



Bristol City Council Clean Air Zone
Outline Business Case

Environmental Appraisal

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Appendix A. Archaeological & Heritage Assets

Acronyms and Abbreviations

AADT	Annual Average Daily Traffic
ANPR	Automatic Number Plate Recognition
AQD	Air Quality Directive (European Union)
AQMA	Air Quality Management Area
BCC	Bristol City Council
CAP	Clean Air Plan
CAZ	Clean Air Zone
Defra	Department for Environment, Food & Rural Affairs
DfT	Department for Transport
HGV	Heavy Goods Vehicle
JAQU	Joint Air Quality Unit (Defra and the Department for Transport)
LGV	Light Goods Vehicle
$\mu\text{g}/\text{m}^3$	Microgrammes per cubic metre
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides (taken to be $\text{NO}_2 + \text{NO}$)
OBC	Outline Business Case
OUV	Outstanding Universal Value
PCM	Pollution Climate Mapping
PM_{10}	Small airborne particles less than 10 micrometres in aerodynamic diameter
$\text{PM}_{2.5}$	Small airborne particles less than 2.5 micrometres in aerodynamic diameter
WHS	World Heritage Site

1. Introduction

1.1 Background

Poor air quality is the largest known environmental risk to public health in the UK¹. Investing in cleaner air and doing more to tackle air pollution are priorities for the EU and UK governments, as well as for Bristol City Council (BCC). BCC has monitored and endeavoured to address air quality in Bristol for decade and declared their first Air Quality Management Area in 2001. Despite this, Bristol has ongoing exceedances of the legal limits for Nitrogen Dioxide (NO₂) and these are predicted to continue until around 2029 without intervention.

The UK has in place legislation transposing requirements in European Union law, to ensure that certain standards of air quality are met, by setting Limit Values on the concentrations of specific air pollutants. In common with many EU member states, the EU limit value for annual mean nitrogen dioxide (NO₂) is breached in the UK and there are on-going breaches of the NO₂ limit value in Bristol. The UK government is taking steps to remedy this breach in as short a time as possible, with the aim of reducing the harmful impacts on public health. Within this objective, the government has published a UK Air Quality Plan and a Clean Air Zone Framework, both published in 2017. The latter document provides the expected approach for local authorities when implementing and operating a Clean Air Zone (CAZ).

Due to forecast air quality exceedances, in 2017 Bristol City Council has been directed by the Minister Therese Coffey (Defra) and Minister Jesse Norman (DfT) to produce a Clean Air Plan to achieve air quality improvements in the shortest possible time. In line with Government guidance, as part of the Plan, Bristol City Council has considered a range of options for the implementation of a Clean Air Zone (CAZ), including both charging and non-charging measures, in order to achieve sufficient improvement in air quality and public health and in line with legal requirements as set out below. This process requires the production of a Strategic Outline Case, an Outline Business Case (this report and a Full business Case, that will be prepared following the Outline Business Case).

Jacobs has been commissioned to support BCC to produce an Outline Business Case (OBC) for the delivery of the CAP; a package of measures which will bring about compliance with the Limit Value for annual mean NO₂ in the shortest time possible in central Bristol. The OBC assesses the shortlist of options set out in the Strategic Outline Case², and proposes a preferred option including details of delivery. The OBC forms a bid to central government for funding to implement the CAP.

In line with Government guidance BCC is considering implementation of the 'Hybrid Option' which includes a diesel car ban across a small area (from 7am-3pm) and a CAZ charging scheme for non-compliant buses, taxis, HGVs and LGVs, alongside a number of other measures.

The UK Government has an obligation to achieve EU Air Quality Limit Values (Directive 2008/50/EC, Annex III). The relevant 'Limit Value' relates to NO₂, which must not exceed 40 µg/m³ as an annual mean (i.e. measured over a calendar year).

The primary drivers for this Limit Value are public health concerns associated with NO₂. Specific health impacts associated with NO₂ inhalation include (WHO, 2016):

- High concentrations can lead to inflammation of the airways; and
- Long-term exposure can increase symptoms of bronchitis in asthmatic children and reduce lung development and function.

A range of other public health issues are also linked to poor air quality, as detailed below. These issues are believed to disproportionately affect 'at-risk' groups, such as older people, children and people with pre-existing respiratory and cardiovascular conditions (World Health Organization, 2013).

¹ Public Health England (2014) Estimating local mortality burdens associated with particular air pollution.
<https://www.gov.uk/government/publications/estimating-local-mortality-burdens-associated-with-particulate-air-pollution>

² Bristol City Council Clean Air Plan: Strategic Outline Case, April 2018
https://www.cleanairforbristol.org/wp-content/uploads/2018/05/Strategic-Outline-Case_BCC_Final_05.04.18.pdf

- Long-term exposure to air pollution is linked to increases in premature death, associated with lung, heart and circulatory conditions;
- Short term exposure can contribute to adverse health effects, including exacerbation of asthma, effects on lung function and increases in hospital admissions;
- Other adverse health effects, including diabetes, cognitive decline and dementia, and effects on the unborn child (Royal College of Physicians, 2016) are also linked to air pollution exposure;
- Exposure can exacerbate lung and heart disease in older people (Simoni *et al.*, 2015); and
- Approximately 40,000 deaths can be attributed to NO₂ and fine particulate matter pollution in England every year (Royal College of Physicians, 2016).

In light of the public health issues outlined above, the UK government is legally responsible for ensuring that it complies with the provisions of the EU Air Quality Directive. The Government assesses air quality compliance with the EU Directive in 43 areas across the country at single locations, using both monitoring and modelling. It uses Defra's Pollution Climate Mapping (PCM) model to forecast exceedances, which is adjusted based on the monitored data. This is the approved means of reporting air quality information to assess legal compliance with the EU legislation.

In 2015, 37 of the 43 monitored areas across the country were in exceedance of the annual mean Limit Value for NO₂.

The locally predicted annual mean concentrations of NO₂ (REV3) at PCM equivalent receptors showed exceedances of the Limit Value for NO₂ in 2021 at various locations, predominantly in central Bristol. In particular six hotspot locations were identified: Rupert Street, Park Street, Queen's Road, College Green, Newfoundland Way and Church Road (see Figures 1.1 and 1.2). In addition to PCM equivalent receptors, four other locations where the limit values are being exceeded were identified at Marlborough Street, Upper Maudlin Street, Park Row and Cheltenham Road.

The UK Government has discretionary powers to pass on the responsibility of managing the exceedances (and associated legal outcomes) to local authorities. Hence, there are public health and regulatory imperatives for improving air quality in BCC. This specifically applies to the city of Bristol.

To meet UK Government regulations, local authorities must demonstrate that they are working towards the National Air Quality Objectives (AQOs). The objective level for concentrations of NO₂ within the national legislation are the same as the European limits (annual mean of 40 µg/m³) but are applied and assessed differently. AQOs only apply where people are exposed for the averaging period of the Objective (i.e. for a year) and therefore compliance with AQOs is assessed most commonly at building facades (where people are regularly present for long periods), including around busy major junctions.

The Government's Local Air Quality Management (LAQM) regime requires all local authorities to regularly review and assess whether AQOs have been achieved at relevant locations. Where the assessment shows exceedances at relevant locations, the authority must declare an Air Quality Management Area (AQMA) and prepare an action plan which identifies appropriate measures in pursuit of the national AQOs.

Further details of the Air Quality modelling undertaken to support the OBC, are set out in Appendix D to the OBC.

Figure 1.1 Predicted NO₂ concentrations in 2021 at PCM-equivalent receptor locations (REV3)

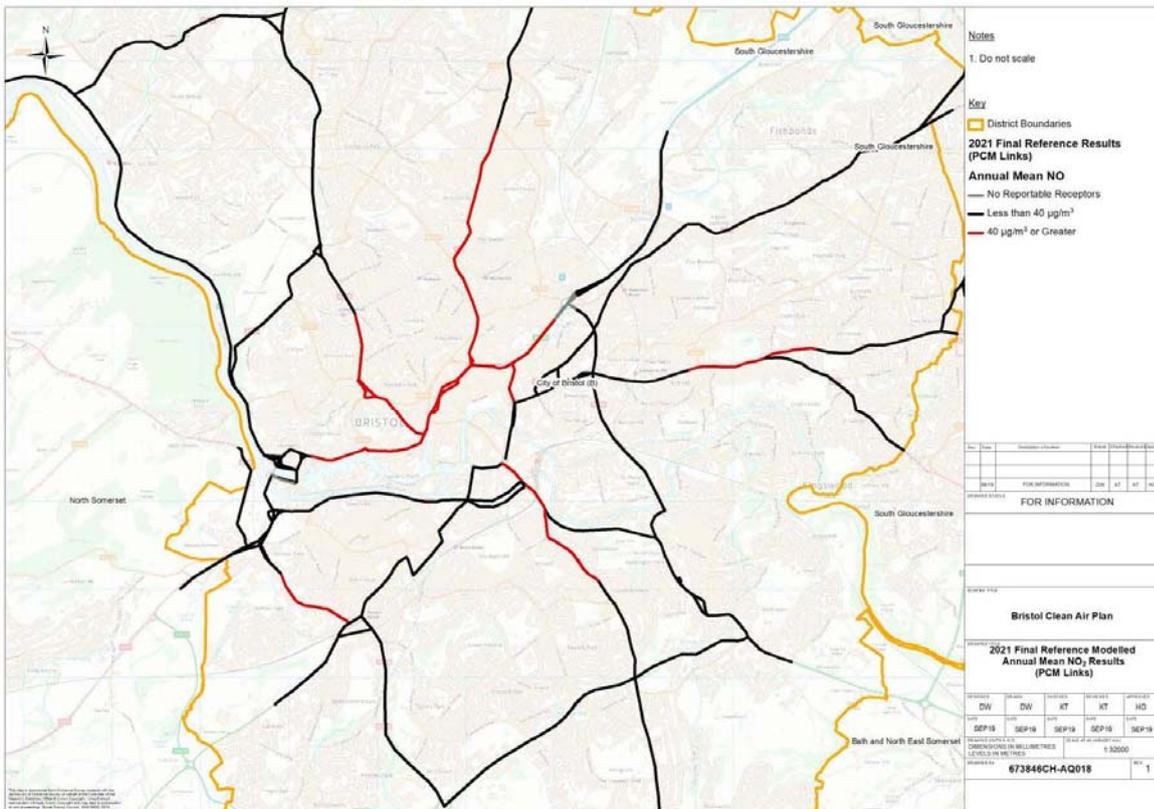


Figure 1.2: Predicted NO₂ concentrations in the 2021 Final References Case at PCM-equivalent receptor locations in the City Centre Focus Areas

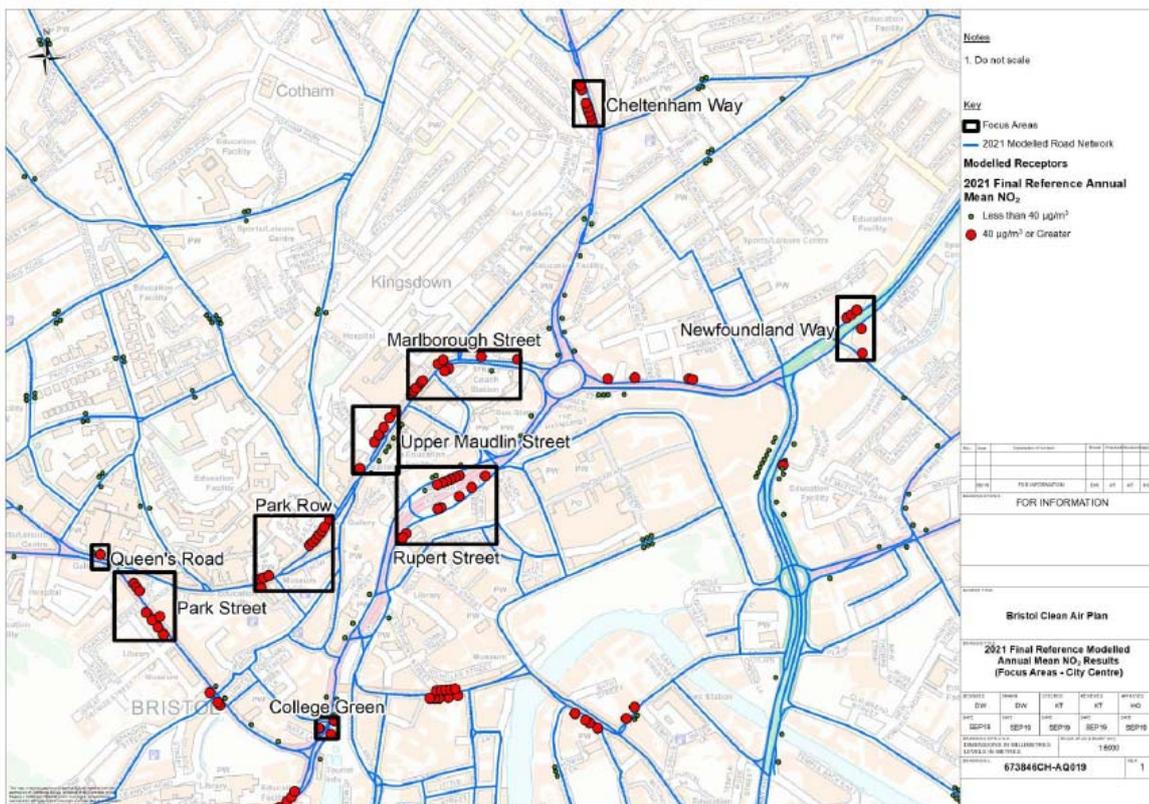
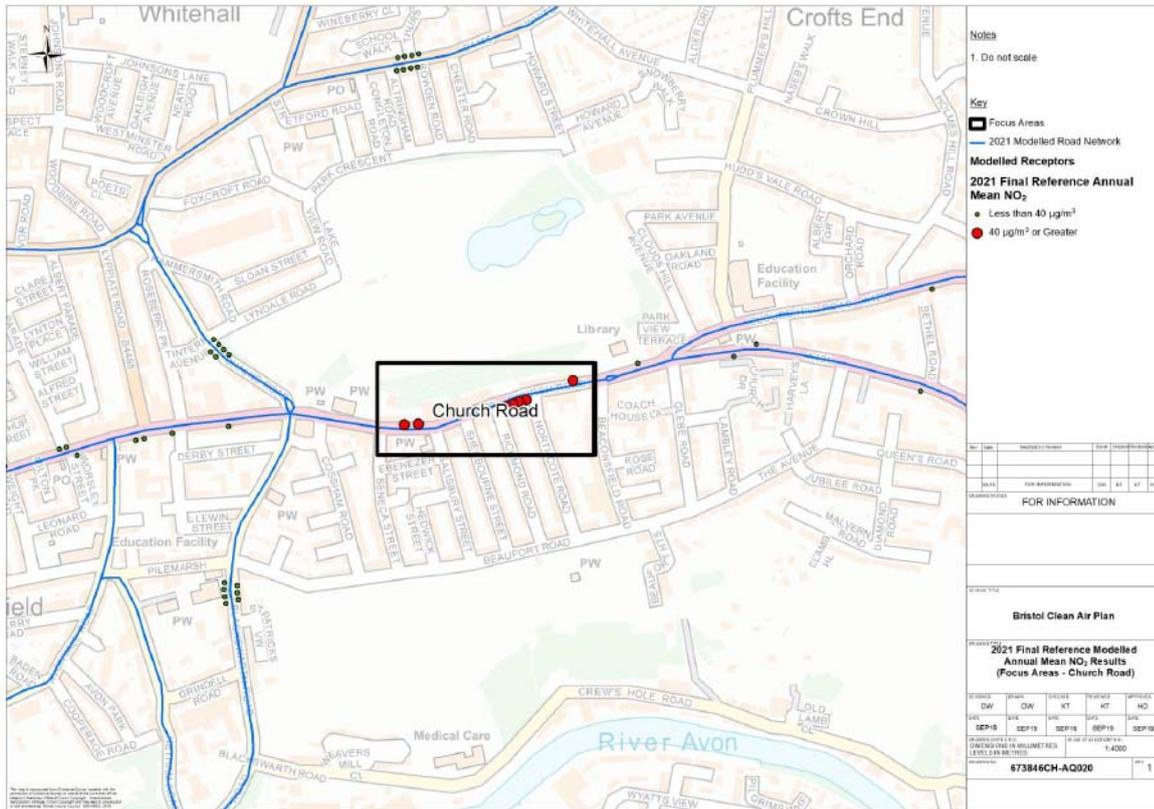


Figure 1.3: Predicted NO₂ concentrations in the 2021 Final Reference Case at PCM-equivalent receptors in the Church Road Focus Area



1.2 Clean Air Zones

In line with Government guidance, BCC has considered the implementation of a Clean Air Zone (CAZ), including both charging and non-charging measures, in order to achieve a sufficient improvement in air quality and public health.

- 1) A CAZ is defined as a specific geographical area where targeted action is taken to improve air quality through charging a daily fee to vehicle owners to enter, or move within, the zone if they are driving a vehicle that does not meet the particular emission standard for their vehicle type in that zone.
- 2) A CAZ is different to a congestion charge. A CAZ aims to improve air quality through discouraging high emission vehicles. A congestion charge targets high traffic flow. The Government is providing funding for Local Authorities to implement charging CAZs within their area.
- 3) A CAZ would be supported by non-charging measures, which would prompt and help enable behaviour change and transport modal shift.
- 4) The CAZ classes are defined in the Defra/DfT's Clean Air Zone Framework (Defra, 2017). The framework sets out which vehicles are affected by each CAZ class and what the minimum Euro standards are for each vehicle type. The four CAZ classes include:
 - Class A charging: buses, coaches, taxis, private hire vehicles
 - Class B charging: buses, coaches, taxis, private hire vehicles and HGVs
 - Class C charging: buses, coaches, taxis, private hire vehicles, HGVs and LGVs
 - Class D charging: buses, coaches, taxis, private hire vehicles, HGVs, LGVs and cars.

1.3 Business Case

Jacobs has been commissioned to support BCC to produce an Outline Business Case (OBC) for the delivery of the CAP; a package of measures which will bring about compliance with the EU Limit Value for annual mean NO₂ in the shortest time possible in Bristol. The OBC assesses the shortlist of options set out in the earlier 2018 Strategic Outline Case (SOC)(CH2M/ Jacobs, 2018), and proposes a preferred option, including details of delivery. The OBC forms a bid to central government for funding to implement the CAP in Bristol.

This document is written to support the OBC and describes the environmental baseline data and potential environmental impacts of implementing the CAP scheme in Bristol. Due to the urban nature of the scheme, this assessment focuses on the environmental topics of most relevance to the inner city of Bristol, where the impacts can be estimated to a greater level of certainty than locations outside of this area. These impacts are attributed solely to vehicle traffic within and around the scheme, and they are predicted based on traffic modelling (Appendix E to the OBC). This document also considers the potential impacts on the adjacent South Gloucestershire Council (SGC) administrative area from the implementation of a Bristol CAP scheme and the potential displacement of traffic into South Gloucestershire.

A detailed assessment of the impacts of this scheme on air quality has been undertaken within the OBC using traffic and air quality models. The options that have been fully modelled are those which had been previously assessed as most likely to achieve compliance (as listed in the SOC), along with variations of these as described below.

- New Option 1
- New Option 2
- Medium CAZ D+ New Option components
- Hybrid Option of New Option 1 and New Option 2

The Hybrid Option is the preferred option and consists of the following:

- A charging scheme for non-compliant buses, taxis, HGVs and LGVs, within a medium sized zone
- A 24 hour a day, seven days a week HGV weight restriction (3.5 tons) on some of the most polluted routes: Rupert Street, Baldwin Street, Park Row/Upper Maudlin Street, Marlborough Street and Lewins Mead.³
- Bus and local traffic interventions in the most polluting areas; this includes a Park and Ride on the M32, an inbound bus lane on the M32 from Junction 2 to Cabot Circus car park, an inbound bus lane on Cumberland Road, and using existing traffic signals to control the amount of traffic entering congested areas with poor air quality.
- A scrappage scheme (up to £2,000) for private diesel cars. This would provide a grant towards a new vehicle or an alternative mode of transport. Vehicles belonging to residents in Bristol, Bath and North East Somerset, North Somerset and South Gloucestershire would be eligible, as long as their drive into work passes through the charging zone area or they live within charging zone.
- All diesel cars are banned from entering a specific central area from 7am to 3pm, 7 days a week (does not apply to taxis, emergency vehicles or private hire vehicles).

The traffic modelling (Appendix E to the OBC) referred to in this report compares the 2021 baseline traffic model results (without scheme), with the results of the preferred option.

A more detailed of why the Hybrid option is the preferred option is provided in Jacobs the Option Assessment Report appended to the OBC (Appendix C).

³ Work undertaken to develop the TROS for this scheme component identified delivery risks associated with imposing restrictions at these four locations. The scheme will be refined to limit the restrictions to Marlborough Street in the FBC.

1.4 Scope of this Assessment

The environmental assessment is focused on the potential environmental impacts of the Hybrid Option as this is the preferred option. The environmental topics (taken from DfT, 2015) of most relevance to the assessment, which are therefore 'scoped in' to this assessment are:

- Noise;
- Air quality;
- Cultural heritage; and
- Townscape.

Topics scoped out due to the insignificance of any potential impacts, based on professional judgment, comprise:

- Biodiversity;
- Greenhouse Gases;
- Landscape; and
- Water Environment.

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2. Noise

There is no noise data for the BCC district and no other information is available relating to the noise baseline within or around the proposed Hybrid scheme. As a result, an assessment of potential noise impacts that could arise from the proposed scheme is not possible.

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3. Air Quality and Human Health

3.1 Baseline

Air pollution has negative impacts on the health of people in Bristol, especially vulnerable members of the population. Evidence suggests that it can cause permanent lung damage in babies and young children and exacerbates lung and heart disease in older people. A recent report into the health effects of air pollution in Bristol concluded that around 300 premature deaths each year in the City of Bristol can be attributed to exposure to NO₂ and fine particulate matter (PM_{2.5}), with roughly an equal number attributable to both pollutants. This represents about 8.5% of deaths in the administrative area of Bristol being attributable to air pollution. This has an estimated cost to the NHS of £83m.

In 2001, an AQMA in Bristol was declared, covering the city centre and part of the main radial roads including the M32 for exceedances of the annual average NO₂ objectives of equal to or above 40µg/m³. The AQMA has been reviewed several times, most recently in 2011.

In 2010, Staple Hill AQMA, Kingswood - Warmley AQMA and Cribbs Causeway AQMA were declared within the administrative boundary of SGC. Staple Hill AQMA incorporates Broad Street A4175, High Street B4465, Victoria Street and Soundwell Road A4017 crossroads. It extends along Broad Street to the junction with Seymour Road, along Soundwell Road to the road linking with Seymour Road and for distances of approximately 200m along High Street and approximately 170m along Victoria Street from the centre of the crossroads.

Kingswood – Warmley AQMA incorporates the A420 road extending from the South Gloucestershire/ Bristol City Council boundary to the east along Two Mile Hill Road, Regent Street, High Street Kingswood, Hill Street, Deanery Road, High Street Warmley and London Road to the junction of Goldney Avenue; to the south along Hanham Road (up to and including The Folly); to the south-east along Tower Road North to the junction of Crown Gardens; and includes any properties that lie within the outlined boundary. Prior to the 2015 amendment, it was previously named as the Kingswood AQMA. Due to the extension of Kingswood AQMA along the A420 to Warmley following the 2014 Warmley Detailed Assessment, the AQMA has been renamed as the Kingswood-Warmley AQMA to reflect that the AQMA now encompasses part of Warmley in addition to Kingswood. Cribbs Causeway AQMA incorporates a single property Hollywood Cottage, Blackhorse Hill, which is adjacent to the M5 Junction 17 roundabout at Cribbs Causeway. All three AQMAs were declared for the exceedances of the annual average NO₂ objective of equal to or above 40µg/m³. In 2012 Kingswood – Warmley AQMA and Staple Hill AQMA were amended, and in 2015 Kingswood – Warmley AQMA was further amended.

Figure 3.1 shows the annual mean modelled concentrations in Bristol and SGC at locations for 2017. The figure shows exceedances of the 40µg/m³ annual mean NO₂ level at various locations around Bristol.

The 2017 NO₂ monitoring indicates several exceedances of the EU Limit Value, particularly in Bristol City Centre (represented in red in Figure 3.1). The likely cause of the exceedances at these locations is a combination of the traffic mix (particularly diesel vehicles), road speed (i.e. slower speeds tending to increase emissions) and presence of canyons (generally tall buildings on either side of the road which prevent pollutants from dispersing as effectively as they would in an open area).

Figure 3.2 shows the percentages of emissions attributed to each vehicle type in Bristol at all reportable roadside receptors. This shows that diesel cars are the most significant sources of vehicle derived NO_x emissions in Bristol. The vehicle type proportions are taken from the Outline Business Case Transport modelling Reports in Appendix E) and Euro standards and the fuel proportions are derived from Automatic Number Plate Recognition (ANPR) data collected around Bristol and described in Jacobs (Air Quality modelling methodology reported in Appendix Di to OBC).

Figure 3.1: Air Quality Monitoring within BCC and SGC – 2017 Annual Mean NO₂

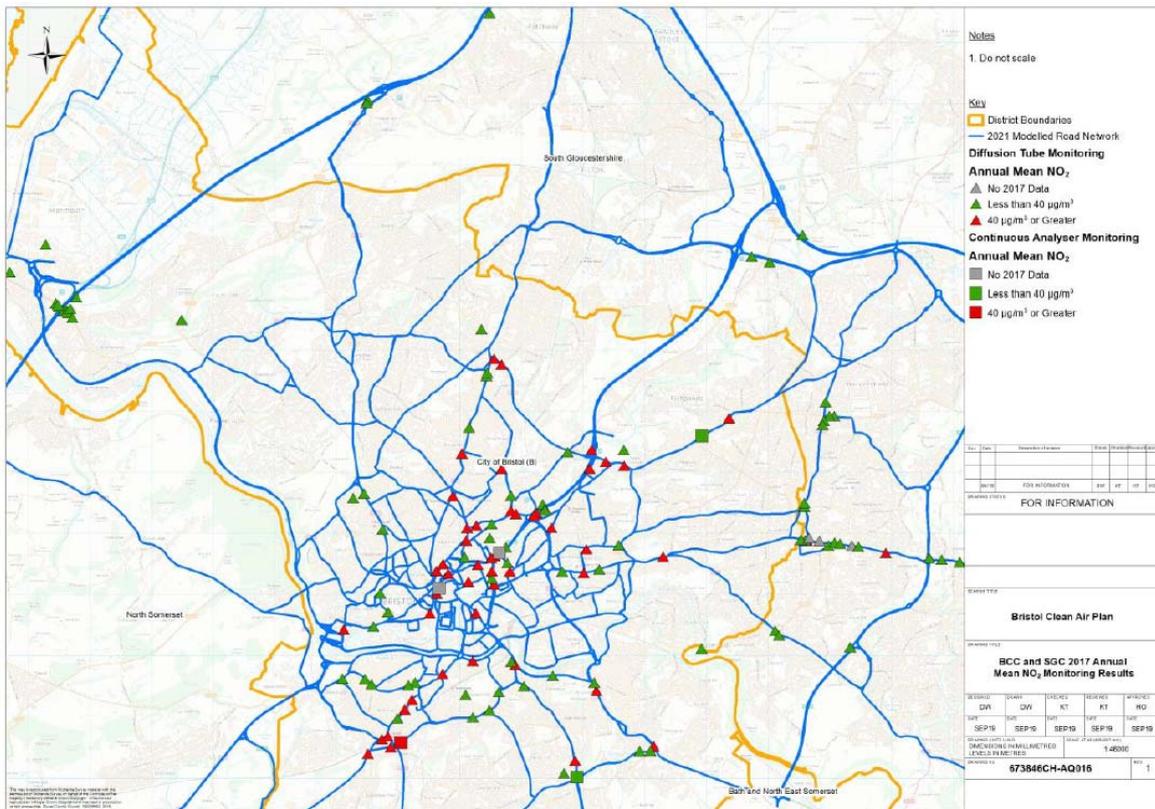
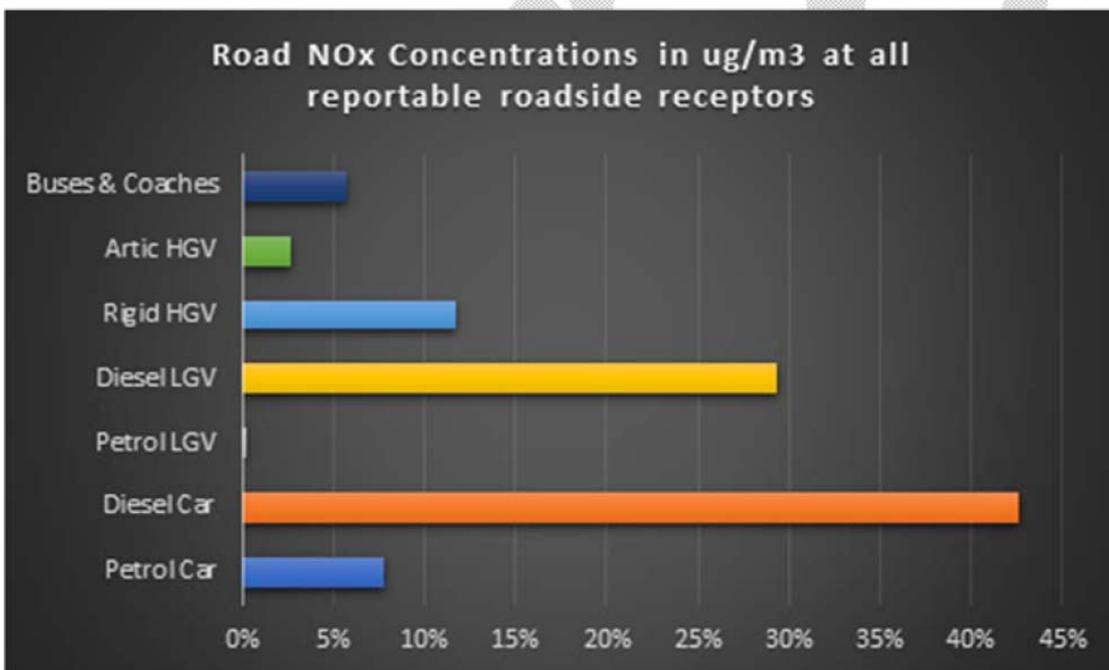


Figure 3.2: NO_x source apportionment by vehicle category across Bristol City Centre (g/km/s) – 2021 baseline. Source: Option Assessment Report, appended to the OBC.



3.2 Potential Impacts

Air quality dispersion modelling has been run at roadside receptors that are listed within the PCM model as exceeding the annual mean Limit Value in 2021 for NO₂ at roadside location (as published by Defra). These locations will comply with public exposure locations. These public exposure locations will not necessarily comply with Air Quality Directive (AQD) siting criteria. However, the rationale for the AQD is that, given that most of the emissions in urban areas are road based, if compliance is achieved at roadside locations, then any sensitive receptors further back from the road are likely to be equally compliant (see Air Quality Reporting in Appendix D to the OBC).

Following the assessment of the options described in Section 1.3, the Hybrid Option (hybrid of New Option 1 and New Option 2) was selected as the preferred option to meet NO₂ compliance in Bristol within the shortest possible time. This option has been modelled as providing compliance across Bristol by 2027, with the exceedance at Church Street responsible for holding back the compliance date until 2027. In terms of air quality, the hybrid option outperforms the other options and is therefore the best scenario to take forward. Further work has indicated the compliance year for the hybrid option would be 2025 (see document OBC-20).

4. Cultural Heritage and Townscape

4.1 Baseline

Bristol contains the following heritage designations, shown on Figure A1 in Appendix A:

- 73 registered historic parks and gardens
- 24 Scheduled Monuments,
- over 4,000 Listed Buildings;
- 33 conservation areas;
- 20 sites on the Heritage at Risk Register; and
- 516 locally valued buildings.

Vehicle emissions contain various pollutants that can damage buildings, including carbon dioxide (CO₂) and sulphur and nitrogen oxides, which all cause stone decay (van Grieken *et al.*, 1998). The deposition of fine particles rich in carbon blackens buildings. Enhanced atmospheric CO₂ can lead to increased carbonic acid concentrations in rainfall, which can degrade limestone, which many properties in Bristol and the south west of England are constructed from.

Deposition of sulphur dioxide and its oxidation to sulphuric acid can damage carbonate stones (Brimblecombe and Grossi, 2007), including the oolitic limestone used for most buildings in Bristol and the south west of England. Allen *et al* (2000) have also shown that NO₂ and SO₂ have a synergistic damaging impact on Bristol's oolitic limestone, whereby the NO₂ acts as a catalyst for the oxidation of SO₂ on stone surfaces. The stone degradation that results is exacerbated in wet and humid conditions. Synergisms between air pollution, acid rain and biological weathering could all become an increasingly important problem for stone decay (Thornbush and Viles, 2006).

4.2 Potential Impacts

4.2.1 Air pollution

The traffic modelling results provided in Figures A1 in Appendix A of this report shows that there will be a reduction in targeted traffic flow along the M32 and Cumberland Road and a slight overall traffic flow reduction within the scheme area and beyond across an average day. However, it does result in some increases on roads mainly outside of the scheme boundary, as drivers attempt to avoid the charge/exclusion areas by using routes around it, namely the A369 and the Clifton Suspension Bridge.

The hybrid option will not result in the greatest trip suppression by 2021. However, it will result in the greatest trip suppression in 2031. This is due to there being very few non-compliant vehicles in 2031 but a significant proportion of diesels.

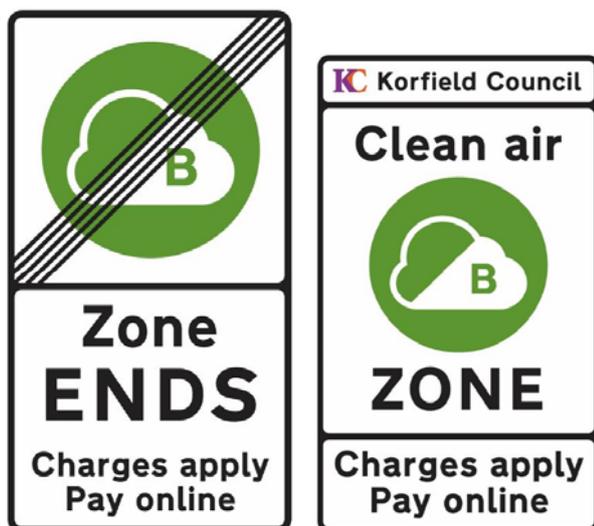
A slight reduction in the numbers of vehicles (AADT) within the proposed scheme could reduce air pollution and therefore have a significant positive impact on the cultural heritage assets within Bristol City Centre. However, with the slight increase in the AADT outside of the scheme boundary there could be a negative effect on the cultural heritage (historic buildings) outside of Bristol City Centre via air pollution.

The magnitude of these impacts (positive and negative) can only be ascertained through the monitoring of historic buildings during the hybrid option implementation.

4.2.2 Townscape

Defra's CAZ Framework guidance, describes 'a minimum requirement for setting up a Clean Air Zone is to "have signs in place along major access routes to clearly delineate the zone" (Defra 2017). To ensure a national standard, the design of the CAZ symbol and traffic sign was produced centrally by Defra's Joint Air Quality Unit (JAQU), as shown in the Figure 4.1 examples.

Figure 4.1: CAZ signage examples provided by JAQU



For Bristol, it is proposed that most scheme boundary cordon points will have two entry and two exit signs, one of each on both sides of the carriageway. Posts would be required on both sides of the carriageway for the erection of one entry and one exit sign anyway.

Unless placed sensitively, new signage could potentially affect important viewpoints in Bristol, including the visual setting of historic sites and buildings. The historic feature that is the most sensitive to such visual impacts is the Clifton Suspension Bridge.

Clifton Suspension Bridge spans the Avon Gorge and River Avon, links Clifton in Bristol to Leigh Woods in North Somerset. The bridge is a Grade I listed structure based on an early design by Isambard Kingdom Brunel.

It is proposed that the bridge would have two entry signs, two exit signs and two enforcement signs (on either side of the road). It is also proposed that ANPR cameras are installed at both locations (also on either side of the road).

Signage should be designed and installed with viewpoints in mind, particularly near the Clifton Suspension Bridge. Where possible, the number of signs should be minimised to minimise impacts on the setting of these historic structures. The size of signs should also be minimised, whilst being fit for purpose.

5. Conclusions

Implementation of a hybrid Option as the preferred option in Bristol is anticipated to reduce air pollution across the city centre, the wider SGC administrative area and potentially beyond. However, it is recommended that signage should be designed and installed with viewpoints in mind, particularly near Clifton Suspension Bridge, due to their historic importance and visual amenity value.

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Appendix A. Archaeological & Heritage Assets

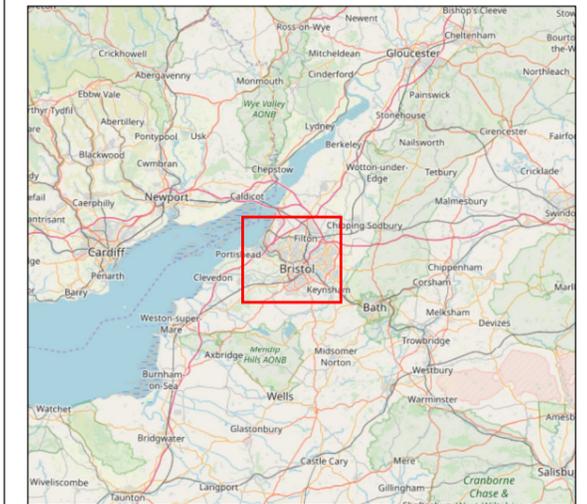
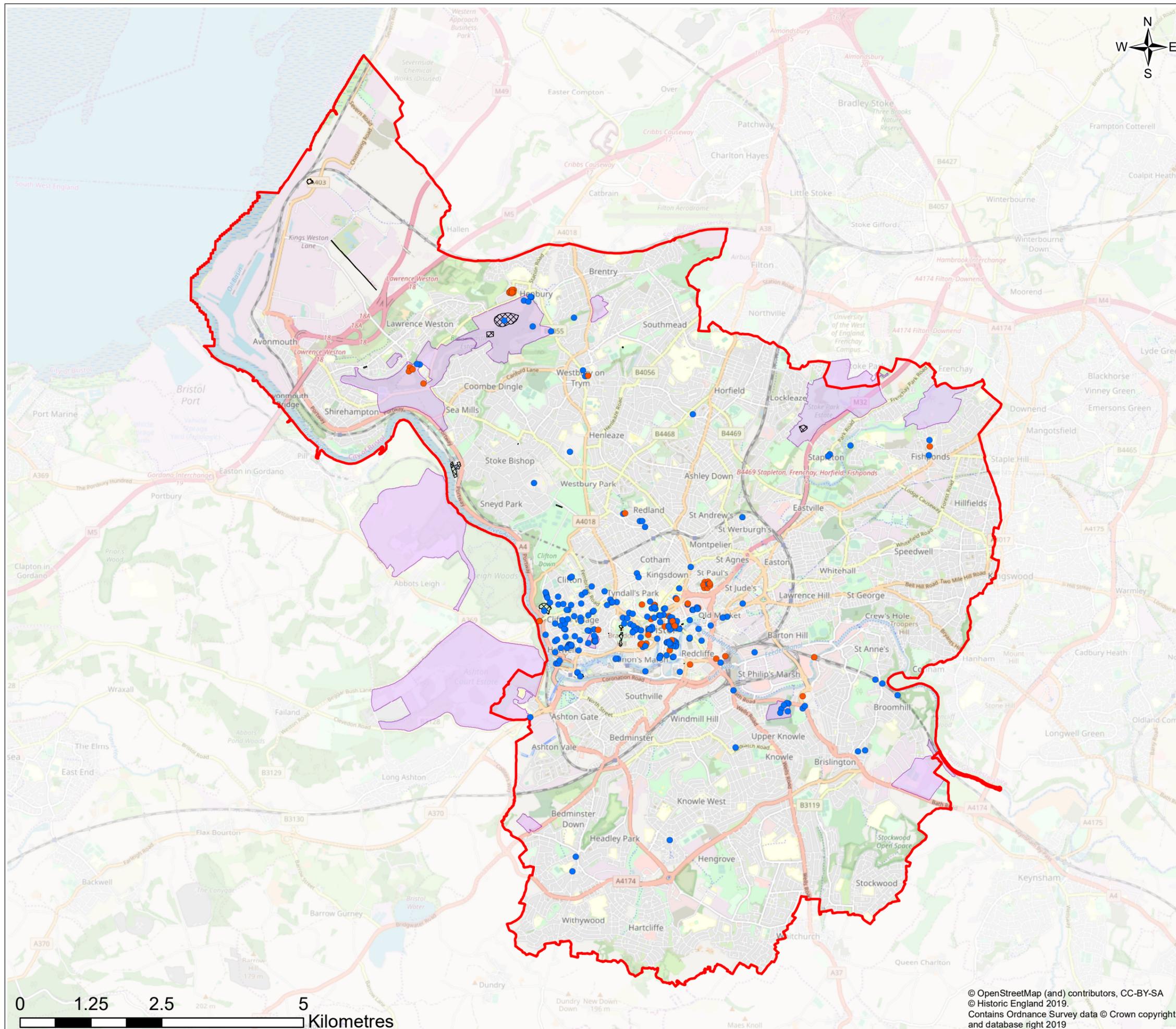
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FIGURE A1



Legend

- Bristol City Council boundary
- Scheduled Monument
- Registered Park and Garden
- Listed Building**
- Grade I
- Grade II*



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Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

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Client: **BRISTOL CLEAN AIR PLAN**

Project: **ARCHAEOLOGICAL AND HERITAGE ASSETS**

Scale @ A3	1:65,000	DO NOT SCALE
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