WCTIS-UKCBP Phase 1

Appendix H: Air Quality Assessment

Gloucester County Council

8 October 2019

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1. Introduction

Atkins Ltd was commissioned to undertake an air quality assessment to support the proposed highway improvement scheme West of Cheltenham Transport Improvement Schemes – UK Cyber Business Park (WCTIS-UKCBP) Phase 1, hereon referred to as the "Proposed Scheme".

The Proposed Scheme is located around Arle Court roundabout which is located on the A40 west of the M5 Junction 11, within the administrative boundary of Cheltenham Borough Council (CBC). The key objectives of the Proposed Scheme are to address existing and future congestion problems, improve connectivity with the road network and allow for future planned development. The Proposed Scheme is expected to open in 2021 and comprises the first phase of a wider programme of investments on the A40 in Cheltenham through the WCTIS-UKCBP. This report presents an assessment of the potential local air quality effects associated with the construction and operation of the Proposed Scheme.

During construction, dust and particulate matter may be generated by dust-raising activities. Once complete and operational, there may be changes in emissions from traffic using nearby roads as a result of the Proposed Scheme.

The key air pollutants that are addressed in this assessment are nitrogen dioxide (NO_2) and fine particulate matter (PM_{10} and $PM_{2.5}$), as these pollutants are the most likely to be present at concentrations close to or above national air quality criteria. Construction dust is also considered as this has the potential to result in dust soiling (deposited dust) and to human health and ecological effects.

1.1. Study Area

The Proposed Scheme is located within CBC and the air quality study area extends into the administrative boundary of Tewkesbury Borough Council (TBC) located to the west of the study area. Air quality has been examined across the study area within both local authority areas.

The majority of sensitive receptors within the air quality study area are located within the residential areas of north east Cheltenham.

There is one nationally designated ecological site, Badgeworth SSSI, in close proximity to the air quality study area, located 1 kilometre from the proposed scheme. This site is designated for the presence of the rare habitat, adder's-tongue spearwort (Ranunculus ophioglossifolius).

The study area is presented in Figure 1.

1.2. Assessment Scope

An air quality assessment has been prepared to include the following information:

- A review of local air pollutants (NO_2, PM_{10} and $PM_{2.5}$) and the regulatory and policy context;
- A summary of baseline conditions and measured ambient concentrations in the study area and a comparison with the relevant air quality criteria;
- A qualitative assessment of the potential air quality effects during the construction phase;
- Quantitative assessment of ambient local air pollutant concentrations and potential local air quality impacts associated with changes in traffic flows on the local road network during the operational phase of the Proposed Scheme;
- Recommendations for mitigation of potentially significant effects; and
- Conclusions.

2. Legislation, Policy and Guidance

2.1. Air Pollutants

In most urban areas in the UK, the main local source of air pollutants is road traffic. Emissions from vehicle exhausts contain a complex mixture of pollutants including oxides of nitrogen (a mixture of

nitrogen dioxide and nitric oxide – dominated by the latter), particulate matter (PM), carbon monoxide, and hydrocarbons (including benzene and 1,3-butadiene). The quantities of each pollutant emitted depend upon the vehicle type, quantity and type of fuel used, engine size, speed of the vehicle and abatement equipment fitted. In recent years, the local air pollutants of greatest concern have been nitrogen dioxide and fine particulate matter (PM_{10} and $PM_{2.5}$). In addition to these air pollutants, dust may be generated during the construction phase. Further information is provided below.

2.1.1. Nitrogen Dioxide

Nitrogen dioxide (NO_2) is generally produced by the oxidation of nitric oxide (NO) in ambient air (i.e. it is not formed directly and as such is known as a secondary pollutant). The pollutants NO and NO_2 are collectively termed oxides of nitrogen (NO_x). One third of UK NO_x emissions are from road transport[1]. The majority of NO_x emitted from vehicles is in the form of NO, which oxidises rapidly in the presence of ozone (O_3) to form NO_2. In high concentrations NO_2 can affect the respiratory system, whereas NO does not have any observable effect on human health at the range of concentrations found in ambient air. High concentrations of NO_x can have an adverse effect on vegetation, including leaf or needle damage and reduced growth. Deposition of pollutants derived from NO_x emissions contribute to acidification and/or eutrophication of sensitive habitats.

2.1.2. Particulate Matter

Particulate matter in vehicle exhaust gases consists of carbon nuclei onto which a wide range of compounds are absorbed. These particles have an effective aerodynamic diameter of less than 10 micrometres (µm). Particles in this size range are referred to as PM_{10}. Diesel engines produce the majority of particulate emissions from the vehicle fleet. Approximately 12 percent of PM_{10} emissions in the UK are derived from road transport[2]. Particulate matter is associated with a range of symptoms of ill health including effects on the respiratory and cardiovascular systems, on asthma and on mortality. There is evidence that exposure to a finer fraction of particles ($PM_{2.5}$, which typically make up around two thirds of PM_{10} emissions and concentrations) has a significant contributory role in human all-cause mortality and in particular in cardiopulmonary mortality[3].

2.1.3. Dust

Dust is defined within the Institute of Air Quality Management (IAQM)'s "Guidance on the assessment of dust from demolition and construction" (IAQM Dust Guidance) [4] as solid particles that are suspended in air or that have settled out onto a surface after having been suspended in air. It includes particles that give rise to soiling (deposited dust) and to human health and ecological effects.

The IAQM Dust Guidance states that there is evidence that, without effective mitigation, major construction sites can lead to an increase in annual mean PM_{10} concentrations and the number of exceedances of the short term 24-hour objective for PM_{10}. In addition, construction activities have the potential to cause higher than normal levels of dust deposition in the surrounding area. Dust emissions from a construction site may be mechanically generated due to land preparation (e.g. demolition, land clearing and earth moving) or released from site plant and from the movement of road vehicles on temporary roads, open ground and haul routes.

2.2. Air Quality Legislation

2.2.1. UK Legislation

There are two types of air quality regulations that apply in England:

- Regulations implementing mandatory European Union Directive limit values: The Air Quality Standards Regulations 2010 (Statutory Instrument (SI) 2010 No. 1001)[5]; and

[1] http://naei.beis.gov.uk/overview/pollutants?pollutant_id=6 (accessed September 2018)
[2] http://naei.beis.gov.uk/overview/pollutants?pollutant_id=24 (accessed September 2018)
[3] Air Quality Expert Group (AQEG) Fine Particulate Matter ($PM_{2.5}$) in the UK (2021), https://uk-air.defra.gov.uk/assets/documents/reports/cat11/1212141150_AQEG_Fine_Particulate_Matter_in_the_UK.pdf (accessed September 2018)
[4] Institute of Air Quality Management (IAQM) (2014). Guidance on the assessment of dust from demolition and construction. http://iaqm.co.uk/text/guidance/construction-dust-2014.pdf
[5] The Air Quality Standards Regulations 2010: http://www.legislation.gov.uk/uksi/2010/1001/contents/made

- Regulations implementing national air quality objectives: Air Quality (England) Regulations 2000 (SI 2000 No. 928) and Air Quality (England) (Amendment) Regulations 2002 (SI 2002 No. 3043)[6,7].

2.2.2. EU Limit Values

In April 2008, the European Commission adopted the Directive on ambient air quality and cleaner air for Europe (2008/50/EC). This Directive merged the previous Air Quality Framework Directive and the first three daughter directives and introduced new objectives for $PM_{2.5}$. UK regulations (SI 2010 No. 1001) implement the EU Directive. The relevant EU limit values in the context of this assessment for the protection of human health are presented in Table 1.

2.2.3. National Air Quality Strategy

The 2007 Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland[8] (UK AQS) sets out the national air quality standards and objectives for a number of local air pollutants. The standards are set by expert organisations with regard to scientific and medical evidence on the effects of the particular pollutant on health and define the level of pollution below which health effects are expected to be minimum or low risk even for the most sensitive members of the population. The objectives are targets for air pollution levels to be achieved by a specified timescale, which take account of the costs and benefits of achieving the standard, either without exception or, for certain short-term averaging period standards, with a permitted number of exceedances. Local authorities have a responsibility (under Part IV of the Environment Act 1995, see below) to review and assess local pollution levels against these objectives. These criteria are defined in Regulations SI 2000 No. 928 and SI 2002 No. 3043.

It should be noted that the UK AQS objectives only apply in locations likely to have 'relevant exposure' i.e. where members of the public are exposed for periods equal to or exceeding the averaging periods set for the standards. For this assessment, locations of relevant exposure include building façades of residential premises, schools, public buildings and medical facilities; places of work (other than certain community facilities) are excluded.

In January 2019, the UK Government published its Clean Air Strategy[9], which sets out actions proposed by the Government to improve air quality by reducing pollution from a wide range of sources. Within the strategy, the Government sets an ambitious target to reduce the population exposed to concentrations of $PM_{2.5}$ above 10 µg/m^3 by 50% by 2025.

2.2.4. Local Air Quality Management

Under Part IV of the Environment Act 1995 all local authorities are responsible for Local Air Quality Management (LAQM), the mechanism by which the Government's AQS objectives are to be achieved. As part of this LAQM role, local authorities are required to periodically review air quality in their area and to assess present and likely future air quality against the objectives defined in Regulations. Where a local authority anticipates an objective is expected to be breached within their area, they must designate an Air Quality Management Area (AQMA) and develop an action plan to improve pollution levels and work towards achieving the AQS objectives. Under the current LAQM regime, a local authority is responsible for regular review and assessment of local air quality, reports on which are published following public consultation and review by the Department for Environment, Food and Rural Affairs (DEFRA).

Statutory responsibility for achieving EU limit values rests with the Secretary of State and local authorities have no responsibility for achieving the national air quality criteria, although they should contribute to this through local action plans designed to reduce pollution levels in AQMAs.

The relevant air quality criteria for the protection of human health are outlined in Table 1.

[6] The Air Quality (England) Regulations 2000: http://www.legislation.gov.uk/uksi/2000/928/contents/made
[7] The Air Quality (England) (Amendment) Regulations 2002: http://www.legislation.gov.uk/uksi/2002/3043/contents/made
[8] Department for Environment, Food and Rural Affairs (Defra), 2007. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. http://archive.Defra.gov.uk/environment/quality/air/airquality/strategy/documents/air-qualitystrategy-vol1.pdf
[9] Defra, 2019. Clean Air Strategy 2019. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf.

Table 1 - Relevant Air Quality Criteria

Pollutant	Objective
NO_2	Hourly mean concentration should not exceed 200 µg/m^3 more than 18 times a year Annual mean concentration should not exceed 40 µg/m^3
PM_{10}	24-hour mean concentration should not exceed 50 µg/m^3 more than 35 times a year Annual mean concentration should not exceed 40 µg/m^3
$PM_{2.5}$	UK (Except Scotland) annual mean concentration should not exceed 25 µg/m^3† Exposure reduction^ (UK urban areas): target of 15% reduction in concentrations at urban background between 2010 and 2020*

† UK AQS objective is 25 µg/m^3 to be met by 2020. EU limit value is 25 µg/m^3 to be met by 2015, with a requirement in urban areas to bring exposure down to below 20 µg/m^3 by 2020.

^ EU limit value exposure reduction target of 20% reduction between 2010 and 2020.

* 25 µg/m^3 is a cap to be seen in conjunction with 15% reduction.

2.2.5. Ecological Criteria

The EU Directive sets a critical level for annual mean concentrations of nitrogen oxides (NO_x) to protect sensitive vegetation. This is included in the Air Quality Standards Regulations[5]. Assessment of compliance with this critical level is undertaken at locations more than 20 kilometres from towns with more than 250,000 inhabitants or more than 5 kilometres from other built-up areas, industrial installations or motorways or major roads with traffic counts of more than 50,000 vehicles per day. UK statutory nature conservation agencies' (Natural England) policy is to apply the criterion of 30 µg/m^3, on a precautionary basis as a benchmark only, in all designated conservation sites, including 'Ramsar' sites, SPAs, SACs and SSSIs.

Critical loads for nitrogen deposition have been set by the United Nations Economic Commission for Europe. A critical load is a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur, according to present knowledge. Critical loads vary by type of habitat and species. The critical load for deposition (eutrophication) is given as a range and is quoted in units of kg/ha/year.

2.2.6. Dust Deposition

There are no national standards or guidelines for dust deposition currently set for the UK, nor by the European Union or any international organisation. This is mainly due to the difficulty in setting a standard that needs to relate to dust being a perceptual problem rather than being specifically related to health effects. Typically, assessments use an indicative threshold for the 'likelihood of complaint' for instance, in residential areas a dust deposition flux (as an average measured over a month using a passive deposition gauge) of 200 mg/m^2/day or greater.

2.3. Air Quality Planning Policy and Guidance

2.3.1. National Planning Policy

2.3.1.1. National Planning Policy Framework

The Government's planning guidance of general relevance to air quality is found within the National Planning Policy Framework (NPPF) [10]. It assists local authorities to incorporate air quality considerations into planning decisions and attempts to protect the environment and to promote sustainable growth.

Paragraph 103 refers to sustainable transport:

"*The planning system should actively manage patterns of growth in support of these objectives. Significant development should be focused on locations which are or can be made sustainable, through limiting the need to travel and offering a genuine choice of transport modes. This can help*

[10] Ministry of Housing, Communities & Local Government, National Planning Policy Framework (NPPF), July 2018, from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/728643/Revised_NPPF_2018.pdf

to reduce congestion and emissions and improve air quality and public health. However, opportunities to maximise sustainable transport solutions will vary between urban and rural areas, and this should be taken into account in both plan-making and decision-making."

Paragraph 181 considers impacts on local air quality:

"Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. So far as possible these opportunities should be considered at the plan-making stage, to ensure a strategic approach and limit the need for issues to be reconsidered when determining individual applications. Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan."

2.3.1.2. Planning Practice Guidance

Planning Practice Guidance (PPG)[11] is intended to support the NPPF and provide further detail to its policies. PPG indicates at paragraph 006 that information relating to air quality could be important to decision makers, and when there are concerns about air quality, the local planning authority may want to know about:

- *"the 'baseline' local air quality;*
- *whether the Proposed Development could significantly change air quality during the construction and operational phases; and/or*
- *whether there is likely to be a significant increase in the number of people exposed to a problem with air quality, such as when new residential properties are proposed in an area known to experience poor air quality."*

PPG also advocates, at paragraph 006, early engagement with the local planning and environmental health departments to establish the scope of any assessment. Guidance is also given on the level of detail required in an air quality assessment, and measures which could be employed to mitigate adverse effects.

2.3.2. Regional Planning Policy

2.3.2.1. Gloucester County Council Local Transport Plan (2015-2031)[12][13][14]

The 2015 Local Transport Plan (LTP) for Gloucester County Council is currently under review. The LTP is composed of an overarching strategy document, six connecting places strategies and six policy documents. It sets up a long-term transport strategy up to 2031, enabling sustainable economic growth, enable community connectivity, conserve the environment and improve community health and wellbeing.

2.3.3. Local Planning Policy

2.3.3.1. Joint Core Strategy

The Joint Core Strategy (JCS) was adopted in December 2017 by Gloucester City Council, Cheltenham Borough Council and Tewkesbury Borough Council to arrange the development of the area up to 2031. The JCS establishes three sustainable community strategy visions for each local authority:

-Gloucester City Vision 2012-2022; including sustainable growth and regeneration program.

[11] National Planning Portal, available at http://planningguidance.planningportal.gov.uk/blog/guidance/air-quality/

[12] https://www.gloucestershire.gov.uk/transport/gloucestershires-local-transport-plan-2015-2031/introduction/

13 https://www.gloucestershire.gov.uk/media/3037/ltp_-_guidance_note_-_v3_20160607-67278.pdf

14 https://www.gloucestershire.gov.uk/transport/gloucestershires-local-transport-plan-2015-2031/connecting-places-strategies-cps/

-Cheltenham Sustainable Community Strategy Vision 2008-2028; and

-Tewkesbury Sustainable Community Strategy Vision 2008-2028

Amongst the JCS strategic objectives is to ensure “environmental quality and air quality is protected.”

Furthermore, a number of infrastructure and sustainable development policies are relevant to air quality as shown below:

Policy INF1: Transport Network

“Developers will be required to assess the impact of proposals on the transport network through a Transport Assessment. The assessment will demonstrate the impact, including cumulative impacts, of the prospective development on: …

iii) Noise and/or atmospheric pollution within the zone of influence of the development”

Policy SD3: Sustainable Design and Construction

“Development proposals will demonstrate how they contribute to the aims of sustainability by increasing energy efficiency, minimising waste and avoiding the unnecessary pollution of air, harm to the water environment, and contamination of land or interference in other natural systems. In doing so, proposals (including changes to existing buildings) will be expected to achieve national standards.”

Policy SD4: Design Requirements

iii. Amenity and space;

“New development should enhance comfort, convenience and enjoyment through assessment of the opportunities for light, privacy and external space, and the avoidance or mitigation of potential disturbances, including visual intrusion, noise, smell and pollution.”

Policy SD14: Health and Environmental Quality

New development must:

ii) “Result in no unacceptable levels of air, noise, water, light or soil pollution or odour, either alone or cumulatively, with respect to relevant national and EU limit values”

iii)” Result in no exposure to unacceptable risk from existing or potential sources of pollution.”

2.3.3.2. Cheltenham Borough Local Plan 2006

Cheltenham Borough Local Plan Second Review sets out core policies and proposals in which the following policy is related to air quality:

Policy CP3: Sustainable Environment

Development will be permitted only where it would:

e) not give rise to harmful levels of pollution to land, air or water (surface or ground)

Cheltenham Borough Local plan 2006 will be replaced by a new local plan, currently in examination stages and due to be published in early 2020. This new plan is sought to be used in combination with the JCS.

2.3.3.3. Cheltenham Borough - Planning for Air Quality Guidance 2013

A good practice guide for planners and developers was published by CBC in May 2013. This local guidance identifies which developments should assess air quality within the borough of Cheltenham and what an air quality assessment should include.

2.3.3.4. Cheltenham Borough - Air Quality Action Plan 2014

The air quality action plan identifies road transport as the principal source of air pollution and encourages sustainable travel following a series of transport measures within the Local Sustainable Transport Plan (LSTP). Measures identified in the Air Quality Action Plan (AQAP) include highway improvements, air quality awareness by publishing air quality data and encouraging sustainable transport choices, promoting the use of park-ride schemes, personalised travel plans, promoting bike use to commute to school for parents and kids, car sharing, greener vehicles, HGV and LGV restrictions, school and business travel grants, wayfinding initiatives, adopting an air quality policy to ensure impact of significant developments are assessed and mitigation measures in places where necessary, traffic light appraisal, bus and taxi quality partnership, reducing speed limit to 20mph in busier roads, low emission bus fleets and improvement of road layouts and greener areas.

2.3.3.5. Tewkesbury Borough Local Plan 2006

Tewkesbury Local Plan 2006 is being replaced by the new Tewkesbury Borough Plan 2011 to 2031. Policies will focus on employment allocations, housing allocations, settlement boundaries, retail and centre locations and strategic gaps. The new Local Plan is expected to be available by early 2020.

2.3.3.6. Tewkesbury Air Quality Action Plan 2011

Tewkesbury Local Air Quality Action Plan was published in 2011. It identified that vehicle emissions were the main source of annual mean NO_2 objective exceedances within the Tewkesbury Town Centre AQMA declared in 2008. Actions proposed included soft measures to reduce vehicle use by 5% through the town and a proposal to remove all heavy goods vehicle exceeding 7.5 tonnes. These proposals have been incorporated into the Tewkesbury Town Master Plan. The 2017 Air quality Annual Status Report identified that no exceedances of the annual mean NO_2 objective had been reported at monitoring locations since 2014. The local authority are considering revoking the AQMA if the monitoring continues to indicate that air quality objectives are not being exceeded.

2.3.4. LAQM Technical Guidance

Guidance concerning local air quality management is given in DEFRA's technical guidance LAQM.TG(16)[15]. The guidance provides relevant methods concerning treatment and interpretation of data for local authorities in relation to the LAQM regime but is frequently applied when undertaking assessments for planning applications.

2.3.5. Land-Use Planning and Development Control Guidance

Environmental Protection UK (EPUK) and the Institute of Air Quality Management (IAQM)'s 'Land-use Planning and Development Control: Planning for Air Quality' (2017)[16] guidance sets out to ensure that air quality is adequately considered in the land-use planning and development control processes. It comprises an initial screening stage to determine the need for an air quality assessment. If further assessment is required, a number of more stringent criteria are provided to help establish the need for further work, which may be either qualitative or quantitative, simple or detailed, depending on the impact of the development on, for instance, traffic flow. It also provides a framework for describing the magnitude of changes in local air pollutant concentrations at individual receptors (the impact) and gives advice on how overall significance may be assessed using professional judgement (the effect).

2.3.6. Construction Dust Guidance

The IAQM Construction Dust Guidance[4] provides a framework for a risk-based approach to the assessment of dust emissions from demolition and construction land development schemes and outlines options for mitigation depending on the level of 'dust risk' identified for a site through the assessment process.

[15] http://laqm.defra.gov.uk/documents/LAQM-TG16-April-16-v1.pdf
[16] Environmental Protection UK and Institute of Air Quality Management (2017), 'Land-Use Planning & Development Control: Planning for Air Quality', http://iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

3. Assessment Methodology

3.1. Baseline

Information on existing baseline air quality conditions within the study area was obtained from the following sources:

- CBC's and TBC's air quality review and assessment reports[17];
- Air quality background concentrations from DEFRA's Air Information Resource (UK-AIR)[18];
- Designated ecological site information from Natural England Multi-Agency Geographic Information for the Countryside (MAGIC) website[19];
- AQMA mapping[20];
- Ordnance Survey (OS) Mastermap and AddressBasePlus base mapping to identify locations of sensitive receptors (residential properties, schools, hospitals and elderly care homes); and
- Department for Environment, Food and Rural Affairs (DEFRA) Pollution Climate Mapping (PCM) model data for the latest available reference year (2017)[21].

3.2. Construction Phase

The IAQM Construction Dust Guidance[4] provides a framework for a risk-based approach to the assessment of dust emissions from demolition and construction. The assessment of dust emissions during construction of the Proposed Scheme is considered in the context of the overall scale and nature of the development under consideration and the potential sensitivity of neighbouring land uses. The quantity and distribution of dust emissions varies according to type, duration and location of activity, weather conditions and the effectiveness of suppression (mitigation) measures. Good practice control measures that are "highly recommended" or "desirable" for dust control for the various dust risk categories are recommended.

3.2.1. Construction Dust Risk Assessment

Assessment of the potential impact of the construction phase of the Proposed Scheme on air quality with regards dust and PM_{10} emissions has been carried out with reference to the four-step process described in the IAQM Construction Dust Guidance[22]. These steps are summarised in Appendix A.

3.2.2. Construction Vehicle Emissions

The EPUK/IAQM's 'Land-use Planning and Development Control: Planning for Air Quality' (2017)[23] advises that an air quality assessment would be required where a development causes a change in Heavy Duty Vehicle (HDV)[24] flows on local roads of more than 25 per day within an AQMA. The construction period for the proposed scheme will last less than a year and any effect on air quality from construction traffic will be temporary. Where construction flows are likely to exceed 25 vehicles per day for extended periods during the construction works on sensitive routes, it is recommended that a traffic management plan should be prepared.

[17] https://www.cheltenham.gov.uk/info/66/environmental_protection_and_pollution/288/air_quality_and_pollution & https://www.tewkesbury.gov.uk/air-quality
[18] https://uk-air.DEFRA.gov.uk/
[19] http://magic.DEFRA.gov.uk/
[20] https://uk-air.DEFRA.gov.uk/aqma/
[21] https://uk-air.DEFRA.gov.uk/library/no2ten/2019-no2-pm-projections-from-2017-data
[22] Institute of Air Quality Management (2014) "Guidance on assessment of dust from demolition and construction", version 1.1, http://iaqm.co.uk/text/guidance/construction-dust-2014.pdf
[23] Environmental Protection UK and Institute of Air Quality Management (2017), 'Land-Use Planning & Development Control: Planning for Air Quality', http://iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf
[24] HDV comprises goods vehicles and buses >3.5 tonnes gross vehicle weight

3.3. Operational Phase

3.3.1. Local Air Quality Assessment

An assessment of changes in local air pollutant concentrations has been undertaken using the detailed dispersion modelling software ADMS-Roads (version 4.1.1.0) with reference to DEFRA's Technical Guidance LAQM.TG(16)v1[15]. The model uses information on vehicle emission rates, road alignment and width, and local meteorological data to estimate NO_x, PM_{10} and $PM_{2.5}$ concentrations at discreet sensitive receptor locations.

3.3.2. Traffic Data

The traffic data used were derived from the Proposed Scheme PARAMICS traffic model and the outputs were provided by Atkins Transportation Team.

3.3.3. Assessment Scenarios

Traffic data were provided for the following scenarios:

- Base Year (2017);
- Opening year (2021), without the Proposed Scheme; and
- Opening year (2021), with the Proposed Scheme.

Pollutant concentrations have been modelled at selected sensitive receptors for each of the scenarios described above in order to determine the impact of the Proposed Scheme on local air quality.

3.3.4. Affected Road Network

The traffic data was processed to present the 2-way flow for each link before determining the overall change in traffic flow between the with and without scheme scenarios.

The need for an assessment of operational impacts associated with the Proposed Scheme has been determined based on the screening criteria in EPUK/IAQM Planning Guidance[16], as agreed in consultation with CBC[25].

Screening criteria indicate an air quality assessment is required if a scheme or development results in:

- a change in flows of light duty vehicles (LDV) of more than 500 AADT (or more than 100 AADT within or adjacent to an AQMA); or
- a change in flows of heavy duty vehicles (HDV) of more than 100 AADT (or more than 25 AADT within or adjacent to an AQMA).

The criteria within or adjacent to an AQMA were applied to all links within the CBC boundary and the alternative criteria were applied to all links within the TBC boundary. The resulting affected road network (ARN) and local air quality study area, defined as the area within 200 metres of the ARN, is shown in Figure 1:-

Increases in traffic flows on the following roads: -

- A40 between the M5 Junction 11 and Benhall Roundabout;
- Princess Elizabeth Way;

Decreases in traffic flows on the following roads: -

- Sections of smaller roads within the St Marks residential area, including Gloucester Road, Libertus Road, Tennyson Road and Roman Road.

The ARN and 200 metres buffer are presented in Figure 1.

[25] Discussion with Head of Pollution at CBC, Sarah Clark, confirmed the appropriate criteria of change to apply to traffic data to determine the affected road network (ARN) as used to define the local air quality study area.

3.3.5. Traffic Conditions

Traffic conditions vary throughout the course of a day and between weekdays and weekends, hence 24-hour profiles for both weekday and weekend days have been applied in the model to improve the estimation of vehicle emissions in each hour of the year. The ADMS-Roads model was set up with an emission rate entered into the model for each road link and a time varying emissions file created containing the hourly traffic profile. Further details of the traffic data and modelled diurnal emission profile used are provided in Appendix B.

3.3.6. Emission Factors

Vehicle exhaust emissions of NO_x, PM_{10} and $PM_{2.5}$ for each road link were calculated using DEFRA's Emissions Factors Toolkit (EFT, version 9.0, May 2019)[26] for the 2017 base and 2021 opening year (without the Proposed Scheme and with the Proposed Scheme) scenarios. The emission calculations assumed a road type of either Motorway, Urban, or Rural, (not London), as appropriate, for all modelled roads.

3.3.7. Background Concentrations

The output from the ADMS dispersion model provides the contribution from road traffic emissions to annual mean concentrations of NO_x, PM_{10} and $PM_{2.5}$ at discrete receptor points. These incremental concentrations are combined with estimates of background concentrations, to account for other sources of air pollution, and derive total annual mean concentrations.

Background concentrations were derived from DEFRA's background maps (for a 2017 reference year). A comparison of mapped and measured background concentrations is provided in Appendix D, and showed that the background maps were considered acceptable for use. To avoid double counting, the contribution from modelled emission sources (i.e. the in-square contributions from Motorways, Trunk A roads and Primary A-roads) within DEFRA's background maps were removed from the total background NO_2 concentration, using the NO_2 Adjustment for NO_x sector removal tool v7.0, May 2019. The in-square contributions from Motorways, Trunk A-roads and Primary A-roads were also removed from background NO_x, PM_{10} and $PM_{2.5}$ background concentrations combined with modelled road contributions.

3.3.8. Meteorological Data

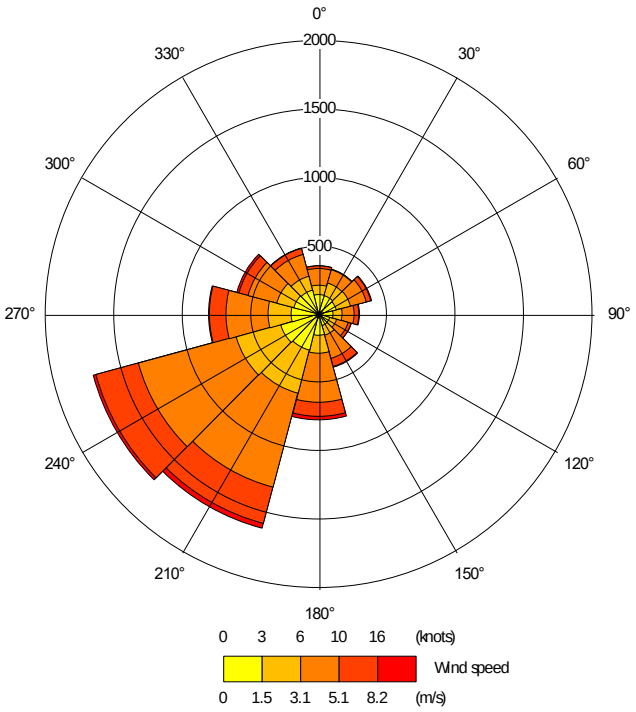
Hourly sequential meteorological data for the nearest suitable meteorological station, in this case Gloucester Airport, were used in the model for the year 2017 (to match the traffic model base year). The weather station is approximately 1.8 kilometres east of the Proposed Scheme.

A windrose for Gloucester Airport 2017 is presented in

[26] Emission Factors Toolkit (EFT) version 9.0 published May 2019, DEFRA and devolved administrations, https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.htm

Insert 3-1 - Windrose for Gloucestershire Meteorological Site - 2017, which indicates that the prevailing wind is from the southwest.

Insert 3-1 - Windrose for Gloucestershire Meteorological Site - 2017



3.3.9. Receptors

Receptors could be affected by changes in air quality where they are located within 200 metres of a road expected to have a change in traffic in excess of the relevant traffic change criteria, identified in the ARN. Ordnance Survey AddressBasePlus data was used to determine the location of sensitive human health receptors (e.g. residential dwellings, schools and hospitals) and Natural England's MAGIC website[19] was used to identify any sensitive ecological receptors.

Pollutant concentrations were modelled at 36 locations. 30 locations representing existing human health receptors (e.g. residential properties, hospitals, schools and residential homes). These receptors are adjacent to the road links which were considered likely to experience the highest pollutant concentrations and/or the largest changes in pollutant concentrations as a result of the Proposed Scheme.

Six receptors were located within 4 metres of a section of the A40 between Arle Court and Benhall roundabout identified by DEFRA as exceeding the EU Limit Value for annual mean NO_2 concentrations in 2017.

There were no designated ecological sites found within 200 metres of the ARN.

The locations of the modelled receptors are shown in Figure 2 and reported in Appendix C, Table 19.

3.3.10. Model Inputs and Assumptions

The air dispersion model scenarios have been based on the following key inputs and assumptions:

- Ordnance Survey maps and site layout plans to define the modelled road geometry (including road widths) and receptor locations;
- Road widths, manually determined from Google Earth Pro aerial photography and Mastermap Topography data;
- Traffic data in 24 hour Annual Average Daily Traffic (AADT) format for the base year (2017) and opening year (2021) without and with the Proposed Scheme scenarios;
- Diffusion tubes have been assigned heights from the latest LAQM reports;
- Meteorological data has been obtained for Gloucester Airport (2017);
- Surface roughness defined as 0.5 metres for the modelled area (representative of parkland, open suburbia) and as 0.5 metres for the meteorological station (parkland, open suburbia)[27];
- Model default values used for surface albedo and Priestly-Taylor parameter;
- The Monin-Obukhov length for both the modelled area and the meteorological station have been set at 30 metres to represent mixed urban/industrial; and
- Diurnal profiles were used with the available traffic profiles for the M5 and other roads.

3.3.11. Model Uncertainty

Any air dispersion modelling exercise has inherent areas of uncertainty, including:

- input data (traffic data, emissions data);
- simplifications in model algorithms and empirical relationships that are used to simulate complex physical and chemical processes in the atmosphere;
- background concentrations; and
- meteorological data.

Uncertainty associated with vehicle emissions data has been minimised by using the most recent version of the ADMS-Roads modelling software (version 4.1.1.0) and DEFRA emission factors (EFT v90) available at that time.

Uncertainty associated with model algorithms and empirical relationships have been minimised by using algorithms and relationships within a dispersion model (ADMS-Roads) that has been independently validated and judged as fit for purpose.

Hourly sequential meteorological data have been used to estimate future concentrations provided by an approved supplier and which has been subject to robust quality checks. The key limiting assumption is that conditions in the future will be the same as in the past; however, in reality no two years are the same. To address some of this uncertainty, the meteorological data used in the model was for the same year as the air quality monitoring data and traffic data used in the base year verification.

Given the above, the approach taken to this assessment is considered to be robust and is in line with good practice.

3.3.12. Model Verification

Model verification is the process of determining the local area performance of the base year model in comparison with measured data. The verification step involves comparison of modelled pollutant concentrations at suitable monitoring sites with monitored values that are representative of the base model period (in this case 2017).

Where there is a disparity between modelled and measured concentrations, and where further improvements to input data are not possible, then if required, an appropriate adjustment factor can be determined to correct for systematic bias. This adjustment is applied to the base year and future year model outputs.

Verification has been undertaken in accordance with DEFRA's Technical Guidance LAQM.TG(16)[15] and is discussed in detail in Appendix E. In summary, the dispersion model was found to

[27] Surface roughness length is a measure of the vertical height of obstacles to wind flow at the earth's surface.

underestimate measured NO_2 concentrations in the study area, therefore, an adjustment factor of 1.85 was applied to modelled road NO_x concentrations at the modelled receptor locations.

In the absence of PM_{10} and $PM_{2.5}$ monitoring data for the study area against which modelled concentrations can be verified, the model adjustment factor derived for NO_x was also applied to modelled PM_{10} and $PM_{2.5}$ concentrations. This approach is suggested within LAQM.TG(16), which states that "*In the absence of any PM_{10} data for verification, it may be appropriate to apply the road-NO_x adjustment to the modelled road-PM_{10}*" and is considered likely to provide a conservative estimate of the contribution of modelled roads to ambient PM_{10} and $PM_{2.5}$ concentrations.

3.3.13. Comparison with Air Quality Criteria

3.3.13.1. Nitrogen Dioxide

To derive total NO_2 concentrations from modelled road NO_x concentrations, and allow comparison with the air quality criteria, the method described in DEFRA's Technical Guidance LAQM.TG(16)[15] has been used. Total annual mean NO_2 concentrations have been calculated from modelled road NO_x and background NO_2 concentrations, using the latest version of the 'NO_x to NO_2 conversion spreadsheet' (version 7.1) available from the DEFRA UK-AIR website[18].

In addition to the modelled road NO_x and background NO_2 data, DEFRA's NO_x to NO_2 conversion spreadsheet requires a local authority area to be specified to determine regional oxidant concentrations, and a traffic mix to determine the proportion of primary NO_2. The local authority areas selected in the conversion tool were "Cheltenham" and "Tewkesbury" based on the location of the relevant receptors; the traffic mix selected was "All non-urban UK traffic" for those on the western side of the Proposed Scheme by the M5 and "All other urban UK traffic" for the rest of modelled roads.

Since only annual mean concentrations have been generated using the air dispersion model, commentary on potential exceedances of the hourly mean NO_2 standard has been made with reference to DEFRA's Technical Guidance LAQM.TG(16)[15]. The guidance suggests that if annual mean concentrations of NO_2 do not exceed 60 µg/m³ then it is unlikely that hourly mean concentrations would exceed the relevant objective, which allows for 18 exceedances of the hourly standard in a calendar year.

3.3.13.2. Particulate Matter

To determine total annual mean concentrations of PM_{10} and $PM_{2.5}$ at human health receptors, the modelled road contribution has been added to the background concentration to give the total concentration for comparison with the annual mean assessment criterion.

Annual mean PM_{10} concentrations are used to derive the number of exceedances of the 24-hour mean PM_{10} criterion, of which 35 are allowed in a calendar year. The method described in LAQM.TG(16)[15] was applied. This method is based on the relationship between the number of 24-hour exceedances of 50 µg/m³ and the annual mean concentration derived from UK Automatic Network Sites. This is described in Equation 1.

Equation 1 – Calculation of PM_{10} 24-Hour Mean Exceedances

Number of exceedances of 24-hour mean of 50 µg/m³ = $-18.5 + 0.00145 * a^3 + (206/a)$

Where 'a' = total annual mean PM_{10} concentration.

3.3.14. Assessment of Significance

A matrix for describing the impact of a change in concentration at individual receptors is set out in the EPUK/IAQM Planning Guidance[16], reproduced in Table 2. These descriptors are used in the assessment of changes to annual mean concentrations of NO_2, PM_{10} and $PM_{2.5}$ with the Proposed Scheme, and range from negligible to slight, moderate or substantial.

The impact description depends upon:

- the larger value of the total concentration without the Proposed Scheme or with the Proposed Development, as a percentage of the relevant Air Quality Assessment Level (AQAL i.e. AQS objective); and
- the change in concentration, classified according to the percentage change relative to the AQAL of interest. The change is calculated based on concentrations rounded to one decimal place.

The percentage change is then rounded up or down to the nearest whole number before application of the impact descriptor.

Table 2 - IAQM Air Quality Impact Descriptors for Individual Receptors

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

The overall determination of significance of effect requires the professional judgement of a suitably qualified air quality professional. This judgement must take into account such factors as:

- the existing and future air quality in the absence of the scheme or development;
- the extent of current and future population exposure to the impacts (i.e. extrapolating the findings from the individual modelled receptors); and
- the influence and validity of any assumptions adopted when modelling the impacts.

4. Baseline Conditions

4.1. Local Air Quality Management

The air quality study area includes the borough wide AQMA administered by CBC, declared in 2011 for exceedances of the national NO_2 annual mean AQS objective. The AQMA is currently under review and monitoring data published in the Annual Status Report 2018 confirmed that the annual mean AQS objective is only exceeded in isolated areas to the west of Cheltenham town centre. Further details on the revised AQMA should be confirmed by the end of 2019.

TBC declared one AQMA in 2008 encompassing parts of Tewkesbury town centre. This AQMA is located approximately 9 kilometres north west of the Proposed Scheme and 7 kilometres from the air quality study area and is therefore unlikely to be affected by the Proposed Scheme. A summary of the AQMAs is presented in Table 3**Error! Reference source not found.**.

Table 3 - AQMAs declared by CBC and TBC in proximity to the Proposed Scheme

Name	AQS Objective Exceeded	Description
Cheltenham Whole Borough AQMA	Annual mean nitrogen dioxide NO_2	The whole borough of Cheltenham
Tewkesbury Town Centre AQMA	Annual mean nitrogen dioxide NO_2	An area encompassing parts of Tewkesbury town centre, including parts of High Street, Barton Street Church Street and the Eastern Relief Road.
SOURCE: https://uk-air.defra.gov.uk/aqma/		

4.2. Air Quality Monitoring

Air quality monitoring is undertaken by national and local authorities and is a key component of local air quality management. Measurements of pollutant concentrations include analytical instruments that measure continuously, and passive sampling devices such as diffusion tubes which give longer period results (typically monthly, to calculate an annual mean concentration).

4.2.1. Continuous Monitoring Data

The nearest Continuous Monitoring Station (CMS) to the Proposed Scheme is located at a kerbside site (within 2 metres of the edge of the road) on the junction between St Georges Street and Swindon Road in Cheltenham located 5 kilometres north east of the proposed scheme. Annual mean NO_2 concentrations measured at the site for the past five years are shown in Table 4. No exceedances of the annual mean AQS objective for NO_2 are reported between 2014 and 2018[28].

Table 4 - NO_2 Automatic monitoring results (µg/m^3)

Site ID	Site Name	Site Type	X	Y	2014	2015	2016	2017	2018
CM1	St Georges Street	Kerb side	394760	222878	35	35	34	36	32

CBC installed an AQ Mesh unit 650 metres east of the Proposed Scheme. The site is located at a roadside location (3 metres from the kerb) on the north side of Gloucester Road near a bus stop and within 60 metres of the roundabout junction with Princess Elizabeth Way (Grid Reference - 391868, 222084). The unadjusted data from the unit between April and December 2018 recorded a

28 Cheltenham Borough Council, 2018 Air Quality Annual Status Report (ASR) v1.1, July 2018 with additional data provided by Cheltenham Borough Council for monitoring results in 2018 not yet published.

mean NO_2 concentration of 31.1 µg/m^3 and a mean PM_{10} concentration of 13.5 µg/m^3. The monitoring period excludes winter months, when concentrations tend to be highest, therefore the mean measured concentration may underestimate compared to an annual mean covering a full year. As such, following the annualization process as provided in the LAQM.TG16 guidance, measured NO_2 mean concentration for the site has been adjusted to give an annual mean of 33.5 µg/m^3, indicating that annual mean NO_2 concentrations at this location are still considered to be below the AQS objective.

4.2.2. Passive Monitoring Data

Annual mean NO_2 concentrations are also measured by both CBC[28] and TBC[Error! Bookmark not defined.] using diffusion tubes. Concentrations of NO_2 measured at the diffusion tubes near to the Proposed Scheme are presented below in Table 5.

At present only one site, 5, located at 422 High Street, exceeded the annual mean NO_2 AQS objective in 2018 with a measured concentration of 42.9µg/m^3. This site is located approximately 5 kilometres from the Proposed Scheme in the St Pauls district of Cheltenham Town Centre near the CMS location. It is not in the air quality study area and is therefore unlikely to be affected by the Proposed Scheme.

Sites located within the air quality study area are highlighted in blue in Table 5. Measured concentrations at these sites in 2018, ranged between the highest annual mean reported of 37.1 µg/m^3 at site 28, Princess Elizabeth Way North and the lowest, 27.9 µg/m^3 at 15N near the M5 north of Junction 11; all were below the annual mean AQS objective.

All the monitoring sites are presented in Figure 1 with annual mean concentrations for 2018, where this information is available.

Table 5 - NO_2 Diffusion tube monitoring results (µg/m^3)

Site ID	Site Name	Site Type	X	Y	2014	2015	2016	2017	2018
14N	69 Sussex Gardens	Urban	387915	217389	26.3	25.4	26.8	24.7	27.0
15N	Comus Bamfurlong	Urban	389714	221845	27.9	28.5	25.6	26.2	27.9
16N	15 Withybridge Gardens	Urban	390461	225544	27.8	26.5	29.0	25.7	25.1
52N	43 Stocken Close	Roadside	387570	216935	25.5	25.1	26.2	25.6	24.2
1	Municipal Offices (Front)	Roadside	394757	222320	No Data	No Data	No Data	26.4	21.8*
2	Municipal Offices (Back)	Roadside	394724	222320	No Data	No Data	No Data	32.9	26.6*
3	Ladies College	Roadside	394621	222215	33.9	36.6	33.8	32.8	26.1*
4	2 Gloucester Road	Roadside	394235	223055	**41.7**	**46.5**	**43.2**	**45.4**	39.1*
5	422 High St	Roadside	394350	222923	**46.5**	**47.3**	**45.5**	**49.9**	**42.9***
6	New Rutland	Roadside	394738	222888	**42.1**	**42.4**	**40.8**	**41.6**	35.9*
7	Co-location – 1	Roadside	394760	222878	35.1	34.6	32.9	36.0	30.9*
8	Co-location – 2	Roadside	394760	222878	34.0	35.2	34.2	36.9	31.6*
9	Co-location – 3	Roadside	394760	222878	34.1	34.0	32.8	36.2	31.1*
10	2 Swindon Road	Kerbside	394830	222845	38.8	37.9	38.2	39.4	33.8*
11	Portland Street	Roadside	395110	222670	35.2	36.8	35.7	35.9	30.9*
12	Winchcombe/Fairview	Roadside	395210	222618	39.3	33.0	32.2	32.8	30.2*
13	Albion Street (outside no. 54)	Kerbside	395207	222465	No Data	No Data	No Data	34.8	29.7*
14	2 London Road	Roadside	395362	222000	**40.1**	**40.0**	38.0	37.1	35.5*
15	YMCA - High St	Roadside	395182	222183	35.2	34.5	32.9	31.9	27.6*

Site ID	Site Name	Site Type	X	Y	2014	2015	2016	2017	2018
16	8a Bath Road	Roadside	395146	222149	**40.8**	**41.1**	38.4	38.0	32.7*
17	Clarence Parade (opp no. 6)	Roadside	394801	222454	No Data	No Data	No Data	33.8	31.1*
18	81 London Road	Roadside	395660	221670	**41.8**	**41.4**	39.6	38.4	35.4*
19	264 Gloucester Road	Roadside	393296	222170	34	36.7	32.2	34.4	29.1*
20	340 Gloucester Road	Roadside	392912	221862	36.3	38.7	35.9	38.6	33.5*
21	14 Imperial Square	Roadside	394807	222058	No Data	No Data	No Data	No Data	22.2*
22	Hatherley Lane	Roadside	391177	221638	No Data	No Data	No Data	35.1*	35.4*
23	St James Square	Roadside	394576	222425	No Data	No Data	No Data	29.6*	29.9*
24	St Gregorys Church	Roadside	394566	222602	No Data	No Data	No Data	26.7*	27.0*
25	St Georges Street	Roadside	394704	222755	No Data	No Data	No Data	30.5*	30.8*
26	St Pauls Road	Roadside	394894	223011	No Data	No Data	No Data	27.7*	28.0*
27	St Lukes College Road	Roadside	395157	221865	No Data	No Data	No Data	23.7*	24.0*
28	Princess Elizabeth Way North	Roadside	393077	223644	No Data	No Data	No Data	36.7*	37.1*
29	Princess Elizabeth Way South	Roadside	392055	222527	No Data	No Data	No Data	29.8*	30.1*
No Data indicates site was not operational during that year									
*Annualised tubes									

4.3. DEFRA Mapped Concentrations

Estimates of background pollutant concentrations in the UK are available on the DEFRA UK-Air website[29]. The background estimates, which are a combination of measured and modelled data, are available for each 1 kilometre grid square throughout the UK for the years 2017 to 2030. The estimated annual average background concentrations in the area covering the Proposed Scheme for the baseline year (2017) and the Proposed Scheme opening year (2021) are presented below for the pollutants' NO_x, NO_2, PM_{10} and $PM_{2.5}$. Background concentrations of key pollutants are expected to be well below[30] relevant AQS objectives in both 2017 and 2021.

[29] https://laqm.DEFRA.gov.uk/review-and-assessment/tools/background-maps.html
[30] EPUK/IAQM Planning guidance advises that at exposure less than 75% of this value, i.e. well below, the degree of harm is likely to be small.

Table 6 - DEFRA mapped background concentrations, 2017 and 2021 (µg/m^3)

Grid Square (x,y)	2017 Background Concentration (µg/m^3)				2021 Background Concentration (µg/m^3)			
	NO_x	NO_2	PM_{10}	$PM_{2.5}$	NO_x	NO_2	PM_{10}	$PM_{2.5}$
391500, 221500	22.5	15.8	13.8	9.4	21.6	15.3	13.6	9.2
390500, 221500	22.5	15.9	13.9	9.1	21.4	15.2	13.7	9.0

4.4. Compliance with EU Limit Values

DEFRA's Pollution Climate Mapping (PCM) model[31] provides estimates of roadside concentrations of pollutants, including annual mean NO_2 and PM_{10}, which are used in annual reporting regarding compliance with EU Limit Values[32].

The Proposed Scheme includes a road identified by DEFRA as exceeding the EU Limit Value for annual mean NO_2 concentrations. The latest update of the PCM modelling indicates that the EU Limit Value was exceeded at roadside locations in 2017 on part of the A40 (PCM census ID 77985 [PCM model links 93730, 93690, 93678]), running from the B4063 at Arle Court Roundabout to the A4013 at Princess Elizabeth Way Roundabout on the western side of Cheltenham. The PCM model estimates that the EU Limit Value will, however, be achieved by 2019. The estimated roadside NO_2 concentrations for these links are as follows (same value reported for each of the three links in model):

- 2017 40.3 µg/m^3
- 2019 38.2 µg/m^3
- 2020 36.4 µg/m^3
- 2021 34.5 µg/m^3

In 2018 DEFRA directed CBC to prepare a Targeted Feasibility Study to Deliver Nitrogen Dioxide Concentration Compliance in The Shortest Possible Time. This document is published on the Air Quality Plan website and was used to prepare DEFRA's Supplement to The UK Plan for Tackling Roadside Nitrogen Dioxide Concentrations. Where the proposed scheme results in an increase in PCM concentrations resulting in an exceedance of the EU Limit Value, an EU compliance assessment may be required to determine the impact the Proposed Scheme will have on achieving the EU Limit Value.

4.5. Summary of Existing Conditions

The entire borough of Cheltenham is declared an AQMA, due to exceedances of the annual mean NO_2 AQS objective. Monitoring data from the local authority diffusion tube survey indicate the annual mean NO_2 concentrations exceeded the relevant AQS objective at Gloucester Road and High Street, Cheltenham in 2017, however no exceedances were recorded at monitoring sites within the air quality study area. The latest update of the DEFRA PCM modelling indicated that the EU Limit Value was exceeded at roadside locations in 2017 on part of the A40, running from the B4063 at Arle Court Roundabout to the A4013 at Princess Elizabeth Way Roundabout on the western side Cheltenham. The PCM model predicts that the EU Limit Value would, however, be achieved by 2019.

[31] DEFRA (2017) 2019 NO_2 projections data (2017 reference year). https://uk-air.DEFRA.gov.uk/library/no2ten/2019-no2-projections-from-2017-data
[32] The Air Quality Standards Regulations 2010: http://www.legislation.gov.uk/uksi/2010/1001/contents/made

5. Potential Impacts

5.1. Construction Phase 1

5.1.1. Construction Dust

The planned construction period will last approximately 50 weeks and given the close proximity of some receptors to the proposed scheme, an assessment of construction dust emissions has been undertaken.

In accordance with IAQM Construction Dust Guidance[4], an initial screening assessment was carried out using Ordnance Survey [33] base mapping and DEFRA's mapping website "Magic"**Error! Bookmark not defined.** to determine the location and number of sensitive receptors within relevant distances of the Proposed Scheme. Approximately 346 human health receptors are located within a buffer of 350 metres around the site (and within 200 metres of routes to be used by construction vehicles), while no ecological sites were identified within 50 metres of either the site boundary or the routes likely to be used by construction vehicles). The site boundary, site compound, buffers and sensitive human health receptors are shown in Figure 3 - Construction Dust Assessment.

Table 7 shows the assumed dust emission magnitude for each construction activity. Earthworks were classed as "medium", considering the area of the Proposed Scheme is less than 2,500 m^2 and material moved is less than 20,000 tonnes. Demolition activities will involve a total building volume of less than 20,000 m^3, with potentially dusty materials involved and a "large" dust emission magnitude is assigned. Construction activities are categorised as "medium" due to a total building volume of less than 25,000 m^3 using potentially dusty construction materials for road building. Estimates of vehicle movements for the construction of the Proposed Scheme are not available at this stage, therefore a conservative assumption of between 10 to 50 HGV outward movements per day with very little unpaved road accessing the site compound to provide a "medium" emission magnitude for trackout.

Table 7 - Dust Emission Magnitude

Activity	Dust Emission Magnitude
Demolition	Large
Earthworks	Medium
Construction	Medium
Trackout	Medium

There are 27 high sensitivity receptors within 20 metres of the site boundary, and consequently the sensitivity of the surrounding area to dust soiling is high. As annual mean PM_{10} concentrations are below 24 µg/m^3 in the area (see Table 6**Error! Reference source not found.**), the sensitivity of the surrounding area to human health impacts is low. More than 10 sensitive receptors were identified within 50 metres of likely trackout routes and the sensitivity of the surrounding area to dust soiling and human health is low. The effect on ecological sites was scoped out given that there were no ecological receptors within the required distance for assessment.

The potential risk of dust soiling and human health impacts, given the dust emissions magnitudes and sensitivities described above, are summarised in Table 8Table 8.

Table 8 - Summary of Expected Dust Risk

Sensitivity of Surrounding Area		Summary of Dust Risk			
		Earthworks	Construction	Demolition	Trackout
Dust Soiling	High	Medium	Medium	High	Low
Human Health	Low	Low	Low	Medium	Low

[33] https://www.ordnancesurvey.co.uk/opendatadownload/products.html

5.1.2. Construction Traffic

An estimate of between 10 and 50 outward HDV movements per day has been identified for the proposed scheme. This would equate to between 20 and100 HDV movements on the traffic network during the 50 week construction period for the Proposed Scheme. Although this might exceed the assessment threshold within an AQMA of more than 25 HDV movements no data is currently available regarding the likely route of the vehicles. Baseline data reported in section 4 indicated that current air quality in the vicinity of Arle Court roundabout is below the AQS objectives, however exceedances are recorded in the PCM modelling near to the A40 between Arle Court and Princess Elizabeth Way. It is recommended that a preferred route should be prepared to identify routes for supplier and contractor vehicles accessing the site, avoiding sensitive sections of the road network. It is acknowledged that changes as a result of construction traffic are temporary, will vary during the construction period and will revert to normal operation when the scheme is completed.

5.2. Operational Phase 1

5.2.1. Nitrogen Dioxide

Total annual mean NO_2 concentrations and changes in concentrations of NO_2 at modelled receptors in 2021 are presented in Table 9.

The results indicate that annual mean NO_2 concentrations are expected to be well below the AQS objective of 40 µg/m^3 at all modelled sensitive receptor locations in 2021, either without or with the Proposed Scheme. The highest modelled annual mean NO_2 concentration at a sensitive receptor location was 30.3 µg/m^3 at receptor R10, with the Proposed Scheme in place. This receptor is located on the Keltruck site west of Arle Court roundabout.

The Proposed Scheme is expected to result in changes in annual mean NO_2 concentrations of negligible impact at all sensitive receptor locations, except R10 where there is expected to be a slight deterioration as a result of an expected increase in traffic flow and a decrease in traffic speed on the closest link as a result of the scheme.
As estimated annual mean NO_2 concentrations do not exceed 60 µg/m^3 at any receptor, it is unlikely that the 1-hour mean AQS objective would be exceeded.

Table 9 - Annual Mean NO_2 Concentrations (µg/m^3) and Impact

Receptor ID	2021 Without	2021 With	Change	Impact of Change
R1	17.2	17.3	+0.1	Negligible
R2	18	17.9	+0.1	Negligible
R3	15.4	15.5	+0.1	Negligible
R4	19.3	19.4	+0.1	Negligible
R5	18.4	18.4	<0.1	Negligible
R6	15.5	15.4	-0.1	Negligible
R7	27.9	28	+0.1	Negligible
R8	15.8	15.8	<0.1	Negligible
R9	24.5	24.2	-0.3	Negligible
R10	29.4	30.3	+0.9	Slight
R11	18.8	18.8	<0.1	Negligible
R12	17.3	17.4	+0.1	Negligible
R13	21.9	21.2	-0.7	Negligible
R14	20.6	20.7	+0.1	Negligible
R15	27.7	27.1	-0.6	Negligible
R16	18.3	18.4	+0.1	Negligible

R17	22.8	22.5	-0.3	Negligible
R18	21.1	20.9	-0.2	Negligible
R19	24.5	24.2	-0.3	Negligible
R20	26.2	26	-0.2	Negligible
R21	17.9	17.7	-0.2	Negligible
R22	18.6	18.8	+0.2	Negligible
R23	21.9	22	+0.1	Negligible
R24	20.4	20.6	+0.2	Negligible
R25	15.4	15.3	-0.1	Negligible
R26	23.7	23.5	-0.2	Negligible
R27	25.3	25.2	-0.1	Negligible
R28	23.1	23.3	+0.2	Negligible
R29	19.9	20	+0.1	Negligible
R30	18.5	18.7	+0.2	Negligible

EU Compliance

Total annual mean NO_2 concentrations and changes in concentrations of NO_2 at roadside locations representative of PCM roadside concentrations in 2021 are presented in Table 10. These receptors are located 4 metres away from the kerbside and represent predicted roadside exceedances of the EU limit value within DEFRA's PCM model in 2017.

The results indicate that annual mean NO_2 concentrations are expected to be well below the EU limit value of 40 µg/m^3 at all modelled locations in 2021, either without or with the Proposed Scheme. The highest modelled annual mean NO_2 concentration is 34.2 µg/m^3 at receptor PCM1, with the Proposed Scheme in place.

The Proposed Scheme is expected to result in moderate improvements at receptors PCM1 and PCM2, slight improvement in annual mean NO_2 concentrations at receptors PCM3 and PCM4, and a negligible change for receptors PCM5 and PCM6. Improvements in concentration are expected to occur, despite a predicted increase in LDV flows of between 700 and 1000 vehicles per day because average traffic speeds are expected to increase from 20 kph to 33 kph on links adjacent to PCM1 and PCM2 and 32 kph to 45 kph adjacent to PCM3 and PCM4. This reflects a reduction in congestion, reducing emissions from vehicles such that at these locations, close to the road edge, an improvement in local air quality is expected.

Table 10- Annual Mean NO_2 Concentrations (µg/m^3) and Impact at PCM roadside locations

Receptor ID	2021 Without	2021 With	Change	Impact of Change
PCM1	36.8	34.2	-2.6	Moderate
PCM2	36.9	32.4	-4.5	Moderate
PCM3	33.3	31.8	-1.5	Slight
PCM4	33.1	31.1	-2	Slight
PCM5	28.6	27.6	-1	Negligible
PCM6	29.9	28.4	-1.5	Negligible

5.2.2. Particulate Matter (PM_{10})

Total annual mean PM_{10} concentrations, the number of exceedances of the daily mean standard (in brackets) and changes in concentrations of PM_{10} for selected receptors are presented in Table 11.

The results indicate that total annual mean concentrations of PM_{10} are expected to be well below the AQS objective of 40 µg/m^3 at all receptors, either with or without the Proposed Scheme in place. Likewise, no exceedances of the daily mean AQS objective (50 µg/m^3, not to be exceeded more than 35 times a year) are expected to occur at any receptor. The Proposed Scheme is expected to result in negligible changes in annual mean PM_{10} concentrations at all modelled receptor locations compared to the scenario without the Proposed Scheme.

Table 11 - Annual Mean PM_{10} Concentrations (µg/m^3) and Impact

Receptor ID	2021 Without	2021 With	Change	Impact of Change
R1	14 (0)	14 (0)	<0.1 (<1)	Negligible
R2	14.1 (0)	14.1 (0)	<0.1 (<1)	Negligible
R3	13.8 (0)	13.9 (0)	+0.1 (<1)	Negligible
R4	14.8 (1)	14.8 (1)	<0.1 (<1)	Negligible
R5	14.5 (0)	14.6 (0)	+0.1 (<1)	Negligible
R6	13.7 (0)	13.7 (0)	<0.1 (<1)	Negligible
R7	15.9 (1)	16.1 (1)	+0.2 (<1)	Negligible
R8	13.8 (0)	13.8 (0)	<0.1 (<1)	Negligible
R9	15.5 (1)	15.6 (1)	+0.1 (<1)	Negligible
R10	16.2 (1)	16.3 (1)	+0.1 (<1)	Negligible
R11	14.4 (0)	14.4 (0)	<0.1 (<1)	Negligible
R12	13.6 (0)	13.6 (0)	<0.1 (<1)	Negligible
R13	14.7 (0)	14.7 (0)	<0.1 (<1)	Negligible
R14	14.7 (0)	14.8 (1)	+0.1 (+1)	Negligible
R15	15.7 (1)	15.8 (1)	+0.1 (<1)	Negligible
R16	14.3 (0)	14.3 (0)	<0.1 (<1)	Negligible
R17	15.4 (1)	15.4 (1)	<0.1 (<1)	Negligible
R18	14.3 (0)	14.3 (0)	<0.1 (<1)	Negligible
R19	14.8 (1)	14.8 (1)	<0.1 (<1)	Negligible
R20	15.5 (1)	15.5 (1)	<0.1 (<1)	Negligible
R21	14.2 (0)	14.2 (0)	<0.1 (<1)	Negligible
R22	14.3 (0)	14.4 (0)	+0.1 (<1)	Negligible
R23	15.1 (1)	15.1 (1)	<0.1 (<1)	Negligible
R24	14.2 (0)	14.2 (0)	<0.1 (<1)	Negligible
R25	13.8 (0)	13.8 (0)	<0.1 (<1)	Negligible
R26	15 (1)	15 (1)	<0.1 (<1)	Negligible
R27	15 (1)	15 (1)	<0.1 (<1)	Negligible
R28	15.2 (1)	15.3 (1)	+0.1 (<1)	Negligible
R29	14.5 (0)	14.5 (0)	<0.1 (<1)	Negligible
R30	14 (0)	14 (0)	<0.1 (<1)	Negligible

5.2.3. Particulate Matter ($PM_{2.5}$)

Total annual mean $PM_{2.5}$ concentrations and changes in concentrations of $PM_{2.5}$ for selected receptors are presented in Table 12.

The results indicate that total annual mean concentrations of $PM_{2.5}$ are modelled to be well within the AQS objective of 25 µg/m^3 at all selected receptors, either with or without the Proposed Scheme in place. Furthermore, impacts on annual mean $PM_{2.5}$ concentrations as a result of the Proposed Scheme can be described as negligible at all receptor locations.

Table 12 - Annual Mean $PM_{2.5}$ Concentrations (µg/m^3) and Impact

Receptor ID	2021 Without	2021 With	Change	Impact of Change
R1	9	9	<0.1	Negligible
R2	9.1	9.1	<0.1	Negligible
R3	8.9	8.9	<0.1	Negligible
R4	9.2	9.2	<0.1	Negligible
R5	9.3	9.3	<0.1	Negligible
R6	9.1	9.1	<0.1	Negligible
R7	10.4	10.5	+0.1	Negligible
R8	9.2	9.2	<0.1	Negligible
R9	10.2	10.2	<0.1	Negligible
R10	10.6	10.7	+0.1	Negligible
R11	9.5	9.6	+0.1	Negligible
R12	9.1	9.2	+0.1	Negligible
R13	9.7	9.7	<0.1	Negligible
R14	9.7	9.7	<0.1	Negligible
R15	10.3	10.3	<0.1	Negligible
R16	9.5	9.5	<0.1	Negligible
R17	9.8	9.8	<0.1	Negligible
R18	9.8	9.8	<0.1	Negligible
R19	9.9	9.9	<0.1	Negligible
R20	10.3	10.4	+0.1	Negligible
R21	9.6	9.6	<0.1	Negligible
R22	9.7	9.7	<0.1	Negligible
R23	10.2	10.2	<0.1	Negligible
R24	9.7	9.7	<0.1	Negligible
R25	9.3	9.3	<0.1	Negligible
R26	10.1	10.1	<0.1	Negligible
R27	10.1	10.1	<0.1	Negligible
R28	10.3	10.3	<0.1	Negligible
R29	9.8	9.8	<0.1	Negligible
R30	9.6	9.6	<0.1	Negligible

6. Mitigation

6.1. Construction Phase

6.1.1. Construction dust

Construction works associated with the Proposed Scheme have the potential to generate dust emissions, which will require effective control/minimisation for the duration of the construction project through a Construction Environmental Management Plan (CEMP) or similar. The dust risk was assessed as high during demolition works, medium during earthworks and construction and low during trackout works.

Selected mitigation measures given in the IAQM Dust Guidance[4] which are applicable to a high risk construction site, such as this, are described below. Suggested measures from the Guidance include:

- Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible;
- Erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site;
- Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period;
- Avoid site runoff of water or mud;
- Keep site fencing, barriers and scaffolding clean using wet methods;
- Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover, seed or fence stockpiles to prevent wind whipping;
- Ensure all vehicles switch off engines when stationary – no idling vehicles;
- Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable;
- Impose and signpost a maximum speed limit of 15 mph on surfaced and 10 mph on unsurfaced haul roads and work areas;
- Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials;
- Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing);
- Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems;
- Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigations, using non-potable water where possible and appropriate;
- Use enclosed chutes and conveyors and covered skips;
- Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate;
- Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods;
- Soft strip inside the buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust);
- Ensure effective water suppression is used during demolition operations. Hand held sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground;
- Avoid explosive blasting, using appropriate manual or mechanical alternatives;
- Bag and remove any biological debris or damp down such material before demolition.
- Stakeholder communication is recommended, with community engagement both before and during work on site and the clear display of contact details for those responsible for dust issues

on site. Any complaints and exceptional incidents should be logged along with the appropriate measures taken to reduce emissions.

- Daily site management of emission control measures should be undertaken, with visual inspections of activities and control measures carried out especially during dry conditions. This should include recording of activities, controls, weather (wind direction, precipitation) and ground conditions, and observations of surface dust deposits at and beyond the site boundary near sensitive receptors.
- Hold regular liaison meetings with other high risk construction sites within 500 metres of the site boundary, to ensure plans are co-ordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/ deliveries which might be using the same strategic road network routes.

'Dust mitigation measures to be undertaken on site will be confirmed prior to construction through discussions between the contractor and Cheltenham Borough Council Environmental Health Officers.

6.1.2. Construction traffic

It is acknowledged that changes as a result of construction traffic are temporary, will vary during the construction period and will revert to normal operation when the scheme is completed. A preferred route for supplier and contractor vehicles accessing the site, avoiding sensitive sections of the road network will be agreed by the contractor to minimise effects.

With appropriate mitigation measures in place, any adverse effects resulting from the construction works should be minimised such that there is no significant residual effect on nearby receptors.

6.2. Operational Phase

The air quality assessment indicates that the Proposed Scheme would not result in any new exceedances of AQS objectives or worsening of existing exceedances. No additional air quality mitigation for the operational phase of the Proposed Scheme is therefore required.

7. Conclusions

This air quality assessment included a review of existing air quality conditions, a qualitative assessment of construction dust emissions, and dispersion modelling to estimate the impacts and potential for significant effects due to the operation of the Proposed Scheme.

Construction Dust Assessment

The construction phase of the Proposed Scheme has the potential to generate dust and PM_{10} emissions, which may have a short term adverse impact for dust soiling and nearby human health receptors. With appropriate mitigation measures in place however, these works should not result in a significant residual adverse effect at these receptors. The construction traffic has the potential to affect local air quality, given that traffic flows may exceed 25 HDV movements a day. A management plan for construction traffic would prevent vehicles accessing sensitive roads within the CBC AQMA. Mitigation measures for construction dust should be secured within a Dust Management Plan for the site.

Operational Assessment

The local air quality assessment for the operation of the Proposed Scheme was carried out using detailed dispersion modelling. Annual mean NO_2, PM_{10} and $PM_{2.5}$ concentrations were estimated at sensitive receptor locations in the vicinity of roads likely to be affected by changes in road traffic movements. Estimated concentrations of all pollutants were shown to be below relevant AQS objectives at all receptors with and without the Proposed Scheme. Impacts on NO_2, PM_{10} and $PM_{2.5}$ concentrations as a result of the operation of the Proposed Scheme are expected to be negligible at all but one modelled human health receptors, which was estimated to record a slight increase in annual mean NO_2 concentrations with the scheme in place.

The effect of the Proposed Scheme on air quality at existing human health receptors due to the operation of the Proposed Scheme is therefore considered to be **not significant**.

There are not expected to be any DEFRA PCM links that exceed the EU limit value in the air quality study area either with or without the Proposed Scheme in the opening year of 2021. The compliance assessment demonstrated that annual mean NO_2 concentrations would decrease at receptors near to the PCM links with the Proposed Scheme. The Proposed Scheme is therefore not expected to result in a risk to compliance with the EU Air Quality Directive.

Figure 1 - Air Quality Constraints

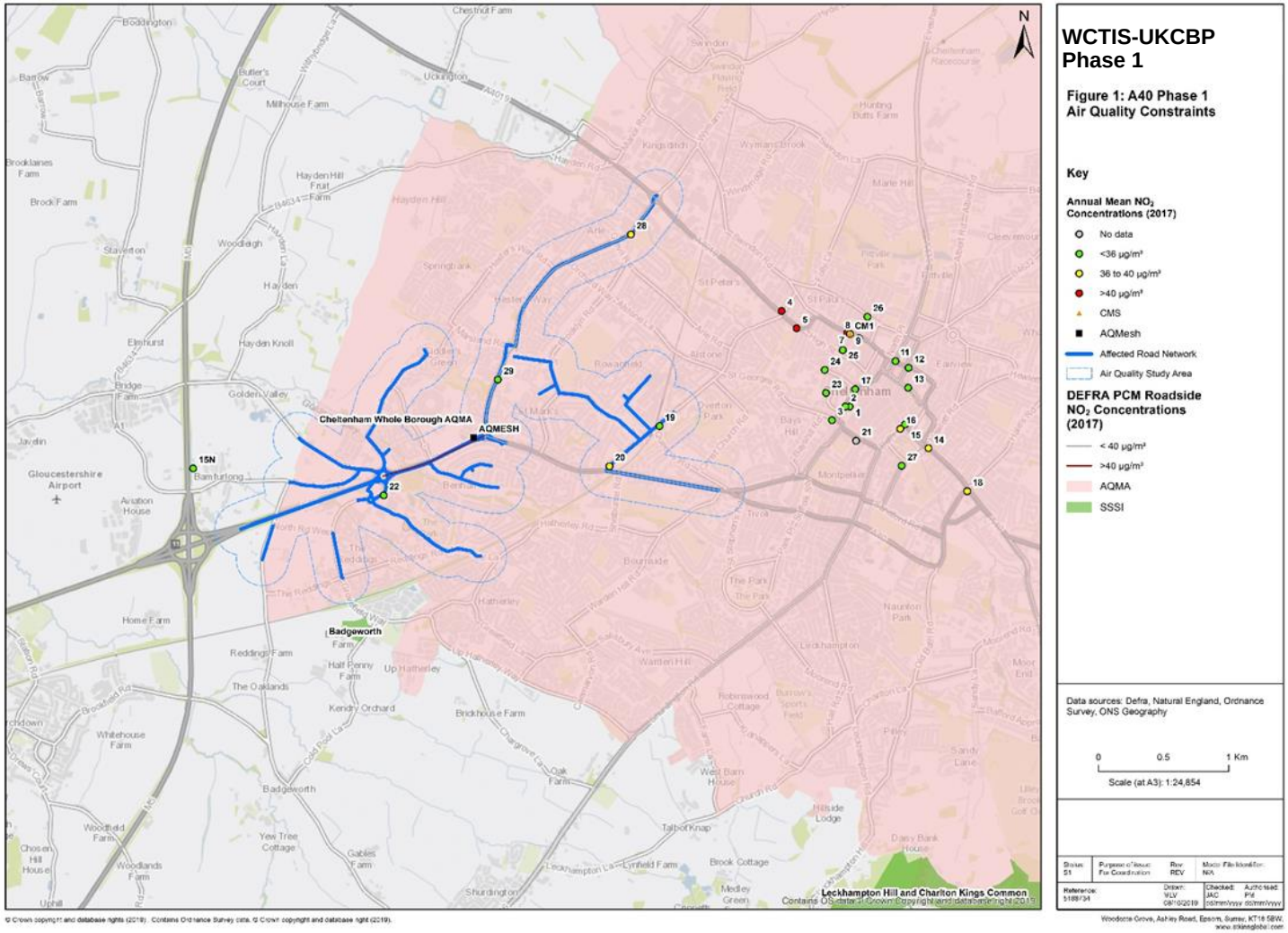


Figure 2 - Air Quality Sensitive Receptors

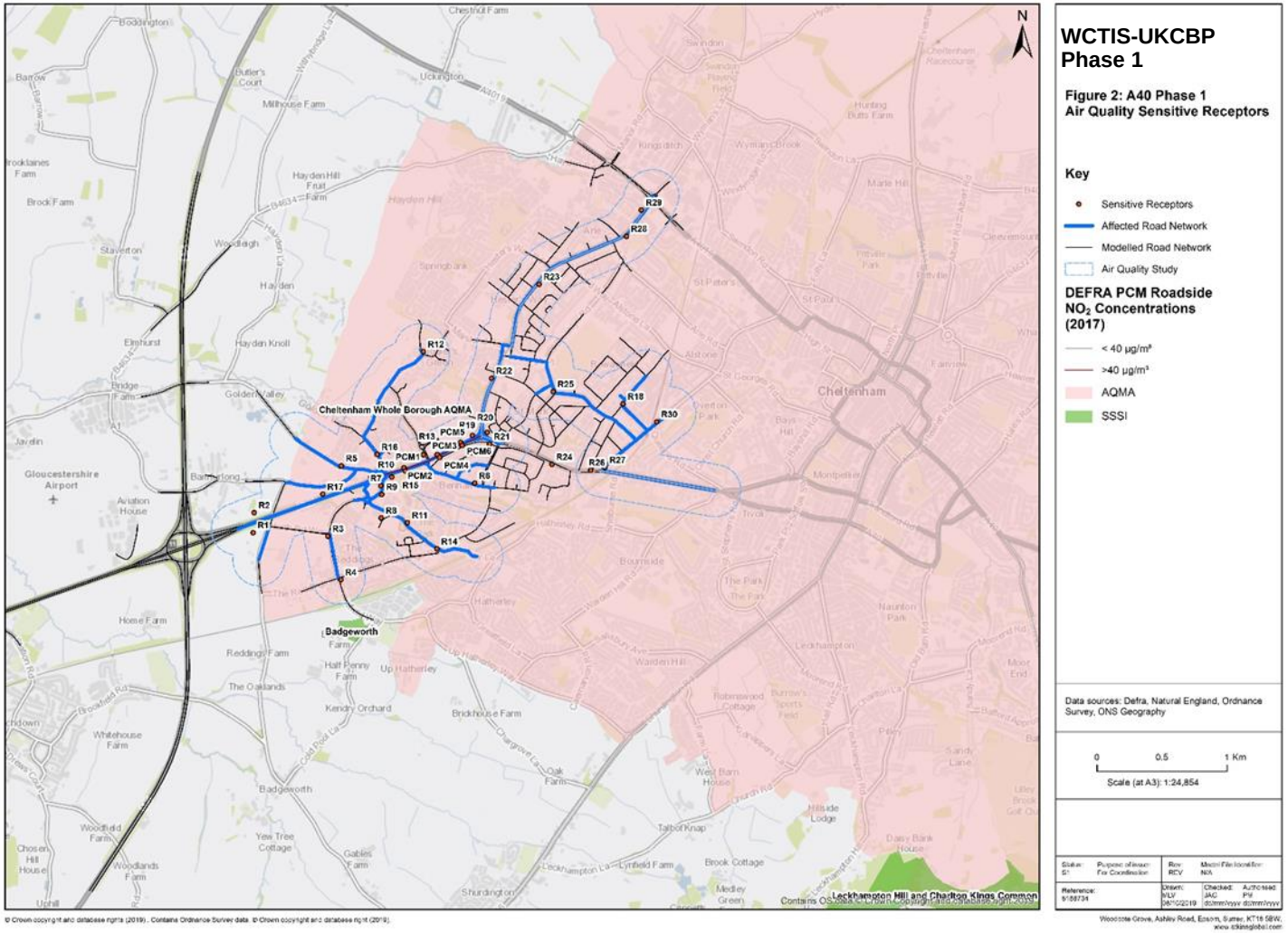
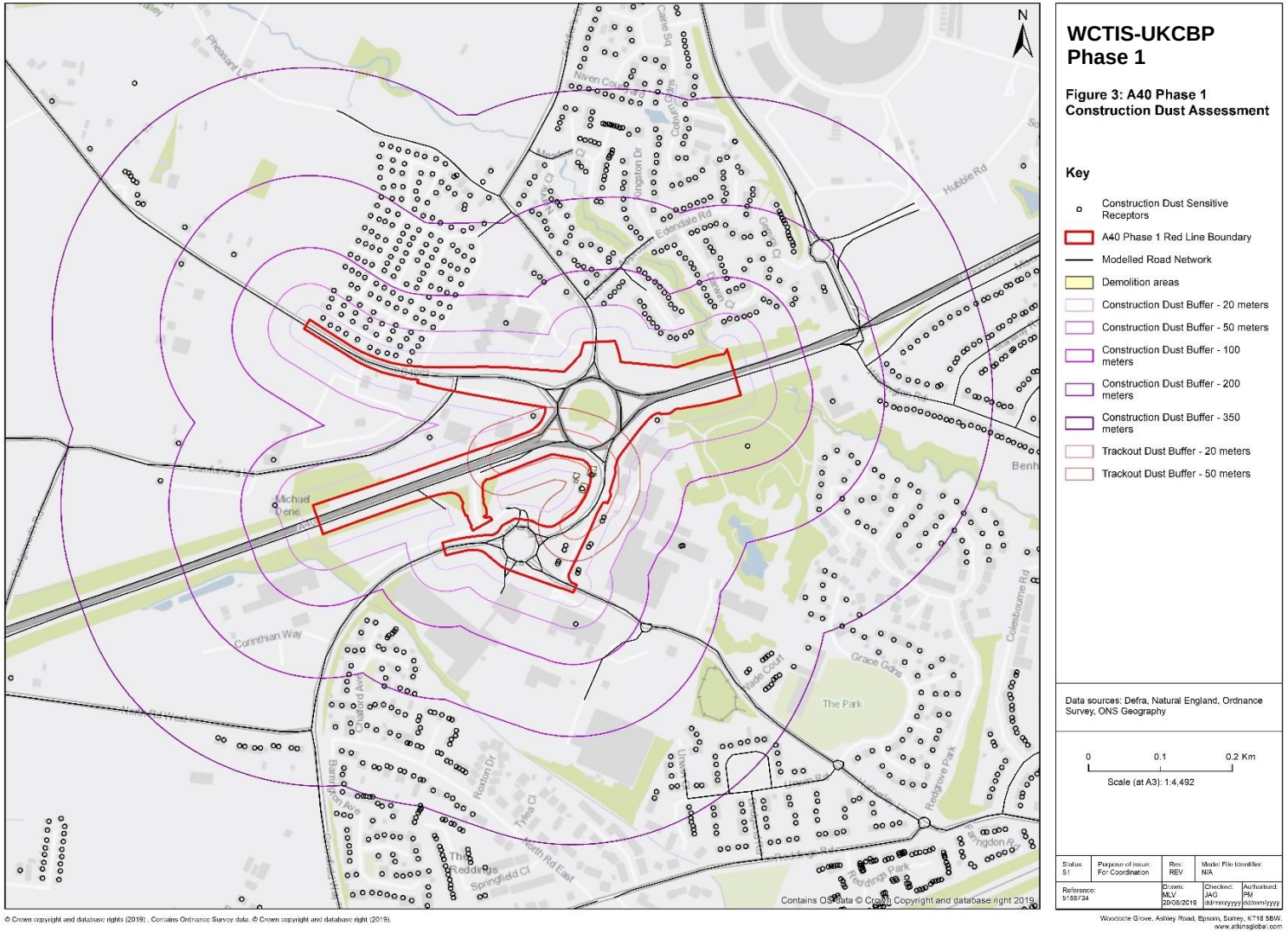


Figure 3 - Construction Dust Assessment



Appendices

Appendix A. Construction Dust Methodology

Assessment of the potential impact of the construction phase of the Proposed Scheme on air quality with regards dust and PM_{10} emissions has been carried out with reference to the four-step process described in the IAQM Dust Guidance. These steps are summarised below:

- Step 1 (screening) – Identification of the number of human receptors within 350 metres of the boundary of the Site and/or within 50 metres of the route(s) used by construction vehicles on the public highway up to 50 metres from the Site entrance. Ecological receptors should also be identified within 50 metres of either the boundary of the Site and/or of the route(s) used by construction vehicles on the public highway up to 50 metres from the Site entrance. No further assessment is required if there are no receptors.

  'Human' receptors include residential dwellings and other premises that may have a particular sensitivity to dust deposition or to the health effects of PM_{10} e.g. vehicle showrooms, museums, long-term car parks, hospitals, schools and residential care homes. 'Ecological' receptors include sites with statutory designations e.g. Ramsar sites, Special Protection Areas (SPA), Special Areas of Conservation (SAC) and Sites of Special Scientific Interest (SSSI), as well as non-statutory sites such as local wildlife sites and/or locations with very specific ecological sensitivities e.g. horticultural operations.
- Step 2 – Assessment of the risk of dust effects by considering the area around the Site in the context of potential dust impacts and distances to nearby receptors in relation to proposed activities in terms of demolition, earthworks, construction, and trackout. Trackout can be defined as the deposition of dust and dirt from a construction site onto a public road network where it may then be re-suspended in the air by vehicles using the road network.

  Dust emission magnitude classes of 'large', 'medium' and 'small' are used to define the level of risk arising from each activity depending on the nature and scale of operation.

  The sensitivity of the area is defined as 'high', 'medium' or 'low' for dust soiling effects, human health impacts, and ecological impacts separately, considering the sensitivity of receptors, distance and number of receptors from dust generating activities, and other site specific factors (defined in the IAQM Dust Guidance). In addition, for the effect on human health, background PM_{10} concentrations are considered. The definitions are provided in Tables 2, 3 and 4 of the IAQM Dust Guidance[4].
- Step 3 – Site specific mitigation in terms of the identified risks is identified.
- Step 4 – Assessment of the significance of the residual dust risk, after the application of the site specific mitigation.

Tables 6 to 9 of the IAQM Dust Guidance are used to define the risk of impact based on the dust emission magnitude and sensitivity of area. These are reproduced in Table 13 to Table 15 below.

Table 13 - Air Quality: Risk of Dust Impacts - Demolition

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Medium Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible

Table 14 - Air Quality: Risk of Dust Impacts – Earthworks and Construction

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Table 15 - Air Quality: Risk of Dust Impacts - Trackout

Sensitivity of Area	Dust Emission Magnitude		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

Appendix B. Traffic Data and Diurnal Emissions Profile Phase 1

Traffic data below represents the modelled traffic data. To determine the affected road network directional flows on motorways and dual carriageways were combined to determine the overall change in traffic near to sensitive receptors, however they were modelled as each way flows.

Table 16 – Summary of Modelled Traffic Data

Link Reference	Road Name	Base 2017		Without the Proposed Scheme 2021		With the Proposed Scheme 2021		AADT Change	HGV Change
		AADT	HGV%	AADT	HGV%	AADT	HGV%		
621_325	M5	21356	5	23361	6	23358	6	-3	-4
621_326	M5	29558	5	31214	5	31211	5	-2	-3
622_329	M5	22583	6	23691	6	23799	6	108	6
580_327	M5	31047	5	32532	5	32929	5	397	10
581_326	M5	29584	5	31212	5	31209	5	-3	-1
582_580	M5	31105	5	32577	5	32961	5	384	10
583_581	M5	29616	5	31190	5	31190	5	0	-1
585_582	M5	31130	5	32602	5	32978	5	376	10
586_583	M5	29637	5	31165	5	31167	5	2	-3
622_327	M5	31029	5	32524	5	32899	5	374	9
2190_586	M5	29651	5	31141	5	31150	5	8	-1
1818_621	M5	8202	5	7860	3	7866	3	6	0
1814_1485	M5	8445	3	8837	3	9079	3	241	3
1818_1481	M5	8204	5	7861	3	7871	3	10	0
1813_266	M5	6148	4	6465	4	6575	4	110	9
2191_585	M5	31200	5	32639	5	33051	5	413	13
1815_1814	M5	8444	3	8840	3	9084	3	244	3
1481_264	M5	8214	5	7871	3	7877	3	5	-1

1817_269	M5	8446	3	8838	3	9077	3	239	3
1817_1485	M5	8445	3	8837	3	9078	3	241	3
341_325	M5	21369	5	23360	6	23372	6	12	-4
335_329	M5	22562	6	23656	6	23771	6	115	4
594_337	M5	28755	6	30155	5	30326	5	171	13
595_338	M5	28172	5	29606	5	29688	5	81	-1
2243_1821	M5	6780	6	6179	3	6272	3	93	3
1821_265	M5	6781	6	6179	3	6272	3	93	4
335_272	M5	6184	4	6484	4	6559	4	76	8
341_338	M5	28165	5	29565	5	29653	5	89	1
337_335	M5	28755	6	30127	5	30327	5	199	12
2242_340	M5	6780	6	6186	3	6275	3	89	4
2243_2242	M5	6777	6	6182	3	6274	3	92	3
1813_272	M5	6169	4	6470	4	6559	4	90	7
596_594	M5	28751	6	30148	5	30315	5	167	12
597_595	M5	28204	5	29617	5	29705	5	88	-3
598_596	M5	28724	6	30140	5	30300	5	160	5
599_597	M5	28247	5	29649	5	29712	5	63	-6
600_598	M5	28671	6	30175	5	30242	5	68	-2
601_599	M5	28251	5	29644	5	29735	5	91	-5
603_600	M5	28641	6	30169	5	30207	5	38	-1
604_601	M5	28260	5	29649	5	29763	5	114	-5
1822_340	M5	6781	6	6185	3	6271	3	85	3
1907_200	B4063	7014	3	7273	3	7446	3	173	4
207_200	B4063	6952	3	7199	3	7437	3	238	6
207_206	B4063	6931	3	7146	3	7436	3	290	8
215_206	Minor Road	4123	2	4178	2	4583	2	405	5
218_215	Minor Road	4096	2	4193	2	4589	2	395	5
218_216	Minor Road	4110	2	4225	2	4594	2	368	5

223_216	Minor Road	4133	2	4264	2	4596	2	332	5
1947_223	Minor Road	4177	2	4342	1	4602	1	260	4
225_224	Minor Road	4212	2	4396	1	4608	1	211	3
226_225	Minor Road	4224	2	4414	1	4610	1	196	3
227_222	Minor Road	2462	1	2551	1	2717	1	166	6
227_226	Minor Road	4237	2	4432	1	4611	1	179	3
1946_228	Minor Road	5509	1	5754	1	5997	1	243	2
235_228	A40(T)	5543	1	5800	1	5996	1	197	2
236_235	Minor Road	5425	1	5699	1	5843	1	144	0
1667_236	Minor Road	5454	1	5716	1	5847	1	131	1
267_266	Minor Road	14502	3	14679	3	14818	3	139	10
268_267	A40(T)	4786	4	5048	4	5128	4	79	7
269_268	Minor Road	14659	3	15349	3	15745	3	396	10
264_263	Minor Road	14426	4	14383	3	14541	3	158	3
263_262	A40(T)	9967	4	9689	2	9780	2	91	-1
1816_267	A40(T)	9675	3	9610	3	9691	3	81	4
279_222	Minor Road	2463	1	2555	1	2714	1	159	6
285_274	A40(T)	22576	2	23659	2	24245	2	585	34
1806_274	A40(T)	22575	2	23662	2	24246	2	585	34
290_288	A40(T)	10225	1	11184	2	11220	2	36	1
290_273	A40(T)	19769	2	20750	2	20903	2	153	6
339_266	Minor Road	8362	3	8217	3	8241	2	24	0
347_285	Minor Road	22571	2	23664	2	24240	2	576	34
1776_345	A40(T)	19406	2	20551	2	20871	2	320	10
1805_349	A40(T)	22572	2	23663	2	24241	2	578	34
564_563	B4063	25859	2	27283	2	28230	2	947	36
571_568	Minor Road	18338	1	19478	1	20009	2	530	52
563_439	Minor Road	23208	2	24502	2	25329	3	827	35
562_351	Minor Road	28441	2	29965	2	30602	2	637	-29

563_368	Minor Road	2644	1	2782	1	2893	1	111	1
360_359	Minor Road	1680	2	1648	2	1855	2	206	1
361_360	Minor Road	1694	2	1683	2	1861	2	178	1
369_359	Minor Road	3587	1	3580	1	3956	1	375	3
369_366	Minor Road	3613	1	3643	1	3966	1	322	2
367_366	Minor Road	3396	1	3431	1	3723	1	292	3
370_366	Minor Road	557	3	561	2	598	2	37	0
364_361	Minor Road	536	2	529	2	596	2	66	1
374_367	Minor Road	1025	2	1059	2	1119	2	60	0
374_372	Minor Road	1031	2	1074	2	1119	2	45	0
373_372	Minor Road	1039	2	1094	2	1120	2	27	0
375_373	Minor Road	1047	2	1106	2	1121	2	15	0
380_367	Minor Road	2992	1	3024	1	3290	1	266	4
381_380	Minor Road	598	2	611	0	636	0	25	0
383_381	Minor Road	600	2	618	0	636	0	18	0
386_380	Minor Road	2844	1	2878	1	3124	1	246	4
392_386	Minor Road	2851	1	2895	1	3124	1	228	4
392_388	Minor Road	2854	1	2910	1	3124	1	214	4
2041_388	Minor Road	2860	1	2919	1	3126	1	207	4
2156_396	Minor Road	2984	1	3154	1	3176	1	22	-1
404_396	Minor Road	2984	1	3153	1	3175	1	22	-1
418_397	Minor Road	2108	1	2252	1	2250	1	-2	0
419_393	Minor Road	899	2	939	2	953	2	13	2
422_419	Minor Road	898	2	940	2	953	2	13	2
390_389	Minor Road	6356	1	6624	1	6814	1	191	2
391_390	Minor Road	6362	1	6626	1	6810	1	184	2
1700_439	Minor Road	24650	2	25793	2	26950	2	1158	39
2153_437	A40	17707	3	18571	3	19184	3	613	34
455_351	Minor Road	18347	2	19114	3	19607	2	493	-31

458_453	A40	19675	2	20555	2	20919	2	364	12
469_468	Minor Road	26	0	34	15	32	16	-2	0
470_469	Minor Road	24	0	10	0	5	0	-5	0
474_470	Minor Road	2368	2	2229	2	2509	2	280	10
504_475	Minor Road	970	3	0	0	0	0	0	0
474_453	Minor Road	1388	2	1229	2	1438	2	209	1
471_470	Minor Road	2384	2	2229	2	2510	2	281	10
476_471	Minor Road	2426	2	2220	2	2509	2	289	5
477_476	Minor Road	163	9	104	10	72	14	-32	0
478_477	Minor Road	182	8	102	11	95	12	-6	0
479_476	Minor Road	2352	2	2195	2	2474	2	279	-1
480_478	Minor Road	196	5	120	9	117	9	-2	0
482_480	Minor Road	126	8	128	12	121	17	-7	5
483_482	Minor Road	126	8	132	11	129	15	-3	5
481_480	Minor Road	226	5	168	7	207	11	39	10
487_481	Minor Road	1781	2	1643	2	1805	2	163	5
487_486	Minor Road	1788	2	1665	2	1808	2	143	6
488_481	Minor Road	1672	2	1387	2	1688	2	301	3
488_479	Minor Road	1643	2	1366	2	1671	2	305	3
489_479	Minor Road	2137	2	2132	2	2272	1	140	-5
491_489	Minor Road	2164	2	2175	2	2277	1	102	-5
493_492	Minor Road	640	2	623	2	629	2	6	0
495_491	Minor Road	660	3	698	4	703	4	5	2
492_491	Minor Road	2808	2	2852	1	2965	2	113	7
496_492	Minor Road	3255	1	3266	1	3393	1	127	6
495_486	Minor Road	660	3	696	4	704	4	8	2
486_483	Minor Road	1216	2	1141	2	1238	2	98	2
494_493	Minor Road	641	2	623	2	629	2	6	0
494_486	Minor Road	1339	2	1358	2	1378	3	20	11

1461_502	Minor Road	1579	1	1617	2	1578	2	-39	-1
502_483	Minor Road	325	6	309	6	310	10	1	10
483_459	Minor Road	1383	2	1291	2	1391	2	100	2
502_460	Minor Road	1796	1	1843	2	1779	2	-65	-2
504_474	Minor Road	971	3	1003	2	1068	3	65	10
512_453	A40	18357	2	19242	2	19367	2	125	5
468_466	Minor Road	26	0	34	15	32	16	-2	0
466_463	Minor Road	26	0	34	15	32	16	-2	0
463_462	Minor Road	26	0	34	15	32	16	-2	0
462_461	Minor Road	26	0	34	15	32	16	-2	0
461_459	Minor Road	26	0	34	15	32	16	-2	0
460_459	Minor Road	53	19	42	0	54	9	12	5
517_460	Minor Road	1792	1	1843	2	1774	2	-69	-1
521_459	Minor Road	1382	2	1283	2	1389	2	106	2
533_529	A40	19745	3	20449	3	20485	3	36	11
530_517	A40	1792	1	1844	2	1775	2	-69	-1
523_460	Minor Road	37	27	29	0	37	14	7	5
524_523	Minor Road	37	27	29	0	37	14	7	5
525_524	Minor Road	37	27	29	0	37	14	7	5
537_530	Minor Road	8542	3	8776	4	8441	4	-335	-11
533_530	A40	10334	3	10630	3	10215	3	-415	-13
552_544	A4013	18149	3	19155	3	19761	3	606	37
549_545	A40	18610	3	19332	3	19275	3	-57	0
542_539	A40	14413	3	15113	3	15789	3	676	39
551_542	A40	16233	3	16872	3	17626	3	754	39
544_543	A40	9415	3	9813	3	10292	3	480	27
547_545	A40	9883	3	9994	3	9803	3	-191	-7
543_531	A40	9414	3	9806	3	10282	3	476	27
549_542	A40	1836	2	1766	2	1848	2	82	1

549_548	A40	16777	3	17558	3	17438	3	-120	-1
551_550	A4013	7518	3	7808	3	8071	3	263	5
552_538	A4013	9435	3	10088	2	10207	2	119	3
553_548	A40	16772	3	17532	3	17437	3	-95	1
555_539	A40	14400	3	15110	3	15804	3	694	37
556_555	A40	14397	3	15109	3	15812	3	704	39
558_553	A40	16754	3	17441	3	17437	3	-4	4
556_446	A40	14392	3	15139	3	15835	3	696	38
558_506	A40	16696	3	17349	3	17440	3	90	8
560_424	Minor Road	4647	1	4886	1	4945	1	59	2
561_401	Minor Road	3234	0	3449	0	3474	0	24	1
357_348	A40(T)	19223	2	20386	2	20860	2	474	9
562_211	A40(T)	22570	2	23740	2	24240	2	500	-51
349_211	A40(T)	22570	2	23659	2	24195	2	536	-9
2154_359	Minor Road	4145	1	4123	1	4544	1	421	1
564_209	B4063	4818	2	4815	2	5239	2	424	8
1908_206	B4063	8750	2	8951	2	9470	2	519	13
1916_571	Minor Road	8221	1	8610	1	9010	2	399	52
1925_574	Minor Road	7433	1	7932	1	8036	1	104	3
575_574	Minor Road	7440	1	7941	1	8037	1	96	1
576_575	Minor Road	7444	1	7950	1	8035	1	86	1
577_576	Minor Road	7455	1	7954	1	8038	1	84	1
577_235	Minor Road	1313	1	1374	1	1429	1	55	6
1928_577	Minor Road	7606	1	8074	1	8195	1	121	4
1665_579	Minor Road	1544	2	1644	2	1636	2	-8	-2
997_893	A4013	21600	3	22797	2	22993	2	196	3
894_876	A4019	11056	3	11533	2	11539	2	6	2
1687_908	A4019	9641	3	10156	3	10188	3	32	-1
1853_997	A4013	21602	3	22786	2	22970	2	184	4

1854_998	A4013	21615	3	22799	2	22967	2	168	4
2057_1005	A4013	19542	3	20661	3	20807	3	146	3
1851_1004	A4013	16470	3	17462	3	17626	3	165	7
1849_1845	A4013	16292	3	17292	3	17453	3	161	6
1008_1002	Minor Road	416	5	445	4	448	4	4	0
1009_1003	Minor Road	3986	4	4288	4	4297	4	9	1
2258_1694	A4013	17085	3	18133	3	18340	3	207	12
1011_1010	A4013	17177	3	18205	3	18400	3	195	9
2067_1012	A4013	17207	3	18227	3	18427	3	200	9
2257_1013	A4013	17096	3	18089	3	18327	3	239	9
1299_1013	Minor Road	442	7	466	6	462	5	-5	-4
2256_1013	A4013	16850	3	17815	3	18065	3	249	12
1018_1017	Minor Road	776	4	807	4	821	4	14	1
1671_1019	A4013	17304	3	18265	3	18530	3	265	13
1322_1019	Minor Road	1261	3	1293	3	1288	3	-5	2
1020_1019	A4013	17500	3	18472	3	18723	3	251	12
1024_1023	Minor Road	4536	1	4833	1	4797	1	-36	-2
1022_1020	Minor Road	10968	3	11638	3	11687	3	49	1
1026_1022	Minor Road	5275	2	5647	2	5492	2	-156	-9
1025_1023	Minor Road	9953	3	10404	2	10595	2	191	6
1025_1022	A4013	11081	3	11748	3	11656	3	-92	3
1668_1027	Minor Road	15764	3	16492	3	16846	3	354	9
1031_1027	A4013	965	3	1007	3	1019	3	11	-6
1029_1027	Minor Road	1115	4	1195	4	1206	4	11	2
1945_1030	A4013	16939	3	17880	3	18235	3	355	8
1037_1030	A4013	717	5	752	5	786	5	34	0
1543_1036	A4013	8252	3	8547	3	8835	3	288	6
1045_1035	A4013	4638	4	4790	4	4850	3	60	-4
1036_1035	A4013	1483	4	1538	4	1564	4	26	1

1077_1074	Minor Road	4254	2	4528	2	4521	2	-7	-5
1078_1077	Minor Road	2069	3	2185	3	2186	3	2	0
1079_1077	Minor Road	3024	2	3247	2	3244	2	-2	-6
2261_1010	A4013	3926	2	4236	1	4247	1	10	0
1117_1080	Minor Road	1689	5	1841	4	1838	5	-4	3
1100_1018	Minor Road	276	5	275	4	276	4	1	0
1109_1018	Minor Road	548	5	579	6	596	6	17	3
1109_1108	Minor Road	408	9	427	7	429	7	3	1
1110_1109	Minor Road	638	5	676	5	695	5	19	1
1111_1110	Minor Road	677	11	711	10	732	10	21	3
2263_1116	Minor Road	51	80	54	70	65	69	11	7
1116_1110	Minor Road	51	80	54	70	65	69	11	7
1108_1012	Minor Road	856	4	903	4	901	4	-2	0
1117_1090	Minor Road	1499	5	1629	5	1604	4	-25	-7
1117_1108	Minor Road	240	10	255	8	265	11	10	10
1118_1011	A4013	123	24	111	14	124	20	13	10
1119_1118	Minor Road	123	24	111	13	124	20	13	10
1119_1009	Minor Road	91	28	89	17	105	24	16	10
1132_1130	Minor Road	1359	2	1427	2	1434	2	6	-2
1132_1024	Minor Road	2563	2	2699	2	2710	1	11	-3
1134_1024	Minor Road	2077	2	2235	2	2207	2	-28	2
1143_1139	Minor Road	1695	2	1836	2	1820	1	-16	-7
1144_1143	Minor Road	283	5	282	4	291	4	9	1
1146_1143	Minor Road	1681	2	1805	2	1799	1	-6	-8
1147_1146	Minor Road	1118	1	1182	1	1199	1	17	0
1148_1147	Minor Road	353	0	383	0	377	0	-6	0
1152_1148	Minor Road	352	0	384	0	377	0	-7	0
1156_1146	Minor Road	2585	1	2747	1	2766	1	19	-9
1156_1149	Minor Road	2585	1	2746	1	2765	1	19	-9

1157_1149	Minor Road	5581	1	5823	1	5955	1	132	3
1158_1149	Minor Road	6362	1	6628	1	6808	1	181	3
1158_391	Minor Road	6360	1	6628	1	6809	1	180	2
1168_1157	Minor Road	2927	3	3063	2	3121	2	57	-1
2265_1168	Minor Road	2925	3	3063	2	3120	2	57	-1
1171_1169	Minor Road	2925	3	3064	2	3119	2	56	-1
1268_1005	A4013	6686	2	7019	2	7106	2	87	0
2260_1269	Minor Road	6694	2	7018	2	7098	2	80	-1
1271_1269	Minor Road	6698	2	7020	2	7098	2	79	-1
1272_1271	Minor Road	5576	3	5866	3	5934	3	68	1
1273_1271	Minor Road	1441	5	1486	5	1518	5	32	-1
1279_1268	Minor Road	6686	2	7017	2	7096	2	78	0
1281_1268	Minor Road	90	22	80	19	85	18	5	0
1282_1281	Minor Road	89	22	80	19	85	18	5	0
1283_1282	Minor Road	90	22	80	19	85	18	4	0
1288_1283	Minor Road	89	22	80	19	85	18	5	0
1288_1284	Minor Road	89	22	80	19	85	18	5	0
1284_1009	Minor Road	3999	4	4296	4	4307	4	11	1
1289_1284	Minor Road	4019	4	4307	4	4326	4	18	1
1290_1119	Minor Road	67	7	74	13	71	14	-3	0
2118_1290	Minor Road	71	0	87	17	76	7	-11	-10
1291_1289	Minor Road	4053	4	4340	4	4354	4	14	2
1299_1016	Minor Road	444	7	466	6	462	5	-4	-4
1300_1016	Minor Road	444	7	461	5	458	5	-3	2
1301_1016	Minor Road	94	11	101	10	89	0	-12	-10
1302_1301	Minor Road	94	11	101	10	90	0	-11	-10
1302_1297	Minor Road	94	11	101	10	90	0	-11	-10
1311_1300	Minor Road	123	12	134	11	142	7	8	-5
1305_1300	Minor Road	488	6	508	5	510	5	2	2

1306_1305	Minor Road	488	6	508	5	509	5	1	2
2115_1306	Minor Road	471	6	491	4	492	5	1	3
1317_1021	Minor Road	262	6	277	9	279	7	2	-5
1315_1306	Minor Road	70	14	64	8	76	13	12	5
1318_1315	Minor Road	70	14	64	8	76	13	11	5
1318_1317	Minor Road	70	14	64	8	76	13	11	5
1322_1021	Minor Road	1234	2	1274	3	1267	3	-7	1
1322_1321	Minor Road	123	16	125	12	120	17	-6	5
1321_1320	Minor Road	123	16	127	12	121	16	-5	5
1320_1319	Minor Road	123	16	126	12	121	16	-5	5
1319_1317	Minor Road	289	7	294	9	302	7	8	-5
1327_1026	Minor Road	5604	1	5957	1	5833	1	-124	-4
1327_1319	Minor Road	355	6	368	5	372	7	4	5
1329_1327	Minor Road	5800	1	6169	1	6037	1	-133	-5
1328_1026	Minor Road	1177	3	1221	3	1222	2	1	-9
1330_1329	Minor Road	3095	1	3196	1	3198	1	2	-14
1334_1310	Minor Road	20	0	10	0	15	0	5	0
1334_1332	Minor Road	20	0	10	0	15	0	5	0
1333_1332	Minor Road	20	0	10	0	15	0	5	0
1335_1330	Minor Road	3089	1	3191	1	3190	1	-1	-10
1292_1273	Minor Road	1440	5	1487	5	1515	5	28	-1
1362_1359	Minor Road	4876	1	5154	1	5090	1	-64	8
1365_1363	Minor Road	698	7	740	7	715	6	-25	-11
1365_1350	Minor Road	112	13	108	14	96	5	-12	-10
1373_1372	Minor Road	5265	1	5560	1	5405	1	-154	-1
1372_1362	Minor Road	4882	1	5151	1	5079	1	-72	8
1374_1373	Minor Road	4807	2	5113	2	5001	2	-112	-3
1376_1373	Minor Road	7150	2	7632	2	7450	2	-182	-3
1375_1374	Minor Road	3951	2	4205	2	4135	2	-70	-4

1377_1375	Minor Road	4550	2	4857	2	4716	2	-141	-5
1380_1375	Minor Road	4958	1	5325	1	5209	1	-116	1
1378_1377	Minor Road	4268	2	4570	2	4411	2	-158	-6
1379_1378	B4633	4274	2	4564	2	4395	2	-169	-5
1383_1379	B4633	7670	2	8151	2	7788	2	-363	1
1384_1379	B4633	7093	3	7439	2	7188	2	-251	-3
1385_1384	Minor Road	154	10	166	16	134	19	-32	-2
1385_1377	Minor Road	343	9	334	8	362	10	28	8
1383_1374	Minor Road	892	2	955	3	750	3	-205	-5
1518_1380	Minor Road	4857	1	5246	1	5125	1	-121	-4
1391_1329	Minor Road	5862	1	6223	1	6107	1	-115	-6
1391_1390	Minor Road	5851	1	6204	1	6085	1	-119	-7
2002_1390	Minor Road	5762	1	6134	1	5993	1	-141	-5
1392_1390	Minor Road	525	3	580	6	556	2	-24	-25
1389_1387	Minor Road	5184	1	5503	1	5357	1	-146	-7
1387_1386	Minor Road	4516	1	4800	2	4647	1	-153	-9
1386_1382	Minor Road	4518	1	4801	2	4648	1	-154	-9
1388_1387	Minor Road	1628	2	1723	2	1704	2	-19	2
2001_1396	Minor Road	1271	2	1312	2	1320	2	9	-2
1397_1396	Minor Road	882	3	953	3	960	2	7	-6
1397_1395	Minor Road	319	6	335	7	326	5	-9	-10
1395_1394	Minor Road	318	6	335	7	327	5	-8	-10
1394_1382	Minor Road	637	4	666	5	663	4	-2	-7
1398_1394	Minor Road	348	8	362	9	357	7	-5	-7
1398_1397	Minor Road	72	21	82	24	62	16	-20	-10
1402_1397	Minor Road	1103	2	1171	2	1173	2	2	-5
2105_1402	Minor Road	1106	2	1172	2	1171	2	-1	-5
1404_1398	Minor Road	349	8	365	9	367	7	3	-7
1405_1404	Minor Road	1715	2	1752	2	1786	2	34	-9

1412_1037	Minor Road	506	5	539	5	556	4	17	-1
1413_1037	Minor Road	497	6	534	6	549	6	15	0
1412_1410	Minor Road	508	5	539	5	557	4	18	0
1400_1396	Minor Road	571	4	578	4	578	4	1	-4
1396_1392	Minor Road	296	8	314	8	314	5	0	-10
1401_1392	Minor Road	297	2	324	8	333	8	9	0
1416_1031	Minor Road	967	3	1013	4	1018	3	5	-11
1417_1416	Minor Road	967	3	1014	4	1019	3	4	-11
1417_1392	Minor Road	462	6	509	6	506	6	-3	0
1417_1415	Minor Road	710	4	733	4	751	3	18	-7
1415_1328	Minor Road	711	4	734	4	750	3	17	-7
1421_1328	Minor Road	814	3	851	3	843	3	-8	-3
1425_1029	Minor Road	1119	4	1195	4	1206	4	11	2
1427_1400	Minor Road	578	3	598	4	594	3	-4	-1
1427_1406	Minor Road	584	4	594	4	591	3	-3	-1
1428_1401	Minor Road	114	0	122	8	135	15	13	10
1429_1428	Minor Road	168	12	157	13	173	14	16	5
1431_1429	Minor Road	716	5	627	5	700	5	73	4
1429_1406	Minor Road	574	6	510	7	512	6	2	-6
1406_1405	Minor Road	1690	2	1712	2	1741	2	29	-9
1408_529	A40	19738	3	20446	3	20464	3	18	10
2213_1408	A40	18645	3	19338	3	19317	3	-21	9
1413_1040	Minor Road	535	7	533	8	574	7	40	-4
1436_1413	Minor Road	771	5	755	6	811	4	56	-7
1437_1040	Minor Road	101	20	85	12	89	11	4	0
1438_1437	Minor Road	98	20	82	12	86	12	4	0
1439_1438	Minor Road	63	16	50	10	58	9	8	0
1440_1439	Minor Road	65	15	51	10	58	9	7	0
1441_1440	Minor Road	64	16	51	10	58	9	7	0

1451_1442	Minor Road	74	20	66	8	67	7	2	0
1441_1428	Minor Road	98	20	85	12	89	11	4	0
1442_1438	Minor Road	75	20	66	8	68	7	2	0
1443_1442	Minor Road	31	0	30	17	29	0	-1	-5
1449_1439	Minor Road	15	0	16	0	26	0	10	0
1448_1437	Minor Road	15	0	16	0	26	0	10	0
1448_1447	Minor Road	15	0	16	0	26	0	10	0
1447_1446	Minor Road	15	0	16	0	26	0	10	0
1449_1446	Minor Road	15	0	16	0	26	0	10	0
1451_1441	Minor Road	76	20	67	7	70	7	3	0
1452_1451	Minor Road	31	0	30	17	29	0	-1	-5
1434_525	Minor Road	37	27	29	0	37	14	7	5
1453_1434	Minor Road	37	27	30	0	37	14	7	5
1454_1453	Minor Road	37	27	30	0	37	14	7	5
1457_1454	Minor Road	83	6	83	6	83	12	0	5
1458_1454	Minor Road	97	15	92	5	97	10	5	5
1461_494	Minor Road	1721	2	1777	2	1732	2	-45	1
1461_1460	Minor Road	285	7	287	5	286	6	-2	1
1462_1460	Minor Road	37	0	50	10	43	23	-8	5
1460_1459	Minor Road	281	7	284	5	283	6	-1	2
1459_1457	Minor Road	81	6	79	6	70	0	-9	-5
1466_1458	Minor Road	2399	2	2486	2	2498	1	11	-12
1464_1459	Minor Road	257	7	259	6	252	7	-6	2
1467_1457	Minor Road	37	0	50	10	43	23	-8	5
1467_1462	Minor Road	37	0	50	10	43	23	-8	5
1469_1468	Minor Road	143	14	140	14	148	14	8	0
1470_1469	Minor Road	755	4	770	4	769	4	-1	0
1468_1385	Minor Road	263	11	234	11	251	8	17	-5
1479_1472	B4633	7163	3	7454	2	7192	2	-262	-2

1474_1471	Minor Road	134	15	112	9	135	15	23	10
1472_1384	B4633	7167	3	7465	2	7199	2	-266	-3
1487_1479	Minor Road	3420	2	3542	2	3616	2	74	2
1487_1473	Minor Road	146	3	134	4	159	13	25	15
1473_1471	Minor Road	146	3	134	4	159	13	25	15
1480_1474	A40	18975	3	19525	3	19508	3	-17	7
1490_1482	A40	15248	2	15698	2	15839	2	141	24
1491_1435	A40	18655	3	19331	3	19337	3	6	7
1491_1480	A40	19670	3	20195	3	20180	3	-14	9
1492_1491	A40	2124	2	1993	2	2016	1	23	-15
1480_1470	A40	760	4	751	4	762	4	11	-1
1494_1380	Minor Road	1803	2	1900	2	1905	2	4	-3
1494_1469	Minor Road	753	4	769	4	777	3	7	-5
1495_1494	Minor Road	1650	2	1753	1	1764	1	11	-1
1496_1383	Minor Road	8094	2	8590	1	8242	2	-348	-1
1516_1515	Minor Road	52	19	48	0	43	0	-5	0
1516_1511	Minor Road	405	12	416	11	410	9	-6	-12
1511_1372	Minor Road	500	5	525	5	507	4	-17	-7
1511_1365	Minor Road	769	6	809	7	781	5	-28	-11
1514_1513	Minor Road	43	12	44	0	50	0	5	0
1518_1382	Minor Road	4951	1	5355	1	5214	1	-142	-9
1518_1513	Minor Road	410	10	428	11	422	8	-6	-12
1515_1514	Minor Road	43	12	44	0	49	0	5	0
2048_1492	Minor Road	2141	2	1994	2	2013	1	18	-14
1707_1000	A4013	21617	3	22822	2	22979	2	157	0
2228_2227	Minor Road	5770	1	6144	1	6151	1	6	-3
2265_1169	Minor Road	2925	3	3063	2	3120	2	57	-1
2014_2013	Minor Road	205	0	213	5	218	2	5	-5
1819_263	A40(T)	4448	4	4697	4	4763	4	66	6

1693_1613	A4019	18885	3	19887	3	19930	3	43	-2
2017_1698	Minor Road	1381	2	1479	2	1463	2	-17	0
1708_562	A40(T)	5871	3	6219	3	6366	3	147	24
1847_1740	Minor Road	12945	1	13747	1	14008	1	260	-4
1805_347	A40(T)	22571	2	23663	2	24243	2	579	33
2068_393	Minor Road	3753	0	3977	1	3968	0	-9	-4
2234_2229	Minor Road	12959	1	13746	1	14016	1	270	-4
1006_1001	Minor Road	2809	1	2961	1	2985	2	24	12
2004_1929	Minor Road	11150	1	11756	1	11982	1	226	-6
2232_1981	Minor Road	2166	0	2348	0	2364	0	16	0
2105_1404	Minor Road	1452	2	1502	2	1526	1	24	-7
1080_1079	Minor Road	3077	3	3317	3	3313	3	-4	-6
1993_1986	Minor Road	11123	1	11740	1	11998	1	258	-6
1023_1020	A4013	10504	2	11042	2	11281	2	239	6
2257_1012	Minor Road	17087	3	18090	3	18327	3	237	9
1930_1929	Minor Road	5748	1	6101	1	6115	1	14	-2
1602_1517	A4019	9640	3	10154	3	10187	3	33	0
1682_1479	B4633	3211	3	3353	3	3025	3	-328	-5
1408_1406	A40	2683	2	2666	2	2703	1	37	-12
1736_1672	Minor Road	4574	2	4791	2	4866	2	75	8
2230_1971	Minor Road	11101	1	11725	1	11988	1	263	-6
1546_1482	A40	15305	3	15750	3	15920	3	170	20
1679_538	A4013	9439	3	10089	2	10206	2	117	3
1925_1919	Minor Road	4100	1	4401	1	4415	1	14	0
2057_1006	A4013	19546	3	20656	3	20807	3	151	3
2028_2027	Minor Road	12550	1	13214	1	13405	1	190	-1
1946_227	Minor Road	5503	1	5751	1	5999	1	248	2
1593_904	A4019	9539	2	9993	2	9998	2	5	2
2140_2139	Minor Road	2820	1	2990	1	3016	1	26	12

2174_1108	Minor Road	623	5	676	5	654	5	-23	1
1618_404	Minor Road	2983	1	3154	1	3174	1	20	-1
1684_1267	A4019	9274	2	9740	2	9774	2	34	-1
1689_1267	Minor Road	322	3	340	3	337	3	-3	-1
2227_2226	Minor Road	5817	1	6183	1	6208	1	25	-1
1503_891	Minor Road	17703	2	18745	2	18834	2	90	2
2051_2050	Minor Road	2132	2	2214	2	2229	2	15	-5
1682_1487	B4633	3548	2	3661	2	3746	2	85	2
2014_2006	Minor Road	1832	1	1936	2	1971	2	35	-1
2225_1931	Minor Road	9863	1	10390	1	10625	1	235	-2
2002_1389	Minor Road	3109	1	3338	1	3310	1	-28	-3
439_368	Minor Road	1486	2	1313	2	1641	1	328	-1
1267_1256	A4019	9014	2	9474	2	9509	2	35	0
1924_1918	Minor Road	9668	1	10310	1	10482	1	173	53
1721_1715	Minor Road	1331	3	1399	2	1400	3	1	5
547_537	A40	9894	3	10008	3	9802	3	-206	-8
572_570	Minor Road	18330	1	19466	1	20009	2	543	51
1032_1030	A4013	16894	3	17829	3	18157	3	328	5
1635_1593	A4019	9525	2	9987	2	9990	2	4	3
2226_2225	Minor Road	9853	1	10393	1	10624	1	231	-2
2052_2050	Minor Road	283	9	216	5	218	7	1	5
2228_1993	Minor Road	11132	1	11751	1	12008	1	258	-6
2260_1279	Minor Road	6690	2	7017	2	7097	2	80	-1
269_264	Minor Road	6214	3	6514	3	6666	3	152	3
2115_1021	Minor Road	1349	3	1384	2	1394	2	10	7
1945_1027	A4013	16934	3	17880	3	18235	3	355	8
2227_2006	Minor Road	1825	1	1933	2	1967	2	34	-1
2212_445	A40	17623	3	18465	3	19099	3	634	33
2226_1998	Minor Road	5578	1	5832	1	6078	1	246	-2

1692_1602	A4013	18773	2	19824	2	19982	2	159	4
1741_1738	Minor Road	4573	2	4795	2	4866	2	71	8
2039_2030	Minor Road	2583	1	2715	1	2696	2	-19	13
1668_1025	A4013	15752	3	16497	3	16849	3	352	11
354_209	B4063	3922	2	4109	2	4221	2	112	5
1613_898	Minor Road	8217	3	8729	3	8731	3	2	-1
1851_1705	Minor Road	16483	3	17465	3	17623	3	158	6
1930_1721	Minor Road	1329	3	1398	2	1401	2	4	5
2067_1011	A4013	17211	3	18235	3	18437	3	202	11
1926_1681	Minor Road	7285	1	7708	1	7797	1	89	2
1694_1010	A4013	17080	3	18136	3	18338	3	203	14
2049_2048	Minor Road	2172	2	2000	2	2019	1	19	-16
1703_1004	A4013	437	5	452	3	451	3	-1	0
1715_1702	Minor Road	1384	2	1477	2	1464	2	-13	0
1003_1002	A4013	16151	3	17149	3	17311	3	162	7
2213_1435	A40	18650	3	19317	3	19315	3	-2	9
1824_1263	A4019	445	5	465	5	465	5	1	-2
2229_1740	Minor Road	12950	1	13745	1	14012	1	266	-4
2135_2007	Minor Road	1747	1	1832	1	1856	1	24	0
537_521	Minor Road	1380	2	1280	2	1387	2	107	2
2259_1003	A4013	17090	3	18127	3	18338	3	210	12
2045_2028	Minor Road	12532	1	13190	1	13379	1	189	-1
1921_573	Minor Road	10300	1	11059	1	11098	1	38	-2
2044_2042	Minor Road	10	0	15	0	15	0	0	0
545_544	A40	8736	3	9346	2	9470	3	124	7
1913_1912	Minor Road	1298	8	1374	10	1521	13	147	54
2118_1289	Minor Road	71	0	87	17	76	7	-11	-10
1635_1620	A4013	19170	3	20176	2	20178	2	2	1
1679_1036	A4013	6776	3	7005	2	7261	2	256	4

2111_361	Minor Road	1177	3	1178	3	1277	3	99	1
2030_2029	Minor Road	2580	1	2715	1	2695	2	-20	13
2116_2115	Minor Road	1547	2	1616	2	1612	2	-4	1
1682_1546	A40	8151	2	8526	3	8374	3	-152	0
1543_1032	A4013	16900	3	17838	3	18153	3	315	6
2136_481	Minor Road	3524	1	3040	2	3537	1	497	2
2061_1682	B4633	8817	3	8936	3	9363	3	427	16
1925_1920	Minor Road	3332	1	3526	0	3622	1	96	3
1806_289	A40(T)	12708	1	13370	1	13630	2	260	28
1700_437	A40	17717	3	18604	3	19210	3	606	34
1845_1002	Minor Road	16293	3	17291	3	17452	3	161	8
1742_1739	Minor Road	5811	2	6150	1	6197	2	47	9
1849_1004	Minor Road	16292	3	17292	3	17448	3	155	9
1692_1620	A4013	8156	3	8598	2	8581	2	-17	2
1691_1499	A4019	20143	2	21181	2	21310	2	129	1
1928_1927	Minor Road	5605	1	5975	1	5955	1	-20	1
1644_418	Minor Road	2106	1	2252	1	2250	1	-2	0
1543_1542	A4013	8639	3	9273	3	9291	3	18	0
2155_393	Minor Road	3250	1	3440	1	3438	1	-1	-1
2180_1684	A4019	9258	2	9729	2	9763	2	34	-2
1809_268	A40(T)	9872	2	10298	2	10618	2	321	2
2141_2139	Minor Road	2827	1	2991	1	3018	1	27	12
2009_2007	Minor Road	1744	1	1832	1	1855	1	23	0
2061_1474	A40	8849	3	8958	3	9393	3	436	17
1926_578	Minor Road	4649	1	4923	0	5014	1	91	2
2014_1737	Minor Road	1671	2	1753	1	1793	1	39	4
441_401	Minor Road	3232	0	3449	0	3472	0	23	1
1729_506	A40	16535	3	17300	3	17445	3	145	11
1927_1665	Minor Road	1539	2	1642	2	1634	2	-8	-2

1737_1715	Minor Road	691	2	721	1	729	1	8	0
1705_1005	A4013	16723	3	17721	3	17863	3	142	8
1710_1700	A40	6929	1	7173	1	7728	1	555	4
1516_1513	Minor Road	401	11	416	11	408	9	-8	-12
1923_1847	Minor Road	5960	1	6237	1	6497	0	261	-1
1908_1746	B4063	8744	2	8937	2	9468	2	531	14
1692_893	A4013	10617	2	11227	2	11406	2	179	3
1706_1705	A4013	434	5	459	3	453	3	-7	0
2261_1080	Minor Road	3923	2	4236	1	4251	1	15	0
1738_1672	Minor Road	4573	2	4792	2	4867	2	74	8
2266_1981	Minor Road	2168	0	2348	0	2363	0	16	0
2079_422	Minor Road	898	2	940	2	952	2	12	2
1912_573	Minor Road	678	7	695	13	802	11	107	2
533_531	A40	9413	3	9801	3	10276	3	476	25
1680_1267	Minor Road	9372	2	9834	2	9819	2	-15	2
1745_1716	A40	19652	2	20553	2	20896	2	342	13
2009_1737	Minor Road	1771	1	1852	1	1878	1	26	-1
1850_1006	A4013	21615	3	22831	2	22988	2	157	1
1907_202	B4063	7020	3	7289	3	7430	3	141	1
1674_441	Minor Road	1170	4	1267	3	1253	4	-14	5
1969_1079	Minor Road	139	35	155	37	150	35	-5	-5
2230_1986	Minor Road	11112	1	11733	1	11991	1	258	-6
1667_238	Minor Road	5460	1	5716	1	5848	1	132	0
1816_290	A40(T)	9616	3	9593	3	9689	3	96	6
2051_498	Minor Road	2151	2	2227	2	2249	2	22	-4
2140_1001	Minor Road	2817	1	2986	1	3010	1	24	12
2234_2233	Minor Road	7071	1	7590	1	7599	1	9	-3
1917_1847	Minor Road	6978	1	7506	1	7510	1	4	-3
1776_348	A40(T)	19240	2	20396	2	20846	2	450	9

898_891	Minor Road	17697	2	18750	2	18834	2	84	3
2012_2011	Minor Road	206	0	214	5	218	2	4	-5
1852_998	A4013	21611	3	22791	2	22965	2	174	3
1478_1474	A40	10052	3	10518	3	10050	3	-468	-9
1924_1909	Minor Road	411	2	440	3	448	2	8	0
1679_1035	A4013	3200	5	3302	5	3337	5	36	-4
2068_389	Minor Road	3243	1	3429	1	3446	1	16	1
1853_1852	A4013	21606	3	22786	2	22967	2	181	3
1693_1653	A4019	9229	2	9697	2	9736	2	39	-1
1691_1602	A4019	9133	2	9673	2	9795	2	122	3
2005_1929	Minor Road	5410	1	5659	1	5880	1	221	1
1850_1707	A4013	21617	3	22827	2	22984	2	157	1
415_397	Minor Road	873	1	903	1	922	1	19	-1
1710_456	A40	19647	2	20555	2	20893	2	338	15
552_551	A4013	8717	3	9067	3	9558	3	491	33
1923_1916	Minor Road	9055	1	9478	1	9911	1	433	52
1679_1678	A4013	7533	3	7803	3	8058	3	254	5
1698_578	Minor Road	4447	1	4736	1	4731	1	-5	-2
1924_1917	Minor Road	10071	1	10741	1	10921	1	180	51
1927_1926	Minor Road	5220	1	5562	1	5557	1	-5	2
1918_1909	Minor Road	513	2	542	0	547	0	5	0
1708_354	B4063	25071	2	26590	2	27222	2	632	34
2001_1389	Minor Road	2924	1	3077	1	2957	1	-121	-3
2154_368	Minor Road	4133	1	4105	1	4539	1	434	0
2002_2001	Minor Road	2901	1	3027	1	2910	1	-117	-3
1693_1635	A4019	9650	3	10187	3	10190	3	3	-2
2156_403	Minor Road	2984	1	3156	1	3175	1	18	-1
1618_397	Minor Road	2982	1	3155	1	3173	1	17	-1
2013_2012	Minor Road	206	0	213	5	218	2	4	-5

2256_1017	Minor Road	16849	3	17813	3	18065	3	252	11
1921_1912	Minor Road	620	10	652	8	722	15	71	53
1671_1017	Minor Road	17326	3	18292	3	18558	3	266	14
2180_905	A4019	9245	2	9716	2	9752	2	36	-1
1928_578	Minor Road	4770	1	5032	1	5139	1	106	0
1730_475	Minor Road	969	3	0	0	0	0	0	0
1542_1040	Minor Road	543	7	529	8	573	7	44	-3
2050_2049	Minor Road	2241	2	2037	2	2045	2	8	-11
2228_1998	Minor Road	5578	1	5831	1	6076	1	245	-2
1678_550	A4013	7513	3	7814	3	8078	3	264	5
1922_571	Minor Road	10136	1	10879	2	10998	2	119	0
2027_2004	Minor Road	11150	1	11751	1	11979	1	228	-5
2062_1468	Minor Road	263	10	233	6	260	8	27	5
1947_224	Minor Road	4203	2	4384	1	4606	1	222	3
1742_1674	Minor Road	1171	4	1267	3	1253	4	-13	5
2232_2231	Minor Road	2163	0	2349	0	2363	0	14	0
512_443	Minor Road	4574	2	4789	2	4865	2	76	8
2005_1931	Minor Road	5411	1	5660	1	5880	1	219	1
1479_1477	B4633	567	5	583	4	574	4	-8	0
2233_2231	Minor Road	2163	0	2351	0	2363	0	12	0
2069_2068	Minor Road	2017	1	2104	1	2105	1	1	-1
1920_1919	Minor Road	6838	1	7325	1	7413	2	89	51
570_455	Minor Road	8223	1	8610	1	9011	2	401	51
1499_898	Minor Road	9466	2	10017	1	10102	2	85	3
345_273	Minor Road	19489	2	20620	2	20881	2	262	8
2212_2153	A40	17689	3	18541	3	19156	3	616	33
2069_2041	Minor Road	2861	1	2925	1	3126	1	200	4
1746_209	B4063	8740	2	8928	2	9466	2	538	14
1653_905	A4019	9229	2	9701	2	9736	2	35	-2

2069_389	Minor Road	3179	1	3269	1	3451	1	181	4
1922_573	Minor Road	10973	1	11752	2	11900	1	148	-1
570_351	Minor Road	10099	1	10853	2	10994	2	141	1
1729_512	A40	15463	3	17331	3	17485	3	154	12
572_568	Minor Road	18334	1	19472	1	20008	2	535	51
2062_1471	Minor Road	264	9	233	6	262	8	28	5
1923_1917	Minor Road	3099	2	3253	2	3428	4	175	53
2224_497	Minor Road	1942	1	1985	1	2039	1	54	-2
2259_2258	A4013	17087	3	18130	3	18341	3	211	12
1914_1913	Minor Road	1299	8	1354	10	1519	13	164	53
1910_1909	Minor Road	926	2	982	1	993	1	10	0
1708_357	A40(T)	19213	2	20377	2	20858	2	481	9
2155_403	Minor Road	3252	1	3441	1	3440	1	-1	-1
1682_1478	A40	10054	3	10525	3	10060	3	-465	-9
2044_2030	Minor Road	10	0	15	0	15	0	0	0
2011_2010	Minor Road	206	0	213	5	217	2	4	-5
1620_893	A4013	11007	3	11576	3	11596	3	20	-1
2010_2009	Minor Road	206	0	213	5	218	2	5	-5
1736_443	Minor Road	4574	2	4789	2	4865	2	76	8
1824_1267	A4019	443	5	465	5	466	5	2	-2
564_354	B4063	21143	2	22476	2	23001	2	524	29
512_441	Minor Road	4422	1	4697	1	4709	1	12	8
1679_1542	A4013	8926	3	9541	3	9622	3	81	2
1730_1729	Minor Road	969	3	0	0	0	0	0	0
2029_2027	Minor Road	2576	1	2715	1	2697	2	-18	13
1920_1918	Minor Road	10167	1	10847	1	11029	1	182	53
1739_1644	Minor Road	2106	1	2252	1	2250	1	-3	0
2233_1971	Minor Road	6183	1	6609	1	6634	1	25	-3
1808_1806	A40(T)	9871	2	10291	2	10618	2	326	4

512_445	Minor Road	17445	3	18483	3	19127	3	644	31
1716_456	A40	19651	2	20555	2	20893	2	338	13
1931_1930	Minor Road	5648	1	6010	1	6003	1	-7	-3
512_446	Minor Road	14391	3	15185	3	15852	3	668	36
1691_1650	A4019	11021	3	11514	2	11519	2	5	0
2234_1971	Minor Road	6032	1	6311	1	6578	0	267	-1
1922_1916	Minor Road	842	1	875	1	910	1	34	1
1809_1808	A40(T)	9870	2	10299	2	10618	2	319	4
1517_908	A4019	9641	3	10155	3	10187	3	32	0
1745_458	A40	19655	2	20556	2	20901	2	346	12
1742_424	Minor Road	4643	1	4885	1	4945	1	60	2
1741_1739	Minor Road	3709	2	3901	2	3950	2	50	9
1546_1477	A40	7134	3	7210	3	7526	3	315	16
1741_415	Minor Road	872	1	903	1	922	1	18	-1
2047_2045	Minor Road	12530	1	13183	1	13375	1	191	-1
1613_1499	Minor Road	10675	3	11162	3	11204	3	41	-1
1921_1919	Minor Road	10919	1	11710	1	11815	2	105	48
1682_1477	A40	6577	3	6628	3	6953	4	325	15
1650_894	A4019	11038	3	11519	2	11525	2	7	0
1267_904	Minor Road	9607	2	10052	2	10060	2	9	3
1710_455	Minor Road	26569	2	27722	2	28614	2	892	20
291_281	Minor Road	1322	2	1381	2	1405	1	24	0
296_283	Minor Road	1544	1	1607	1	1683	2	77	7
297_296	Minor Road	1548	1	1610	1	1683	2	72	7
298_297	Minor Road	1549	1	1612	1	1682	2	70	7
299_298	Minor Road	1548	1	1613	1	1682	2	69	7
339_265	Minor Road	8377	3	8224	3	8243	2	20	0
265_262	Minor Road	15167	4	14401	3	14519	3	117	4
497_496	Minor Road	3147	2	3213	2	3297	1	84	-16

1464_497	Minor Road	2126	2	2195	2	2175	2	-20	-15
1466_1464	Minor Road	2249	2	2312	2	2302	2	-10	-11
1466_1465	Minor Road	1928	2	2011	1	2043	1	32	0
2038_499	Minor Road	2582	1	2717	1	2696	2	-21	13
2039_2038	Minor Road	2583	1	2715	1	2697	2	-18	13
2040_499	Minor Road	10	0	15	0	15	0	0	0
499_496	Minor Road	2581	1	2715	1	2698	2	-17	13
181_180	B4063	5377	4	5556	3	5590	3	34	-3
183_181	B4063	5376	4	5558	3	5592	3	34	-3
987_986	B4634	8893	2	9205	2	9238	2	32	-4
989_988	B4634	8913	2	9217	2	9254	2	36	-4
988_987	B4634	8908	2	9215	2	9246	2	31	-6
989_177	B4634	8910	2	9215	2	9251	2	36	-4
178_177	Minor Road	1651	2	1749	2	1752	2	3	0
990_177	B4634	9854	2	10192	2	10239	2	47	-5
1906_180	B4063	5377	4	5547	3	5587	3	40	-3
184_183	B4063	5372	4	5560	3	5595	3	35	-3
912_863	A4019	7754	3	8150	3	8157	3	7	4
860_859	A4019	10244	3	10642	3	10660	3	18	3
922_859	A4019	10244	3	10652	3	10668	3	16	3
871_870	Minor Road	5717	2	6030	2	6042	2	12	2
1958_872	Minor Road	5892	2	6217	2	6216	2	-1	5
1960_873	Minor Road	862	5	935	5	925	4	-10	-3
885_867	A4019	1954	3	2059	3	2058	3	-1	-1
922_861	A4019	10205	3	10610	3	10627	3	17	3
1961_873	Minor Road	857	5	936	5	924	4	-12	-3
1062_872	Minor Road	5897	2	6219	2	6220	2	1	6
1063_1062	Minor Road	1540	1	1616	1	1615	1	-1	1
1065_1063	Minor Road	1525	1	1616	1	1616	1	0	1

1068_1062	Minor Road	4457	2	4716	2	4708	2	-8	4
885_881	Minor Road	5120	1	5397	1	5410	1	13	2
885_861	A4019	18863	3	19737	3	19758	3	21	7
1960_1958	Minor Road	3409	1	3627	1	3614	1	-13	-1
885_876	Minor Road	11084	3	11546	2	11544	2	-2	3
1960_870	Minor Road	3169	1	3345	1	3347	1	2	-1
911_885	A4019	9621	3	10138	3	10156	3	18	3
863_861	A4019	7721	3	8117	3	8125	3	8	5
871_867	Minor Road	1960	3	2064	3	2063	3	-1	-1
1958_870	Minor Road	3034	3	3193	3	3196	3	4	1
871_861	A4019	3753	2	3962	1	3983	2	21	5
1687_911	A4019	9639	3	10156	3	10187	3	30	1
885_877	Minor Road	3998	1	4162	1	4149	1	-13	1
320_314	Minor Road	652	2	685	2	694	2	9	0
320_316	Minor Road	651	2	686	2	696	2	10	0
317_316	Minor Road	650	2	686	2	695	2	9	0
318_317	Minor Road	651	2	686	2	693	2	7	0
1823_82	A40	23946	2	24476	2	24687	2	211	24
96_95	A40(T)	15683	2	15901	2	15938	2	38	4
85_80	A40(T)	11488	3	11768	2	11903	2	135	4
88_85	A40(T)	28646	2	29111	2	29276	2	164	7
87_86	A40(T)	6696	4	6705	4	6679	4	-26	-3
88_75	A40(T)	6219	2	6243	2	6263	2	20	0
1727_92	A40(T)	23876	2	24379	2	24608	2	229	24
J6_614	B4063	28735	2	28928	2	28987	2	58	3
118_96	A40(T)	15678	2	15901	2	15939	2	38	4
192_80	A40(T)	11487	3	11757	2	11901	2	144	2
1812_122	B4063	12588	2	12305	2	12262	2	-43	-3
123_122	B4063	12622	2	12329	2	12292	2	-37	-1

124_123	B4063	70	0	73	0	66	0	-6	0
125_123	B4063	12628	2	12333	2	12300	2	-33	-4
196_87	A40(T)	13080	3	13374	3	13363	3	-11	1
1820_286	A40(T)	15521	2	15904	2	15956	3	52	5
2151_276	A40(T)	17173	2	18077	2	18406	2	329	34
288_275	A40(T)	10315	1	11209	2	11229	2	20	2
289_276	A40(T)	12709	1	13368	1	13632	2	264	28
321_286	A40(T)	15534	2	15904	2	15957	2	53	4
322_287	A40(T)	17190	2	18076	2	18419	2	343	34
323_321	Minor Road	15568	2	15906	2	15950	2	44	5
1825_613	A40(T)	17209	2	18073	2	18369	2	296	32
614_95	A40(T)	15687	2	15900	2	15935	2	35	4
615_613	A40(T)	17202	2	18071	2	18400	2	330	33
616_118	A40(T)	15666	2	15899	2	15937	2	38	2
1811_620	A40(T)	17210	2	18074	2	18416	2	341	34
1810_616	A40(T)	15649	2	15902	2	15940	2	38	3
620_94	Minor Road	17206	2	18072	2	18420	2	349	33
619_93	Minor Road	15627	2	15899	2	15951	2	53	3
324_94	Minor Road	17200	2	18067	2	18417	2	350	34
323_93	Minor Road	15582	2	15907	2	15947	2	40	5
324_322	Minor Road	17197	2	18077	2	18421	2	344	33
624_192	A40(T)	11497	3	11761	2	11879	2	117	0
623_196	A40(T)	13085	3	13375	3	13368	3	-7	1
1639_1638	Minor Road	6970	1	7253	1	7212	1	-41	-1
1642_1639	Minor Road	6853	1	7128	1	7087	1	-41	-1
1645_1642	A40(T)	7008	1	7292	1	7256	1	-37	-1
1646_1645	Minor Road	7008	1	7294	1	7258	1	-36	-1
1647_1646	Minor Road	7011	1	7295	1	7257	1	-38	0
1648_1647	Minor Road	6534	1	6808	1	6766	1	-41	1

1935_1755	Minor Road	7111	1	7356	1	7360	1	4	0
1758_1756	Minor Road	7118	1	7362	1	7370	1	8	1
1934_1758	Minor Road	7115	1	7364	1	7369	1	5	1
1760_1759	Minor Road	7114	1	7353	1	7373	1	20	1
1763_1762	Minor Road	6582	1	6755	1	6782	1	27	0
1764_1762	Minor Road	2374	2	2421	1	2457	2	35	9
1762_1760	Minor Road	7113	1	7347	1	7374	1	27	1
1770_1767	Minor Road	1061	2	1092	2	1097	2	5	3
J3_1974	B4063	7991	3	8202	3	8254	3	52	19
1973_86	B4063	23861	3	24051	3	24052	3	1	-1
J3_1973	B4063	7638	1	7840	2	7854	2	14	7
1976_108	A40	16691	3	16685	3	16683	3	-2	-4
1977_115	A40	16414	2	16748	2	16899	2	151	4
1731_1530	A40(T)	6385	2	6670	2	6683	2	12	3
1935_1756	Minor Road	7115	1	7359	1	7367	1	7	1
1973_107	B4063	16226	3	16216	3	16213	3	-3	-2
2151_287	A40(T)	17174	2	18079	2	18408	2	329	34
1727_82	A40(T)	23189	2	23679	2	23892	2	213	23
1810_619	A40(T)	15641	2	15900	2	15947	2	47	3
107_83	B4063	24219	3	24423	3	24470	3	47	16
1727_77	A40(T)	693	2	707	2	717	2	10	-1
2170_276	A40(T)	4458	4	4711	4	4773	4	63	6
2170_1819	A40(T)	4457	4	4709	4	4773	4	65	7
2066_1974	B4063	15667	2	16061	2	16120	2	59	25
1812_75	B4063	12551	2	12288	2	12238	2	-50	-2
86_85	A40(T)	17161	2	17344	2	17372	2	29	1
92_91	A40(T)	10827	2	11347	2	11549	2	202	24
1530_91	A40(T)	6387	2	6714	2	6703	2	-11	3
1728_77	Minor Road	1451	1	1505	1	1511	1	7	-1

1731_87	A40(T)	6385	2	6670	2	6683	2	12	3
1820_275	A40(T)	15517	2	15905	2	15955	3	50	6
1484_262	A40(T)	5208	5	4709	5	4737	5	28	5
1934_1759	A40(T)	7117	1	7360	1	7371	1	11	1
1484_275	A40(T)	5207	5	4700	5	4726	5	26	4
108_83	A40	16686	3	16684	3	16685	3	1	-6
1811_615	A40(T)	17208	2	18079	2	18405	2	326	32
1825_91	A40(T)	17211	2	18078	2	18309	2	231	31
1823_83	A40	7536	2	7742	3	7789	3	47	19
82_77	A40	757	0	798	0	795	0	-3	0
614_92	A40(T)	13048	2	13032	2	13058	2	26	-1
1823_115	A40	16412	2	16745	2	16901	2	156	3

Table 17 - Modelled Diurnal Emissions Profile M5

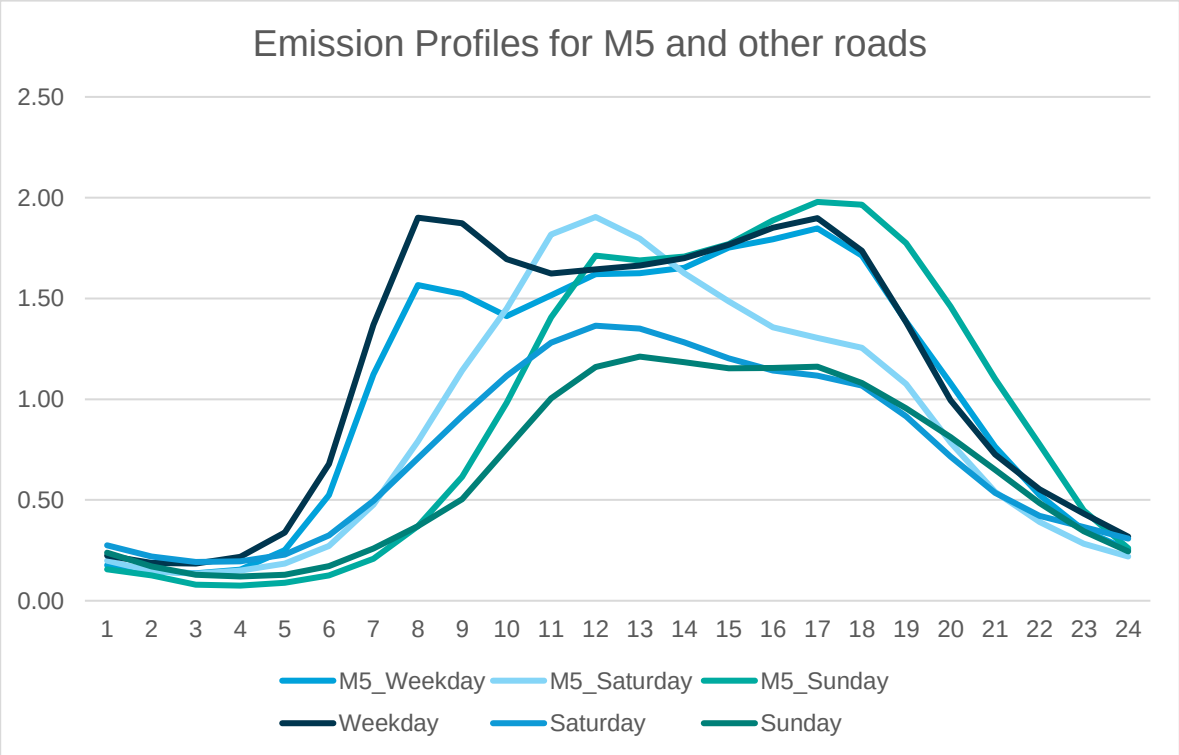
Hour	Weekday	Saturday	Sunday
1	0.18	0.20	0.16
2	0.15	0.15	0.13
3	0.14	0.13	0.08
4	0.15	0.15	0.08
5	0.25	0.18	0.09
6	0.52	0.27	0.13
7	1.12	0.48	0.21
8	1.57	0.79	0.37
9	1.52	1.14	0.61
10	1.41	1.45	0.98
11	1.52	1.82	1.41
12	1.62	1.90	1.71
13	1.62	1.80	1.69
14	1.65	1.63	1.71
15	1.75	1.49	1.77
16	1.79	1.36	1.89
17	1.85	1.30	1.98
18	1.71	1.26	1.96
19	1.39	1.08	1.77
20	1.08	0.79	1.46
21	0.76	0.54	1.10
22	0.52	0.39	0.78
23	0.35	0.28	0.45
24	0.25	0.22	0.26

Table 18 - Modelled Diurnal Emissions Profile – All other modelled links

Hour	Weekday	Saturday	Sunday
1	0.22	0.27	0.24
2	0.19	0.22	0.17
3	0.18	0.19	0.13
4	0.22	0.20	0.12
5	0.34	0.23	0.13
6	0.68	0.32	0.17
7	1.37	0.50	0.26
8	1.90	0.71	0.37
9	1.87	0.92	0.50
10	1.70	1.12	0.76

11	1.62	1.28	1.00
12	1.64	1.36	1.16
13	1.66	1.35	1.21
14	1.70	1.28	1.18
15	1.77	1.20	1.15
16	1.85	1.14	1.16
17	1.90	1.12	1.16
18	1.74	1.07	1.08
19	1.38	0.92	0.96
20	0.99	0.71	0.81
21	0.73	0.54	0.65
22	0.55	0.42	0.48
23	0.43	0.37	0.34
24	0.32	0.31	0.24

Insert B-1 - Modelled Diurnal Traffic Profiles



Appendix C. Modelled Receptors Phase 1

Table 19 - Modelled Specific Sensitive Receptors

Receptor ID	Description	X	Y	Height (m)
R1	Residential property at Badgeworth Road	390203	221351	1.5
R2	Residential property at Elm Gardens Drive	390211	221505	1.5
R3	Shakespeare Cottage at North Road West	390777	221324	1.5
R4	Residential property at The Reddings	390877	220991	1.5
R5	Residential property at Fiddlers Green Lane	390881	221866	1.5
R6	Residential property at Whittington Road	391904	221733	1.5
R7	Residential property at Hatherley Lane (proposed for demolition)	391185	221712	1.5
R8	Nuffield Health Cheltenham Hospital	391186	221464	1.5
R9	Residential property at Hatherley Lane	391191	221646	1.5
R10	Potentially residential property at Keltruck Site, Gloucester Road, West of Arle Court Roundabout	391107	221779	1.5
R11	Residential property at Wade Court	391389	221429	1.5
R12	Residential property at Magnolia Court	391511	222742	1.5
R13	Residential property at Gemini Close	391512	221951	1.5
R14	Residential property at Reddings Road	391615	221227	1.5
R15	Residential property at Hatherley Lane	391269	221780	1.5
R16	Residential property at Fiddlers Green Lane	391155	221953	1.5
R17	Residential property at Badgeworth Road	390738	221648	1.5
R18	Residential property at Roman Road	393047	222341	1.5
R19	Residential property at Sotherby Drive	391888	222100	1.5
R20	Residential property at Monkscroft	392002	222123	1.5
R21	Residential property at Miserden Road	392019	222032	1.5
R22	College at Princess Elizabeth Way	392035	222538	1.5
R23	Residential property at Princess Elizabeth Way	392401	223261	1.5
R24	Residential property at Gloucester Road	392499	221876	1.5
R25	Residential property at Tennyson Road	392509	222436	1.5
R26	Holly House Residential Home	392797	221833	1.5
R27	Residential property at Gloucester Road	392908	221854	1.5
R28	Residential property at Providence Park	393073	223630	1.5
R29	Residential property at Frank Brookes Road	393186	223831	1.5
R30	Queensgate at Gloucester Road	393305	222204	1.5

PCM1	Proposed Receptor next to a PCM link	391361	221850	1.5
PCM2	Proposed Receptor next to a PCM link	391372	221826	1.5
PCM3	Proposed Receptor next to a PCM link	391618	221953	1.5
PCM4	Proposed Receptor next to a PCM link	391636	221929	1.5
PCM5	Proposed Receptor next to a PCM link	391798	222046	1.5
PCM6	Proposed Receptor next to a PCM link	391810	222022	1.5

Appendix D. Background Concentrations

Estimated annual mean background NO_2 concentrations used in this assessment were obtained from the background mapping provided on the DEFRA UK-AIR website[18] (for a 2017 reference year). No background monitoring sites were available in Cheltenham for comparison with the DEFRA background mapping values in 2017. One diffusion tube within the TBC monitoring survey is identified as background. Diffusion tube 20N is located at the north eastern extent of TBC boundary near Snowshill more than 1 kilometre from any motorways or A roads. In order to assess the likely accuracy of mapped background concentrations in the study area, 2017 monitoring data from the 20N diffusion tube was compared with the 2017 mapped background concentration for the corresponding grid square. Table 20 presents the results of this comparison, which indicates that the mapped background concentration was within 30% of the measured concentration. As such, it was considered appropriate to use unadjusted mapped background NO_2 concentrations in the local air quality assessment, particularly as such a comparison is only possible at a single site.

Table 20 - Comparison of Mapped and Measured Background NO_2 Concentrations

Site	Monitoring Type	X, Y	1 km Grid Square X, Y	2017 DEFRA Background (µg/m^3)	2017 Measured Background (µg/m^3)	%Difference (grid square NO_2 – monitored NO_2) / monitored NO_2*100)
20N - Snowshill Hill Farm	Diffusion Tube	412224, 233012	412500, 233500	5.9	6	-2%

Appendix E. Air Dispersion Model Verification Phase 1

It is good practice to compare modelled estimates of pollutant concentrations with real-world monitoring to assess the model's performance for a base year and to inform the interpretation of model results for future years. Verification of the 2017 base year scenario has been undertaken by comparison of the modelled concentration against that measured at the closest monitoring sites to the study area.

Uncertainty in modelled estimates has been considered by calculating root mean square error (RMSE) and fractional bias statistics. An air dispersion model can be considered to perform reasonably well where modelled concentrations are within 25% of monitored concentrations at 95% of sites, in accordance with DEFRA's Technical Guidance LAQM.TG(16)[15]. The root mean square error (RMSE) is acceptable if it is well below 25% of the AQS objective at 10 µg/m^3 (a requirement) and is ideal if below 10% of the AQS objective i.e. an RMSE of 4 µg/m^3. The Fractional Bias (FB) has an ideal value of 0 but is acceptable in the range between +2 and -2.

Step 1

Firstly, unadjusted modelled estimates of total annual mean NO_2 concentrations have been compared against monitored annual mean concentrations as shown in Table 21. Out of 4 comparisons, two modelled estimated concentrations were greater than +/- 25% of monitored concentrations without adjustment and two locations were within +/- 25%. Unadjusted model statistics are shown in Table 22. The RMSE is over 10% of the AQS objective. The Fractional Bias (FB) is above the ideal value of 0, indicating that the model tends to underestimate.

Table 21 - Comparison of Modelled and Measured NO_2 Concentrations (µg/m^3), Unadjusted

Site Name	Background Annual Mean NO_2 (µg/m^3)	Monitored Annual Mean Total NO_2 (µg/m^3)	Modelled Annual Mean Total NO_2 (µg/m^3)	Modelled NO_2 Minus Monitored NO_2 (µg/m^3)	% Difference (unadjusted modelled NO_2 - monitored NO_2) / monitored NO_2 * 100
22	14.5	35.1	27.1	-8.0	-23%
28	15.0	36.7	24.0	-12.7	-35%
AQMesh	13.3	33.1	24.1	-9.0	-27%
29	13.6	29.8	24.5	-5.3	-18%

Table 22 - Model Statistics Pre-Adjustment

RMSE[i]	FB[ii]	r[iii]
9.16	0.30	0.185

[i] Root Mean Square Error: RMSE is used to define the average error or uncertainty of the model (units = µg/m^3). In the case of modelled annual mean NO_2 a value of less than 10 is acceptable and less than 4 is the ideal

[ii] Fractional Bias: FB is used to identify if the model shows a systematic tendency to over or under estimate. Ideal value is 0

[iii] Correlation coefficient: r is used to measure the linear relationship between modelled and observed data. Ideal value is 1

Step 2

The model itself does not provide annual mean NO_2, this is determined using DEFRA LAQM.TG(16)[15] methods. The second comparison is thus of modelled estimates of road contributed annual mean NO_x with the road NO_x component derived from monitoring data, as presented in Table 23. This analysis requires the estimation of the monitored road NO_x component

from the measured total annual mean NO_2 concentration. This was undertaken using DEFRA's NO_x to NO_2 calculator (version 7.1), April 2019

Table 23 - Comparison of Modelled and Measured NO_x Concentrations (µg/m³), Unadjusted

Site Name	Monitored Annual Mean Road NO_x (µg/m³)	Modelled Annual Mean Road NO_x (µg/m³)	Modelled NO_x Minus Monitored NO_x (µg/m³)	Monitored Road NO_x / Modelled Road NO_x	% Difference (unadjusted modelled NO_x - monitored NO_x) / monitored NO_x * 100
22	42.0	24.8	-17.2	1.7	-41%
28	44.6	17.4	-27.2	2.6	-61%
AQMesh	40.0	20.9	-19.1	1.9	-48%
29	32.3	21.2	-11.1	1.5	-34%

The results from the comparison above have been used to determine a trend line and the regression correction factor of 1.85, derived in accordance with LAQM.TG(16)[15] was used to adjust modelled road NO_x contributions.

Step 3

The third comparison of the adjusted modelled estimates of total annual mean NO_2 with monitored concentrations is presented in Table 24. The model statistics post-adjustment are presented in Table 25. The overall RMSE calculated is considered acceptable, as it is less than 10. The FB is just above the ideal value of 0, indicating that the model tends to slightly underestimate.

Table 24 - Comparison of Modelled and Measured NO_2 Concentrations (µg/m³)

Site Name	Background Annual Mean NO_2 (µg/m³)	Monitored Annual Mean Total NO_2 (µg/m³)	Adjusted Modelled Annual Mean Total NO_2 (µg/m³)	Modelled NO_2 Minus Monitored NO_2 (µg/m³)	% Difference (adjusted modelled NO_2 - monitored NO_2) / monitored NO_2 * 100
22	14.5	35.1	36.8	1.7	+5%
28	15.0	36.7	31.1	-5.6	-15%
AQMesh	13.3	33.1	32.5	-0.6	-2%
29	13.6	29.8	33.0	3.2	+11%

Table 25 - Model Statistics Post-Adjustment

RMSE[i]	FB[ii]	r[iii]
3.35	0.01	0.002

[i] Root Mean Square Error: RMSE is used to define the average error or uncertainty of the model (units = µg/m³). In the case of modelled annual mean NO_2 a value of less than 10 is acceptable and less than 4 is the ideal

[ii] Fractional Bias: FB is used to identify if the model shows a systematic tendency to over or under estimate. Ideal value is 0

[iii] Correlation coefficient: r is used to measure the linear relationship between modelled and observed data. Ideal value is 1