	27	31	31	31
J7-EEB	21,133	20,034	20,034	20,041	2.4	3.2	3.2	3.2	25	37	37	37
J7-WEB	17,747	17,983	17,988	18,018	2.2	3.4	3.4	3.4	26	37	37	37
J7-WWB	24,329	27,911	28,032	28,052	0.8	1.0	0.9	1.0	25	41	41	41
J7-NSLIP	19,522	19,058	19,142	19,125	1.7	1.6	1.6	1.6	25	43	43	43
J8-N	11,313	13,662	13,761	13,754	2.1	1.5	1.5	1.5	24	39	39	39
J8-E	7,265	7,325	7,353	7,343	4.3	3.2	3.1	3.1	28	44	44	43
J8-WEB	8,327	8,387	8,441	8,440	4.0	2.7	2.6	2.7	23	48	48	48
J8-WWB	1,495	1,720	1,727	1,729	1.6	2.1	2.0	2.1	25	40	40	40
J8-S	21,926	23,484	23,587	23,588	1.2	1.3	1.3	1.3	25	42	42	42
J9-N	18,506	18,344	18,466	18,461	1.7	1.5	1.4	1.4	21	29	29	29
J9-S	22,523	22,040	22,178	22,191	2.5	1.7	1.7	1.7	23	44	44	44
J9-E	11,910	14,477	14,582	14,575	2.1	1.5	1.5	1.5	24	39	39	39
J9W	13,752	11,136	11,221	11,232	2.0	1.6	1.6	1.6	25	39	39	39
J10-N	14,087	14,156	14,229	14,228	1.2	1.3	1.3	1.3	23	32	32	32
J10-S	16,062	15,885	15,994	15,999	2.2	1.6	1.6	1.6	24	41	41	41
J10-E	19,133	19,639	19,777	19,791	2.8	2.4	2.4	2.4	23	33	33	33
J11-N	16,507	16,842	16,968	16,970	2.0	1.5	1.5	1.5	21	31	31	31
J11-S	341	276	275	276	0.8	0.0	0.0	0.0	32	42	42	42
J11-W	7,735	7,052	7,095	7,105	5.1	4.8	4.7	4.7	32	43	43	42
J12-N	18,110	17,414	17,547	17,555	1.7	1.6	1.6	1.6	19	31	31	31
J12-S	19,036	20,334	20,478	20,490	2.8	2.4	2.4	2.4	23	35	35	35
J12-E	14,739	13,719	13,824	13,833	1.9	2.0	2.0	2.0	23	37	37	37
J13-N	21,769	22,460	22,612	22,621	4.0	3.7	3.7	3.7	22	33	33	33
J13-S	18,303	18,606	18,748	18,757	1.7	1.6	1.6	1.6	19	31	31	31

Link Description	AADT				HGV %				Speed (kph)			
	BY	DM	DS1	DS2	BY	DM	DS 1	DS 2	B Y	D M	DS 1	DS 2
J13-E	13,867	13,733	13,816	13,826	4.4	4.2	4.2	4.2	21	38	38	38
J13-W	18,191	19,175	19,301	19,306	0.0	4.0	4.0	3.9	20	35	36	34
J13-EW	19,671	21,289	21,108	21,434	0.0	4.0	2.5	4.0	22	32	34	31
J14-N	7,798	7,922	7,971	7,977	0.0	1.6	1.5	1.6	21	33	34	33
J14-EEB	15,388	15,606	15,675	15,723	6.0	5.2	5.2	5.2	22	36	36	36
J14-EEBE	17,705	18,474	18,600	18,629	4.6	4.1	4.2	4.1	20	34	35	39
J14-ENOR RD	3,707	3,835	3,851	3,862	2.6	0.9	0.9	0.9	22	30	30	30
J14-COP RD	10,904	10,690	10,734	10,706	2.5	1.8	1.9	1.8	24	39	39	39
J14-SB	17,349	18,033	18,102	18,152	5.0	4.6	4.7	4.6	22	32	32	32
J14-S	29,492	29,297	29,152	29,127	5.2	4.8	4.8	4.8	26	41	41	41
J14-NS	16,491	16,146	16,035	16,030	5.5	4.6	4.7	4.6	24	41	41	41
J15-N	21,120	20,017	19,889	19,865	4.3	3.4	3.4	3.4	24	38	38	38
J15-S	16,153	15,075	14,934	14,998	5.5	3.9	3.5	4.0	24	43	42	42
J15-ESLIP	17,272	16,401	16,295	16,276	2.9	3.9	3.9	3.9	23	42	42	42
J15-W	16,576	16,734	16,632	16,620	4.2	4.3	4.4	4.3	24	39	38	38
J15-MAIN	14,037	13,230	13,173	13,164	6.1	6.3	6.3	6.3	24	46	46	46
J16-NNB	15,782	16,150	16,071	16,061	4.5	4.5	4.5	4.5	25	39	42	42
J16-S	13,020	13,350	13,242	13,219	3.1	4.1	4.1	4.2	23	39	39	39
J16-E	17,415	17,896	17,737	17,707	2.6	3.4	3.4	3.4	25	33	34	33
J16-W	4,002	4,102	4,076	4,065	0.1	0.1	0.1	0.1	24	47	47	46
J16-NSB	4,113	3,761	3,731	3,726	1.3	1.4	1.5	1.4	24	30	30	30
J16-N	8,121	8,303	8,236	8,224	2.2	2.4	2.2	2.4	24	38	39	38
J17-N	8,345	8,339	8,300	8,279	2.6	2.8	2.8	2.9	24	34	34	34
J17-S	13,840	13,839	13,748	13,708	2.1	2.9	2.9	2.9	26	31	32	31
J17-E	4,925	4,345	4,333	4,320	1.1	1.2	1.2	1.2	25	26	26	25
J17-W	13,946	12,636	12,577	12,551	1.9	2.4	2.4	2.4	23	43	43	43
J17-WS	8,401	8,453	8,368	8,361	2.6	4.2	4.3	4.2	26	29	32	29
J18-N	11,133	10,817	10,748	10,725	2.3	3.1	3.1	3.1	25	34	35	34
J18-S	16,745	16,792	16,668	16,640	2.6	7.1	7.1	7.1	25	63	66	62
J18-W	16,058	14,647	14,583	14,542	2.2	3.0	2.9	2.9	26	37	37	37
J19-NNB	23,149	20,718	20,664	20,605	2.2	2.5	2.5	2.5	24	38	39	38
J19-NSB	22,393	19,894	19,878	19,780	2.0	1.7	1.7	1.7	25	41	42	41
J19-SSB	14,442	13,388	13,353	13,302	1.7	1.7	1.7	1.8	25	39	39	39
J19-SNB	484	402	408	403	1.2	0.5	0.5	1.4	25	34	34	34
J19-W	17,986	15,840	15,810	15,736	3.5	3.0	2.9	2.9	24	38	39	38
J22-N	27,925	27,822	27,820	27,817	4.5	4.6	4.5	4.6	27	34	34	34
J22-S	16,703	16,429	16,420	16,439	2.5	1.7	1.7	1.7	27	38	38	39
J22-E	26,902	26,415	26,407	26,400	3.1	2.7	2.7	2.7	34	48	48	48
J22-W	28,061	27,629	27,628	27,632	4.5	4.6	4.6	4.6	27	34	34	34
J23-N	19,469	18,953	18,948	18,948	6.3	1.4	1.4	1.4	27	41	41	41
J23-S	11,398	11,217	11,227	11,206	1.8	1.6	1.6	1.5	27	28	28	29
J23-E	6,384	6,599	6,590	6,599	1.3	1.9	1.8	1.9	27	28	28	28
J23-W	23,765	23,291	23,288	23,290	5.4	3.0	3.0	3.0	27	37	37	37

Link Description	AADT				HGV %				Speed (kph)			
	BY	DM	DS1	DS2	BY	DM	DS 1	DS 2	B Y	D M	DS 1	DS 2
J24-N	850	1,109	1,099	1,099	0.3	1.3	1.3	1.3	19	33	33	33
J24-S	4,708	5,583	5,628	5,617	7.4	7.4	7.3	7.3	19	25	25	25
J24-E	10,262	12,169	12,168	12,161	2.0	3.1	3.2	3.1	19	37	37	37
J24-W	10,292	12,683	12,683	12,681	3.8	4.5	4.5	4.6	19	30	30	30

Appendix D: Location of Sensitive Receptors

Figure 8: Location of Sensitive Receptors

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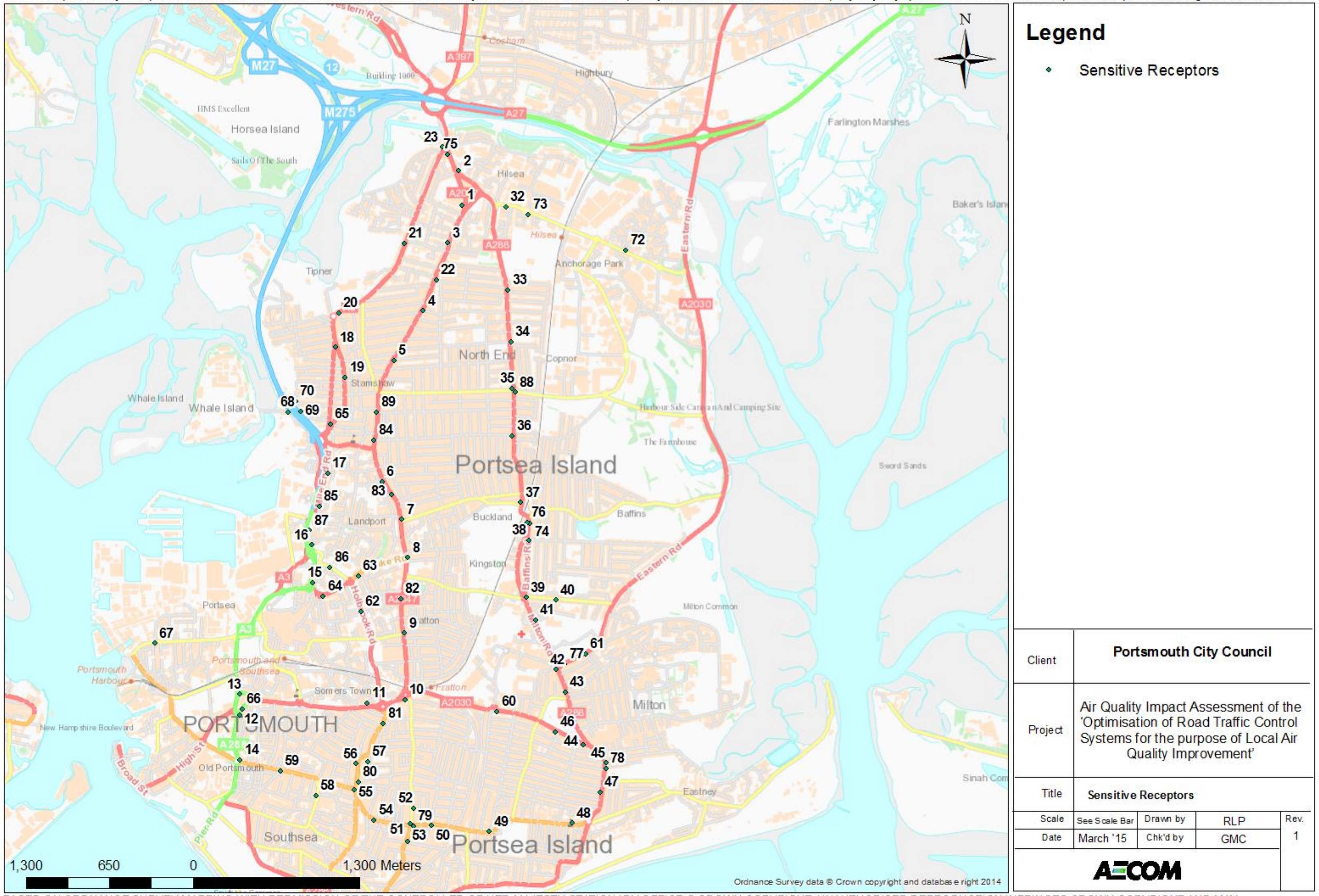
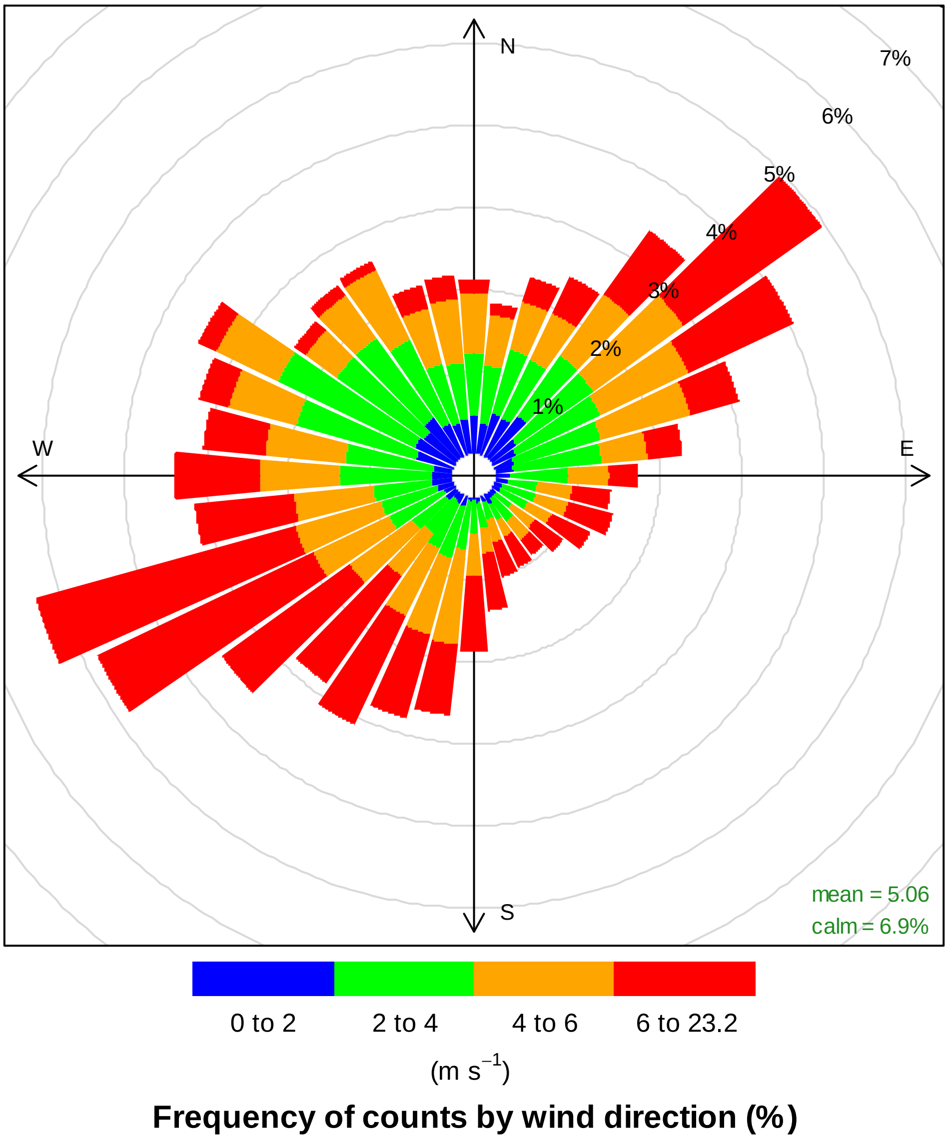


Appendix E: Meteorological Data

The meteorological dataset used in the model was recorded at the meteorological station on Thorney Island, in 2013, located approximately 12 km away from Portsmouth. The Solent meteorological station is located slightly closer to Portsmouth (9 km away); however, the station is exposed and therefore the meteorological conditions at the station on Thorney Island were considered to better represent the meteorological conditions in Portsmouth.

The meteorological data were used to produce a wind/stability rose (Figure 9). This illustrates the wind direction and wind speed as a function of the proportion of the year.

Figure 9: Wind Rose for Thorney Island, 2013



Appendix F: Model Verification

The model was verified by comparison with results from the Portsmouth City Council NO_2 diffusion tube Survey for 2013 and data from three continuous monitoring stations in the city. All modelled NO_X concentrations were adjusted in accordance with the procedure detailed in technical guidance LAQM.TG(09) prior to conversion to total NO_2 concentrations.

Table 26: Comparison of Monitored and Unadjusted Modelled NO_2 Concentrations, 2013

Monitoring Site	Monitor Type	Monitored Total NO_2	Modelled Total NO_2	% Difference [(modelled-monitored)/monitored]
Lord Montgomery Way	DT	41.3	33.4	-19%
Queen Street	DT	30.4	34.3	13%
119 Whale Island Way	DT	27.5	28.7	5%
88 Stanley Road	DT	38.6	29.9	-22%
138 Lower Derby	DT	30.0	27.3	-9%
6 Northern Road	DT	32.0	31.8	0%
Anchorage Road*	DT	29.5	35.0	18%
4 Merlyn Drive*	DT	21.6	34.7	60%
29 Milton Road	DT	28.2	25.8	-9%
Parade Court, London Road	DT	34.1	29.3	-14%
4 Milton Road	DT	27.8	25.4	-9%
7 Velder Avenue	DT	30.7	28.4	-8%
136 Eastney Rd	DT	27.4	24.5	-11%
116 Albert Road	DT	34.0	26.4	-22%
2 Victoria Road North	DT	28.7	28.7	0%
106 Victoria Road North	DT	32.2	29.9	-7%
221 Fratton Road	DT	42.5	31.5	-26%
117 Kingston Road	DT	38.7	33.8	-13%
The Tap London Road*	DT	51.7	38.3	-26%
Market Tavern (Mile End Rd)	DT	37.7	34.1	-10%
Larch Court, Church Rd	DT	31.1	31.3	1%
Mile End Road	CM	35.9	34.3	-4%
Burrfields	CM	33.5	31.7	-5%
London Road	CM	39.7	34.2	-14%

Notes: DT=Diffusion Tube CM = Continuous Monitor. * Sites excluded from verification. Anchorage Road and 4 Merlyn Drive excluded due to monitored annual mean NO_2 concentrations being lower than the mapped background concentration. The Tap London Road omitted due to spurious reading in September 2013 that appeared to skew the annual mean result.

An adjustment factor was calculated as follows:

$NO_{X\ [monitored,\ traffic\ contribution]} = NO_{X\ [monitored]} - NO_{X\ [background]}$

$NO_{X\ [modelled,\ traffic\ contribution]} = NO_{X\ [modelled]} - NO_{X\ [background]}$

$$\text{Adjustment Factor} = NO_{X\ [monitored,\ traffic\ contribution]} / NO_{X\ [modelled,\ traffic\ contribution}$$

An adjustment factor of 1.43 was calculated.

The adjustment factor was subsequently applied to the modelled NO_X concentrations, and background NO_X added to give the adjusted modelled NO_X concentrations:

$NO_{X\,[model\ adjusted,\ traffic\ contribution]} = NO_{X\,[modelled,\ traffic\ contribution]}$ x Adjustment Factor

$NO_{X\,[model\ adjusted]} = NO_{X\,[model\ adjusted,\ traffic\ contribution]} + NO_{X\,[background]}$

The adjusted NO_X concentrations were converted to NO_2 using Version 4.1 of the 'NO_2 to NO_X' calculator provided by the Air Quality Archive and in accordance with the technical guidance, LAQM.TG(09).

Table 27: Comparison of Monitored and Unadjusted Modelled Road NO_X Concentrations

Monitoring Site	Monitored Total NO_2	Monitored Road NO_X	Modelled Road NO_X
Lord Montgomery Way	41.3	41.7	22.6
Queen Street	30.4	7.1	15.8
119 Whale Island Way	27.5	11.2	13.9
88 Stanley Road	38.6	36.8	16.4
138 Lower Derby	30.0	16.7	10.8
6 Northern Road	32.0	20.9	20.6
29 Milton Road	28.2	17.8	12.6
Parade Court, London Road	34.1	27.9	16.8
4 Milton Road	27.8	17.0	11.9
7 Velder Avenue	30.7	24.5	19.2
136 Eastney Rd	27.4	20.1	13.8
116 Albert Road	34.0	35.8	18.3
2 Victoria Road North	28.7	15.8	15.7
106 Victoria Road North	32.2	23.6	18.5
221 Fratton Road	42.5	49.8	22.6
117 Kingston Road	38.7	38.2	26.4
Market Tavern (Mile End Rd)	37.7	32.5	23.8
Larch Court, Church Rd	31.1	16.5	17.0
Mile End Road	35.9	28.2	24.4
Burrfields	33.5	23.3	19.1
London Road	39.7	39.6	26.1

Figure 10: Unadjusted Modelled Road NO_X Versus Monitored Road NO_X Concentrations

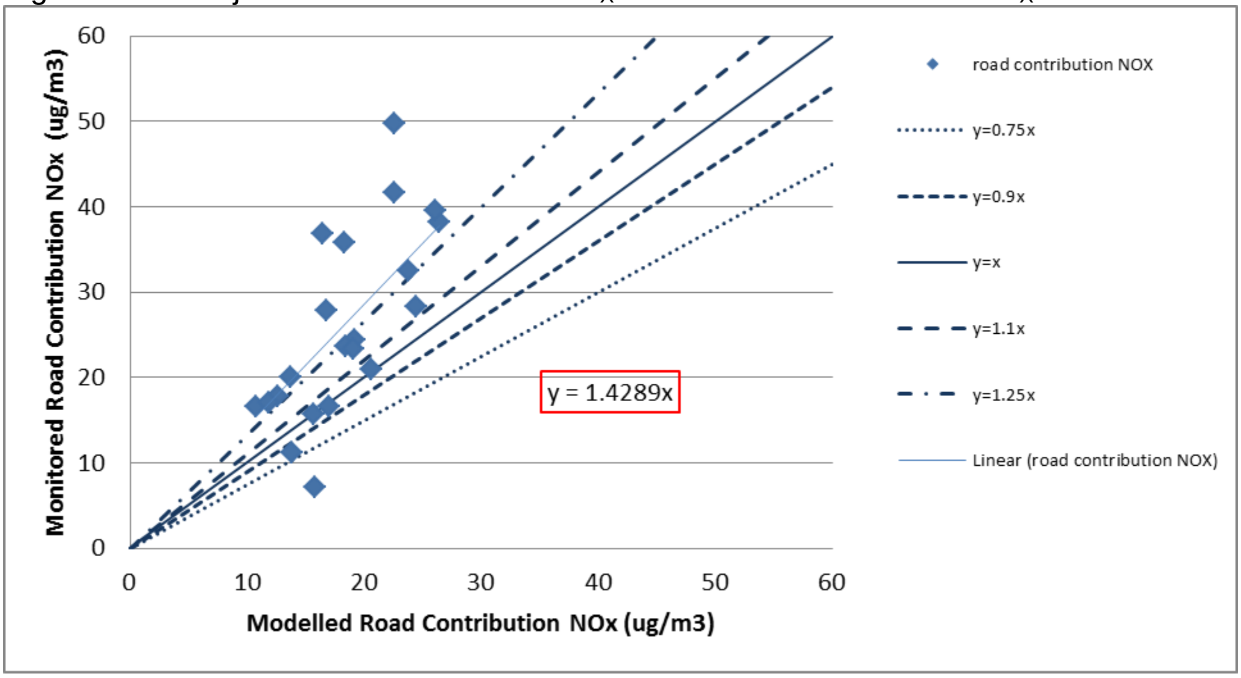
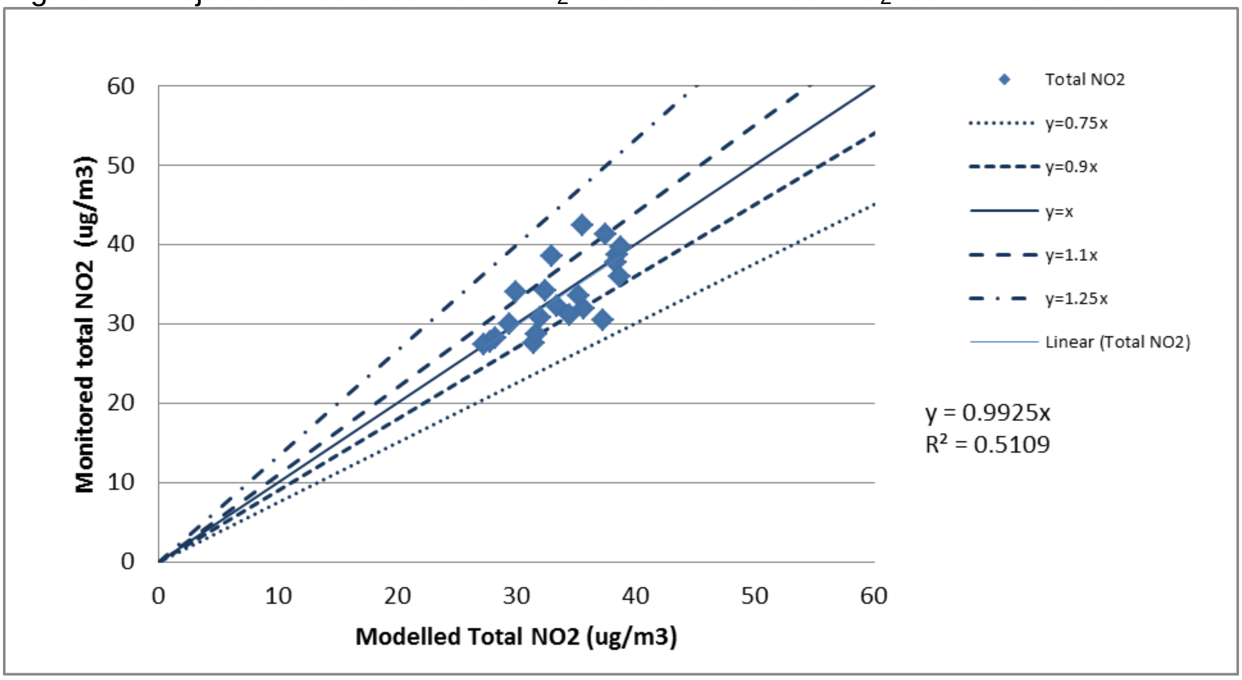


Table 28: Determination of the Adjustment Factor and Total Adjusted NO_2

Monitoring Site	Adjustment Factor for Modelled Road Contribution	Adjusted Modelled Road Contribution NO_X	Adjusted Modelled Total NO_2	Monitored Total NO_2	% Difference [(mod-mon)/mon]
Lord Montgomery Way	1.43	32.3	37.5	41.3	-9%
Queen Street	1.43	22.5	37.3	30.4	22%
119 Whale Island Way	1.43	19.8	31.4	27.5	14%
88 Stanley Road	1.43	23.5	33.0	38.6	-14%
138 Lower Derby	1.43	15.4	29.4	30.0	-2%
6 Northern Road	1.43	29.5	35.6	32.0	11%
29 Milton Road	1.43	18.0	28.2	28.2	0%
Parade Court, London Road	1.43	24.0	32.5	34.1	-5%
4 Milton Road	1.43	17.0	27.8	27.8	0%
7 Velder Avenue	1.43	27.5	32.0	30.7	4%
136 Eastney Rd	1.43	19.7	27.2	27.4	-1%
116 Albert Road	1.43	26.1	29.9	34.0	-12%
2 Victoria Road North	1.43	22.4	31.7	28.7	10%
106 Victoria Road North	1.43	26.4	33.4	32.2	4%
221 Fratton Road	1.43	32.3	35.6	42.5	-16%
117 Kingston Road	1.43	37.7	38.5	38.7	-1%
Market Tavern (Mile End Rd)	1.43	34.0	38.3	37.7	2%
Larch Court, Church Rd	1.43	24.3	34.5	31.1	11%
Mile End Road	1.43	34.9	38.7	35.9	8%
Burrfields	1.43	27.3	35.2	33.5	5%
London Road	1.43	37.3	38.8	39.7	-2%

Figure 11: Adjusted Modelled Total NO_2 versus Monitored NO_2 Concentrations



Appendix G: Location of Monitoring Sites

Figure 12: Location of Monitoring Sites

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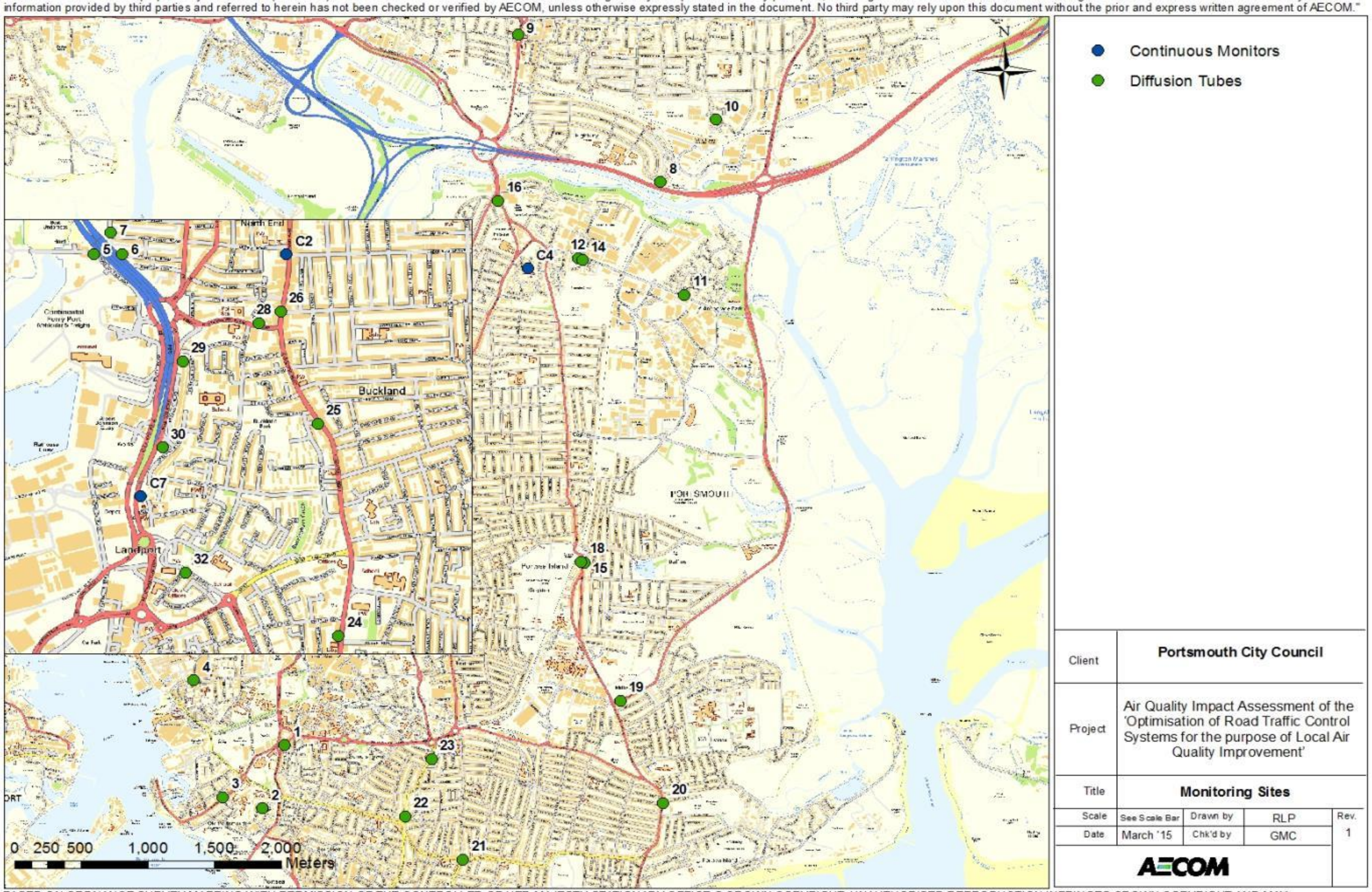

Appendix H: Background Pollutant Concentrations

Table 29: Background NO_2 Concentrations for Cartesian Grid Modelling

Background NO_2 Concentrations (µg/m^3)				
	Grid X	**Grid Y**	**2013**	**2015**
Corridor 1				
Area A	464500	101500	23.1	22.8
	464500	102500	22.1	21.9
	465500	101500	21.7	21.3
	465500	102500	22.0	21.7
	Average		**22.2**	**21.9**
Area B	463500	100500	27.1	26.2
	463500	101500	28.7	28.6
	464500	100500	23.3	22.7
	464500	101500	23.1	22.8
	Average		**25.6**	**25.1**
Area C	463500	99500	23.0	22.8
	463500	100500	27.1	26.2
	464500	99500	21.2	20.9
	464500	100500	23.3	22.7
	Average		**23.6**	**23.2**
Corridor 2				
Area A	464500	99500	21.2	20.9
	464500	100500	23.3	22.7
	465500	100500	20.9	20.5
	465500	99500	19.6	19.3
	Average		**21.2**	**20.9**
Area B	464500	100500	23.3	22.7
	464500	101500	23.1	22.8
	465500	100500	20.9	20.5
	465500	101500	21.7	21.3
	Average		**22.2**	**21.8**
Area C	464500	101500	23.1	22.7
	464500	102500	22.1	21.8
	465500	101500	21.7	21.3
	465500	102500	22.0	21.7
	Average		**22.2**	**21.9**
Corridor 3				
Area A	465500	103500	22.1	21.6
	465500	104500	21.3	20.8
	466500	103500	30.3	28.7
	466500	104500	25.9	24.7
	Average		**24.9**	**23.9**

Background NO_2 Concentrations (µg/m^3)				
	Grid X	**Grid Y**	**2013**	**2015**
Area B	465500	101500	21.7	21.3
	465500	102500	22.0	21.7
	466500	102500	22.8	22.2
	466500	101500	19.6	19.3
	Average		**21.5**	**21.1**
Area C	465500	100500	20.9	20.5
	465500	101500	21.7	21.3
	466500	101500	19.6	19.3
	466500	100500	19.2	18.8
	Average		**20.3**	**20.0**
Area D	465500	99500	19.6	19.3
	465500	100500	20.9	20.5
	466500	100500	19.2	18.8
	466500	99500	17.8	17.5
	Average		**19.4**	**19.0**
Corridor 4				
Area A	464500	104500	20.7	20.5
	464500	105500	20.6	20.3
	465500	105500	22.2	21.8
	465500	104500	21.3	20.8
	Average		**21.2**	**20.9**
Corridor 5				
Area A	464500	98500	19.3	19.1
	464500	99500	21.2	20.9
	465500	98500	17.6	17.4
	465500	99500	19.6	19.3
	Average		**19.4**	**19.2**
Area B	464500	98500	19.3	19.1
	464500	99500	21.2	20.9
	465500	99500	19.6	19.3
	465500	98500	17.6	17.4
	Average		**19.4**	**19.2**

Note: Grid X and Grid Y are the coordinates corresponding to the centre-point of each 1-km grid square. Contributions of modelled roads to background NO_2 concentrations within each grid square have been removed in accordance with the prescribed guidance to avoid double-counting.

Table 30: Background NO_2 Concentrations used for Sensitive Receptor Modelling

Receptor	X	Y	Grid X	Grid Y	Background NO_2 Concentrations ($\mu g/m^3$)	
					2013	2015
1	465589	103808	465500	103500	22.1	21.6
2	465560	104076	465500	104500	21.3	20.8
3	465479	103513	465500	103500	22.1	21.6
4	465283	102984	465500	102500	22.0	21.7
5	465056	102597	465500	102500	22.0	21.7
6	464964	101651	464500	101500	23.1	22.8
7	465119	101355	465500	101500	21.7	21.3
8	465166	101057	465500	101500	21.7	21.3
9	465140	100469	465500	100500	20.9	20.5
10	465143	99949	465500	99500	19.6	19.3
11	464849	99921	464500	99500	21.2	20.9
12	463851	99829	463500	99500	23.0	22.8
13	463853	99992	463500	99500	23.0	22.8
14	463857	99479	463500	99500	23.0	22.8
15	464423	100863	464500	100500	23.3	22.7
16	464414	101158	464500	101500	23.1	22.8
17	464543	101716	464500	101500	23.1	22.8
18	464602	102699	464500	102500	22.1	21.9
19	464678	102465	464500	102500	22.1	21.9
20	464629	102966	464500	102500	22.1	21.9
21	465135	103511	465500	103500	22.1	21.6
22	465387	103227	465500	103500	22.1	21.6
23	465436	104262	465500	104500	21.3	20.8
24	465659	105588	465500	105500	22.2	21.8
25	465711	105661	465500	105500	22.2	21.8
26	465646	105696	465500	105500	22.2	21.8
27	465478	105689	465500	105500	22.2	21.8
28	465514	105513	465500	105500	22.2	21.8
29	465103	105798	465500	105500	22.2	21.8

Receptor	X	Y	Grid X	Grid Y	Background NO_2 Concentrations ($\mu g/m^3$)	
					2013	2015
30	465146	105562	465500	105500	22.2	21.8
31	464894	105796	464500	105500	20.6	20.3
32	465933	103795	465500	103500	22.1	21.6
33	465949	103148	465500	103500	22.1	21.6
34	465974	102742	465500	102500	22.0	21.7
35	465976	102379	465500	102500	22.0	21.7
36	465982	102007	465500	102500	22.0	21.7
37	466048	101489	466500	101500	19.6	19.3
38	466108	101192	466500	101500	19.6	19.3
39	466092	100747	466500	100500	19.2	18.8
40	466322	100726	466500	100500	19.2	18.8
41	466162	100569	466500	100500	19.2	18.8
42	466324	100183	466500	100500	19.2	18.8
43	466394	100009	466500	100500	19.2	18.8
44	466535	99596	466500	99500	17.8	17.5
45	466712	99455	466500	99500	17.8	17.5
46	466319	99698	466500	99500	17.8	17.5
47	466669	99229	466500	99500	17.8	17.5
48	466450	98985	466500	98500	16.0	15.9
49	465802	98920	465500	98500	17.6	17.4
50	465350	98971	465500	98500	17.6	17.4
51	465182	98982	465500	98500	17.6	17.4
52	465208	99102	465500	99500	19.6	19.3
53	465162	98844	465500	98500	17.6	17.4
54	464902	99009	464500	99500	21.2	20.9
55	464748	99243	464500	99500	21.2	20.9
56	464764	99450	464500	99500	21.2	20.9
57	464852	99465	464500	99500	21.2	20.9
58	464450	99201	464500	99500	21.2	20.9
59	464172	99391	464500	99500	21.2	20.9
60	465863	99855	465500	99500	19.6	19.3

Receptor	X	Y	Grid X	Grid Y	Background NO_2 Concentrations ($\mu g/m^3$)	
					2013	2015
61	466553	100306	466500	100500	19.2	18.8
62	464798	100639	464500	100500	23.3	22.7
63	464779	100914	464500	100500	23.3	22.7
64	464505	100757	464500	100500	23.3	22.7
65	464561	102099	464500	102500	22.1	21.9
66	463872	99874	463500	99500	23.0	22.8
67	463190	100390	463500	100500	27.1	26.2
68	464230	102194	464500	102500	22.1	21.9
69	464331	102197	464500	102500	22.1	21.9
70	464291	102279	464500	102500	22.1	21.9
71	465621	105528	465500	105500	22.2	21.8
72	466869	103457	466500	103500	30.3	28.7
73	466107	103733	466500	103500	30.3	28.7
74	466120	101324	466500	101500	19.6	19.3
75	465474	104205	465500	104500	21.3	20.8
76	466097	101332	466500	101500	19.6	19.3
77	466392	100226	466500	100500	19.2	18.8
78	466712	99415	466500	99500	17.8	17.5
79	465209	98964	465500	98500	17.6	17.4
80	464778	99306	464500	99500	21.2	20.9
81	464976	99765	464500	99500	21.2	20.9
82	465111	100737	465500	100500	20.9	20.5
83	465036	101547	465500	101500	21.7	21.3
84	464902	101976	464500	101500	23.1	22.8
85	464478	101457	464500	101500	23.1	22.8
86	464559	100980	464500	100500	23.3	22.7
87	464399	101270	464500	101500	23.1	22.8
88	466004	102348	466500	102500	22.8	22.2
89	464922	102195	464500	102500	22.1	21.9

Note: Grid X and Grid Y are the coordinates corresponding to the centre-point of each 1-km grid square. Contributions of modelled roads to background NO_2 concentrations within each grid square have been removed in accordance with the prescribed guidance to avoid double-counting.