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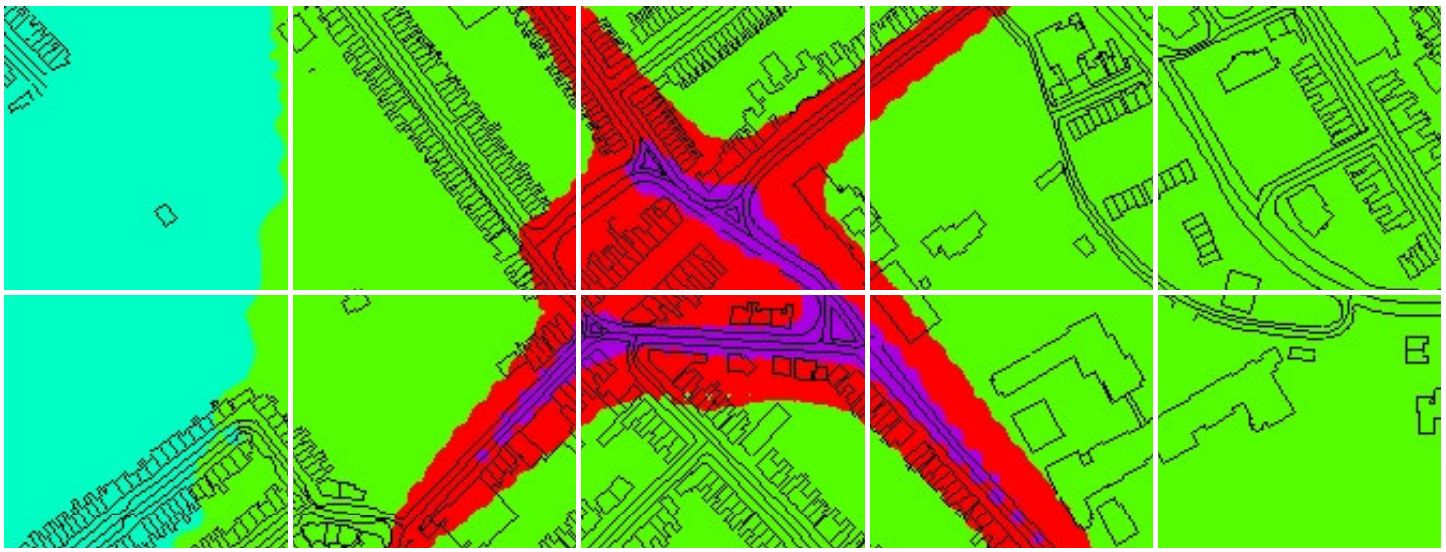

Air Quality: Further Assessment

Air Quality Management Areas 1-6

Report to Watford Borough Council
ED 49325001
Issue1
January 2009

Title	Air Quality: Further Assessment Air Quality Management Areas 1-6
Customer	Watford Borough Council
Customer reference	
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File reference	
Reference number	ED 49325001- Issue 1

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Executive summary

This Further Assessment has considered the following Air Quality Management Areas (AQMAs) in Watford:

- AQMA No 1: St Albans Road
- AQMA No 2: Vicarage Road
- AQMA No 3: Pinner Road
- AQMA No 4: Chalk Hill
- AQMA No 5: A405/Horsehoe Lane
- AQMA No 6: M1/Meriden

The AQMAs were declared in February 2006 following the Detailed Assessment. A draft Further Assessment was prepared in February 2007. Watford Borough Council has considered measures for reducing oxides of nitrogen emissions in the AQMAs and has developed various Action Plan Scenarios. These include:

- Strategic measures to avoid worsening air quality
- Efforts to reduce dependence on cars (e.g. the travel plan)
- Efforts to reduce HGV flow through the AQMAs

The draft Further Assessment has been updated to include an assessment of the effects of these Scenarios on air quality in the AQMAs.

The Further Assessment takes account of additional monitoring and dispersion modelling. The additional monitoring included nitrogen dioxide diffusion tubes throughout the AQMAs and continuous monitoring at a roadside site on Rickmansworth Road. The dispersion modelling took account of detailed traffic count data and queue surveys. The modelling was carried out for the baseline year of 2006. In addition, the following scenarios were modelled in order to investigate the potential impact of the proposed Action Plan Scenarios:

- 2010 baseline based on expected traffic growth from 2006 in the absence of Action Plan measures;
- Zero growth in traffic in the AQMAs from 2006 to 2010;
- A reduction of 10% in car flow rates from 2006 to 2010, with all other vehicle flowrates remaining at 2006 levels;
- A reduction of 10% in HGV flow rates from 2006 to 2010, with all other vehicle flowrates remaining at 2006 levels.

AQMA No 1: St Albans Road

The measured concentration at the St Albans Road diffusion tube site in 2005 and 2006 exceeded the air quality objective for nitrogen dioxide. The modelled concentrations were very similar to those predicted in the Detailed Assessment. The Further Assessment thus confirms the need for an AQMA in this area.

Source apportionment of the modelled oxides of nitrogen concentrations indicated that local road emissions and emissions from background sources made approximately equal contributions in this area. Heavy goods vehicles and buses and stationary vehicles provide a substantial part of the road contribution.

Nitrogen dioxide concentrations are predicted to decrease between 2006 and 2010 at the most affected receptor locations in the area as the result of improvements in vehicle emissions technology. The reduction is sufficient that the air quality objective for nitrogen dioxide will be met at some locations within the AQMA. The Action Plan Scenarios will result in further small reductions in concentrations but the reduction is not sufficient to ensure that the annual mean objective will be met at all locations in the AQMA.

AQMA No 2: Vicarage Road

The measured concentrations at the hospital on Vicarage Road and at Farraline Road exceeded the air quality objective for nitrogen dioxide in 2006.

Predicted concentrations exceed the objective of 40 μg m^{-3} over a wide area covering the whole of the Hornets Gyratory and extending along Cassio Road north to Whippendell Road, along Vicarage Road northeast as far as Exchange Road, along Vicarage Road southwest as far as Occupation Road and 150 m southeast along Wiggenhall Road. The area of exceedence is larger than the area of the existing AQMA and larger than the area predicted in the Detailed Assessment. It is recommended that Watford Borough Council consider increasing the size of the AQMA to cover the whole of the Hornets Gyratory and extending along Cassio Road north to Whippendell Road, along Vicarage Road northeast as far as Exchange Road, along Vicarage Road southwest as far as Occupation Road and 150 m southeast along Wiggenhall Road.

Source apportionment of the modelled oxides of nitrogen concentrations indicated that local road emissions made the largest contribution in this area. Light duty cars and vans provide the greatest part of the road contribution.

Nitrogen dioxide concentrations are predicted to decrease between 2006 and 2010 at the most affected receptor locations in the area as the result of improvements in vehicle emissions technology. The reduction is sufficient that the air quality objective for nitrogen dioxide will be met at some locations within the AQMA. The Action Plan Scenarios will result in further small reductions in concentrations but the reduction is not sufficient to ensure that the annual mean objective will be met at all locations in the AQMA.

AQMA Nos. 3 and 4: Pinner Road and Chalk Hill

The measured nitrogen dioxide concentrations at the Pinner Road and Chalk Hill sites substantially exceeded the air quality objective of 40 μg m^{-3} as an annual mean.

The more detailed traffic data available for the Further Assessment has lead to an increase in the predicted concentrations in this area compared with those predicted in the Detailed Assessment. All properties on the gyratory system with facades on Chalk Hill, Pinner Road and Aldenham Road are predicted to have concentrations greater than the objective of 40 μg m^{-3}. The area extends with the queuing traffic along Eastbury Road as far as Deacon Hill, Pinner Road as far as Oxhey Avenue, Chalk Hill as far as Haydon Road, Aldenham Road as far as The Larches and Lower High Street as far as Dalton Way. It is recommended that Watford Borough Council consider extending the existing AQMAs to cover these areas.

Source apportionment of the modelled oxides of nitrogen concentrations indicated that local road emissions made the largest contribution in this area. Light duty vehicles (cars and vans) and heavy-duty vehicles (heavy goods and buses) provide approximately equal contributions. A large part of the modelled concentrations was attributed to stationary vehicle emissions.

Nitrogen dioxide concentrations are predicted to decrease between 2006 and 2010 at the most affected receptor locations in the area as the result of improvements in vehicle emissions technology. The Action Plan Scenarios will result in further small reductions in concentrations but the reduction is not sufficient to ensure that the annual mean objective will be met at all the most affected receptors in the AQMA.

AQMA No 5: A405/Horsehoe Lane

The measured concentration at the A405/Horseshoe Lane site exceeded the air quality objective for nitrogen dioxide in 2005 and 2006.

The modelled concentrations are similar to, but slightly less than, those predicted in the Detailed Assessment. One property (1026 St Albans Road) that is currently included in the AQMA is shown to

be outside the predicted area of exceedence. However, the predicted concentration is only marginally less than the objective and within the range of uncertainty in the model. It is therefore recommended that no change is made to the area of the AQMA.

Source apportionment of the modelled oxides of nitrogen concentrations indicated that local road emissions made a smaller contribution in this area than the background sources. Light duty vehicles (cars and vans) and heavy duty vehicles (heavy goods and buses) provide approximately equal contributions.

Nitrogen dioxide concentrations are predicted to decrease between 2006 and 2010 at the most affected receptor locations in the area as the result of improvements in vehicle emissions technology. The reduction is sufficient that the air quality objective for nitrogen dioxide will be met throughout the AQMA. The Action Plan Scenarios will result in further small reductions in concentrations.

AQMA No 6: M1/Meriden

The measured concentration at the Ravenscroft site near the motorway was less than the air quality objective for nitrogen dioxide in 2005 and 2006.

The modelled concentrations for this Further Assessment are similar to, but slightly less than, those predicted in the Detailed Assessment. Properties on Ravenscroft, the Gossamers and Eastfield Avenue that are within the existing AQMA are not predicted to exceed the 40 $\mu g\ m^{-3}$ objective. It is therefore recommended that Watford Borough Council consider revoking the AQMA.

Table of contents

1 Introduction 1

1.1 National Air Quality Strategy 1
1.2 Purpose of the Further Assessment 1
1.3 Overview of the approach taken 2
1.4 Relevant DEFRA documentation used 2
1.5 Pollutants considered in this report 2
1.6 Locations that the review and assessment must concentrate on 4

2 Information used to support this assessment 5

2.1 Review and assessment reports 5
2.2 Maps and distances of receptors from roads 5
2.3 Road traffic data 6
2.4 Ambient monitoring 7
2.5 Emission factors 8

3 Detailed Assessment for Nitrogen Dioxide 9

3.1 The national perspective 9
3.2 Standards and objectives for nitrogen dioxide 9
3.3 Conclusions of the first round of review and assessment for nitrogen dioxide 9
3.4 The second round of review and assessment 9
3.5 Background concentrations 9
3.6 Assessment of monitoring data 10
3.7 Overview of the air quality modelling 12
3.8 Detailed modelling results 13
3.9 Source apportionment 15
3.10 Action plan scenarios 17

4 Conclusions 29

4.1 AQMA No 1: St Albans Road 29
4.2 AQMA No 2: Vicarage Road 30
4.3 AQMA Nos. 3 and 4: Pinner Road and Chalk Hill 30
4.4 AQMA No 5: A405/Horsehoe Lane 31
4.5 AQMA No 6: M1/Meriden 31

5 References 32

Appendices

Appendix 1 Traffic data summary
Appendix 2 Air Quality Management Areas

1 Introduction

This section outlines the purpose of this Further Assessment for Watford Borough Council and the scope of the assessment.

1.1 National Air Quality Strategy

The Government prepared the Air Quality Strategy for England, Scotland, Wales and Northern Ireland for consultation in August 1999. It was published in January 2000 (DETR, 2000).

At the centre of the Air Quality Strategy is the use of national air quality standards to enable air quality to be measured and assessed. These also provide the means by which objectives and timescales for the achievement of objectives can be set. These standards and associated specific objectives to be achieved between 2003 and 2010 are shown in Table 1.1.

Local authorities are required to review and assess the air quality in their areas from time to time to determine whether the air quality objectives are likely to be met.

1.2 Purpose of the Further Assessment

The first round of air quality review and assessments is now complete and all local authorities should have completed all necessary stages. Where the likelihood of exceedences of air quality objectives has been identified in areas of significant public exposure, an air quality management area should have been declared, followed by a further Stage 4 review and assessment, and the formulation of an action plan to eliminate exceedences. Local authorities were required to proceed to the second round of review and assessment in which sources of emissions to air are reassessed to identify whether the situation has changed since the first round of review and assessment, and if so, what impact this may have on predicted exceedences of the air quality objectives. Such changes might include significant traffic growth on a major road, which had not been foreseen, construction of a new industrial plant with emissions to air, or significant changes in the emissions of an existing plant.

The second round of review and assessment is undertaken in two steps. The first step is an Updating and Screening Assessment, which updates the Stage 1 and 2 review and assessments previously undertaken for all pollutants identified in the Air Quality Regulations. Where a significant risk of exceedence is identified for a pollutant it is necessary for the local authority to proceed to a Detailed Assessment, equivalent to the previous Stage 3 assessments. Where a local authority does not need to undertake a Detailed Assessment, a progress report is required instead.

Watford Borough Council carried out an Updating and Screening Assessment and concluded that there was a significant risk of exceeding the air quality objectives near some of the busiest roads in Watford. A Detailed Assessment was then carried out, which confirmed that there were six areas in Watford where exceedence of the annual mean air quality objective for nitrogen dioxide was likely. The Council declared these areas as Air Quality Management Areas operational from 17 February 2006.

The Council is then required to carry out a Further Assessment to confirm the exceedences, equivalent to a Stage 4 review and assessment. The council are also required to formulate an action plan to eliminate the exceedences. The further assessment is intended to ‘supplement such information as Council has in relation to the designated area in question’. The Further Assessment should be sufficiently detailed to determine whether an existing AQMA needs amending or revoking.

This report is a Further Assessment for Watford Borough Council as outlined in the Government’s published guidance.

1.3 Overview of the approach taken

The general approach taken to this Further Assessment was to:

- Collect and interpret additional data to support the assessment, including detailed traffic flow data around the AQMAs;
- Consider recent continuous monitoring and diffusion tube measurements;
- Use monitoring data from the continuous monitors located close to Rickmansworth Road in Watford and at background sites in neighbouring authority areas to assess the ambient concentrations produced by the road traffic and to calibrate the output of modelling studies;
- Model the concentrations of NO_2 around the AQMA, concentrating on the locations (receptors) where people might be exposed over the relevant averaging times of the air quality objectives;
- Present the concentrations as contour plots and assess the uncertainty in the predicted concentrations;
- Consider whether the authority should amend or revoke the Air Quality Management Areas and provide recommendations on the scope and extent of any revisions.
- Evaluate the effects on air quality of measures identified in the draft Air Quality Action Plan.

1.4 Relevant DEFRA documentation used

This report takes into account the guidance in LAQM.TG(03)[3], published January 2003 and further advice presented as Frequently Asked Questions on the Review and Assessment Helpdesk internet site.

1.5 Pollutants considered in this report

Table 1.1 lists the pollutants included in the Air Quality Regulations[2] for the purposes of Review and Assessment. Nitrogen dioxide is considered in this report.

Table 1.1 Objectives included in the Air Quality Regulations 2000 and (Amendment) Regulations 2002 for the purpose of Local Air Quality Management

Pollutant	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
Benzene All authorities	16.25 μg/m^3	running annual mean	31.12.2003
Authorities in England and Wales only	5.00 μg/m^3	annual mean	31.12.2010
Authorities in open areas and coastal areas should be cleaner as air changes more frequently and Northern Ireland only	3.25 μg/m^3	running annual mean	31.12.2010
1,3-Butadiene	2.25 μg/m^3	running annual mean	31.12.2003
Carbon monoxide Authorities in England, Wales and Northern Ireland only	10.0 mg/m^3	maximum daily running 8-hour mean	31.12.2003
Authorities in Scotland only	10.0 mg/m^3	running 8-hour mean	31.12.2003
Lead	0.5 μg/m^3 0.25 μg/m^3	annual mean annual mean	31.12.2004 31.12.2008
Nitrogen dioxide[b]	200 μg/m^3 not to be exceeded more than 18 times a year 40 μg/m^3	1 hour mean annual mean	31.12.2005 31.12.2005
Particles (PM_{10}) (gravimetric)[c] All authorities	50 μg/m^3 not to be exceeded more than 35 times a year 40 μg/m^3	24 hour mean annual mean	31.12.2004 31.12.2004
Authorities in Scotland only[d]	50 μg/m^3 not to be exceeded more than 7 times a year 18 μg/m^3	24 hour mean annual mean	31.12.2010 31.12.2010
Sulphur dioxide	350 μg/m^3 not to be exceeded more than 24 times a year 125 μg/m^3 not to be exceeded more than 3 times a year 266 μg/m^3 not to be exceeded more than 35 times a year	1 hour mean 24 hour mean 15 minute mean	31.12.2004 31.12.2004 31.12.2005

b. The objectives for nitrogen dioxide are provisional.
c. Measured using the European gravimetric transfer standard sampler or equivalent.
d. These 2010 Air Quality Objectives for PM10 apply in Scotland only, as set out in the Air Quality (Scotland) Amendment Regulations 2002.

Additional national particles objectives for England, Wales and Greater London are not currently included in Regulations for the purpose of LAQM. The Government and the Welsh Assembly Government however intends that the new particles objectives will be included in Regulations as soon as practicable after the review of the EU's first air quality daughter directive. The additional particles objectives for England, Wales and Greater London are shown in Table 1.2. Whilst authorities have no obligation to review and assess against them, they may find it helpful to do so, in order to assist with longer-term planning, and the assessment of development proposals in their local areas.

Table 1.2: Proposed new particles objectives for England, Wales and Greater London (not included in Regulations)

Region	Air Quality Objective		Date to be achieved by
	Concentration	Measured as	
London	50 μg/m^3 not to be exceeded more than 10 times a year	24 hour mean	31.12.2010
London	23 μg/m^3	annual mean	31.12.2010
London	20 μg/m^3	annual mean	31.12.2015
Rest of England and Wales	50 μg/m^3 not to be exceeded more than 7 times a year	24 hour mean	31.12.2010
Rest of England and Wales	20 μg/m^3	annual mean	31.12.2010

1.6 Locations that the review and assessment must concentrate on

For the purpose of review and assessment, the authority should focus their work on locations where members of the public are likely to be exposed over the averaging period of the objective. Table 1.3 summarises the locations where the objectives should and should not apply.

Table 1.3 Typical locations where the objectives should and should not apply

Averaging Period	Pollutants	Objectives *should* apply at …	Objectives should *not* generally apply at …
Annual mean	1,3 Butadiene Benzene Lead Nitrogen dioxide Particulate Matter (PM_{10})	All background locations where members of the public might be regularly exposed.	Building facades of offices or other places of work where members of the public do not have regular access.
		Building facades of residential properties, schools, hospitals, libraries etc.	Gardens of residential properties.
			Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term
24 hour mean and 8-hour mean	Carbon monoxide Particulate Matter (PM_{10}) Sulphur dioxide	All locations where the annual mean objective would apply.	Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.
		Gardens of residential properties.	
1 hour mean	Nitrogen dioxide Sulphur dioxide	All locations where the annual mean and 24 and 8-hour mean objectives apply.	Kerbside sites where the public would not be expected to have regular access.
		Kerbside sites (e.g. pavements of busy shopping streets).	
		Those parts of car parks and railway stations etc. which are not fully enclosed.	
		Any outdoor locations to which the public might reasonably be expected to have access.	
15 minute mean	Sulphur dioxide	All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer.	

It is unnecessary to consider exceedences of the objectives at any location where public exposure over the relevant averaging period would be unrealistic. Locations should also represent non-occupational exposure.

2 Information used to support this assessment

This section lists the key information used in this review and assessment.

2.1 Review and assessment reports

Watford Borough Council completed the following review and assessments of air quality during the first round of Review and Assessment (http://www.hertsbedsair.org.uk/hertsbeds/asp/reports.asp):

- Stage 1 (December 1998)[4]
- Stage 2
- Stage 3 (December 2000)

The Third Stage Review and Assessment of NO_2 concluded that concentrations of NO_2 and particulate matter, PM_{10} at certain locations close to major roads in the area were likely to exceed air quality objective limits. Watford Borough Council considered the potential for public exposure at these locations and concluded that there were no domestic properties within the likely area of exceedence. The Council was satisfied that there was no relevant public exposure and so no Air Quality Management Areas were declared.

Watford Borough Council completed its Updating and Screening assessment in June 2003. The Updating and Screening Assessment identified several areas within Watford where there was a risk that the air quality objectives for nitrogen dioxide and particulate matter PM_{10} might be exceeded. A Detailed Assessment was carried out in April 2004. The Detailed Assessment indicated that it was likely that the annual mean objective for nitrogen dioxide would not be met in six areas. These areas came into operation as Air Quality Management Areas in February 2006. The Detailed Assessment indicated that it was likely that the objectives for PM_{10} would be met.

Watford Borough Council produced a Progress Report in 2005. The Progress Report reviewed newly available air quality monitoring data and traffic data and considered the effects of potential new developments in the Borough. Exceedences of the national objective for nitrogen dioxide were identified from diffusion tube measurements at 7 points in the Borough, but these were all within the 6 AQMAs.

2.2 Maps and distances of receptors from roads

Watford Borough Council provided electronic OS LandLine™ data which were used in the Geographical Information System (GIS) used in assessment. The maps were used to provide details of the location of road centrelines and road widths. Individual buildings or groups of buildings (receptors) were also identified. The distances of these receptors from the road were accurately determined from the maps.

2.3 Road traffic data

This section summarises the information used in this report; more detailed information is given in Appendix 1. Appendix 1 lists the locations of the traffic flow and speed measurement points, flow and speed data and other relevant traffic statistics.

Hertfordshire County Council provided 12-hour turning counts for most of the main junctions within the Air Quality Management Areas. This data was supplemented with traffic count data from the Watford Borough Council's Detailed Assessment, from the Progress Report and from the NAEI 2004 database. The base year for the traffic flows was variously 2004, 2005 and 2006. Traffic growth factors were calculated from the National Road Traffic Forecast and correction factors provided by the Tempro 5.3 database. The overall growth factors applied are shown in Table 2.1.

Table 2.1: Traffic growth factors applied

Year	NRTF factor	Tempro factor		Overall growth factor
		GB	Watford	
2004	115	1	1	1
2005	117	1.011	1.017	1.023
2006	119	1.021	1.045	1.059
2010	126.2	1.064	1.0765	1.110

Vehicle speeds were generally assumed to approach 50 kph in urban areas, 110 kph on the M1 motorway and 80 kph on non-urban roads (corresponding to the appropriate speed limits) on straight sections of the roads. Reduced speeds in the range 20-50 kph were applied near to junctions. A diurnal variation in traffic flow was assumed, typical of urban roads near London.

Hertfordshire County Council also carried out a queue survey at most of the main junctions in the Air Quality Management Areas. In addition the locations of bus stops and pedestrian crossings were identified. Table 2.2 shows the frequency of buses and their times waiting at bus stops (taken from the Detailed Assessment).

Table 2.2: Traffic control measures

Road	Traffic control measures	Bus frequency, (one way)	Average bus waiting time	Average traffic light waiting time
Vicarage Road	Bus stops 4 Pedestrian crossings 1	0630-2230 3 per hour	40-60 seconds	45 seconds
Vicarage Road/ Wiggenhall Road junction	Pedestrian crossings 3			45 seconds
Horseshoe Lane	Bus stops 9 Pedestrian crossings 2 Traffic light controlled junctions 1	0630-2230 4 per hour	30-40 seconds	90-120 seconds
Pinner Road	Bus stops 7 Pedestrian crossings 2 Zebra crossing 1	i) 0700-2350 4 per hour ii) 0450-0100 12 per hour outside Bushey Station	i) 20-30 seconds ii) up to 1 minute	Notable rush hour congestion at zebra crossing
St Albans Road	Bus stops 16 Pedestrian crossings 2 Traffic light controlled junctions 6	0600-2330 8 per hour	60-90 seconds	45-60 seconds
Bushey Mill Lane	Bus stops 5 Pedestrian crossings 1 Traffic light controlled junctions 2 Level crossing 1	0630-2230 2 per hour	20-40 seconds	80 seconds

2.4 Ambient monitoring

The assessment has considered continuous automatic monitoring data from monitoring stations in Watford and neighbouring local authorities for nitrogen dioxide and ozone. The continuous monitors from part of the Hertfordshire and Bedfordshire Network, HBNet operated and maintained by Kings College, London on behalf of the local authorities. Nitrogen dioxide concentrations are measured by ozone chemiluminescence.

The Watford Town Hall roadside monitoring station (334850 390680) is located approximately 5 m from the side of the Rickmansworth Road at the Town Hall. The manifold inlet is approximately 4 metres high.

Table 2.3 shows the locations of urban background sites in neighbouring local authority areas.

Table 2.3: Urban background monitoring sites in neighbouring local authorities

Local authority area	Site	OS Grid reference
Three Rivers	Rectory Road, Rickmansworth	505450, 194460
St Albans	Fleetville Community Centre, Royal Road, St Albans	516550, 207360

Nitrogen dioxide diffusion tube measurements were made at 17 locations throughout Watford during 2005 and 2006. The Council's diffusion tubes are analysed at Harwell Scientifics using a procedure based on 50% acetone and 50%TEA. One of the diffusion tubes was collocated with the continuous monitor on Rickmansworth Road.

2.5 Emission factors

The vehicle emission factors used for national mapping have recently been revised by Defra and the devolved administrations[1]. The most recent emission factors have been used in this detailed assessment.

Emissions from stationary traffic in queues and at bus stops were estimated using the emission factor for vehicles moving at 5 km h^{-1} and taking account of the proportion of time stationary vehicles are present and the length of road over which emissions take place. The average length of a queuing vehicle was assumed to be 5 m. The average queue length at pedestrian crossings and bus stops was estimated from the annual average daily traffic flow and the waiting times shown in Table 2.2. It was assumed that significant queues could form during 8 hours of the day.

Vehicles travelling up Chalk Hill will emit pollutants at an increased rate because of the slope of the hill. Emission factors for vehicles travelling up hill are not currently available. In this assessment, it has been assumed that vehicles travelling uphill emit at twice the rate for vehicles travelling on flat roads.

[1] The new set of emission factors on the NAEI website (www.naei.org.uk/emissions/index.php) approved by DEFRA and DTLR for use in emissions and air quality modelling, following consultation of the TRL Report "Exhaust Emission Factors 2001: Database and Emission Factors" by TJ Barlow, AJ Hickman and P Boulter, TRL, September 2001

3 Detailed Assessment for Nitrogen Dioxide

3.1 The national perspective

The principal source of NO_x emissions is road transport, which accounted for about 46% of total UK emissions in 2001. Major roads carrying large volumes of high-speed traffic (such as motorways and other primary routes) are a predominant source, as are conurbations and city centres with congested traffic. Within most urban areas, the contribution of road transport to local emissions will be much greater than for the national picture.

Meeting the annual mean objective is e considerably more demanding than achieving the 1-hour objective. National studies have indicated that the annual mean objective is likely to be achieved at all urban background locations outside of London by 2005, but that the objective may be exceeded more widely at roadside sites throughout the UK in close proximity to busy road links. Projections for 2010 indicate that the EU limit value may still be exceeded at urban background sites in London, and at roadside locations in other cities.

3.2 Standards and objectives for nitrogen dioxide

The Government and the Devolved Administrations have adopted two Air Quality Objectives for nitrogen dioxide, as an annual mean concentration of 40 μgm^{-3}, and a 1-hour mean concentration of 200 μgm^{-3} not to be exceeded more than 18 times per year. The objectives are to be achieved by the end of 2005 and in subsequent years.

3.3 Conclusions of the first round of review and assessment for nitrogen dioxide

The Third Stage Review and Assessment of NO_2 concluded that concentrations of NO_2 at certain locations close to major roads in the area were likely to exceed air quality objective limits. Watford Borough Council considered the potential for public exposure at these locations and concluded that there were no domestic properties within the likely area of exceedence. The Council was satisfied that there was no relevant public exposure and so no Air Quality Management Areas were declared.

3.4 The second round of review and assessment

The Updating and Screening Assessment for nitrogen dioxide concluded that there was a need to proceed to a detailed assessment for nitrogen dioxide at many locations close to roads in Watford. A Detailed Assessment was then carried out, which confirmed that there were six areas in Watford where exceedence of the annual mean air quality objective for nitrogen dioxide was likely. The Council declared these areas as Air Quality Management Areas operational from 17 February 2006. The Air Quality Management Area Orders are included in Appendix 2.

3.5 Background concentrations

The estimated annual average background nitrogen dioxide (NO_2) concentration provided by the UK background maps for 2005 was 22.8 μgm^{-3} averaged across Watford with a maximum concentration of 25.4 μgm^{-3}

The estimated annual average background oxides of nitrogen (NO_x) concentration provided by the UK background maps for 2005 was 37.0 μgm^{-3} averaged across Watford with a maximum concentration of 43.2 μgm^{-3} .

3.6 Assessment of monitoring data

Table 3.1 summarises the measurements of nitrogen dioxide concentrations at continuous monitoring stations in Watford and neighbouring local authorities for relevant periods.

Table 3.1: Continuous monitoring data

Site	Period	Data capture, %	NO_x, concentration, µg m^{-3} as NO_2	NO_2 Concentration, µg m^{-3}	
			Period average	Period average	99.8th percentile hourly
Watford	2005	97	75	38.0	111.0
	1/12/05-30/11/06	92	66.8	37.9	
	2006	92	65.6	37.6	110.6
Three Rivers	2005	90	71.8	30.2	
	1/12/05-30/11/06	78	63.2	39.1	
	2006	85	66.8	29.1	96.7
St Albans	2005	90	47.8	26.5	96.6
	1/12/05-30/11/06	91	45.0	25.4	
	2006	93	44.9	25.1	88.4

The annual mean nitrogen dioxide concentrations measured at the Watford roadside site in 2005 and 2006 were less than the annual mean objective of 40 µg m^{-3}. The concentrations at sites further from major roads in neighbouring local authorities were significantly less than the objective.

The 1-hour mean nitrogen dioxide concentrations measured at all the sites have not exceeded the hourly objective of 200 µg m^{-3} more than 18 times in a year (the 99.8th percentile).

Nitrogen dioxide diffusion tube measurements were made at 17 locations throughout Watford during January 2005-November 2006. Bias adjustment factors have been calculated based on the measurements at the Watford co-location site over the periods January-December 2005 and December 2005-November 2006. The bias adjustment factor for 2005 was 0.889. This value may be compared with the best estimate of the bias adjustment factor of 0.88 for derived from collocation studies at 13 other locations in the UK using 50% TEA in Acetone tubes analysed by Harwell Scientifics in 2005. The bias adjustment factor for the period December 2005-November 2006 calculated from the collocated tube in Watford was 0.926. Table 3.2 shows the annual average nitrogen dioxide concentrations at the diffusion tube sites. It shows the unadjusted values and the concentrations adjusted for the local bias adjustment factor and the national bias adjustment factor. It also shows the projected concentrations for 2010 calculated using year adjustment factors taken from the LAQM internet site http://www.airquality.co.uk/archive/laqm/tools.php?tool=year.

Table 3.2: Annual average nitrogen dioxide concentrations at diffusion tube sites, µg m^{-3}

Code	Address	2005 data				2006 data		
		Raw data	Local bias adjustment	National bias adjustment	2010 Forecast	Raw data	Local bias adjustment	2010 Forecast
WF02	Grove Pumping Station, Hempstead Road	23.9	21.3	21.0	17.5	25.9	24.0	20.4
WF03	Hospital, Vicarage Road	41.8	37.2	36.8	30.6	44.4	41.2	35.0
WF06	Leisure Centre, Horseshoe Lane	30.8	27.3	27.1	22.5	29.8	27.6	23.5
WF29	Pinner Road	63.8	56.8	56.2	46.7	66.7	61.8	52.6
WF31	High Road Leavesden	40.6	36.1	35.7	29.7	42.0	38.9	33.1
WF34	Westland Road	44.7	39.8	39.3	32.7	47.8	44.3	37.7
WF35	Rickmansworth Road Colocation	42.7	38.0	37.6	31.3	40.6	37.6	32.0
WF36	Ravenscroft	39.0	34.7	34.3	28.5	39.4	36.5	31.1
WF37	St Albans Road 2	48.3	43.0	42.5	35.4	51.4	47.6	40.5
WF38	A405 Horseshoe Lane	46.2	41.1	40.6	33.8	48.9	45.3	38.6
WF39	Balmoral Road	55.6	49.4	48.9	40.7	59.7	55.3	47.0
WF40	Salisbury Road	47.5	42.2	41.8	34.8	52.8	48.9	41.7
WF41	Leavesden Road	43.3	38.5	38.1	31.7	42.8	39.7	33.8
WF42	Queens Road	48.0	42.7	42.2	35.1	47.6	44.1	37.5
WF43	Farraline Road	65.2	58.0	57.4	47.7	67.6	62.6	53.3
WF44	Chalk Hill	94.3	83.9	83.0	69.0	98.9	91.6	78.0
WF45	Wellington Road	53.2	47.3	46.8	38.9	41.8	38.7	32.9

The 2005 and 2006 diffusion tube measurements indicate that the annual average objective will be met at the Grove Pumping station, Horseshoe Lane Leisure Centre, High Road Leavesden, Rickmansworth Road, Ravenscroft and Leavesden Road sites. It seems likely that the objective will not be met at the Pinner Road, St Albans Road, Horseshoe Road, Balmoral Road, Salisbury Road, Queens Road, Farraline Road or Chalk Hill sites. Projections for 2010 indicate that the objective will still not be met at many of these sites.

The Hospital Vicarage Road site is approximately 2 m from the road on an access road between Watford General Hospital and Watford Football Club. It is possible that there will be relevant exposure of members of the public at this location.

The Pinner Road diffusion tube site is on a post at the kerbside at the junction of Villiers Road and Pinner Road. It is unlikely to be representative of exposure of members of the public over the annual averaging time.

The St Albans road diffusion tube is mounted on a post less than 1 m from the kerb on the St Albans Road and approximately 3 m from a light controlled pedestrian crossing, where it is likely to be influenced by queueing traffic. It is unlikely to be representative of public exposure over the annual averaging period, although short-term exposure relating to the 1-hour objective may be considered relevant.

3.7 Overview of the air quality modelling

3.7.1 Summary of the models used

The air quality impact from roads has been assessed using our proprietary urban model (LADS Urban). There are two parts to this model:

- The *Local Area Dispersion System (LADS) model*. This model calculates background concentrations of oxides of nitrogen on a 1 km x 1 km grid. The estimates of emissions of oxides of nitrogen for each 1 km x 1 km area grid square were obtained from the 2004 National Atmospheric Emissions Inventory.
- The *DISP model*. This model is a tool for calculating atmospheric dispersion using a 10 m x 10 m x 3 m volume-source kernel derived from ADMS3.3 to represent elements of the road. The volume source depth takes account of the initial mixing caused by the turbulence induced by the vehicles. Estimates of emissions from vehicles have been calculated using the latest (and finalised for this round of Review and Assessment) vehicle emission factors.

Particular attention was paid to the avoidance of "double counting" of the contribution from major roads in the modelled areas. Thus the emissions from sections of roads modelled using DISP were removed from the LADS inventory.

Hourly sequential meteorological data for 2005 from London Heathrow, approximately 30 km south-west of Watford was used. A surface roughness of 1 m was used in the modelling to represent the urban conditions corresponding to the most exposed sites.

A regional background oxides of nitrogen concentration of 16.2 μg m, measured at Harwell for 2006 was added to the modelled oxides of nitrogen concentrations.

The netcen primary NO_2 model (AQEG 2007) was used to calculate nitrogen dioxide concentrations from the oxides of nitrogen concentrations predicted by LADS Urban. The model takes into account the background ozone, nitrogen dioxide and nitric oxide concentrations, the proportion of the oxides of nitrogen released from vehicles as nitrogen dioxide and the exposure of the site to sunlight. The model was used first to analyse the monitoring data from the Watford roadside site to estimate the proportion of oxides of nitrogen (7.9%) released as nitrogen dioxide. The analysis took account of background measurements of ozone, oxides of nitrogen and nitrogen dioxide concentrations at the Fleetville, St Albans site.

3.7.2 Validation and verification of the model

In simple terms, model validation is where the model is tested at a range of locations and is judged suitable to use for a given application. The modelling approach used in this assessment has been validated, and used in numerous AEA air quality review and assessments.

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. Table 3.3 compares modelled predictions using LADS Urban of oxides of nitrogen with measured values at the Watford, Three Rivers and St Albans continuous monitoring sites.

Bias adjustment is the process where the concentrations of the model are adjusted to agree with local air quality monitoring data. In this case, the model has tended to underestimate the oxides of nitrogen concentrations. An additional 6 μg m^{-3} has been added to the modelled oxides of nitrogen concentrations to take account of emission sources in London outside the modelled domain. Table 3.3 shows the adjusted oxides of nitrogen concentrations.

Table 3.3 shows the modelled and measured nitrogen dioxide concentrations. The agreement is satisfactory and so no further adjustment of the modelled concentrations has been made.

Table 3.3: Comparison of modelled and measured concentrations, 2006

Site	Oxides of nitrogen concentration, µg m^{-3}			Nitrogen dioxide concentration, µg m^{-3}	
	Modelled	Bias adjusted model	Measured	Modelled	Measured
Watford	59.6	65.6	65.6	37.4	37.6
St Albans	37.2	43.2	44.9	31.8	25.1
Three Rivers	39.9	45.9	66.8	32.5	29.1

3.7.3 Model uncertainty

The results of dispersion modelling of pollutant concentrations are necessarily uncertain because of the uncertainties in the estimation of rates of emission, meteorological data and dispersion conditions. Table 3.4 shows confidence levels for modelled nitrogen dioxide concentrations based on a statistical analysis of a comparison of modelled and measured concentrations in London (LAQM. TG(03)). In this report, we present predicted concentrations as isopleths (lines of constant concentration) superimposed on a map of the local area. The concentration values selected reflect the uncertainty bands shown in Table 3.4. Predicted concentrations in excess of 40 µg m^{-3} indicate that there is more than 50 % chance of exceeding the annual average objective for nitrogen dioxide. Public exposure in these areas should be considered in order to assess whether it will be necessary to revise the Air Quality Management Area for nitrogen dioxide.

Table 3.4 Confidence levels for modelled concentrations for future years based on symmetrical concentration intervals and concentration intervals derived purely from the statistics

Description	Chance of exceeding objective	Annual average objective
Very unlikely	Less than 5%	< 28
Unlikely	5 to 20%	28 to 34
Possible	20 to 50%	34 to 40
Probable	50 to 80%	40 to 46
Likely	80 to 95%	46 to 52
Very likely	More than 95%	> 52

3.8 Detailed modelling results

In this section, nitrogen dioxide concentrations predicted for 2006 are presented as a series of contour plots.

3.8.1 AQMA No. 1: St Albans Road

The modelling for St Albans Road was updated from the modelling carried out for the Detailed Assessment. The update included revised traffic flows for St Albans Road and more recent meteorological data. The method of calculating nitrogen dioxide concentrations from modelled oxides of nitrogen concentrations was also updated to take account of the increases in the proportion of primary nitrogen dioxide emissions from new diesel vehicles. Nevertheless, the modelled predictions are very similar to those given in the Detailed Assessment.

Fig. 3.1 shows the predicted nitrogen dioxide concentrations for 2006 for St Albans Road between Bushey Mill Lane and Balmoral Road. Exceedences of the annual average objective are predicted to occur at residential properties on the east side of St Albans Road. These include properties near the

junction with Bushey Mill Lane and Balmoral Road and those near bus stops and the pedestrian crossing.

Fig.3.2 shows the predicted nitrogen dioxide concentrations for St Albans Road between Balmoral Road and Leavesden Road. Exceedences of the annual average objective are predicted to occur at residential properties on both sides of St Albans Road. These include properties near the junctions with Balmoral Road and with Leavesden Road and those near bus stops and the pedestrian crossing.

Fig.3.3 shows the predicted nitrogen dioxide concentrations for St Albans Road between Leavesden Road and Wellington Road. Exceedences of the annual average objective are predicted to occur at residential properties on the both sides of St Albans Road. These include properties near bus stops and pedestrian crossings.

3.8.2 AQMA No. 2: Vicarage Road

Fig. 3.4 shows predicted nitrogen dioxide concentrations for 2006 for the modelled roads around the Hornets Gyratory. Predicted concentrations exceed the objective of 40 μg m^{-3} over a wide area covering the whole of the Hornets Gyratory and extending along Cassio Road north to Whippendell Road, along Vicarage Road northeast as far as Exchange Road, along Vicarage Road southwest as far as Occupation Road and 150 m southeast along Wiggenhall Road.

The predicted concentration at the Hospital, Vicarage Road diffusion tube site for 2006 was 39.0 μg m^{-3} compared to the measured value of 41.2 μg m^{-3} in 2006 and 36.8 μg m^{-3} in 2005. The predicted concentration at the Farraline Road diffusion tube site for 2006 was 46.0 μg m^{-3} compared to the measured value of 57.4 μg m^{-3} in 2006 and 62.6 μg m^{-3} in 2005. The modelled concentrations are smaller than the diffusion tube measurements. The diffusion tube measurements are considerably higher than the concentration measured at the collocation site and so there may be some inaccuracy in the bias adjustment.

The area of exceedence is larger than the area of the existing AQMA and larger than the area predicted in the Detailed Assessment. There are two main causes for the increases in the model predictions in this area. Firstly, Watford Borough Council provided detailed queuing and turning count data for the junctions for this Further Assessment that was not available for the Detailed Assessment. Secondly, the method of calculating nitrogen dioxide concentrations from modelled oxides of nitrogen concentrations has been changed to take account of the increases in the proportion of primary nitrogen dioxide emissions from new diesel vehicles.

It is recommended that Watford Borough Council consider increasing the size of the AQMA to cover the whole of the Hornets Gyratory and extending along Cassio Road north to Whippendell Road, along Vicarage Road northeast as far as Exchange Road, along Vicarage Road southwest as far as Occupation Road and 150 m southeast along Wiggenhall Road.

3.8.3 AQMA Nos. 3 and 4: Pinner Road and Chalk Hill

Hertfordshire County Council provided detailed traffic data and queuing data for the Pinner Road/Chalk Hill gyratory system. The more detailed traffic data has lead to an increase in the predicted concentrations in this area compared with those predicted in the Detailed Assessment. Fig. 3.5 shows the predicted area of exceedence. All properties on the gyratory system with facades on Chalk Hill, Pinner Road and Aldenham Road are predicted to have concentrations greater than the objective of 40 μg m^{-3}. The area extends with the queuing traffic along Eastbury Road as far as Deacon Hill, Pinner Road as far as Oxhey Avenue, Chalk Hill as far as Haydon Road, Aldenham Road as far as The Larches and Lower High Street as far as Dalton Way. It is recommended that Watford Borough Council consider extending the existing AQMAs to cover these areas.

The very high predicted concentrations in this area are supported by the diffusion tube measurements. The modelled concentrations at Chalk Hill of 67.8 μg m^{-3} and at Pinner Road of 55.9 μg m^{-3} approach the measured concentrations of 91.6 μg m^{-3} and 61.8 μg m^{-3}. The diffusion tube measurements are

considerably higher than the concentration measured at the collocation site and so there may be some inaccuracy in the bias adjustment.

3.8.4 AQMA No. 5: Horseshoe Lane

The modelling was updated from that carried out for the Detailed Assessment. The update included revised traffic flows for A405 and A412. The modelled concentrations shown in Fig. 3.6 for 2006 are similar to, but slightly less than, those predicted in the Detailed Assessment for 2005. One property (1026 St Albans Road) that is currently included in the AQMA is shown to be outside the predicted area of exceedence. However, the predicted concentration is only marginally less than the objective and within the range of uncertainty in the model.

3.8.5 AQMA No.6: M1/Meriden

The modelling for the M1 was updated from that carried out for the Detailed Assessment. The update included revised traffic flows for the M1 and A41 and more recent meteorological data. The modelled concentrations shown in Figs. 3.7 and 3.8 for 2006 are similar to, but slightly less than, those predicted in the Detailed Assessment for 2005. Properties on Ravenscroft, the Gossamers and Eastfield Avenue that are within the existing AQMA are not predicted to exceed the 40 $\mu g\ m^{-3}$ objective. The 2004 Detailed Assessment indicated that there was likely to be an exceedence of the air quality objective at these properties. The Detailed Assessment recommended that the uncertainty in the assessment should be resolved using the diffusion tube measurement at Osprey Close when average bias adjustment factors for diffusion tubes for 2003 are reported. The LAQM Review and assessment helpdesk has now reported a diffusion tube bias adjustment factor (0.87) for 50 % TEA in acetone diffusion tubes analysed by Harwell Scientifics for 2003. Applying this factor to the measured concentration (48 $\mu g\ m^{-3}$) gives a bias-corrected concentration of 41.8 $\mu g\ m^{-3}$. Projecting this concentration forward to 2006 using factors given LAQM.TG(03) gives a concentration of 38.3 $\mu g\ m^{-3}$. The diffusion tube on Osprey Close has now been replaced with one on Ravenscroft: bias-corrected concentrations at this site were 36.5 $\mu g\ m^{-3}$ in 2006 and 34.4 $\mu g\ m^{-3}$ in 2005. It is recommended that Watford Borough Council consider revoking AQMA No.6.

3.9 Source apportionment

3.9.1 Source apportionment of 'base case' predictions

Source apportionment is the process whereby the contributions from the sources of a pollutant are determined. In local air quality, the relevant sources could include: traffic; local background; industrial and domestic. Contributions from the different types of vehicles (for example, cars, lorries and buses) can also be considered to highlight which class of vehicle is contributing most to the emissions from traffic. Source apportionment allows the most important source or sources to be identified and options to reduce ambient concentrations of pollutants can then be considered and assessed.

The source apportionment should:

- Confirm that exceedences of NO_2 are due to road traffic
- Determine the extent to which different vehicle types are responsible for the emission contributions to NO_2: this will allow traffic management scenarios to be modelled/tested to reduce the exceedences
- Quantify what proportion of the exceedences of NO_2 is due to background emissions, or local emissions from busy roads in the local area. This will help determine whether local traffic management measures could have a significant impact on reducing emissions in the area of exceedence, or, whether national measures would be a suitable approach to achieving the air quality objectives

3.9.2 What is the 'base case'?

The base case in this assessment is defined as the annual mean concentrations of NO_2 that are predicted in the absence of any measures to improve air quality in Watford. They are the concentrations that should be relevant to defining the extent of Air Quality Management Areas.

3.9.3 Receptors considered

The most affected receptors where there is potential relevant public exposure have been considered: these are shown in Table 3.5.

Table 3.5: Most affected receptors exceeding annual average objective

General Area	Description	OS Grid reference of receptor
St Albans Road	1) Residential properties with facades on the east side north of Bushey Mill Lane for a distance of 70 m; 2) Residential properties with facades on the east side between Bushey Mill lane and Balmoral Road within 40 m of bus stops and pedestrian crossings; 3) Residential properties between Balmoral Road and Leavesden Road with facades on east side or on west side within 40 m of bus stops and pedestrian crossings; 4) Residential properties with facades on both sides between Station Road and Beechen Grove within 40 m of bus stops	510970, 198970 511010, 198330 510900,197750 510760, 197220
Farraline Road	1)-4) Junction Vicarage Road/Farraline Road 4)-7) Junction Wiggenhall Road/Farraline Road	510775, 196002 510764, 196010 510774, 196024 510789, 196016 510902, 195994 510869, 196014 510905, 196034
Pinner Road/Chalk Hill junction	1) Residential properties immediately to the north of the junction on Lower High Street; 2)Residential properties with facades on the north side of Chalk Hill between junction and Aldenham Road 3) Residential property at the juntion of Chalk Hill and Aldenham Road 4) Public house on junction of Pinner Road and Aldenham Road	511870, 195510 511969, 195431 512030, 195436 511943, 195307
Horseshoe Lane/A405 junction	1) Residential property on Horseshoe Lane, closest to junction 2) Two residential properties on St Albans Road nearest to the junction.	511680, 200700 511690, 200620

3.9.4 Sources of pollution

We have considered the effect of the following sources in this detailed assessment at the receptors considered:

- Background from sources outside the local area;
- Moving traffic;
- Traffic stationary at bus stops, pedestrian crossings and junctions.

The concentrations of oxides of nitrogen concentrations apportioned to each source category and the fractions of the total concentrations are shown in Table 3.6.

Table 3.6: Apportionment of oxides of nitrogen concentrations at most affected receptors

	Oxides of nitrogen concentration, µg m^{-3}				
Receptor	Total	Background	Road	HGV/HDV	Stationary
St Albans Road					
1	96.3	51.2	45.0	25.8	14.8
2	114.7	52.0	62.7	47.0	34.7
3	116.2	49.4	66.8	48.4	43.7
4	96.8	51.5	45.4	37.8	32.0
Hornets					
1	151.4	51.5	100.0	38.0	33.5
2	128.4	51.5	76.9	29.0	23.1
3	112.7	51.6	61.1	20.6	18.2
4	125.8	51.6	74.2	26.0	29.5
5	119.2	51.7	67.5	27.5	17.1
6	113.1	51.7	61.4	22.2	22.0
7	92.6	51.9	40.7	15.6	9.9
Oxhey					
1	199.2	53.5	145.7	55.5	61.5
2	349.8	52.0	297.8	163.2	78.0
3	232.9	51.5	181.4	75.5	78.6
4	214.3	51.2	163.1	67.4	69.1
Horseshoe Lane					
1	88.0	48.5	39.5	16.8	
2	77.0	48.3	28.7	11.5	

At many of the receptor sites, the contribution from stationary vehicles at bus stops, pedestrian crossings and junctions provides a significant part of the total oxides of nitrogen concentrations. Heavy-duty vehicles make a substantial contribution at many of the locations assessed.

3.10 Action plan scenarios

Watford Borough Council has carried out an initial assessment to identify the options available for improving air quality in the AQMAs. The key measures could potentially include:

1) Strategic measures to avoid worsening air quality

2) Efforts to reduce dependence on cars (e.g. the travel plan)
3) Efforts to reduce HGV flow through the AQMAs

These measures have been represented for modelling purposes as:

1) Zero growth in traffic in the AQMAs from 2006 to 2010;
2) A reduction of 10% in car flow rates from 2006 to 2010, with all other vehicle flowrates remaining at 2006 levels;
3) A reduction of 10% in HGV flow rates from 2006 to 2010, with all other vehicle flowrates remaining at 2006 levels.

The impact of these measures has been assessed by comparison with the base case for 2010.

Table 3.7 shows the predicted oxides of nitrogen concentrations at the most affected receptors exceeding the annual mean objective in 2006. Table 3.8 shows the predicted nitrogen dioxide concentrations. The oxides of nitrogen dioxide concentrations are predicted to decrease substantially between 2006 and 2010 as the result of improvements in vehicle technology. The Action Plan Scenarios show further small reductions in oxides of nitrogen concentrations at the selected receptor locations.

The nitrogen dioxide concentrations are also predicted to decrease between 2006 and 2010. At some of the receptors in the areas of St Albans Road, the Hornets Gyratory and Horseshoe Lane, the reduction is sufficient that the annual mean objective is expected to be met. The Action Plan Scenarios result in further small reductions in nitrogen dioxide concentrations: however, the reduction is not sufficient to achieve the annual mean objective at any of the selected receptors.

Table 3.7: Predicted oxides of nitrogen concentrations for the Action Plan Scenarios

Receptor	OS Grid coordinates		Oxides of nitrogen concentration, µg m^{-3}				
			2006, baseline	2010 scenarios			
	X, m	Y, m		baseline	1	2	3
St Albans Road							
1	510970	198970	96.3	77.1	75.5	74.0	73.6
2	511010	198330	114.7	91.0	88.7	87.5	85.3
3	510900	197750	116.2	91.9	89.5	88.0	85.9
4	510760	197220	96.8	77.2	75.5	74.9	72.7
Hornets							
1	510775	196002	151.4	116.6	113.5	111.6	111.3
2	510764	196010	128.4	99.6	97.2	95.8	95.5
3	510774	196024	112.7	87.9	86.0	84.7	84.9
4	510789	196016	125.8	97.7	95.3	93.7	93.8
5	510902	195994	119.2	92.7	90.6	89.1	88.8
6	510869	196014	113.1	88.3	86.4	85.0	85.0
7	510905	196034	92.6	73.1	71.8	70.9	70.8
Oxhey							
1	511870	195510	199.2	152.6	148.0	145.8	143.8
2	511969	195431	349.8	263.9	254.7	251.4	243.0
3	512030	195436	232.9	177.5	171.8	169.1	166.3
4	511943	195307	214.3	163.4	158.3	155.6	153.4
Horseshoe Lane							
1	511680	200700	88	69.9	68.6	67.6	67.3
2	511690	200620	77	61.7	60.8	60.0	59.9

Table 3.8: Predicted nitrogen dioxide concentrations for the Action Plan Scenarios

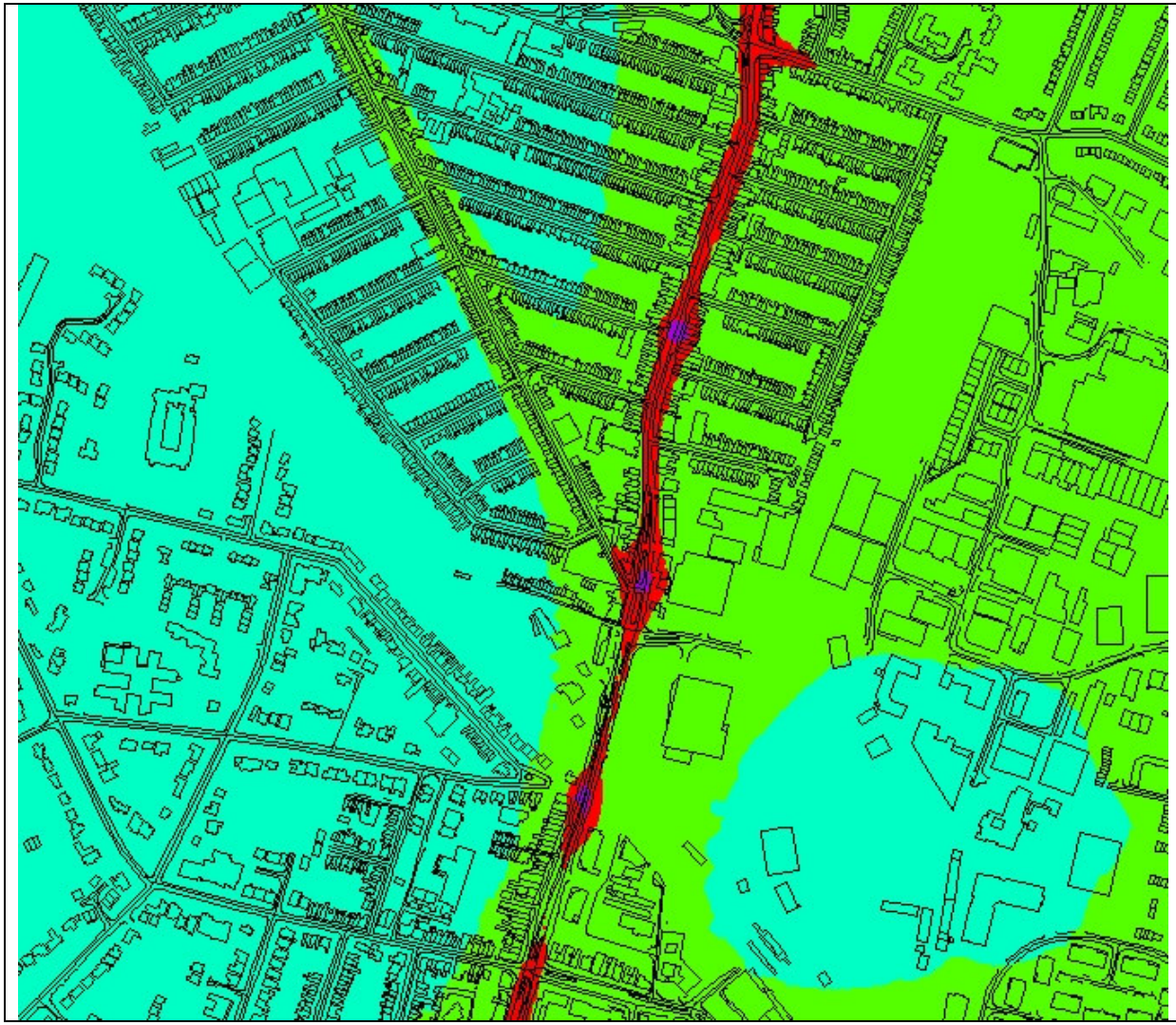
Receptor	OS Grid coordinates		Oxides of nitrogen concentration, µg m^{-3}				
			2006, baseline	2010 scenarios			
	X, m	Y, m		baseline	1	2	3
St Albans Road							
1	510970	198970	42.0	39.5	39.2	38.9	38.8
2	511010	198330	44.4	41.9	41.5	41.3	40.9
3	510900	197750	44.6	42.0	41.6	41.4	41.0
4	510760	197220	42.0	39.5	39.2	39.0	38.6
Hornets							
1	510775	196002	48.7	45.6	45.2	45.0	44.9
2	510764	196010	46.1	43.2	42.9	42.6	42.6
3	510774	196024	44.2	41.4	41.1	40.8	40.9
4	510789	196016	45.8	42.9	42.6	42.3	42.3
5	510902	195994	45.0	42.2	41.8	41.6	41.5
6	510869	196014	44.2	41.4	41.1	40.9	40.9
7	510905	196034	41.4	38.7	38.4	38.3	38.3
Oxhey							
1	511870	195510	53.4	49.9	49.4	49.2	49.0
2	511969	195431	66.4	60.5	59.7	59.4	58.7
3	512030	195436	56.5	52.6	52.0	51.7	51.4
4	511943	195307	54.8	51.1	50.6	50.3	50.0
Horseshoe Lane							
1	511680	200700	40.7	38.1	37.8	37.6	37.5
2	511690	200620	39.0	36.3	36.1	35.9	35.9

Fig. 3.1: Predicted nitrogen dioxide concentrations on St Albans Road between Bushey Mill Lane and Balmoral Road, 2006

Nitrogen dioxide, ug/m3

- 0 - 28
- 28 - 34
- 34 - 40
- 40 - 46
- 46 - 52
- >52

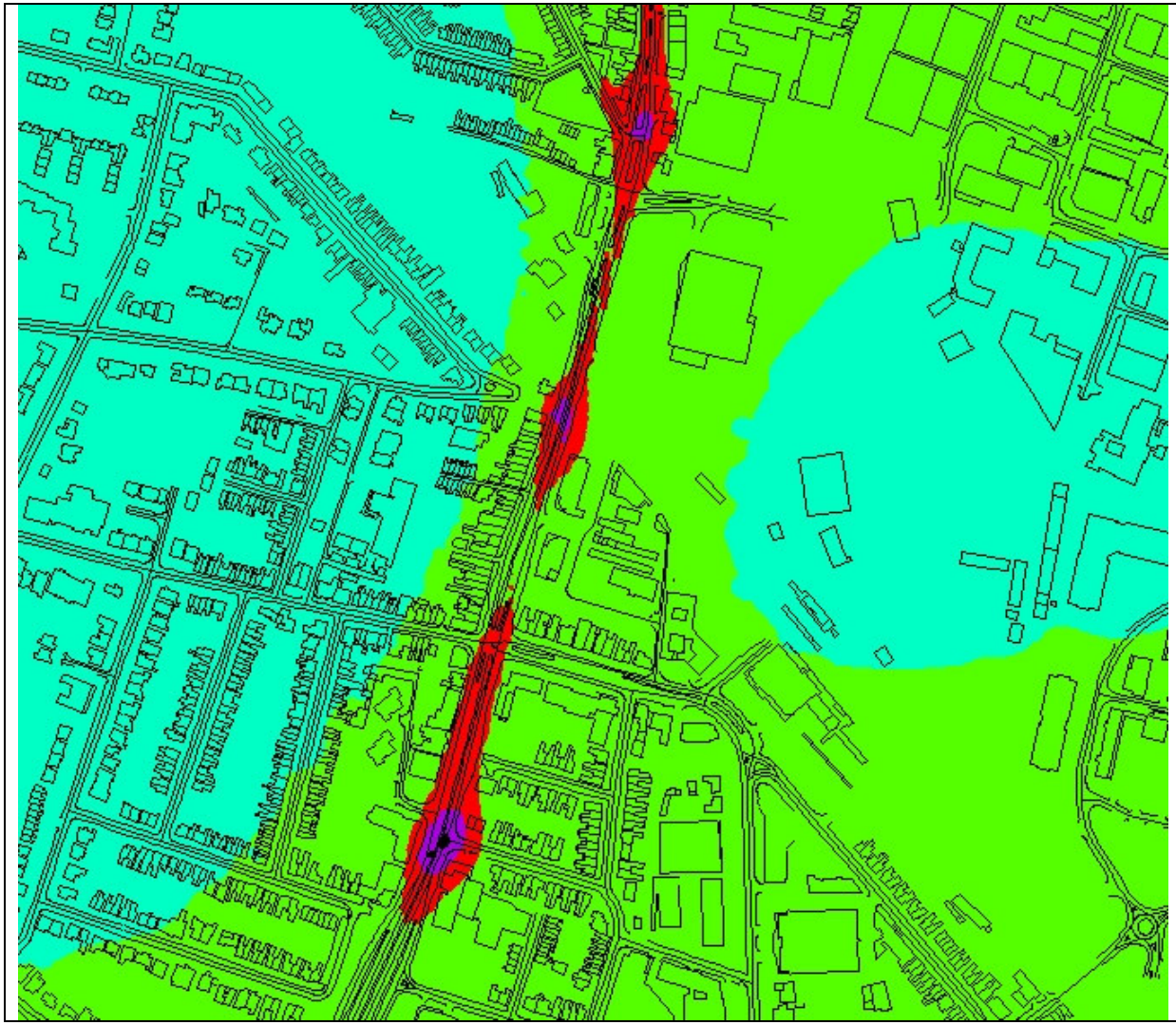
Fig. 3.2: Predicted nitrogen dioxide concentrations on St Albans Road between Balmoral Road and Leavesden Road, 2006



Nitrogen dioxide, ug/m3

- 0 - 28
- 28 - 34
- 34 - 40
- 40 - 46
- 46 - 52
- >52

Fig. 3.3: Predicted nitrogen dioxide concentrations on St Albans Road between Leavesden Road and Wellington Road, 2006



Nitrogen dioxide, ug/m3

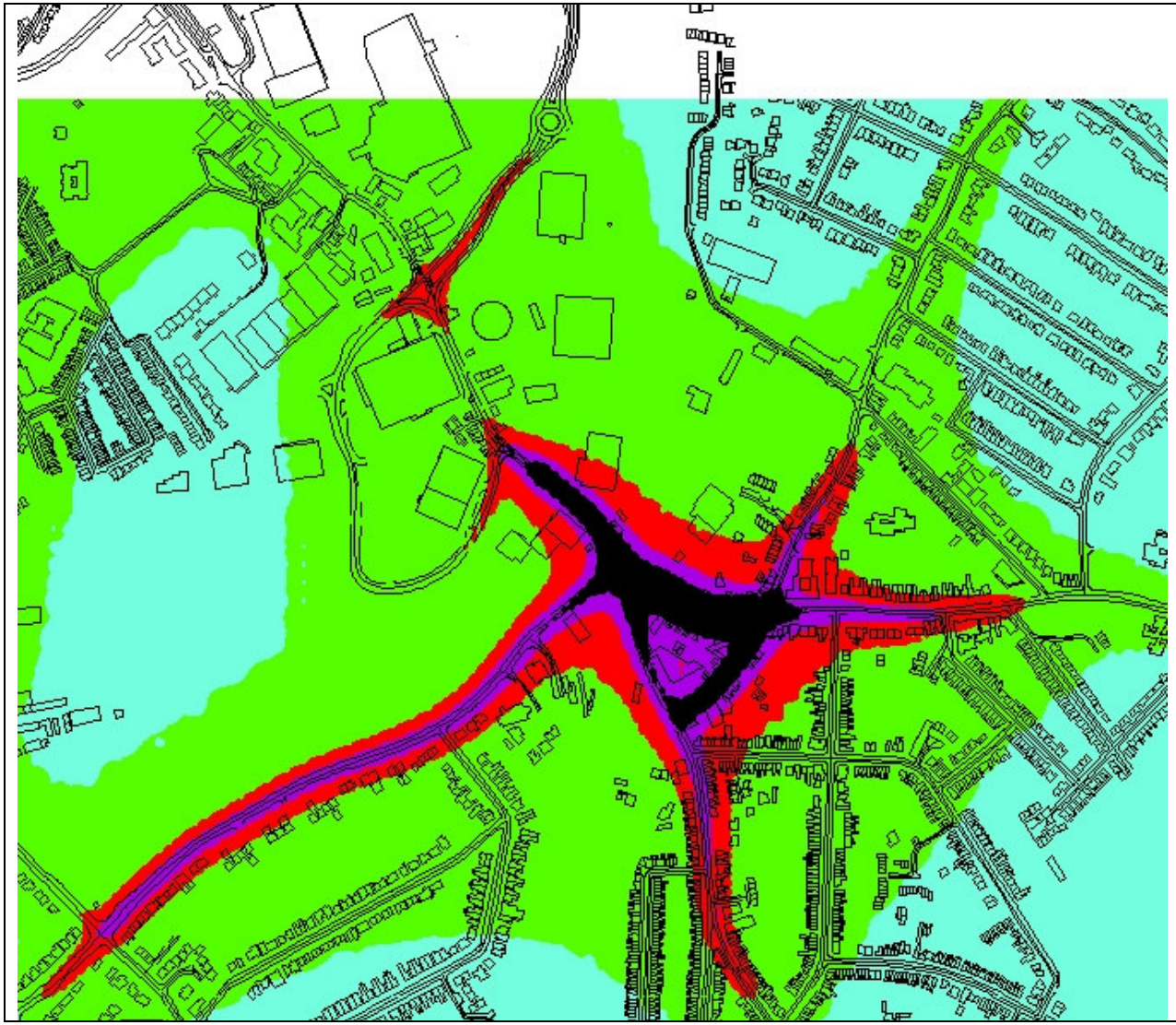
- 0 - 28
- 28 - 34
- 34 - 40
- 40 - 46
- 46 - 52
- >52

Fig. 3.4: Predicted nitrogen dioxide concentrations on the Hornets gyratory, 2006

Nitrogen dioxide, ug/m3

- 0 - 28
- 28 - 34
- 34 - 40
- 40 - 46
- 46 - 52
- >52

Fig. 3.5: Predicted nitrogen dioxide concentrations on Chalk Hill and Pinner Road, 2006



Nitrogen dioxide, ug/m3

- 0 - 28
- 28 - 34
- 34 - 40
- 40 - 46
- 46 - 52
- >52

Fig. 3.6: Predicted nitrogen dioxide concentrations at the junction of St Albans Road and Horseshoe Lane, 2006

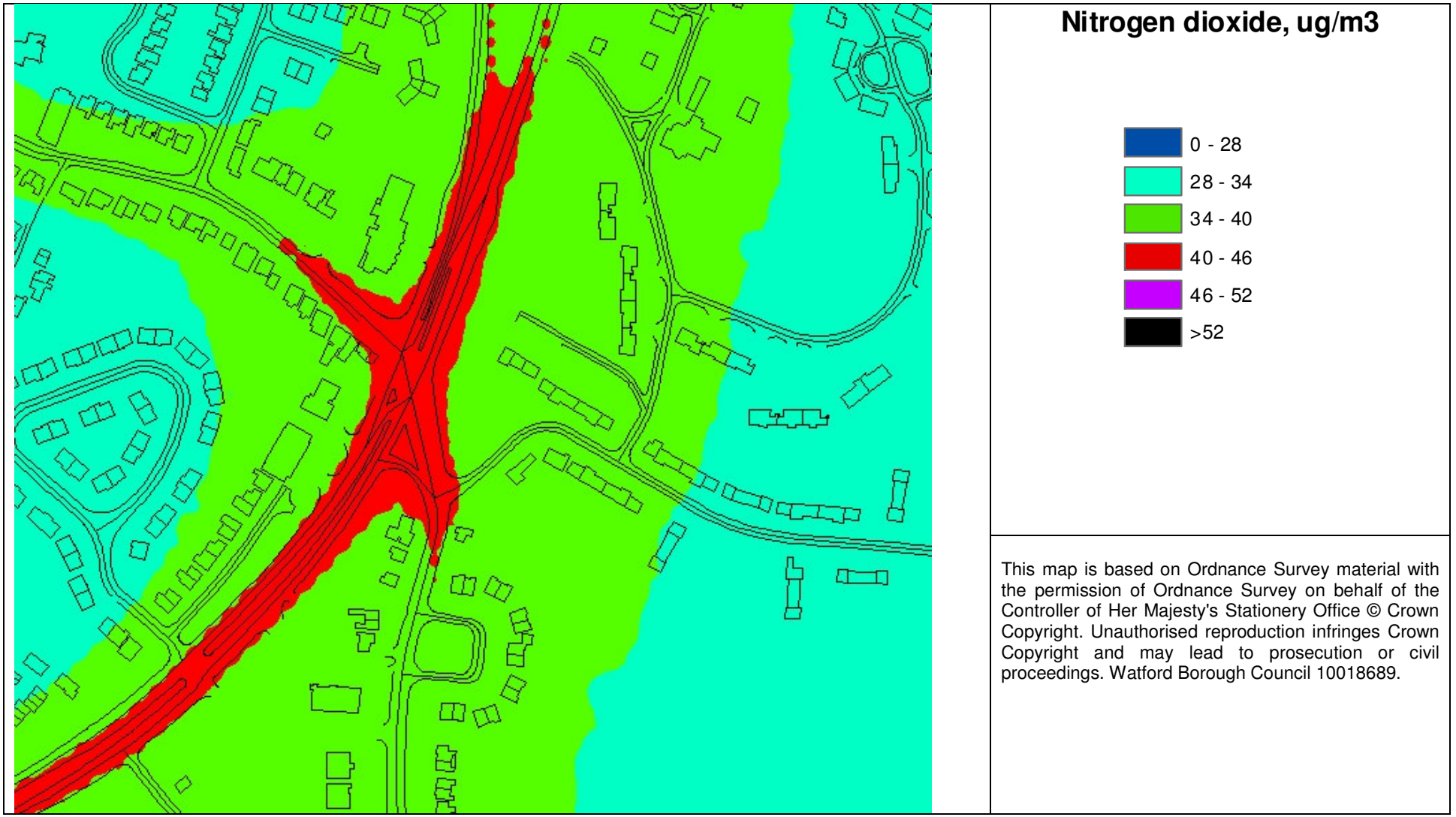


Fig. 3.7: Predicted nitrogen dioxide concentrations near the M1 past Ravenscroft and the Gossamers, 2006

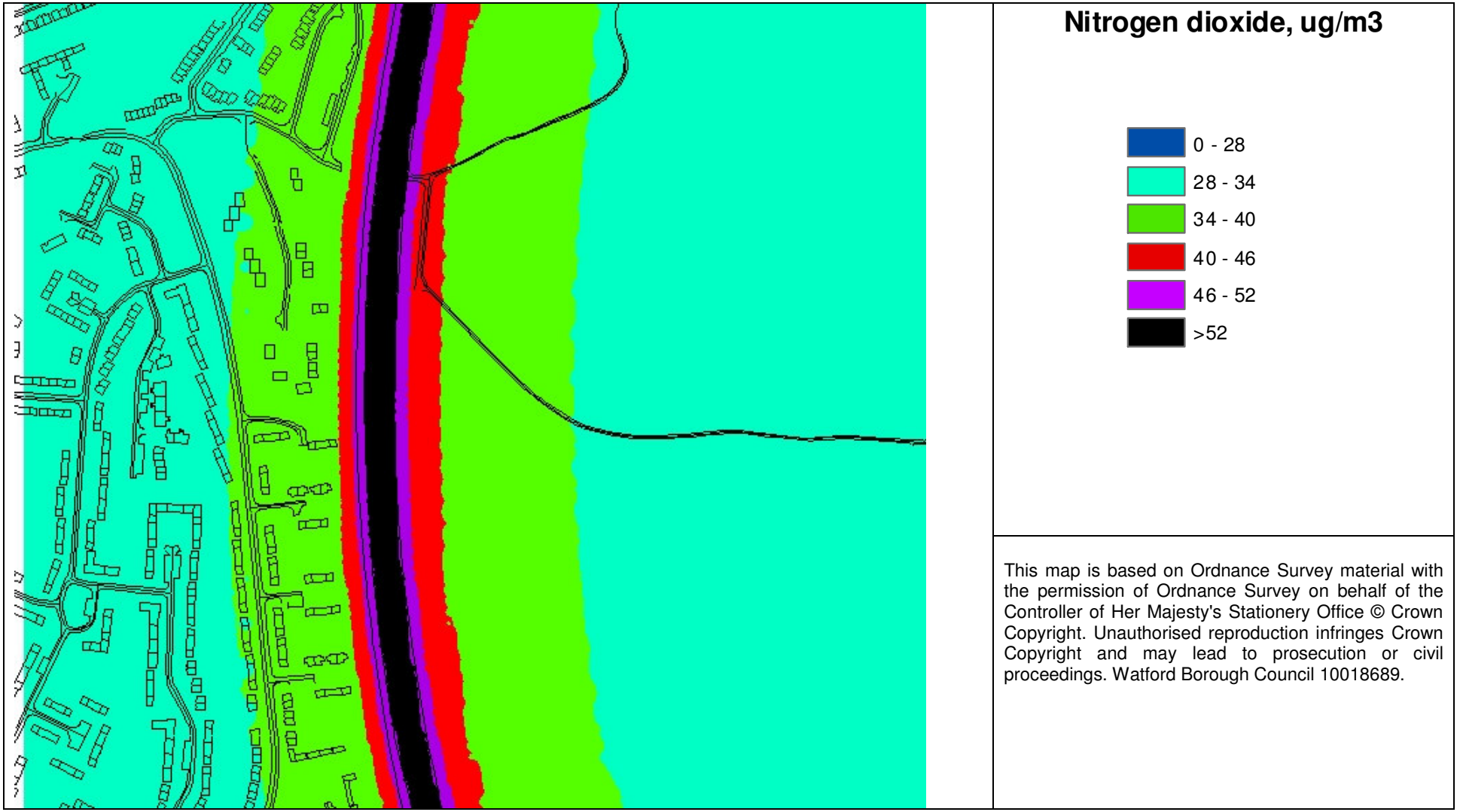
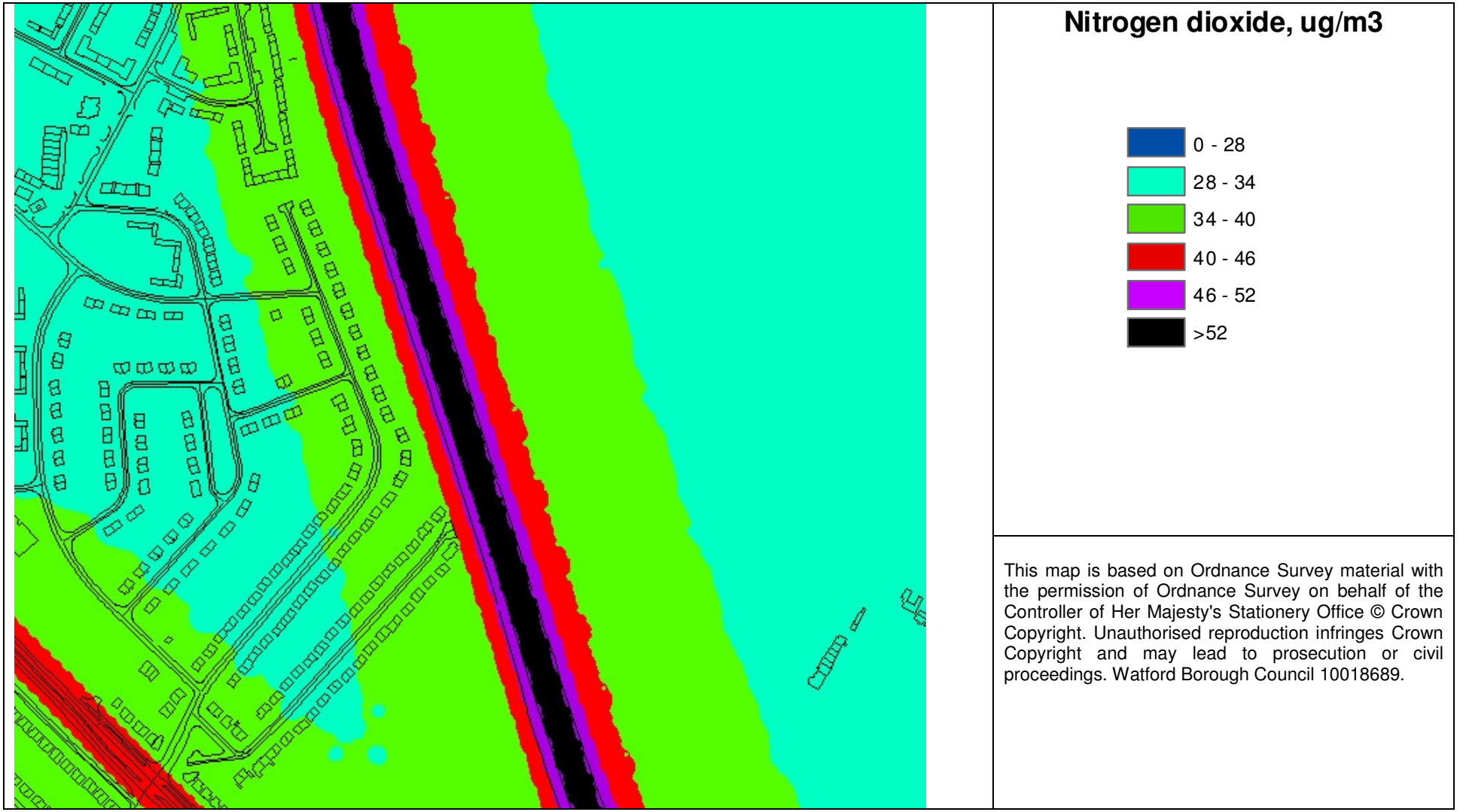


Fig. 3.8: Predicted nitrogen dioxide concentrations near the M1 past Eastfield Avenue, 2006



4 Conclusions

This Further Assessment has considered the following Air Quality Management Areas in Watford:

- AQMA No 1: St Albans Road
- AQMA No 2: Vicarage Road
- AQMA No 3: Pinner Road
- AQMA No 4: Chalk Hill
- AQMA No 5: A405/Horsehoe Lane
- AQMA No 6: M1/Meriden

The AQMAs were declared in February 2006 following the Detailed Assessment. A draft Further Assessment was prepared in February 2007. Watford Borough Council has considered measures for reducing oxides of nitrogen emissions in the AQMAs and has developed various Action Plan Scenarios. These include:

- Strategic measures to avoid worsening air quality
- Efforts to reduce dependence on cars (e.g. the travel plan)
- Efforts to reduce HGV flow through the AQMAs

The draft Further Assessment has been updated to include an assessment of the effects of these Scenarios on air quality in the AQMAs.

The Further Assessment takes account of additional monitoring and dispersion modelling. The additional monitoring included nitrogen dioxide diffusion tubes throughout the AQMAs and continuous monitoring at a roadside site on Rickmansworth Road. The dispersion modelling took account of detailed traffic count data and queue surveys. The modelling was carried out for the baseline year of 2006. In addition, the following scenarios were modelled in order to investigate the potential impact of the proposed Action Plan Scenarios:

- 2010 baseline based on expected traffic growth from 2006 in the absence of Action Plan measures;
- Zero growth in traffic in the AQMAs from 2006 to 2010;
- A reduction of 10% in car flow rates from 2006 to 2010, with all other vehicle flowrates remaining at 2006 levels;
- A reduction of 10% in HGV flow rates from 2006 to 2010, with all other vehicle flowrates remaining at 2006 levels.

4.1 AQMA No 1: St Albans Road

The measured concentration at the St Albans Road diffusion tube site in 2005 and 2006 exceeded the air quality objective for nitrogen dioxide. The modelled concentrations were very similar to those predicted in the Detailed Assessment. The Further Assessment thus confirms the need for an AQMA in this area.

Source apportionment of the modelled oxides of nitrogen concentrations indicated that local road emissions and emissions from background sources made approximately equal contributions in this area. Heavy goods vehicles and buses and stationary vehicles provide a substantial part of the road contribution.

Nitrogen dioxide concentrations are predicted to decrease between 2006 and 2010 at the most affected receptor locations in the area as the result of improvements in vehicle emissions technology. The reduction is sufficient that the air quality objective for nitrogen dioxide will be met at some locations within the AQMA. The Action Plan Scenarios will result in further small reductions in concentrations but the reduction is not sufficient to ensure that the annual mean objective will be met at all locations in the AQMA.

4.2 AQMA No 2: Vicarage Road

The measured concentrations at the hospital on Vicarage Road and at Farraline Road exceeded the air quality objective for nitrogen dioxide in 2006.

Predicted concentrations exceed the objective of 40 μg m^{-3} over a wide area covering the whole of the Hornets Gyratory and extending along Cassio Road north to Whippendell Road, along Vicarage Road northeast as far as Exchange Road, along Vicarage Road southwest as far as Occupation Road and 150 m southeast along Wiggenhall Road. The area of exceedence is larger than the area of the existing AQMA and larger than the area predicted in the Detailed Assessment. It is recommended that Watford Borough Council consider increasing the size of the AQMA to cover the whole of the Hornets Gyratory and extending along Cassio Road north to Whippendell Road, along Vicarage Road northeast as far as Exchange Road, along Vicarage Road southwest as far as Occupation Road and 150 m southeast along Wiggenhall Road.

Source apportionment of the modelled oxides of nitrogen concentrations indicated that local road emissions made the largest contribution in this area. Light duty cars and vans provide the greatest part of the road contribution.

Nitrogen dioxide concentrations are predicted to decrease between 2006 and 2010 at the most affected receptor locations in the area as the result of improvements in vehicle emissions technology. The reduction is sufficient that the air quality objective for nitrogen dioxide will be met at some locations within the AQMA. The Action Plan Scenarios will result in further small reductions in concentrations but the reduction is not sufficient to ensure that the annual mean objective will be met at all locations in the AQMA.

4.3 AQMA Nos. 3 and 4: Pinner Road and Chalk Hill

The measured nitrogen dioxide concentrations at the Pinner Road and Chalk Hill sites substantially exceeded the air quality objective of 40 μg m^{-3} as an annual mean.

The more detailed traffic data available for the Further Assessment has lead to an increase in the predicted concentrations in this area compared with those predicted in the Detailed Assessment. All properties on the gyratory system with facades on Chalk Hill, Pinner Road and Aldenham Road are predicted to have concentrations greater than the objective of 40 μg m^{-3}. The area extends with the queuing traffic along Eastbury Road as far as Deacon Hill, Pinner Road as far as Oxhey Avenue, Chalk Hill as far as Haydon Road, Aldenham Road as far as The Larches and Lower High Street as far as Dalton Way. It is recommended that Watford Borough Council consider extending the existing AQMAs to cover these areas.

Source apportionment of the modelled oxides of nitrogen concentrations indicated that local road emissions made the largest contribution in this area. Light duty vehicles (cars and vans) and heavy-duty vehicles (heavy goods and buses) provide approximately equal contributions. A large part of the modelled concentrations was attributed to stationary vehicle emissions.

Nitrogen dioxide concentrations are predicted to decrease between 2006 and 2010 at the most affected receptor locations in the area as the result of improvements in vehicle emissions technology. The Action Plan Scenarios will result in further small reductions in concentrations but the reduction is not sufficient to ensure that the annual mean objective will be met at all the most affected receptors in the AQMA.

4.4 AQMA No 5: A405/Horsehoe Lane

The measured concentration at the A405/Horseshoe Lane site exceeded the air quality objective for nitrogen dioxide in 2005 and 2006.

The modelled concentrations are similar to, but slightly less than, those predicted in the Detailed Assessment. One property (1026 St Albans Road) that is currently included in the AQMA is shown to be outside the predicted area of exceedence. However, the predicted concentration is only marginally less than the objective and within the range of uncertainty in the model. It is therefore recommended that no change is made to the area of the AQMA.

Source apportionment of the modelled oxides of nitrogen concentrations indicated that local road emissions made a smaller contribution in this area than the background sources. Light duty vehicles (cars and vans) and heavy-duty vehicles (heavy goods and buses) provide approximately equal contributions.

Nitrogen dioxide concentrations are predicted to decrease between 2006 and 2010 at the most affected receptor locations in the area as the result of improvements in vehicle emissions technology. The reduction is sufficient that the air quality objective for nitrogen dioxide will be met throughout the AQMA. The Action Plan Scenarios will result in further small reductions in concentrations.

4.5 AQMA No 6: M1/Meriden

The measured concentration at the Ravenscroft site near the motorway was less than the air quality objective for nitrogen dioxide in 2005 and 2006.

The modelled concentrations for this Further Assessment are similar to, but slightly less than, those predicted in the Detailed Assessment. Properties on Ravenscroft, the Gossamers and Eastfield Avenue that are within the existing AQMA are not predicted to exceed the 40 $\mu g\ m^{-3}$ objective. It is therefore recommended that Watford Borough Council consider revoking the AQMA.

5 References

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Maps of Estimated Ambient Air Pollution in 2001 and Projections for Other Years. http://www.airquality.co.uk/archive/laqm/tools.php

Appendices

Appendix 1:Traffic data summary

Appendix 2: Air Quality Management Areas

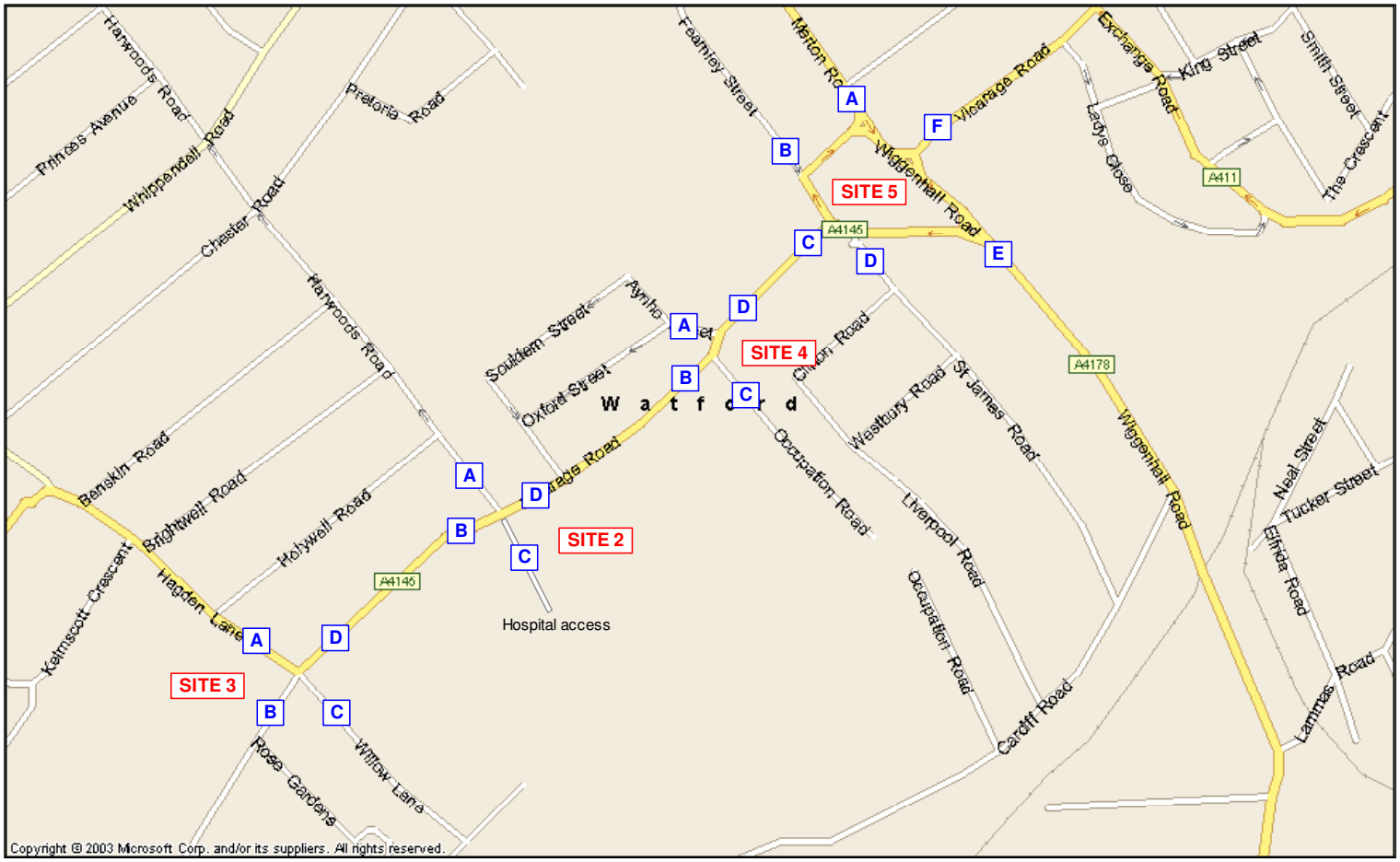
Appendix 1

Traffic data summary

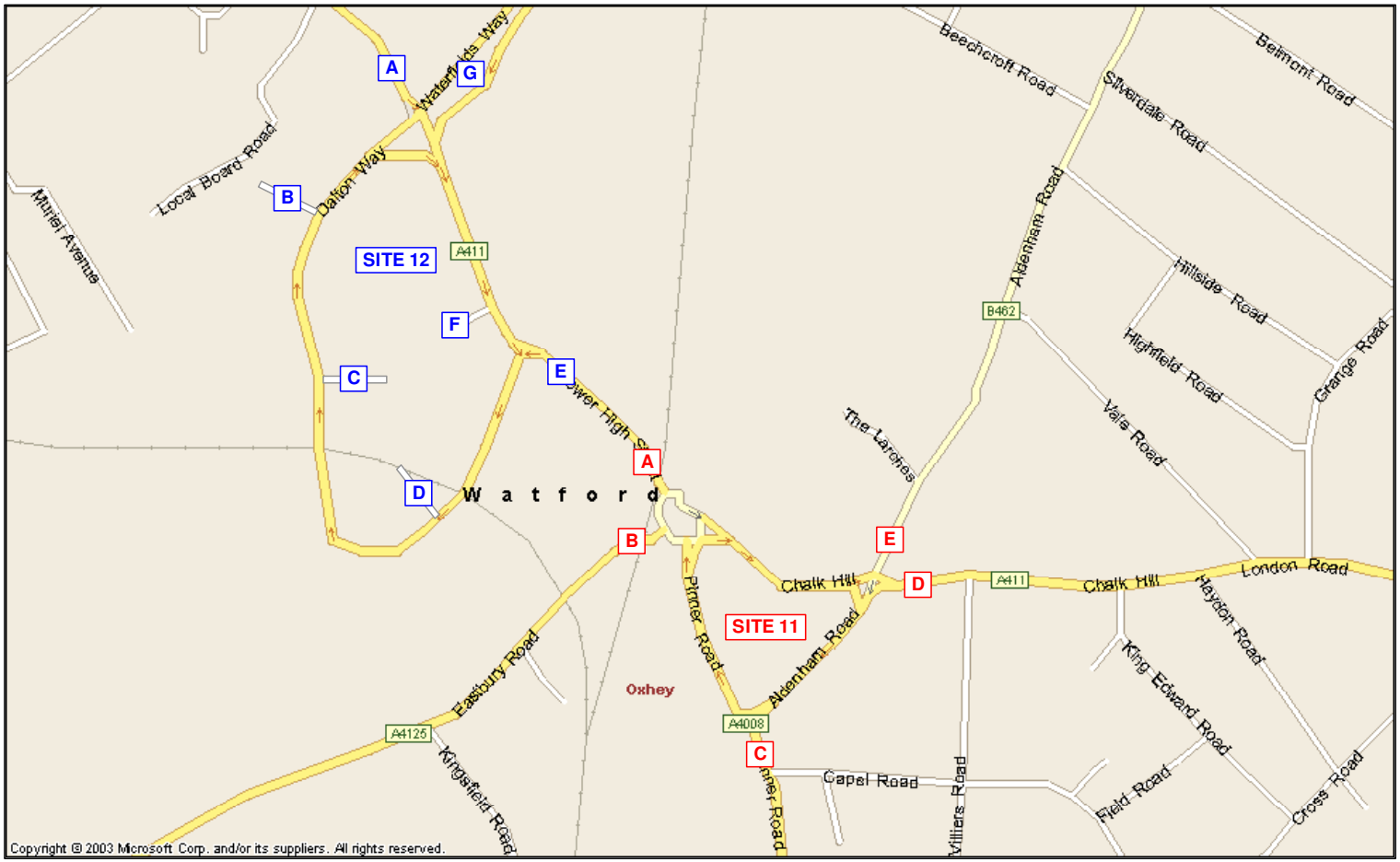
Contents

Map of traffic count sites, Sites 2,3, 4 and 5
Map of traffic count sites, Sites 11 and 12
Map of queue survey sites, Vicarage Road
Map of queue survey sites, Hornets gyratory
Map of queue survey sites, Chalk Hill
8 hour traffic counts at sites 2-5, 11 and 12
Queue lengths
NAEI annual average daily traffic flows on main roads

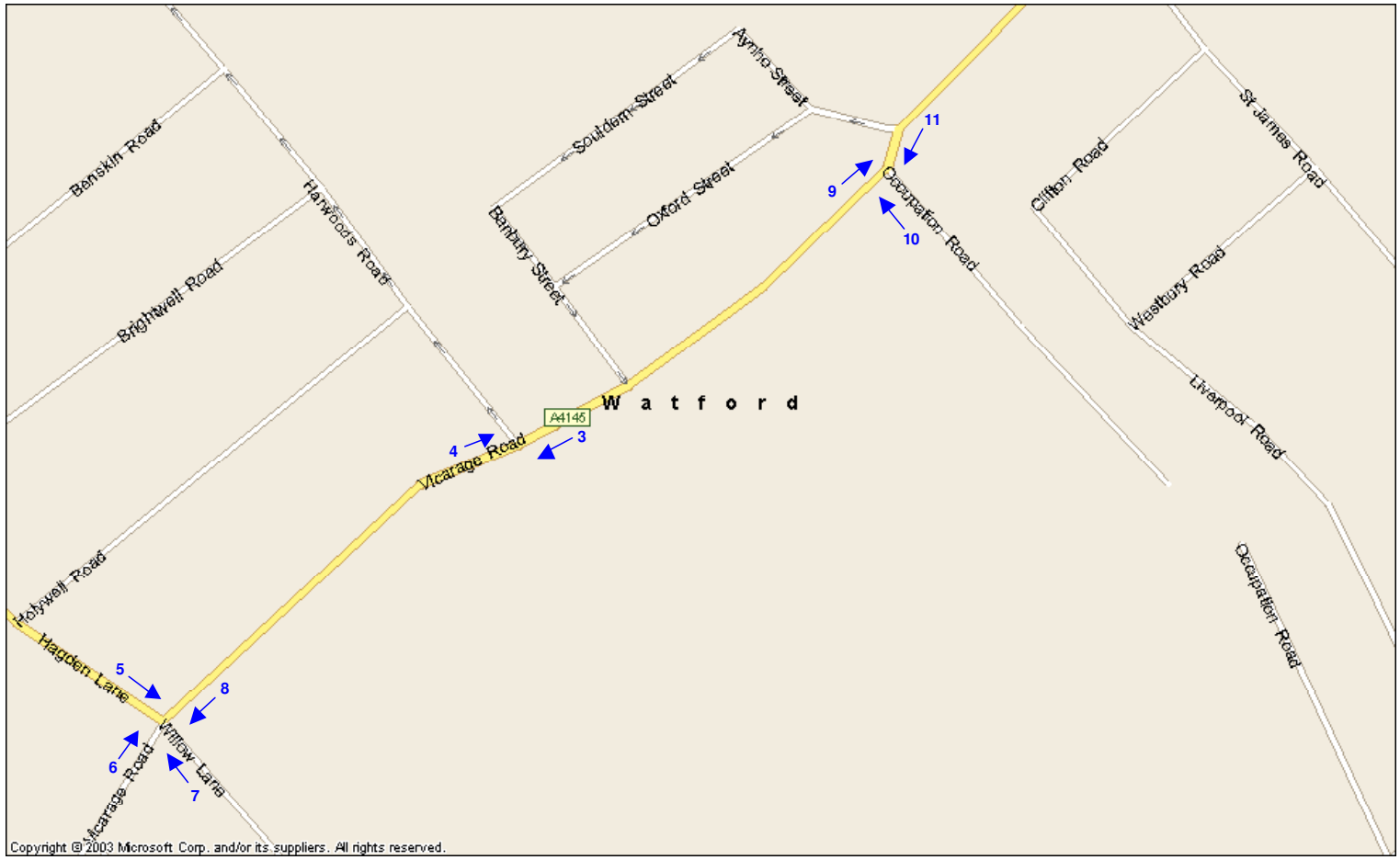
Map of traffic count sites, Sites 2,3, 4 and 5



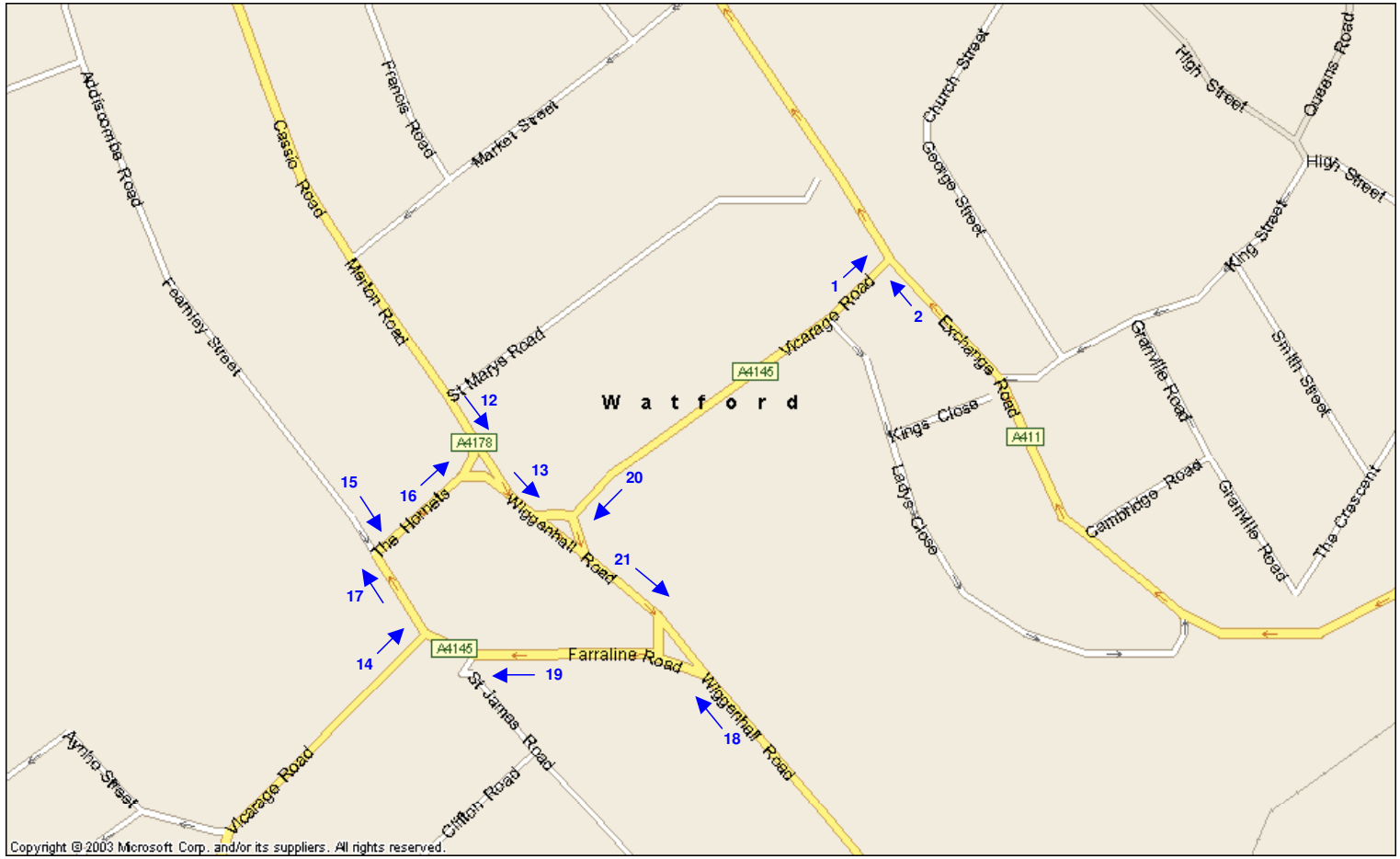
Map of traffic count sites, Sites 11 and 12



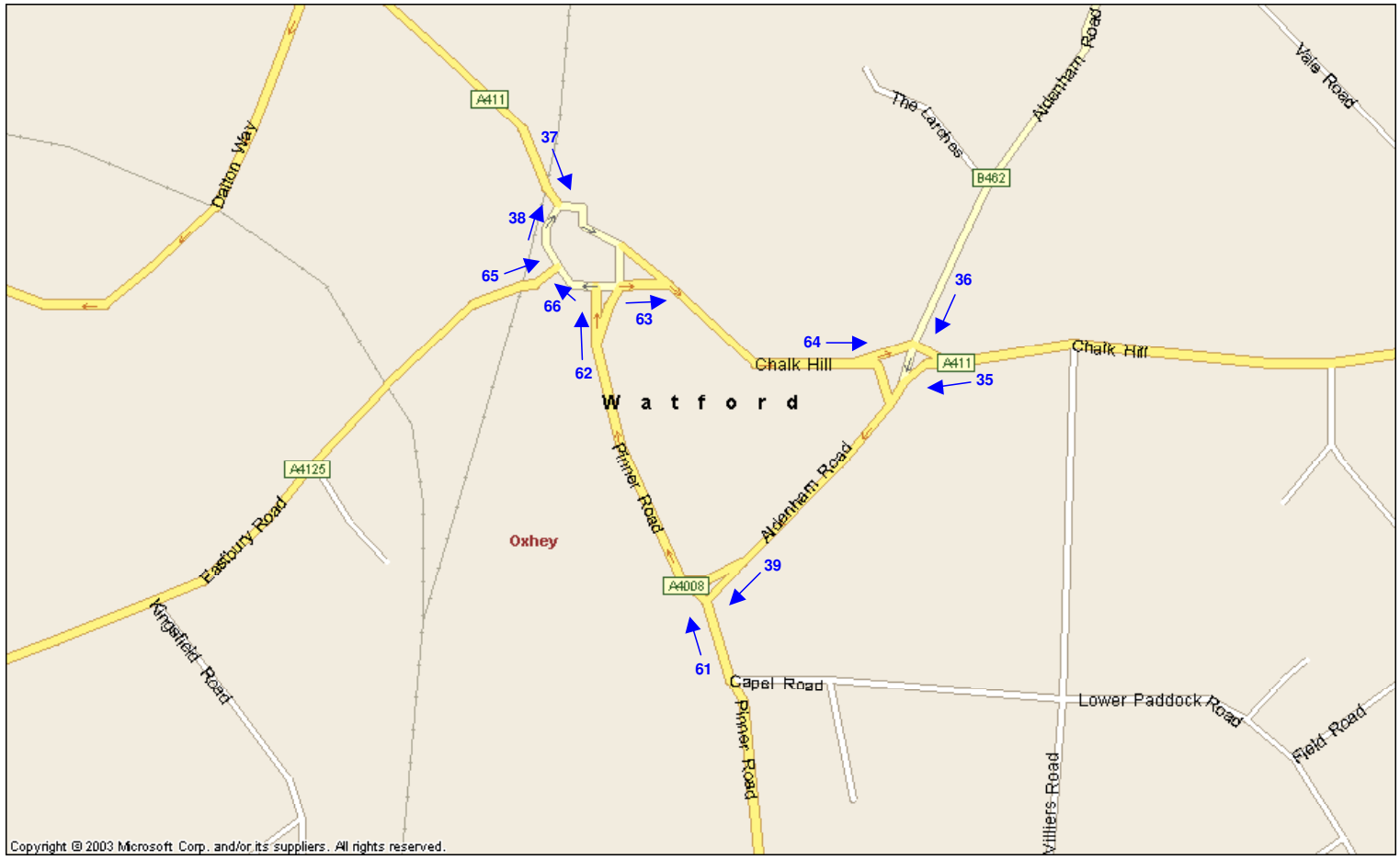
Map of queue survey sites, Vicarage Road



Map of queue survey sites, Hornets gyratory



Map of queue survey sites, Chalk Hill



8 hour traffic counts at sites 2-5, 11 and 12

Site	Road	CAR	LGV	HGV	S.BUS	O.PSV	MCL
2	B	7226	934	296	72	77	93
2	D	8395	1016	338	72	83	103
3	A	5746	790	395	101	89	91
3	B	2190	223	64	0	37	31
3	C	1252	68	62	1	39	4
3	D	7248	909	479	102	121	120
4	B	8782	983	336	71	84	74
4	D	8961	999	341	71	90	99
5	A ENTRY	3218	415	60	36	29	48
5	A EXIT	3262	367	109	0	28	35
5	B ENTRY	797	91	17	0	9	9
5	C ENTRY	3941	422	36	36	37	40
5	C EXIT	5017	621	199	38	57	114
5	D EXIT	378	41	10	0	2	7
5	E ENTRY	5288	609	186	3	44	60
5	E EXIT	6515	979	258	4	59	76
5	F ENTRY	2667	373	72	2	20	31
5	F EXIT	2370	224	58	34	11	32
11	A ENTRY	6288	872	404	244	133	105
11	A EXIT	6676	806	297	25	106	119
11	B ENTRY	5601	766	261	67	115	112
11	B EXIT	4720	660	293	70	137	78
11	C ENTRY	3260	361	176	6	47	45
11	C EXIT	4031	495	199	25	77	60
11	D ENTRY	2794	296	171	127	53	55
11	D EXIT	2747	345	189	138	51	41
11	E ENTRY	2669	300	111	63	56	32
11	E EXIT	2460	331	131	57	52	51
12	A ENTRY	1140	179	61	158	7	19
12	A EXIT	82	18	9	147	12	6
12	B ENTRY	660	69	13	1	7	12
12	B EXIT	668	68	12	0	4	12
12	C ENTRY	1227	292	26	0	11	8
12	D EXIT	427	109	7	0	2	1
12	E ENTRY	6630	796	174	155	61	84
12	E EXIT	6326	883	236	163	80	82
12	F EXIT	855	195	9	0	6	10
12	G ENTRY	5869	854	205	9	60	77
12	G EXIT	7233	874	213	57	46	93

Queue lengths

Queue	Lane	Percentile of queue lengths over 8-hour peak period, m						
		0%	25%	50%	75%	90%	95%	100%
1	LANE 1	0	35	55	80	106.5	110	120
2	LANE 1	0	0	0	25	85.5	110	110
2	LANE 2	0	0	0	25	60	60	65
3	LANE 1	0	17.5	32.5	40	51.5	62	75
4	LANE 1	0	15	47.5	75	117.5	143.4	147
5	LANE 1	5	10	17.5	45	120	141	180
5	LANE 2	0	5	5	10	11.5	15	25
6	LANE 1	5	10	15	20	30	30	35
7	LANE 1	5	10	20	25	30	33.5	45
8	LANE 1	5	5	10	15	20	20	25
8	LANE 2	10	35	52.5	80	99.5	117	130
9	LANE 1	0	40	146.5	205	263	277	290
10	LANE 1	0	0	0	5	6.5	10	10
11	LANE 1	0	0	0	0	0	0	0
12	LANE 1	0	60	145	190	311.5	315	315
13	LANE 1	0	15	15	15	15	15	15
13	LANE 2	0	27.5	30	30	30	30	30
14	LANE 1	10	87.5	90	90	95	118.1	145
15	LANE 1	0	15	20	25	36.5	40	40
16	LANE 1	0	0	0	20	36.5	43.5	55
16	LANE 2	0	27.5	37.5	45	55	55	55
17	LANE 1	0	0	0	0	0	0	35
17	LANE 2	0	0	0	0	17.5	35	35
18	LANE 1	0	35	77.5	125	156	177	190
19	LANE 1	0	62.5	75	80	80	80	80
19	LANE 2	10	72.5	75	80	80	80	80
20	LANE 1	0	32.5	140	250	250	250	250
21	LANE 1	0	0	0	0	0	0	25
21	LANE 2	0	0	0	0	0	0	0
21	LANE 3	0	50	100	120	120	120	120
22	LANE 1	0	47.5	80	120	186	200	250
23	LANE 1	0	12.5	20	30	33	40	40
24	LANE 1	0	45	80	160	200	200	250
25	LANE 1	0	0	0	20	79	152.5	200
26	LANE 1	0	0	5	5	10	10	30
27	LANE 1	0	5	10	15	16.5	20	25
28	LANE 1	0	10	15	20	26.5	30	40
29	LANE 1	6	20	30	45	61.5	65	85
29	LANE 2	3	150	275	300	300	300	300
30	LANE 1	6	70	70	70	70	70	70
30	LANE 2	5	20	27.5	45	50	53.5	55
31	LANE 1	0	15	22.5	35	41.5	55.5	80

Queue	Lane	Percentile of queue lengths over 8-hour peak period, m						
		0%	25%	50%	75%	90%	95%	100%
32	LANE 1	0	166.5	300	800	800	800	800
33	LANE 1	0	5	10	20	122.5	164.5	190
34	LANE 1	0	20	55	83	121.6	130	130
35	LANE 1	5	55	105	155	189.5	207	210
36	LANE 1	10	90	135	185	205	208.5	210
37	LANE 1	0	62.5	150	150	150	150	150
37	LANE 2	0	20	45	55	55	55	60
38	LANE 1	0	0	10	20	20	20	35
39	LANE 1	15	80	102.5	142	142	142	142
39	LANE 2	20	92.5	142	142	142	142	142
40	LANE 1	0	10	15	25	30	33.5	40
41	LANE 1	0	0	15	15	25	25	25
42	LANE 1	0	110	150	150	150	150	150
43	LANE 1	0	0	10	15	21.5	25	25
43	LANE 2	0	0	0	5	10	10	10
44	LANE 1	0	10	92.5	100	106.5	120.5	135
44	LANE 2	0	52.5	72.5	110	141.5	152	155
44	LANE 3	0	20	25	30	41.5	48.5	100
44	LANE 4	0	5	5	10	11.5	15	15
45	LANE 1	0	0	0	0	0	0	0
46	LANE 1	0	87.5	160	160	160	160	160
46	LANE 2	5	20	30	45	60	67	70
47	LANE 1	10	80	120	140	173	180	190
48	LANE 1	0	100	175	220	234.5	248.5	250
48	LANE 2	0	17.5	75	90	113	123.5	180
49	LANE 1	0	5	5	5	10	10	15
50	LANE 1	0	35	47.5	70	96.5	100	115
51	LANE 1	0	0	0	0	0	0	5
52	LANE 1	0	7.5	12.5	20	25	29.9	35
53	LANE 1	0	10	11	17	27	29.1	32
54	LANE 1	0	5	20	50	73	83.5	90
55	LANE 1	0	0	0	5	10	13.5	25
55	LANE 2	0	0	0	0	5	5	10
56	LANE 1	0	0	5	10	23	33.5	65
57	LANE 1	0	10	20	35	41.5	48.5	60
58	LANE 1	0	0	0	0	8	32.5	45
59	LANE 1	5	95	150	200	230	230	250
59	LANE 2	0	0	0	0	6	27	30
60	LANE 1	10	110	200	200	250	285	330
60	LANE 2	0	30	30	40	43	50	110
61	LANE 1	10	87.5	200	300	345	345	345
62	LANE 1	0	80	120	125	125	125	125
63	LANE 1	0	25	35	45	51.5	62	85

Queue	Lane	Percentile of queue lengths over 8-hour peak period, m						
		0%	25%	50%	75%	90%	95%	100%
64	LANE 1	5	20	27.5	30	35	38.5	40
64	LANE 2	5	122.5	185	185	185	185	185
64	LANE 3	5	67.5	125	145	145	145	145
65	LANE 1	5	60	80	185	630	700	700
65	LANE 2	5	10	15	20	20	20	20
66	LANE 1	0	5	5	10	15	15	20
67	LANE 1	0	0	25	50	50	53.5	70
68	LANE 1	0	0	0	0	0	3.5	5

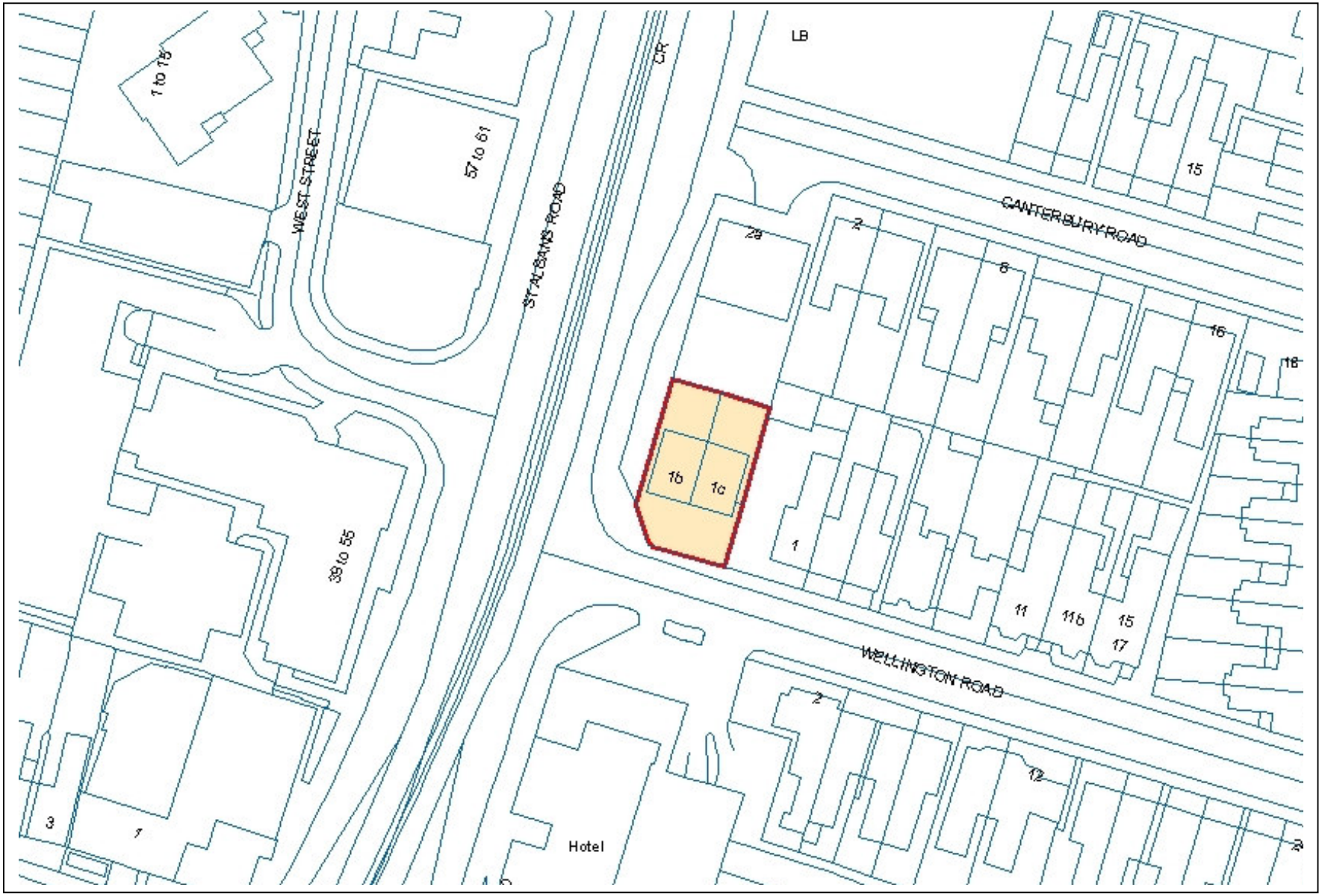
NAEI annual average daily traffic flows on main roads

Census ID	Road	All	Car	Bus	LGV	HGV rigid	HGV articulated	motorcycle
8707	A412	19509	16456	413	1791	532	55	262
28319	A411	26734	23428	287	2178	428	59	354
58090	A412	49159	42109	221	5074	989	185	581
17027	A411	323417	20436	121	2019	570	75	196
18397	A4178	13543	11980	45	1123	258	9	128
38668	A4125	16405	14390	235	1341	325	8	106
8582	A4178	19256	16419	69	2011	512	9	236
57123	A412	10822	8727	347	1052	420	105	171
57111	A405	30948	25709	219	3665	822	245	288
26461	A41	32851	28024	164	3270	783	176	434
16001	M1	91311	72508	494	11609	3630	2210	860

Appendix 2

Air Quality Management Areas

Air Quality Management Area – Watford No.1 (St.Albans Road) Map A



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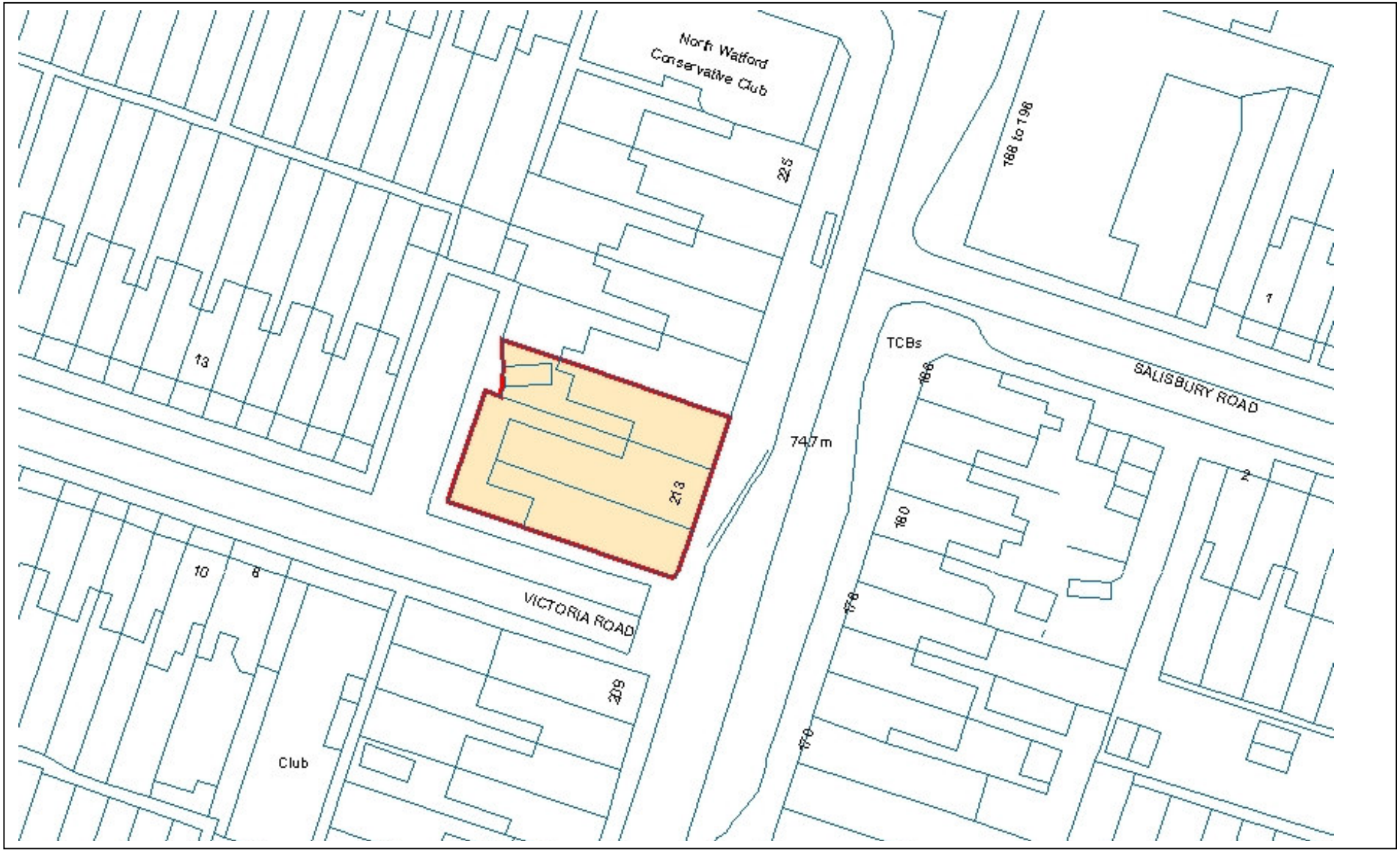
Air Quality Management Area – Watford No.1 (St.Albans Road) Map B

Air Quality Management Area – Watford No.1 (St.Albans Road) Map C



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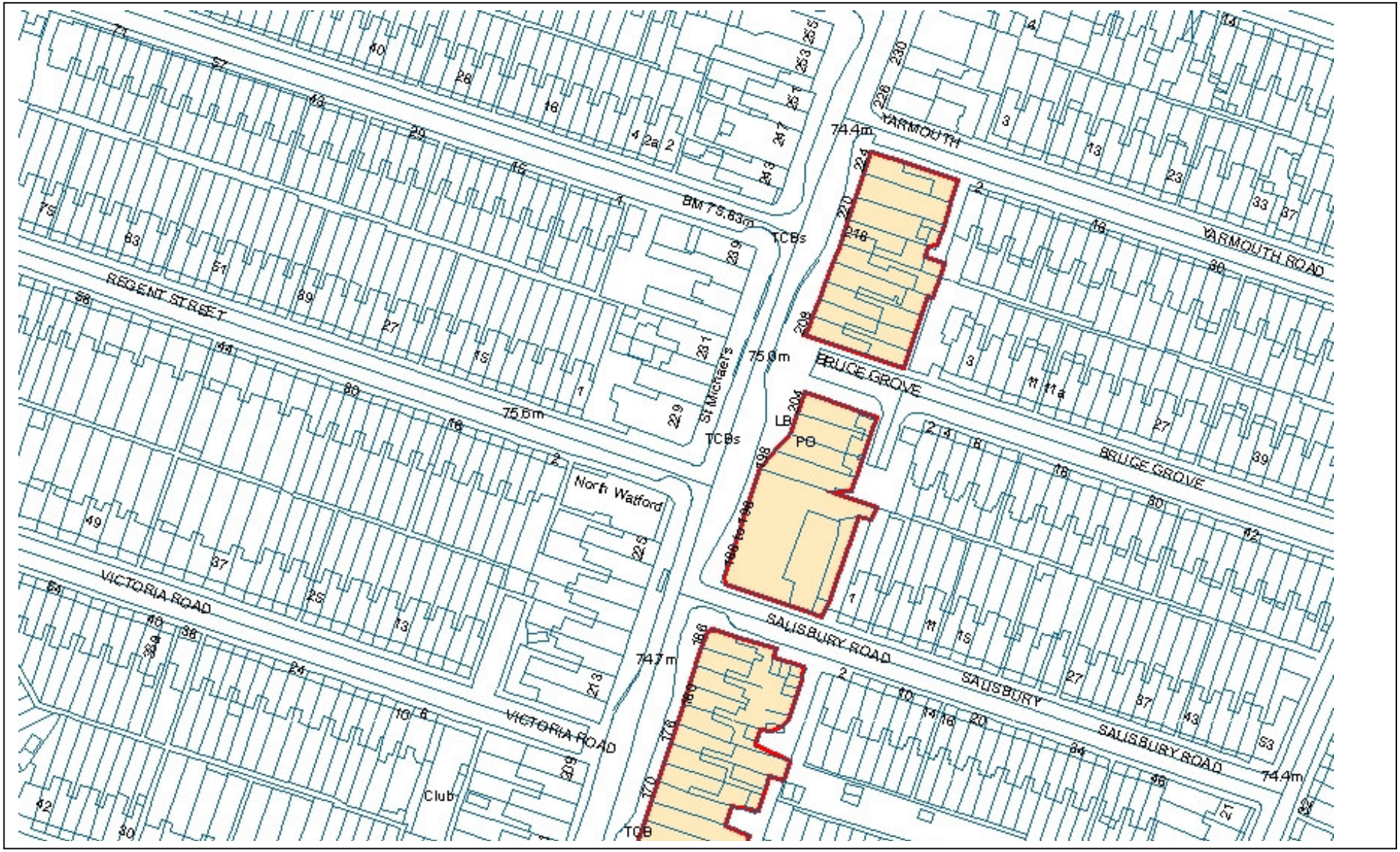
Air Quality Management Area – Watford No.1 (St.Albans Road) Map D



Air Quality Management Area – Watford No.1 (St.Albans Road) Map E

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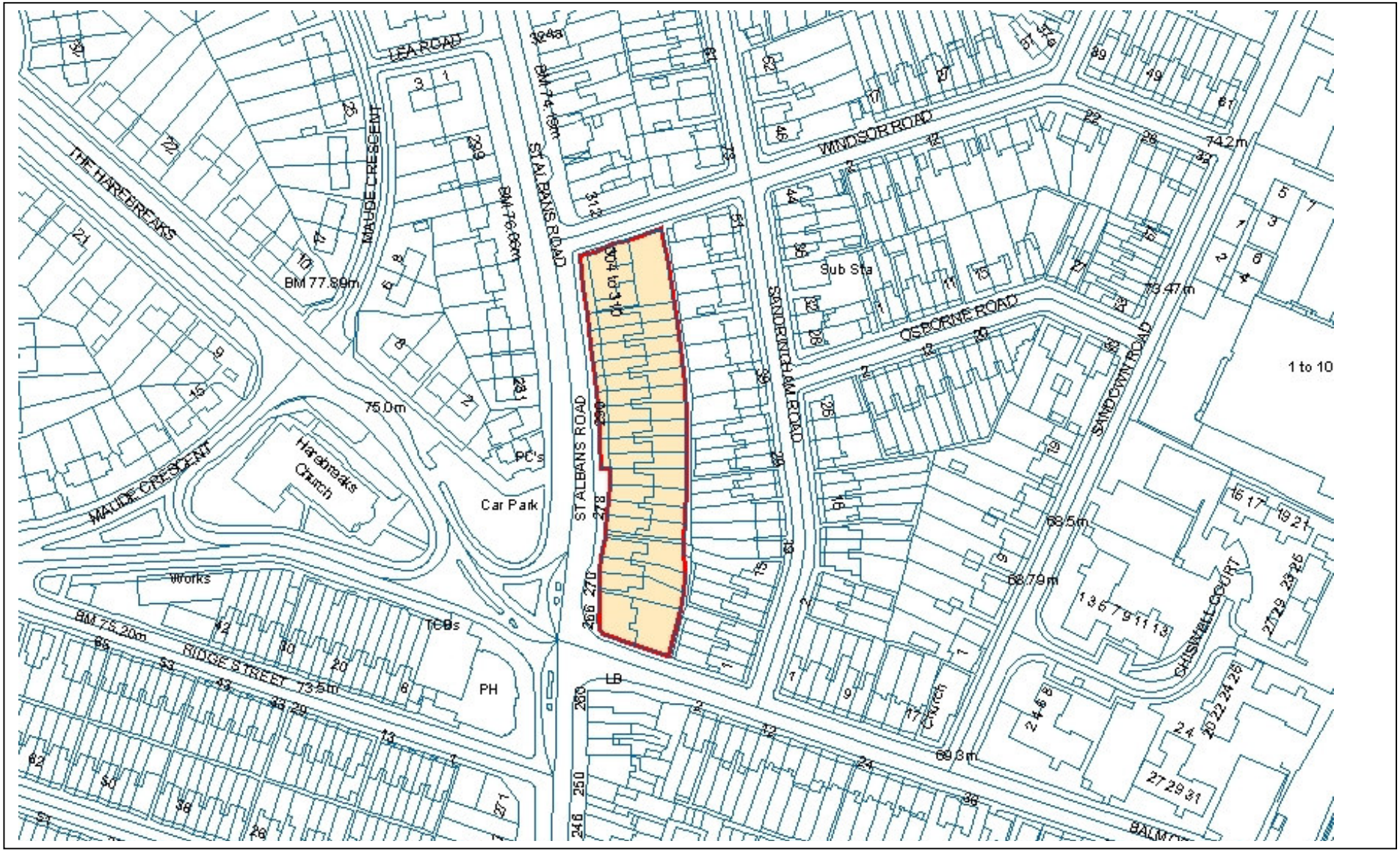
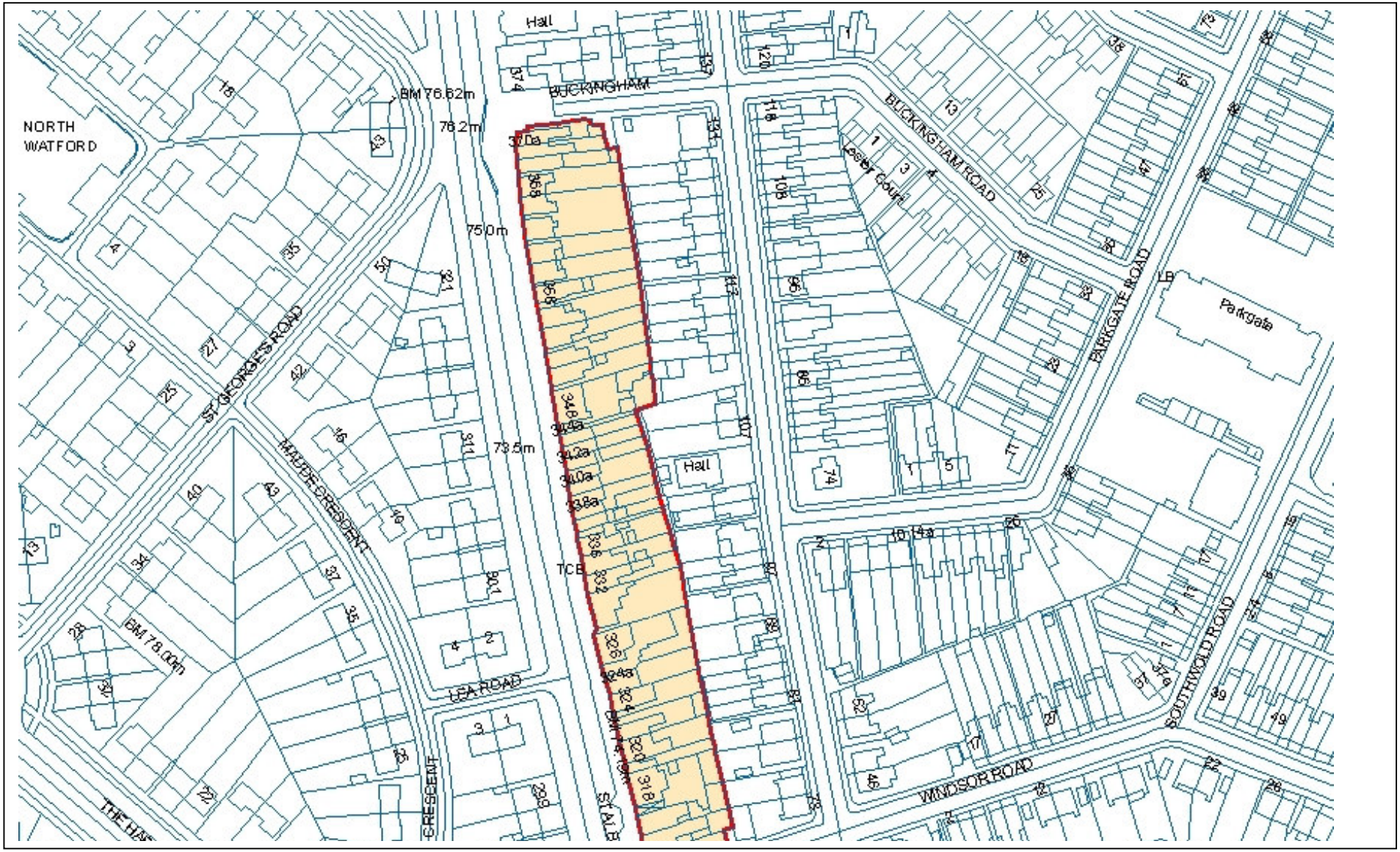
Air Quality Management Area – Watford No.1 (St.Albans Road) Map F



Air Quality Management Area – Watford No.1 (St.Albans Road) Map G



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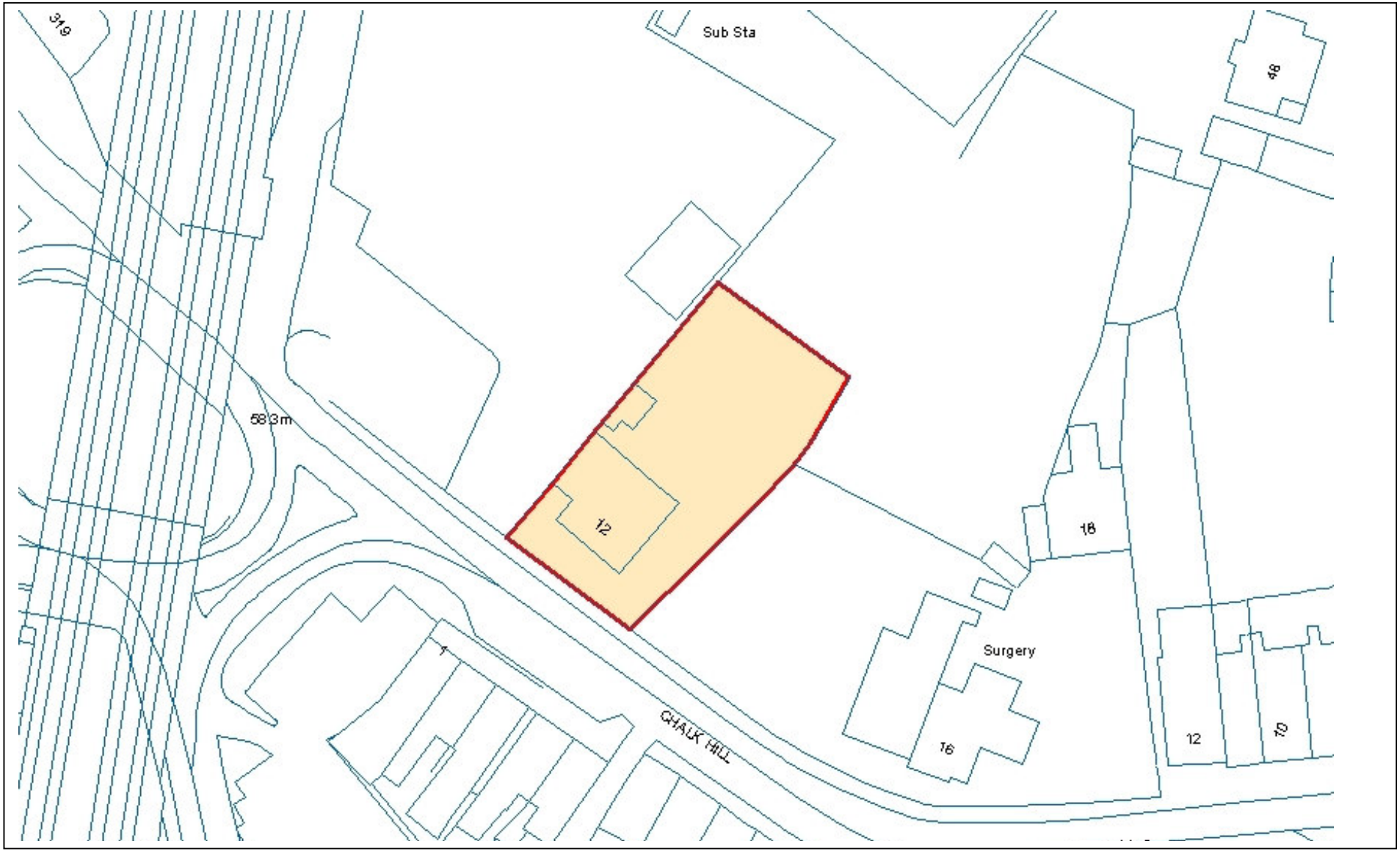
Air Quality Management Area – Watford No.1 (St.Albans Road) Map H

Air Quality Management Area – Watford No.2 (Vicarage Road) Map A

AEA

Air Quality Management Area – Watford No.3 (Pinner Road) Map A

Air Quality Management Area – Watford No.4 (Chalk Hill) Map A



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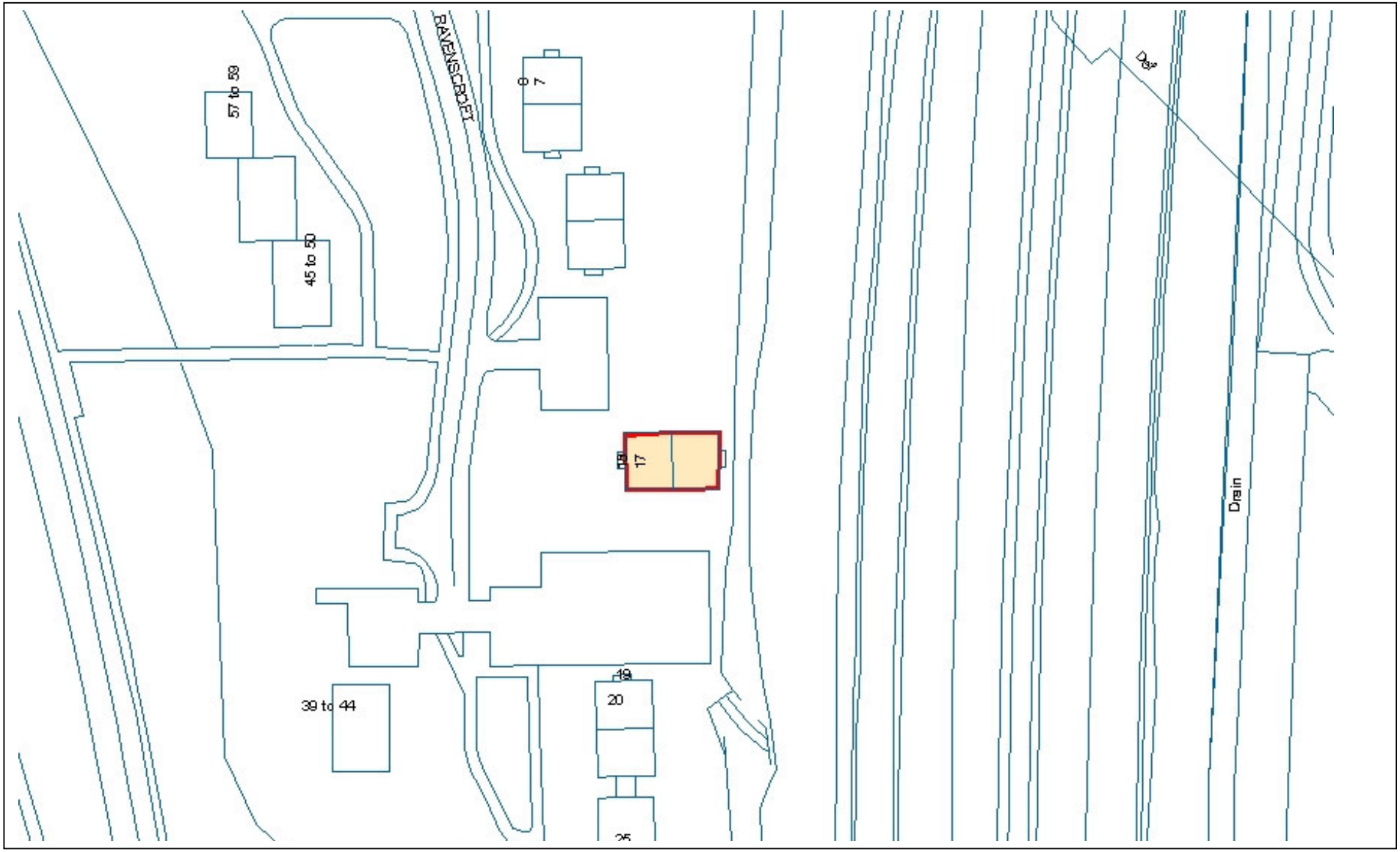
Air Quality Management Area – Watford No.5 (A405/Horseshoe Lane) Map A

Air Quality Management Area – Watford No.6 (M1/Meriden) Map A



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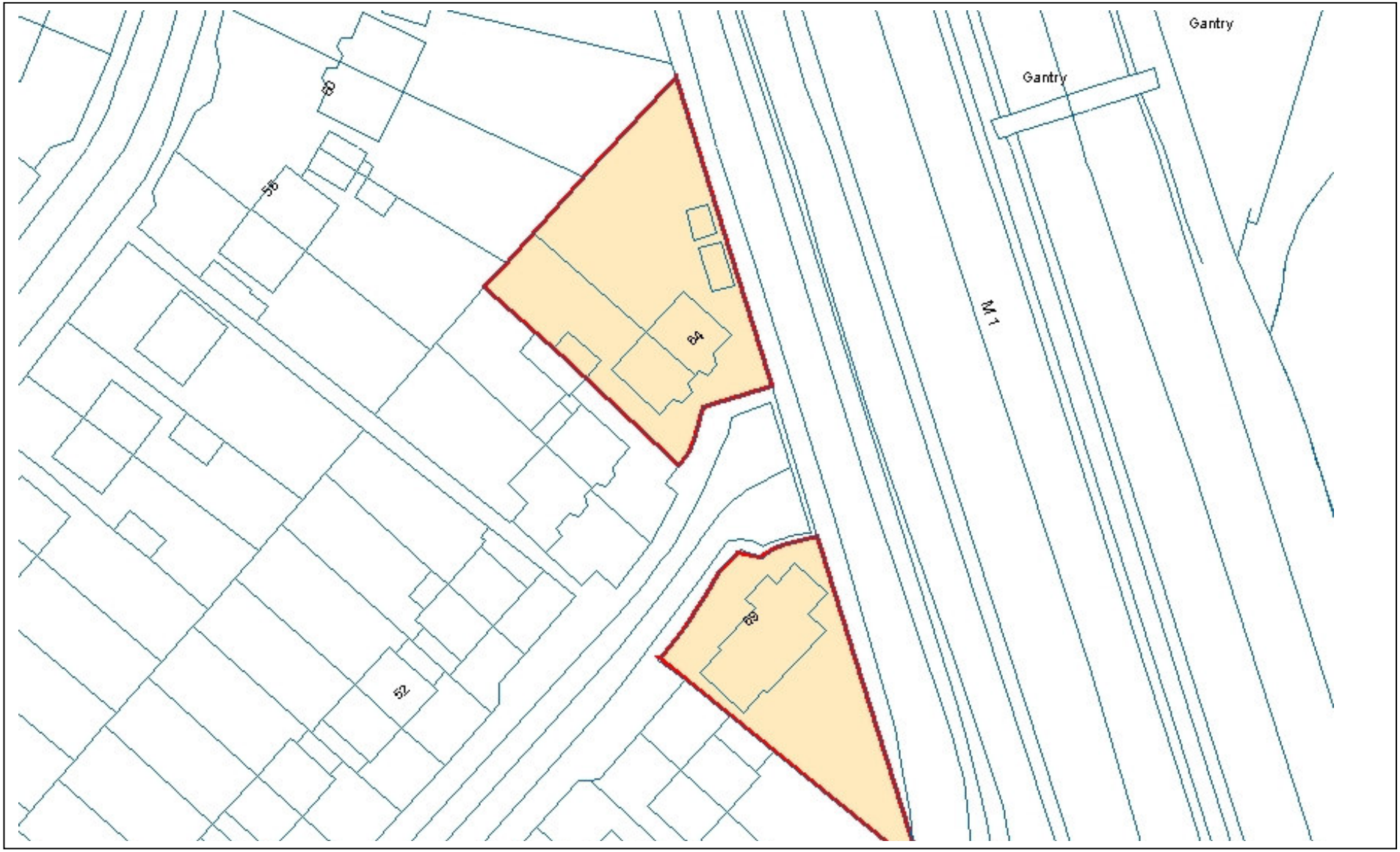
Air Quality Management Area – Watford No.6 (M1/Meriden) Map B

Air Quality Management Area – Watford No.6 (M1/Meriden) Map C



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