CASELLA STANGER

Winchester City Council

Air Quality Review and Assessment – Detailed Dispersion Modelling

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FINAL

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1 INTRODUCTION

1.1 Project Background

Casella Stanger has been commissioned by Winchester City Council to undertake further detailed dispersion modelling for the city centre area of Winchester in respect of NO_2 and PM_{10} concentrations for the fulfilment of duties under Part IV of the Environment Act, 1995.

Previous dispersion modelling[1] [2]has been undertaken for the central Winchester area, the results of which indicated that no exceedences of the air quality objectives are expected to occur. However, this conclusion does not concur with results of continuous monitoring throughout the area which measures current exceedences of the objectives for both pollutants.

Casella Stanger were commissioned to undertake subsequent detailed dispersion modelling with the aim of locally verifying the dispersion modelling results with all available, and suitable, roadside monitoring data. This is in order to determine the extent of exceedences of the air quality objectives and facilitate Winchester City Council in declaring an Air Quality Management Area.

As part of this detailed dispersion modelling a considerable effort has been made by Winchester City Council and Hampshire County Council to collect new and updated traffic flow information on many of the city centre roads and approach roads to Winchester. In addition, Winchester City Council deployed diffusion tubes at 22 new roadside sites in order to provide a better spatial indication of NO_2 concentrations and to facilitate the local verification of dispersion modelling results.

Casella Stanger was initially commissioned to undertake the dispersion modelling in June 2002. Delays in gathering updated traffic information due to large-scale road works have resulted in a much longer reporting time than originally expected. However, there has been some benefit in that traffic information collected is more reflective of the normal conditions in Winchester, and a full 6 months monitoring using diffusion tubes was undertaken across the City.

1.2 Legislative Background

Part IV of the Environment Act places a statutory duty on local authorities to periodically review and assess the air quality within their area. This involves consideration of present and likely future air quality against air quality standards and objectives. Guidelines for the 'Review and Assessment' of local air quality were published in the 1997 National Air Quality Strategy (NAQS) [3] and associated guidance and technical guidance. Standards and objectives for seven pollutants were prescribed through the Air Quality Regulations 1997, which was superseded by the Air Quality Strategy for England, Scotland, Wales and Northern Ireland (AQS) [4] in 2000, along with

[1] Reference Stage 3 Report – full title?
[2] Reference Further Stage 3 Report – full title?
[3] DoE (1997) The United Kingdom Nation Air Quality Strategy The Stationery Office
[4] DETR (2000) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland – Working together for Clean Air, The Stationery Office

a further addendum in 2002[5]. The Air Quality Regulation for England and Wales were published in 2000[6] and subsequently amended in 2002[7].

New Technical Guidance (LAQM.TG(03))[8] and Policy Guidance (LAQM.PG(03))[9] were issued on behalf of Defra in January 2003. This guidance sets the framework for the requirements of review and assessment for future years, taking account of experiences from the previous rounds of review and assessment.

1.3 Scope and Methodology

The approach to the further detailed assessment has been to provide an opportunity for the local authority to supplement the technical information they have already gathered from their earlier review and assessment work in order to more accurately reflect local monitoring data in the dispersion modelling results.

Further to the confirmation of the need for the declaration of an AQMA, the sources of pollution should be assessed to calculate more accurately how much of an improvement in air quality would be required to deliver the air quality objectives within the AQMA, and an Action Plan can be targeted appropriately.

All new dispersion modelling has utilised the new vehicle emission factors released by DEFRA in February 2002. More recent NO_2 diffusion tube monitoring carried out within City has been undertaken and has been used to verify and adjust the modelled results along with continuous monitoring data.

Diffusion tube bias has been estimated based on comparisons with the results of continuous monitoring and is described in later sections of this report along with full details of model verification procedures.

Pollutant concentrations were predicted for the current year, assumed to be 2002 and for 2004 (PM_{10}) and 2005 (NO_2).

2 BASELINE INFORMATION

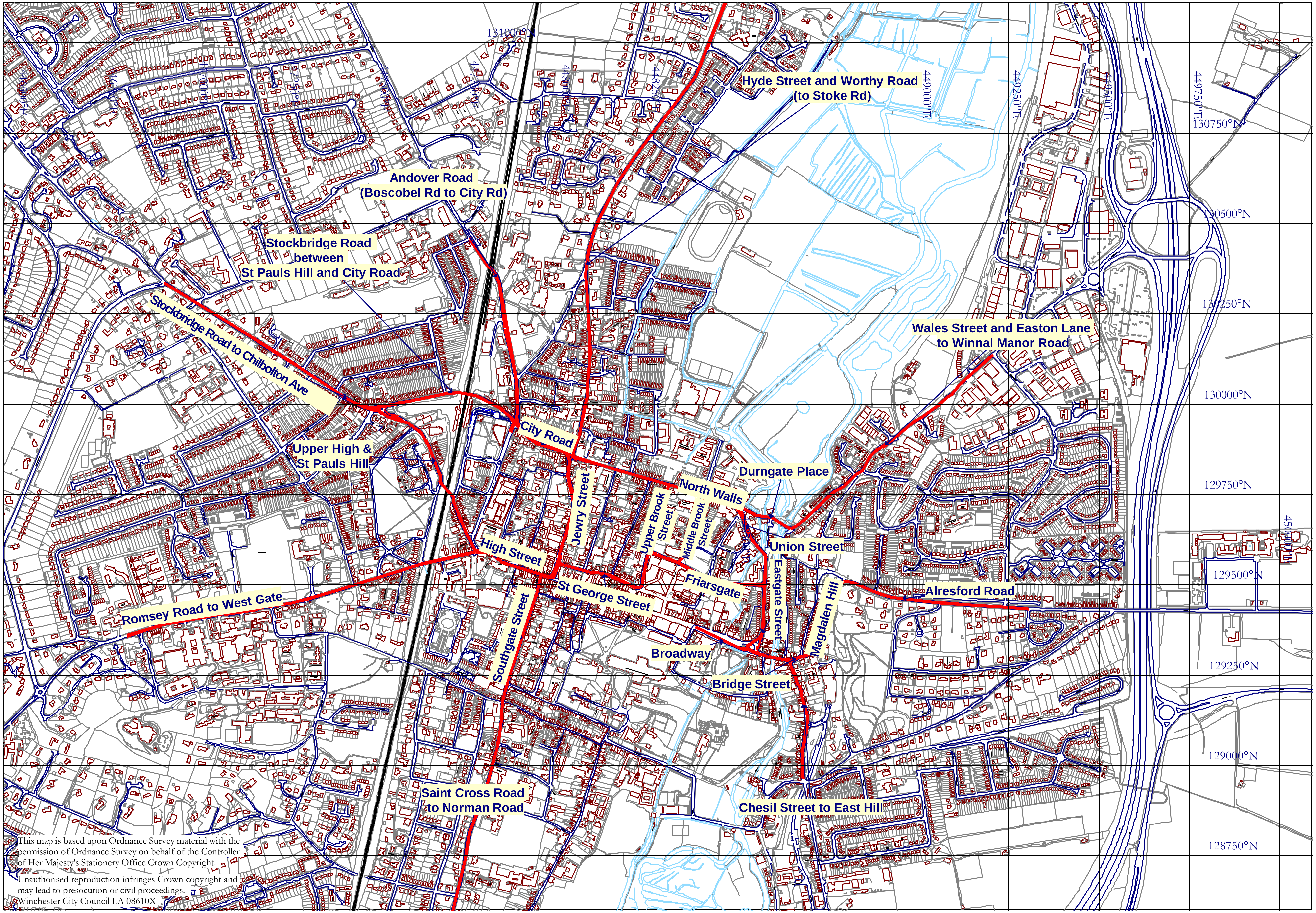
2.1 Traffic Data

Traffic information was provided primarily by Transport Policy, Hampshire County Council, with additional supplementary information provided by the Transport Strategy Group and Winchester City Council.

Figure 2.1 shows roads (red lines) for which traffic data was available for the detailed dispersion modelling.

5 Defra (2002) The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: Addendum, The Stationery Office
6 DETR (2000) The Air Quality Regulations 2000, The Stationery Office
7 Defra (2002) The Air Quality Regulations 2002,The Stationery Office
8 Defra (2003) Technical Guidance LAQM.TG(03), Part IV of the Environment Act 1995, Local Air Quality Management, The Stationery Office
9 Defra (2003) Policy Guidance LAQM.PG(03), Part IV of the Environment Act 1995, Local Air Quality Management, The Stationery Office

Figure 2.1: General Modelled Area of Winchester City Council. Roads in Red are included in detailed dispersion modelling.



Appendix 1 shows the traffic flow data used for the model area, including speeds, percentage of vehicles for different vehicle classes (i.e. cars, buses etc) and forecast traffic flows for the years 2004 and 2005.

Emission factors were calculated using the Emission Factors Toolkit[10] produced by Casella Stanger on behalf of Defra incorporating new emissions data released in 2002. Emissions (expressed as grams per vehicle-kilometre) were calculated based on the detailed vehicles splits shown in Appendix 1.

Emission rates were calculated for a daily average vehicle split and speed as hourly data was not available to this level of detail. This was supplemented with further information on the diurnal pattern of hourly vehicle flows based on manual 12-hour traffic counts, and available continuous 24-hour traffic monitoring data in the area.

Speeds were reduced at junctions throughout the City in order to reflect the general slowing of traffic towards junctions thereby reflecting the higher emissions of congested traffic.

2.2 Air Quality Data

2.2.1 Background Automatic Monitoring Concentrations

Background air quality data was obtained from continuous monitoring undertaken by Winchester City Council. The background continuous monitoring location is shown in Figure 2.2. Both NOx/NO_2 are measured at the site and the annual concentrations for 2003/2003 are reported in Table 2.1.

2.2.2 Roadside Automatic Monitoring Concentrations

Automatic roadside air quality data was obtained from continuous monitoring undertaken by Winchester City Council. The roadside monitoring location is shown in Figure 2.3. Both NOx/NO_2 are measured at the site and the annual concentrations for 2002/2003 are reported in Table 2.1.

2.2.3 Monitoring Equipment Information

Detailed information on equipment used for monitoring purposes are provided in previous review and assessment reports (PT to provide full reference).

[10] www.casellastanger.com

Figure 2.2: Location of Background Continuous Monitor, NOx/NO_2 and PM_{10}

Figure 2.3: Location of Roadside Continuous Monitor, NOx/NO_2 and PM_{10}

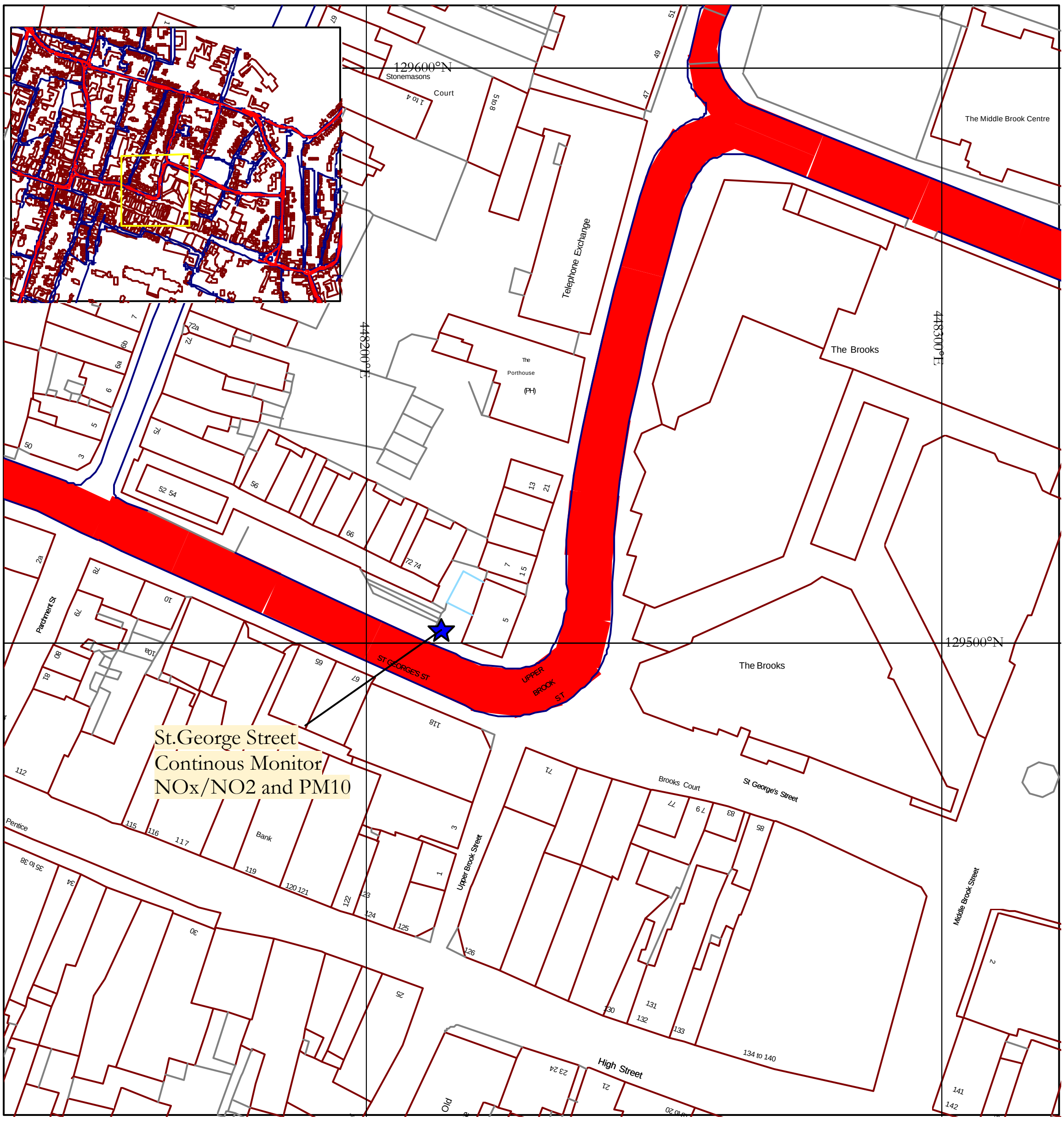


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Table 2.1: Automatic Monitored NO_x/NO_2 Concentrations Winchester City Council.

	Background		Roadside	
2002	**NOx**	**NO_2**	**NOx**	**NO_2**
Annual Average	57.6	29.5	190.1	46.9
% Data Capture	93		76	
No Hours >200	-	0	-	0
2003 (to end 20/3)	**NOx**	**NO_2**	**NOx**	**NO_2**
Period Average	66.1	30.8	151.9	58.9
No Hours >200	-	0	-	1

2.2.4 Projection of Background Concentrations

Projections of background concentrations to future years have been made using the guidance provided in LAQM.TG(03). Table 2.2 shows the projected 2005 background NOx and NO_2 based on the 2002 background monitoring. The 2002 and 2005 background NOx and NO_2 concentrations shown have been used throughout the air quality assessment.

Table 2.2: Background Concentrations in Winchester. (mg/m^3)

	Background NOx	Background NO_2
2002	57.6	29.5
2005	52.1	27.5

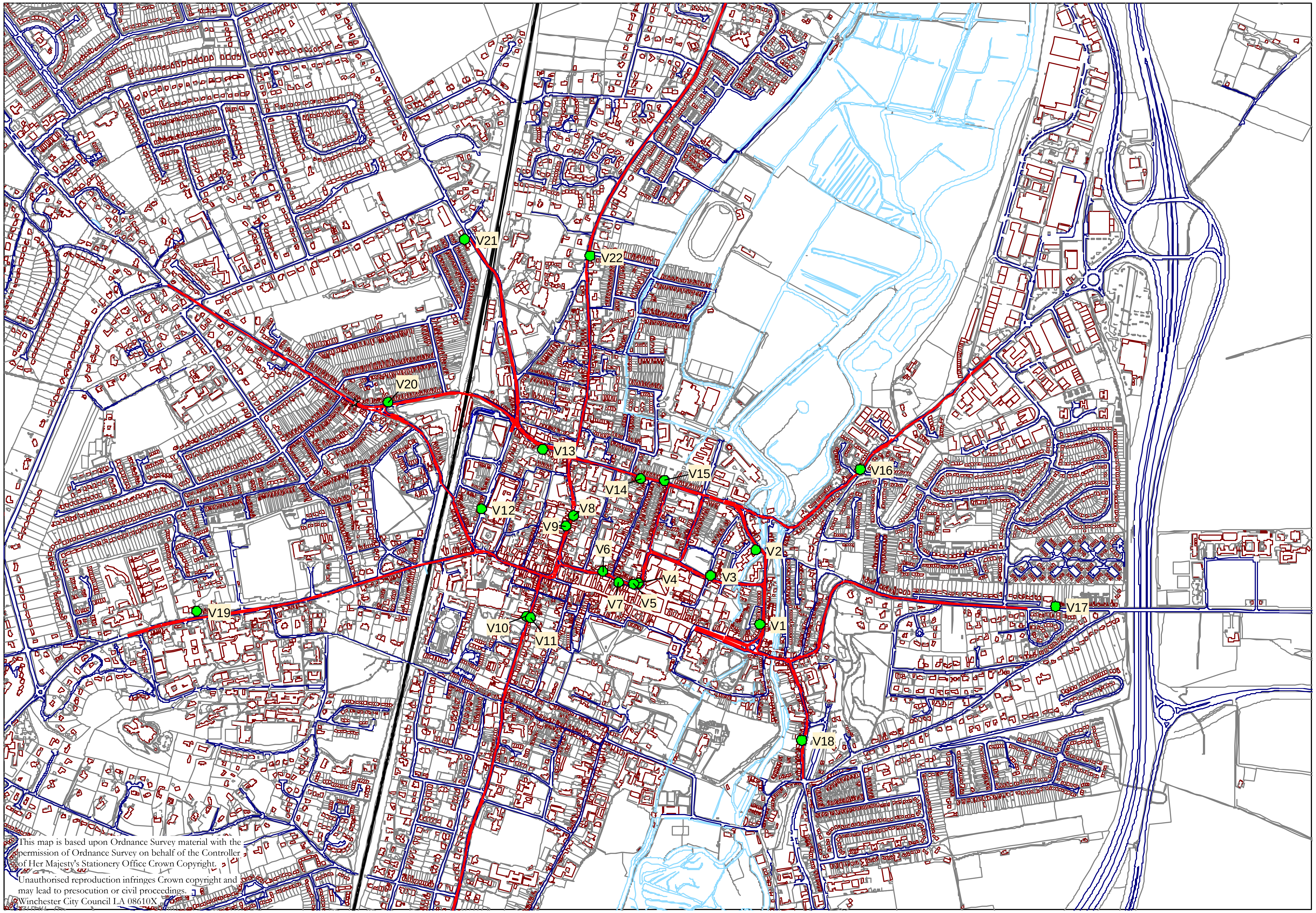
2.2.5 Passive NO_2 Monitoring

Nitrogen dioxide concentrations have been monitored using diffusion tubes following identification of relevant roadside locations as part of the detailed dispersion modelling exercise. The diffusion tubes were deployed in September 2002 and have been changed on a 4/5 week basis (and are not part of the UK Diffusion Tube Network). Additionally, triplicate NO_2 diffusion tubes were collocated with the roadside continuous automatic NO_2 monitor to allow an estimate of bias to be calculated. Triplicate tubes have also been deployed at an additional two sites that also aid in calculating the error (or uncertainty) around the diffusion tube measurements. Table 2.2 gives details of the location of the diffusion tubes used in this study and their locations are shown in Figure 2.4.

Table 2.2: Winchester City Centre Diffusion Tube Location Details

Verification Receptor Number	Site code	Location	X Co-Ordinate	Y Co-Ordinate
V1	Site 1	10 Eastgate St	448563	129390
V2	Site 2,3,4	Greyfriars	448551	129596
V3	Site 5	Friarsgate	448426	129526
V4	Site 6	Middle Brook St	448226	129505
V5	Site 7,8,9	Roadside Monitor	448214	129505
V6	Site 10	St Georges St TC	448128	129537
V7	Site 11	St Georges St Lad	448172	129507
V8	Site 12	Jewry St CH	448047	129691
V9	Site 13	Jewry St FK	448026	129663
V10	Site 14	Southgate St DV	447917	129413
V11	Site 15	Southgate St CH	447928	129409
V12	Site 16	Sussex St	447792	129710
V13	Site 17	City Road	447962	129875
V14	Site 18	74 Northwalls	448233	129794
V15	Site 19	15 Northwalls	448299	129789
V16	Site 20	Wales St	448841	129819
V17	Site 21	Alresford Rd	449381	129440
V18	Site 22	Chesil St	448679	129069
V19	Site 23	Romsey Rd HL	447004	129427
V20	Site 24	Stockbridge Rd	447534	130006
V21	Site 25	Andover Rd	447746	130456
V22	Site 26,27,28	Worthy Rd	448093	130411

Figure 2.4: Location of Diffusion Tubes in Winchester



Diffusion tubes are an economic and convenient method for monitoring NO_2. However, there is uncertainty with respect to the accuracy against more sophisticated methods. Consequently, validation against real-time data from more reliable continuous monitoring is desirable in order to determine the uncertainty of the diffusion tube measurements. The co-located NO_2 concentrations from continuous background site were used to calculate the percent difference or bias:

$$\% \text{ bias} = ((\text{Diff. tube } NO_2 \text{ mean - auto } NO_2 \text{ mean})/\text{Diff. tube } NO_2 \text{ mean}) * 100$$

The percent bias was calculated using the diffusion tube and continuous monitoring data for each sampling period and the mean was taken. Mean concentrations for all diffusion tubes were adjusted to include the percent bias and were therefore all corrected by a factor of 1.27 (representing a bias of –20%). The bias was calculated based on 6 months collocation information as available from September 2002 to March 2003. Table 2.3 shows the bias calculations, and Table 2.4 shows the diffusion tube concentrations for the triplicate exposure sites.

Analysis of bias calculations for diffusion tubes[11] has shown that Gradko tubes prepared with 50% TEA in water show a significant seasonal effect, with higher ratios in the months of August, September, October and November, with lower ratios in all other months. A default bias correction factor for Gradko tubes (50% TEA in water) was also calculated to be 1.39. Additional analysis has indicated that the uncertainty in the bias calculation when based on 6 months of monitoring is ± 5-10% (95% confidence range ±10-23%).

The bias calculated for Winchester equates to a correction factor of 1.27, which is lower than the default factor of 1.39 highlighted above. For the purpose of the current work, the local bias estimate (1.27) has been used as the calculation includes the months where higher bias estimates are thought to occur.

Table 2.5 shows the final annual average diffusion tube results at each of the diffusion tube locations, including bias correction, and projected concentrations for the year 2005 based on factored provided in LAQM.TG(03).

[11] Compilation of Diffusion Tube Collocation Studies Carried out by Local Authorities, Report prepared by AQC On Behalf of Defra and the Devolved Administrations, November 2002.

Table 2.3 Diffusion Tube Bias Calculations – based on available months September 2002 to March 2003 (all as µg/m³)

Exposure Date	Automatic Analyser Mean NO_2	Diffusion Tube Mean NO_2	Diffusion Tube Standard Deviation	Bias (% Difference)
12/09/02 - 10/10/02	60.3	47.5	0.4	-26.8
10/10/02 - 07/11/02	44.4	41.7	0.7	-6.4
07/11/02 - 05/12/02	46.3	42.3	2.3	-9.6
05/12/02 - 09/01/03	56.6	42.4	3.4	-33.4
09/01/03 - 12/02/03	51.1	38.2	2.7	-33.5
12/02/03 - 20/03/03	66.0	43.9	3.1	-50.4
Average Bias (%)				-20
Average Bias (Factor)				1.27

Table 2.4 Diffusion Tube Calculations – adjusted triplicate exposure sites (all as µg/m³)

Location	AQMA/Site Ref	2002 Mean NO_2 Conc. (µg/m³) [a]	Site St.andard Deviation (µg/m³) [a]	Diffusion Tube Precision (µg/m³) [b]	Diffusion Tube Bias (%) [c]	2002 Bias Corrected Mean NO_2 Conc. (µg/m³)	2002 Conc. Range[d]	Estimated 2005 Mean Conc.	2005 Conc. Range[d]
George St Monitor	Continuous	42.7	2.4	3.1	-19.9	54.1	50.9-57.1	49.8	46.9-52.6
Greyfriars	Greyfriars	36.2	2.1			45.9	42.8-49.0	42.3	39.4-45.1
Worthy Road	Worthy Road	33.2	4.3			42.0	38.9-45.0	38.7	35.8-41.5

[a] Projected forward using the conversions reported in LAQM.TG(03) [b] Based on 6 months sampling [c] % Site precision = (Mean overall St. dev/ Mean NO_2 conc.)*100[c] include bias and precision

Table 2.5: Winchester City Centre Diffusion Tube Concentrations – Bias Corrected Annual Average NO_2 (all as mg/m³)

Verification Receptor Number	Site code	Location	2002 Conc.	Projected 2005 Conc.
V1	Site 1	10 Eastgate St	38.4	35.4
V2	Site 2,3,4	Greyfriars	39.3	36.1
V3	Site 5	Friarsgate	34.9	32.1
V4	Site 6	Middle Brook St	**46.0**	**42.3**
V5	Site 7,8,9	Roadside Monitor	**45.8**	**42.2**
V6	Site 10	St Georges St TC	**48.4**	**44.6**
V7	Site 11	St Georges St Lad	**58.8**	**54.2**
V8	Site 12	Jewry St CH	**47.7**	**43.9**
V9	Site 13	Jewry St FK	**49.2**	**45.3**
V10	Site 14	Southgate St DV	**41.9**	38.6
V11	Site 15	Southgate St CH	**53.2**	**49.0**
V12	Site 16	Sussex St	38.8	35.7
V13	Site 17	City Road	**46.5**	**42.8**
V14	Site 18	74 Northwalls	**49.9**	**46.0**
V15	Site 19	15 Northwalls	39.4	36.3
V16	Site 20	Wales St	36.3	33.4
V17	Site 21	Alresford Rd	35.5	32.7
V18	Site 22	Chesil St	39.1	36.0
V19	Site 23	Romsey Rd HL	31.7	29.2
V20	Site 24	Stockbridge Rd	29.7	27.4
V21	Site 25	Andover Rd	38.2	35.2
V22	Site 26,27,28	Worthy Rd	35.4	32.6

The corrected diffusion tube concentrations indicate that a number of exceedences are expected to occur at roadside sites in Winchester City in both the current year and in the year 2005. Figure 2.5 shows those diffusion tube locations were an exceedence of the annual average NO_2 objective occurs based on current monitoring and Figure 2.6 shows those locations were an exceedences is projected for 2005.

Figure 2.5: Current Annual Average NO_2 Objective Exceedences – Diffusion Tube Monitoring

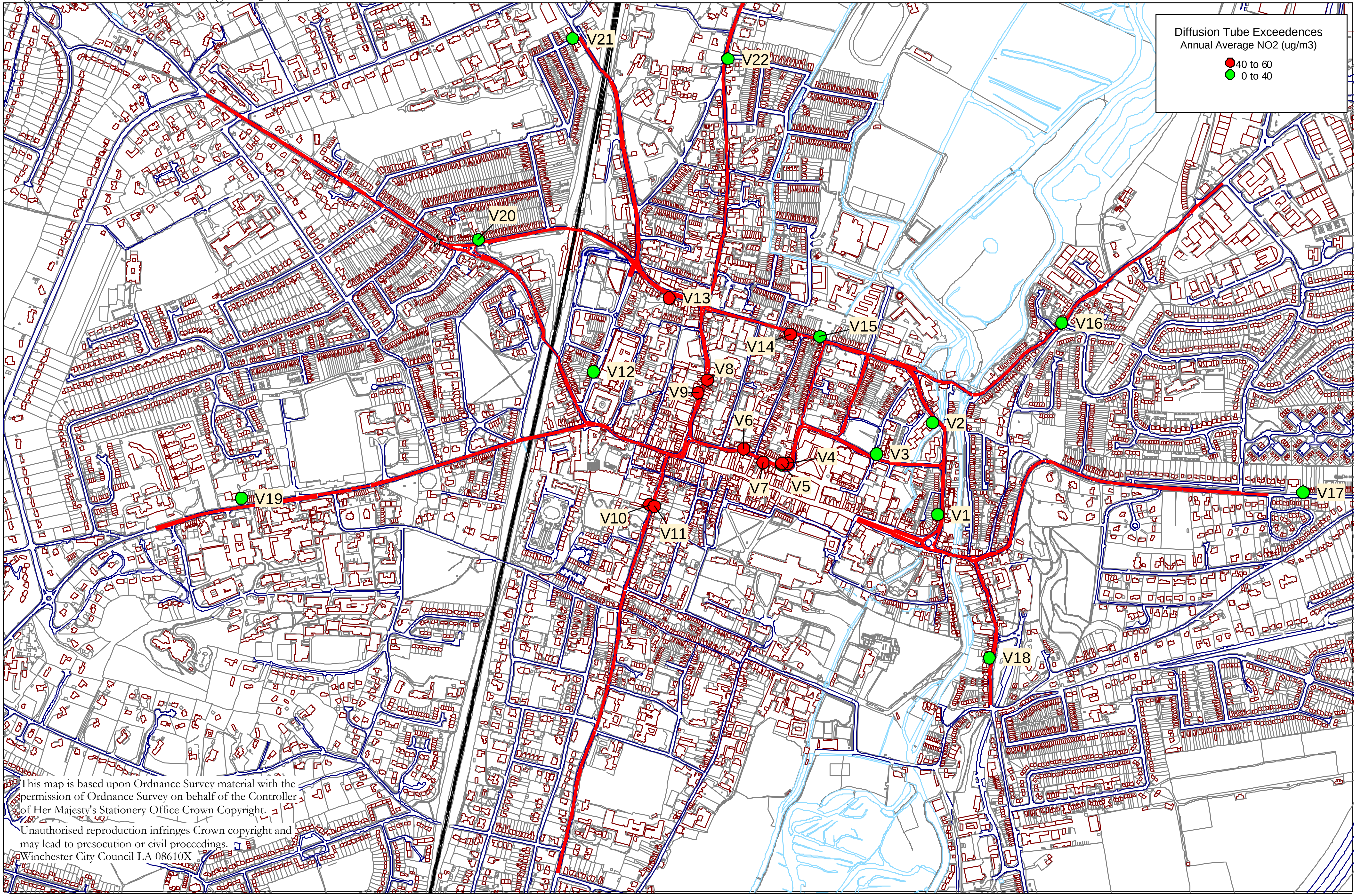
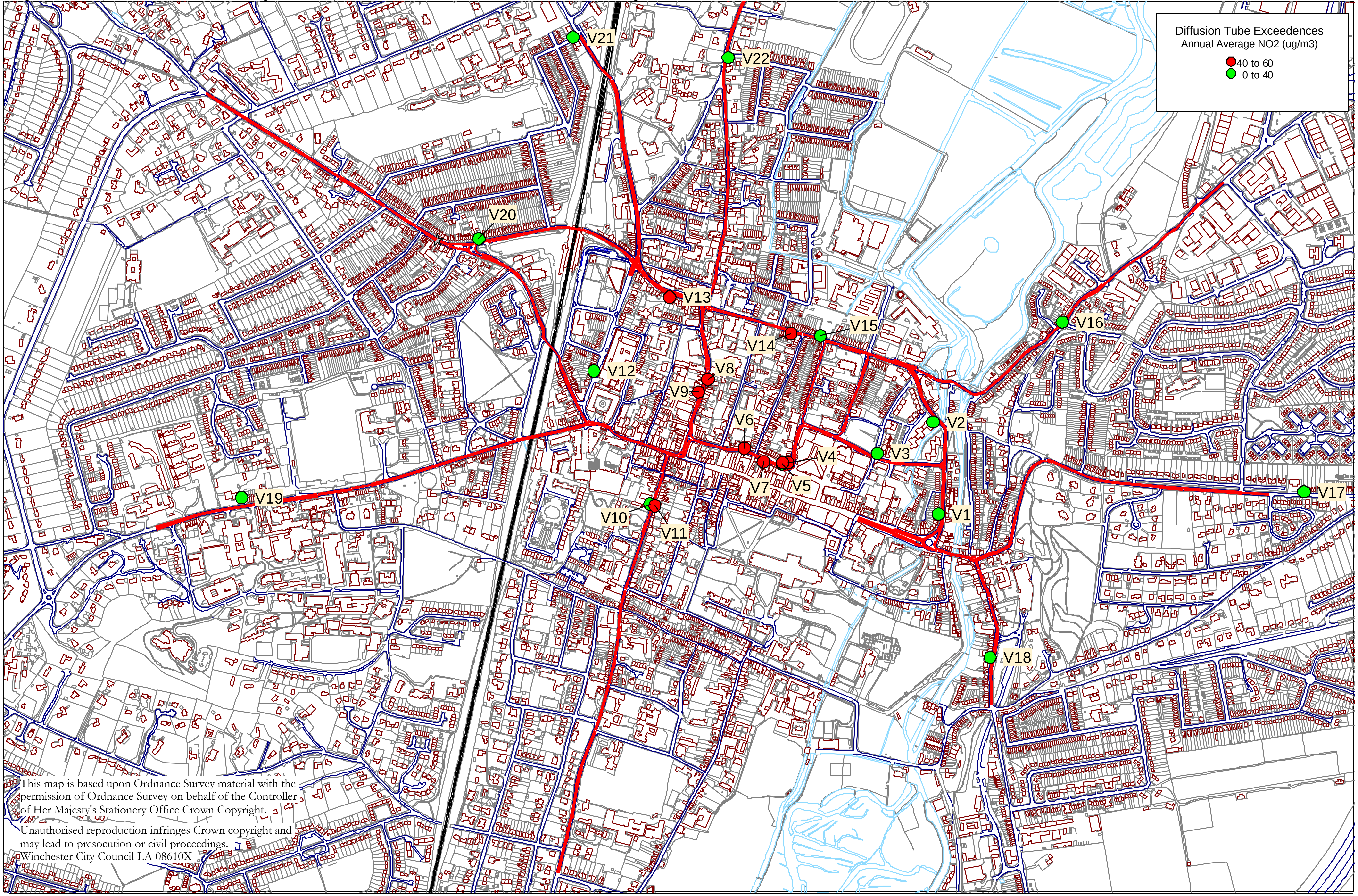


Figure 2.6: Projected 2005 Annual Average NO_2 Objective Exceedences – Diffusion Tube Monitoring



3 DISPERSION MODELLING METHODOLOGY

The Breeze Roads[12] dispersion model has been used to model the contribution of road traffic vehicles to concentrations of NOx and PM_{10}. Background concentrations are added to the modelled contributions and conversion to NO_2 (in the case of NOx) is carried out using the method in LAQM.TG(03).

Winchester City Centre has relatively low traffic flows, generally around 12,000 vehicles per day in the central area. As highlighted earlier, the previous modelling has not predicted exceedences of any of the air quality objectives. However, as described in section 2.2 (Air Quality Data) exceedences of the annual average NO_2 and PM_{10} objectives are currently measured at the roadside location of St. George Street, and wider exceedences are also measured by a number of diffusion tubes throughout the City. Previous review and assessments have not reflected this in the results and all modelling previously has appeared to under-predicted the air quality levels in the City.

This general under-prediction may be due to the presence of small street canyons throughout the City. Many of the local roads are two-lane, with some pavement and buildings on both sides. However, in the strict sense of a street canyon, the buildings are not very tall, often only two stories, and there are often gaps along the length of the roads. However, the monitored levels of NO_2 and PM_{10} at the roadside suggests that there is limited natural dispersal of pollutants giving rise to higher levels of pollution than might be expected from relatively low levels of road traffic.

The Breeze Roads model has been used for the main dispersion modelling exercise because it allows a large of number of predictions at receptors in the City to be undertaken. This facilitates the determination of the extent of exceedences of air quality objectives in order to allow concentration contours to be drawn and the extent of an AQMA (Air Quality Management Area) to be defined. The Breeze Roads model does not allow predictions of pollutant concentrations to be undertaken in street canyons. Whilst this appears to be a short-fall in the capability of the model, it is noteworthy of comment that very few commercially available models used in dispersion modelling do so. Whilst computational fluid dynamics (CFD) models are available, their use in restricted through the relevant data being available for consideration. Consequently, there is a need to compromise between costs, feasibility and accuracy. However, it highlights the importance of comparing the predicted levels of NOx and PM_{10} from roads with monitored concentrations of NOx and PM_{10} (before adding general background levels to the predictions and taking account of any chemical conversion of NOx to NO_2). The method of comparing the modelled and monitored concentrations, or 'verification' is described in detail below.

Hourly sequential information on wind speed and direction from Hurn for the year 2002 was used in the dispersion modelling. This was supplemented by data from Solent for cloud cover.

[12] www.trinityconsultants.com

3.1 Model Verification and Adjustment

3.1.1 NOx/NO_2

Predicted contributions from the road links modelled are made at each of the continuous monitor and diffusion tubes in the areas. However, it is necessary to verify the levels of road contributions modelled, and to included background concentrations, as well as consider the conversion of NOx to NO_2. The method used for verification of NOx and NO_2 has used the guidance provided in LAQM.TG(03). Initially, the roadside continuous monitoring data is used to check the performance of the model for predicting the contribution of roadside NOx and PM_{10}. The verification results at this stage are then applied to predictions at all of the roadside diffusion tube sites and final NO_2 can be determined.

Breeze Roads was used to predict the *Modelled Roads NOx* contribution from the road links at the location of the continuous NOx analyser on St. George Street. The *Modelled NOx* was compared to the, *Monitored Roadside NOx* calculated by subtracting *Background NOx* from the *Total Monitored NOx*.

A correction factor for *Modelled Roads NOx* was calculated to be 10.81 (*Monitored Roadside NOx/Modelled Roads NOx*). This factor was applied to all *Modelled Roads NOx*. A factor of 10.81 is considered to be very high with respect to model under-prediction, and higher than that experienced on projects of a similar nature (where factors of between 1 and 7 have been calculated). In general, the size of the correction factor increases in built-up, enclosed, urban areas, and where smaller roads with small traffic volumes are modelled. Consequently, the result is not surprising in the context of Winchester.

Background NOx is then added to the *Corrected Modelled Roads NOx* to allow the Roadside NO_2 concentration to be estimated as described in LAQM.TG(03) thus:

F Factor for Roadside NO_2 Calculation = -0.068 x Ln (Total NOx)+0.53

The calculated F Factor depends on the total NOx and will therefore vary at all sites. The F Factor is applied to the *Corrected Modelled Roadside NOx* to estimate the *Modelled Roadside NO_2*. The *Modelled Roadside NO_2* was then compared to the estimated *Monitored Roadside NO_2* (calculated by subtracting *Background NO_2* from *Monitored NO_2* at diffusion tube site). This comparison indicates that the *Modelled Roadside NO_2* was overestimated by approximately 30%. The overestimation may be due to the method used for conversion of NOx to NO_2 that is based on wide number of different monitoring sites and the equation representing the NOx to NO_2 is a best fit curve and not an exact fit.

Total NO_2 at each site is calculated by adding *Background NO_2* to *Corrected Roadside NO_2*.

The correction factor derived from continuous monitoring is applied to all modelled *Roadside NOx* at the diffusion tube locations. NO_2 concentrations are derived as described above at the diffusion tube sites and the modelled and monitored NO_2 concentrations are compared again to determine how well final NO_2 concentrations are predicted over a wider area.

Table 3.1 shows the *Modelled Roadside NOx* and *Corrected Modelled Roadside NOx* and derived *Modelled Roadside NO_2* and *Total NO_2* concentrations at each of the diffusion tube sites. A comparison of *Total Modelled NO_2* and *Monitored Diffusion Tube NO_2* (bias corrected

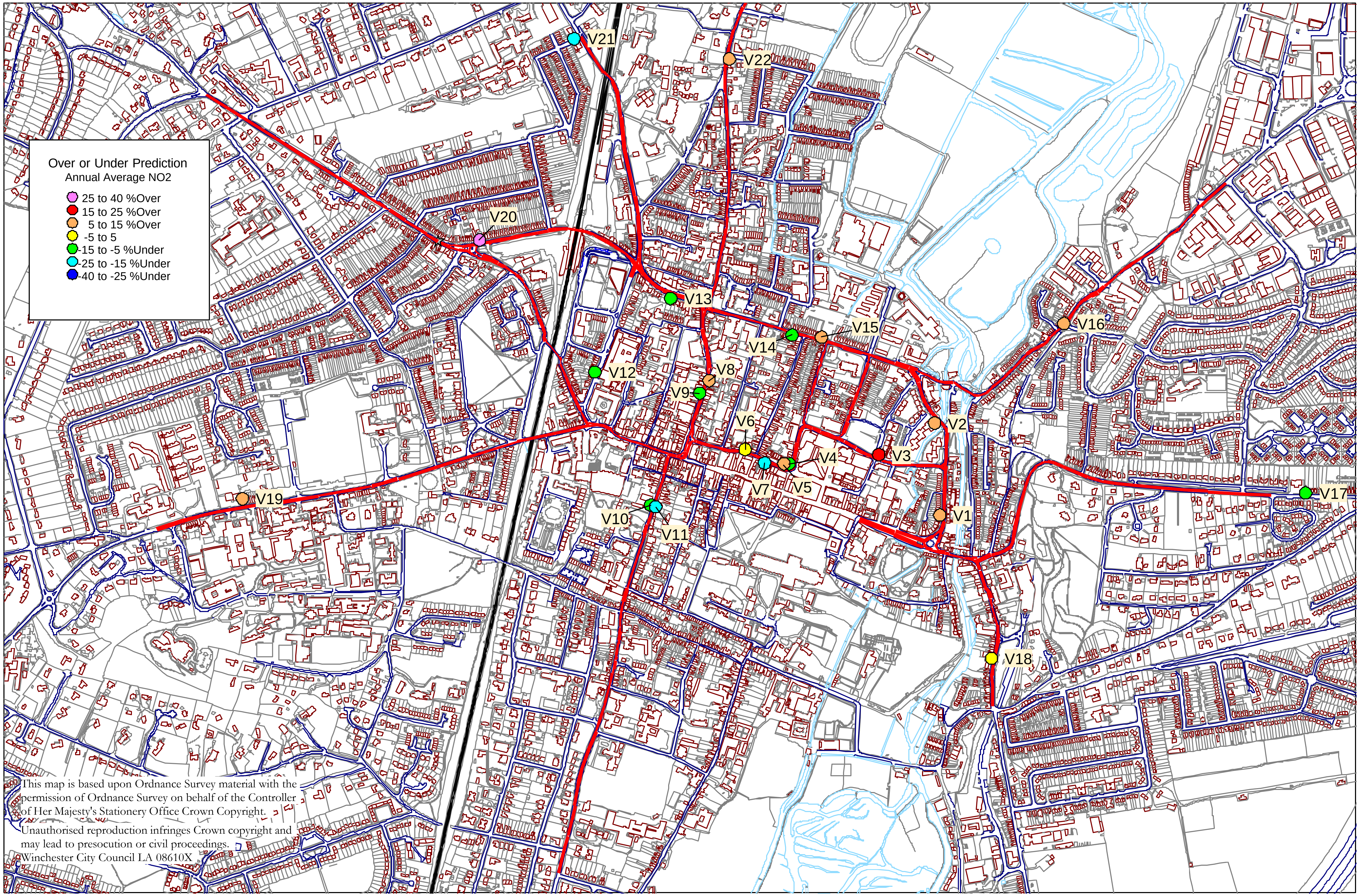
The *Total* NO_2 concentration was compared to the *Total Monitored* NO_2 concentration. An average under-prediction of 1% compared to monitored NO_2 was calculated across all sites, with the highest over-prediction of 35% on Stockbridge Road and the highest under-prediction of 24% on Southgate Street. Figure 3.1 shows locations of over and under prediction of annual average NO_2 concentrations at diffusion tube locations.

Table 3.1 Comparison of Modelled and Monitoring at Roadside Diffusion Tube locations in Winchester City for 2002

Verification Site	Modelled Roadside NOx	Corrected Roadside NOx[a]	Background NOx	Total NOx[b]	Background NO_2	Roadside NO_2[c]	Total NO_2	Monitored NO_2[d]	% Difference NO_2[e]	Under or Over	Correction Factor
V1	5.3	57.7	57.6	115.3	29.5	11.9	41.4	38.4	7.8	Over	0.93
V2	5.3	56.9	57.6	114.5	29.5	11.8	41.3	39.3	5.1	Over	0.95
V3	5.0	54.1	57.6	111.7	29.5	11.3	40.8	34.9	17.0	Over	0.85
V4	6.3	68.6	57.6	126.2	29.5	13.8	43.3	46.0	-5.9	Under	1.06
V5	12.3	132.5	57.6	190.1	29.5	22.9	52.4	45.8	14.4	Over	0.87
V6	9.3	100.8	57.6	158.5	29.5	18.7	48.2	48.4	-0.5	Under	1.00
V7	8.3	89.7	57.6	147.3	29.5	17.1	46.6	58.8	-20.9	Under	1.26
V8	11.0	119.0	57.6	176.6	29.5	21.2	50.7	47.7	6.3	Over	0.94
V9	7.5	81.2	57.6	138.9	29.5	15.8	45.3	49.2	-8.0	Under	1.09
V10	3.3	35.3	57.6	93.0	29.5	7.8	37.3	41.9	-10.9	Under	1.12
V11	4.8	51.5	57.6	109.1	29.5	10.9	40.3	53.2	-24.2	Under	1.32
V12	1.7	18.6	57.6	76.2	29.5	4.4	33.8	38.8	-12.8	Under	1.15
V13	4.7	50.8	57.6	108.5	29.5	10.7	40.2	46.5	-13.5	Under	1.16
V14	7.5	81.3	57.6	138.9	29.5	15.8	45.3	49.9	-9.3	Under	1.10
V15	7.5	81.3	57.6	139.0	29.5	15.8	45.3	39.4	14.8	Over	0.87
V16	4.2	45.2	57.6	102.8	29.5	9.7	39.2	36.3	7.8	Over	0.93
V17	0.5	4.9	57.6	62.5	29.5	1.2	30.7	35.5	-13.5	Under	1.16
V18	3.5	38.1	57.6	95.8	29.5	8.4	37.9	39.1	-3.2	Under	1.00
V19	2.1	22.4	57.6	80.0	29.5	5.2	34.7	31.7	9.2	Over	0.92
V20	4.7	50.6	57.6	108.3	29.5	10.7	40.2	29.7	35.1	Over	0.74
V21	1.0	10.9	57.6	68.5	29.5	2.6	32.1	38.2	-16.0	Under	1.19
V22	3.7	40.3	57.6	98.0	29.5	8.8	38.3	35.4	8.1	Over	0.92
								Average	-0.6	Under	1.02
								Highest Under	35.1	Over	0.74
								Highest Over	-24.2	Under	1.32

[a]: factor 10.81 applied, [b]: corrected roadside NOx + Background NOx, [c]: derived using LAQM.TG(03) method, [d]: bias corrected, [e]: (modelled/monitored)/monitored*100

Figure 3.1: Map showing Under or Over prediction of Annual Average NO_2 Concentrations at Diffusion Tube Sites



4 RESULTS

Annual average concentrations for NO_2 were predicted for the year 2002 and 2004/5 at:

- 7345 receptors forming a grid spaced at 10 metres over the central area of Winchester City; and
- 689 specific receptors on the approach roads to Winchester City representing the façades of buildings on the roadside.

All predicted results have been produced using the methodology described in Section 3 of this report. For the prediction of results for the year 2005, the same verification method was used as described in Section 3 but background NOx and NO_2 for 2005 have been used. Traffic flows and emissions for 2005 have also been used as described in 2.1 and 2.2 as projected from 2002 data.

4.1 NO_2 Concentrations

Figure 4.1 shows the predicted annual average NO_2 concentrations for the year 2002 across the grid of receptors in Winchester City Centre and Figure 4.2 shows those for the specific receptors on the approach roads.

Figure 4.3 shows the predicted annual average NO_2 concentrations for the year 2005 across the grid of receptors in Winchester City Centre and Figure 4.4 shows those for the specific receptors on the approach roads.

Table 4.1 shows the predicted annual average NO_2 concentrations at each of the diffusion tube sites along with the projected 2005 diffusion tube concentration. A comparison of the results indicates that in general, the predicted and projected monitored results compare well.

There is a significant difference between the projected 2005 concentration for V11 Southgate St with concentrations approaching 50 $\mu g/m^3$ being estimated whereas levels of approximately 37 $\mu g/m^3$ are predicted. It is interesting to note the large difference in projected monitored concentrations at sites V10 and V11 both on Southgate Street. V10 is on the western side of the road, while V11 is opposite on the eastern side of the road but there is a difference of over 10 $\mu g/m^3$ between the measurements, one being slightly below the annual average objective, the other well above.

Exceedences of 40 $\mu g/m^3$ annual average NO_2 are predicted to occur at a number of roadside locations in Winchester in both 2002 and 2005 and it is therefore recommended that an AQMA is declared by Winchester City Council.

Table 4.1: Predicted 2005 Concentrations at Winchester City Centre Diffusion Tube Locations (Diffusion Tube measurements Bias Corrected and projected from 2002). Annual Average NO_2 (all as mg/m³)

Verification Receptor Number	Site code	Location	Projected 2005 Conc.	Predicted 2005 Conc.	Difference (mg/m³)
V1	Site 1	10 Eastgate St	35.4	38.0	+2.6
V2	Site 2,3,4	Greyfriars	36.1	37.8	+1.7
V3	Site 5	Friarsgate	32.1	37.3	+5.2
V4	Site 6	Middle Brook St	**42.3**	39.9	-2.4
V5	Site 7,8,9	Roadside Monitor	**42.2**	**48.4**	+6.2
V6	Site 10	St Georges St TC	**44.6**	**44.3**	-0.3
V7	Site 11	St Georges St Lad	**54.2**	**42.8**	-11.4
V8	Site 12	Jewry St CH	**43.9**	**46.6**	+2.7
V9	Site 13	Jewry St FK	**45.3**	**41.6**	-3.7
V10	Site 14	Southgate St DV	38.6	34.1	-4.5
V11	Site 15	Southgate St CH	**49.0**	36.6	-12.4
V12	Site 16	Sussex St	35.7	31.3	-4.4
V13	Site 17	City Road	**42.8**	36.9	-5.9
V14	Site 18	74 Northwalls	**46.0**	**41.4**	-4.6
V15	Site 19	15 Northwalls	36.3	**41.5**	+5.2
V16	Site 20	Wales St	33.4	35.8	+2.4
V17	Site 21	Alresford Rd	32.7	28.6	-4.1
V18	Site 22	Chesil St	36.0	34.6	-1.4
V19	Site 23	Romsey Rd HL	29.2	31.8	+2.6
V20	Site 24	Stockbridge Rd	27.4	38.0	+10.6
V21	Site 25	Andover Rd	35.2	29.7	-5.5
V22	Site 26,27,28	Worthy Rd	32.6	34.9	+2.3

Figure 4.1: Predicted annual average NO_2 concentration contours in central Winchester – 2002 – all as µg/m³

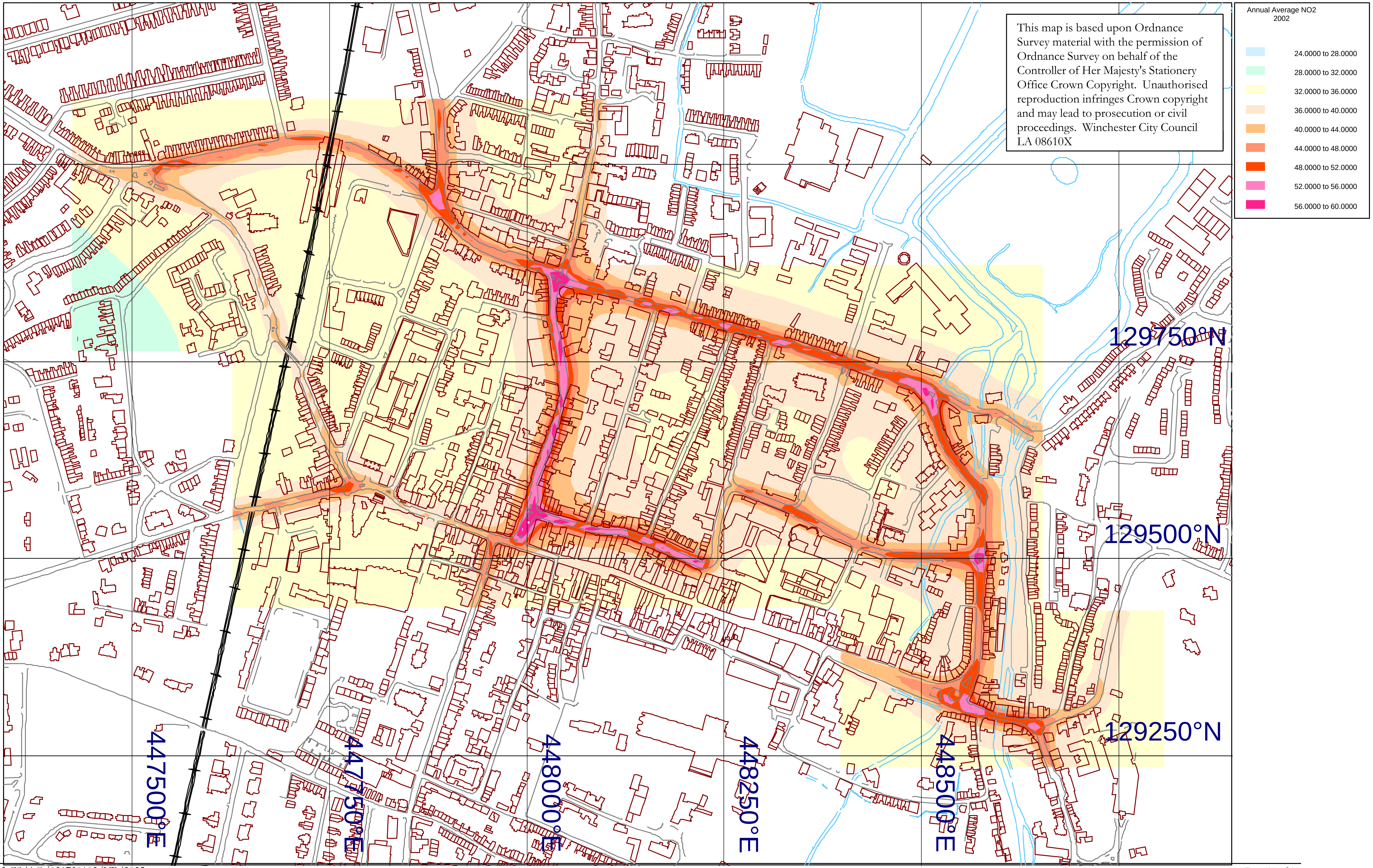


Figure 4.2: Predicted annual average NO_2 concentrations at specific receptors in Winchester – 2002 – all as μg/m³

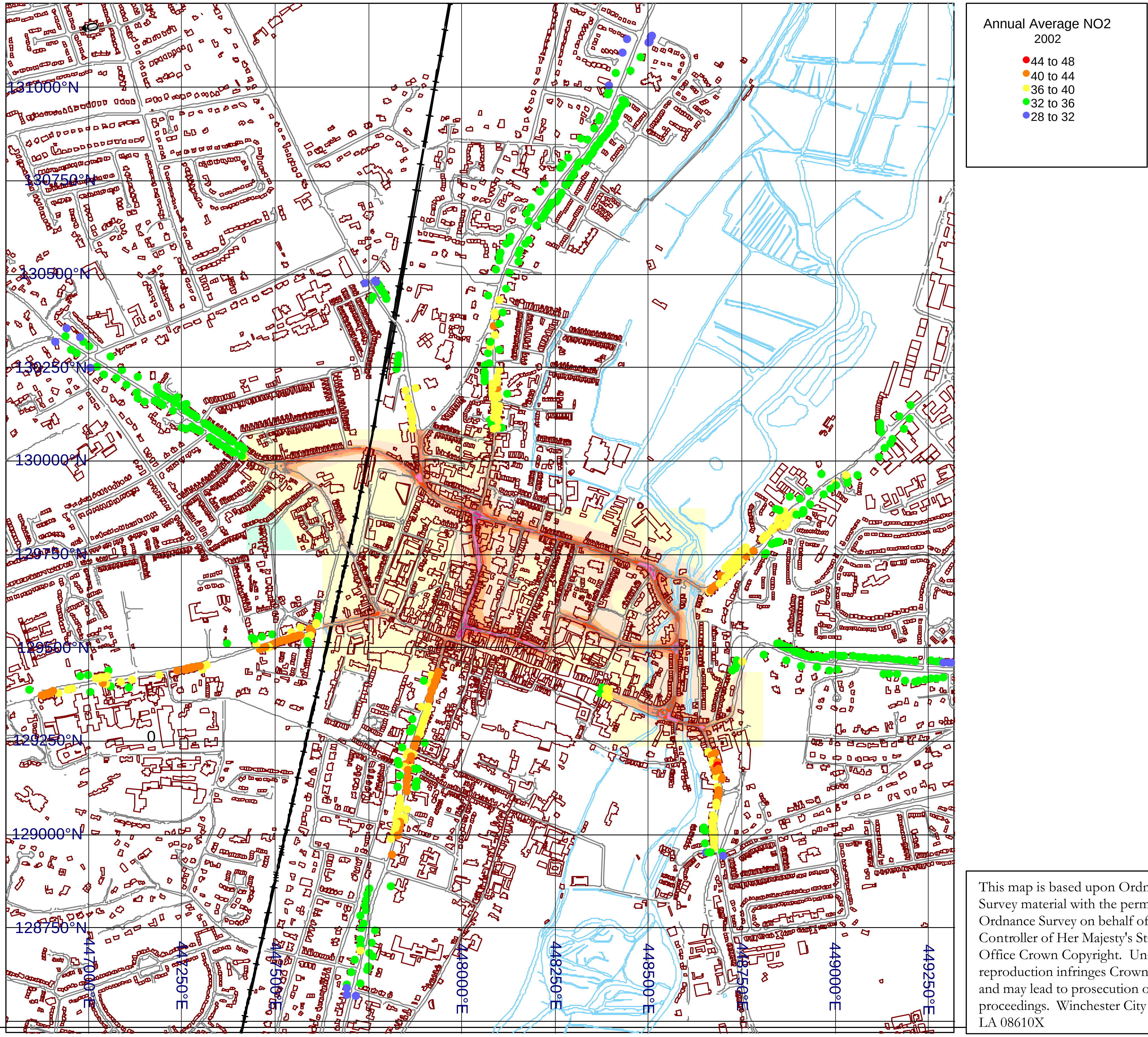


Figure 4.3: Predicted annual average NO_2 concentration contours in central Winchester – 2005 – all as μg/m³

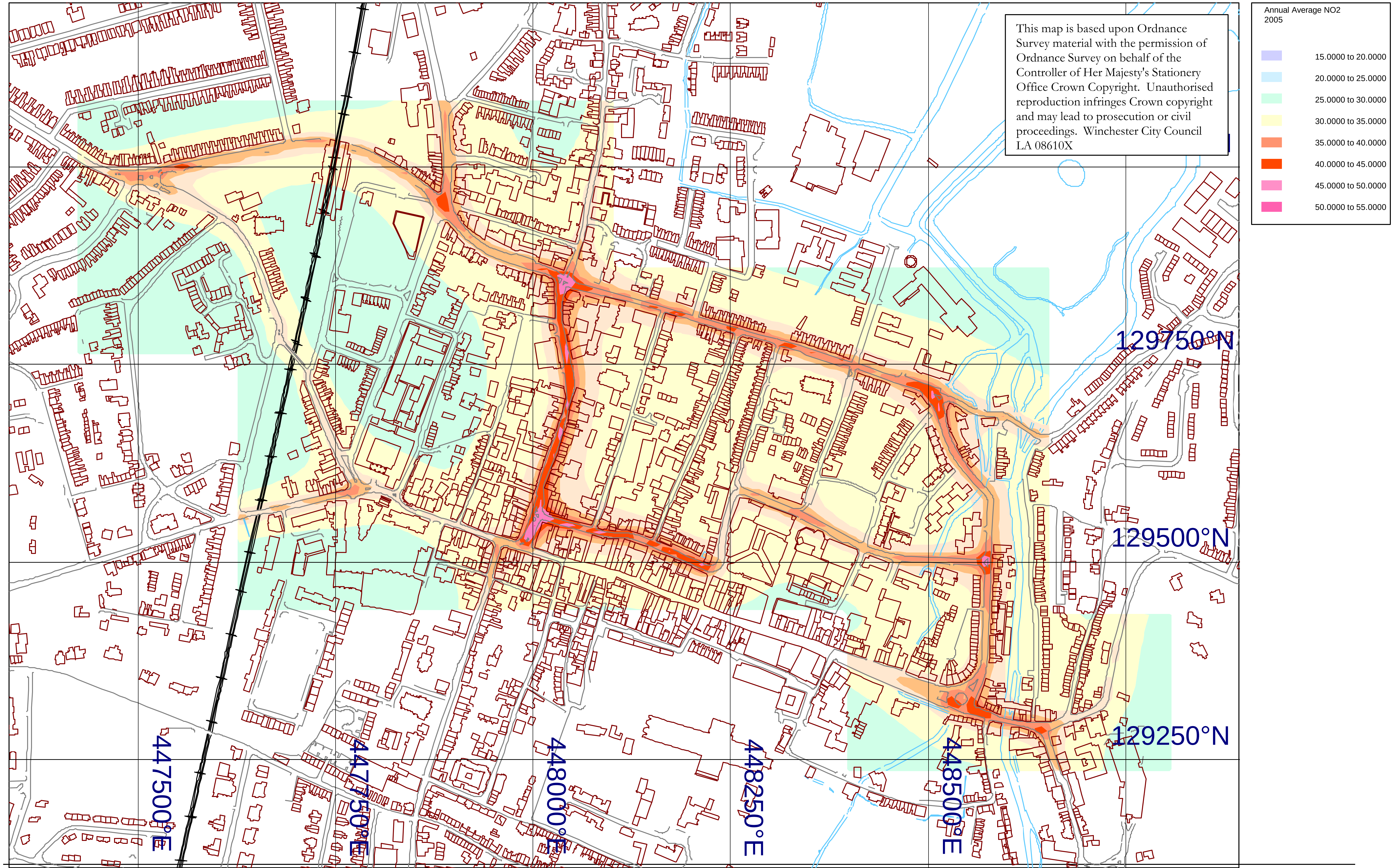
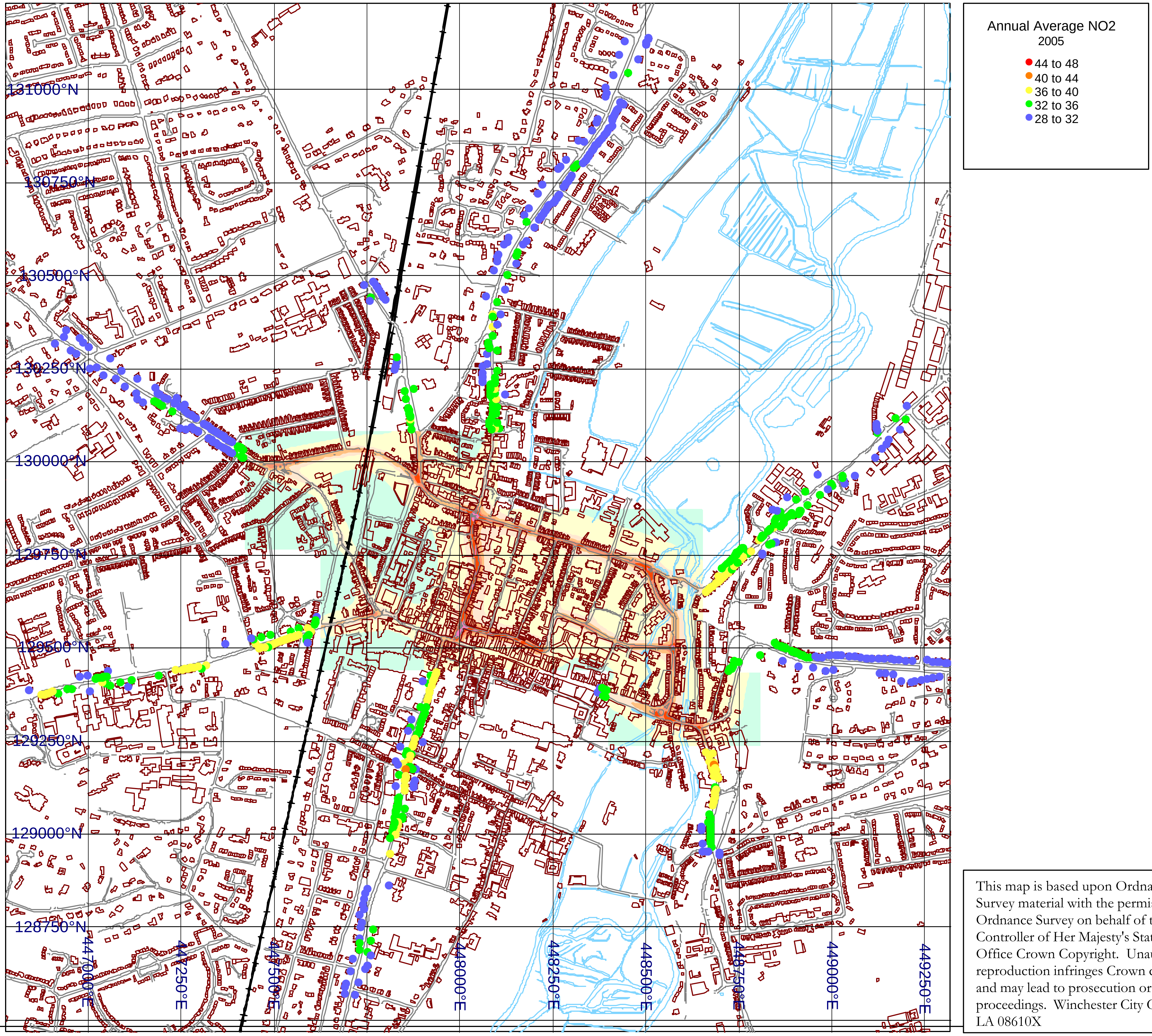


Figure 4.4: Predicted annual average NO_2 concentrations at specific receptors in Winchester – 2005 – all as μg/m³



In addition to the contoured area of central Winchester, exceedences of the annual mean objective in 2005 were also predicted at 4 specific receptors in 2005. The location so these are shown in Figures 4.5 and 4.6.

Figure 4.5: Predicted annual average NO_2 concentrations at specific receptors on St. Cross Road – 2005 – all as $\mu g/m^3$

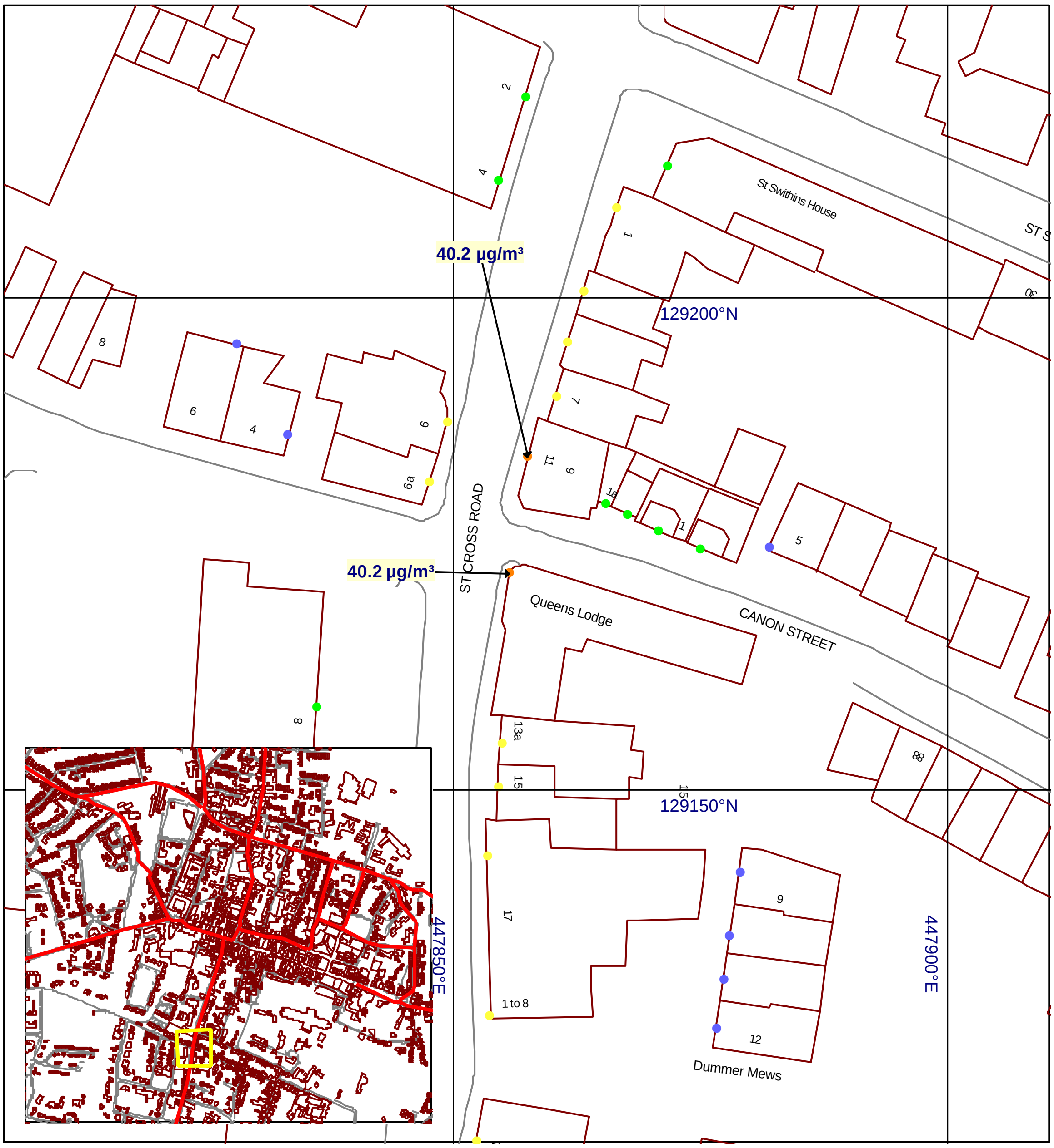
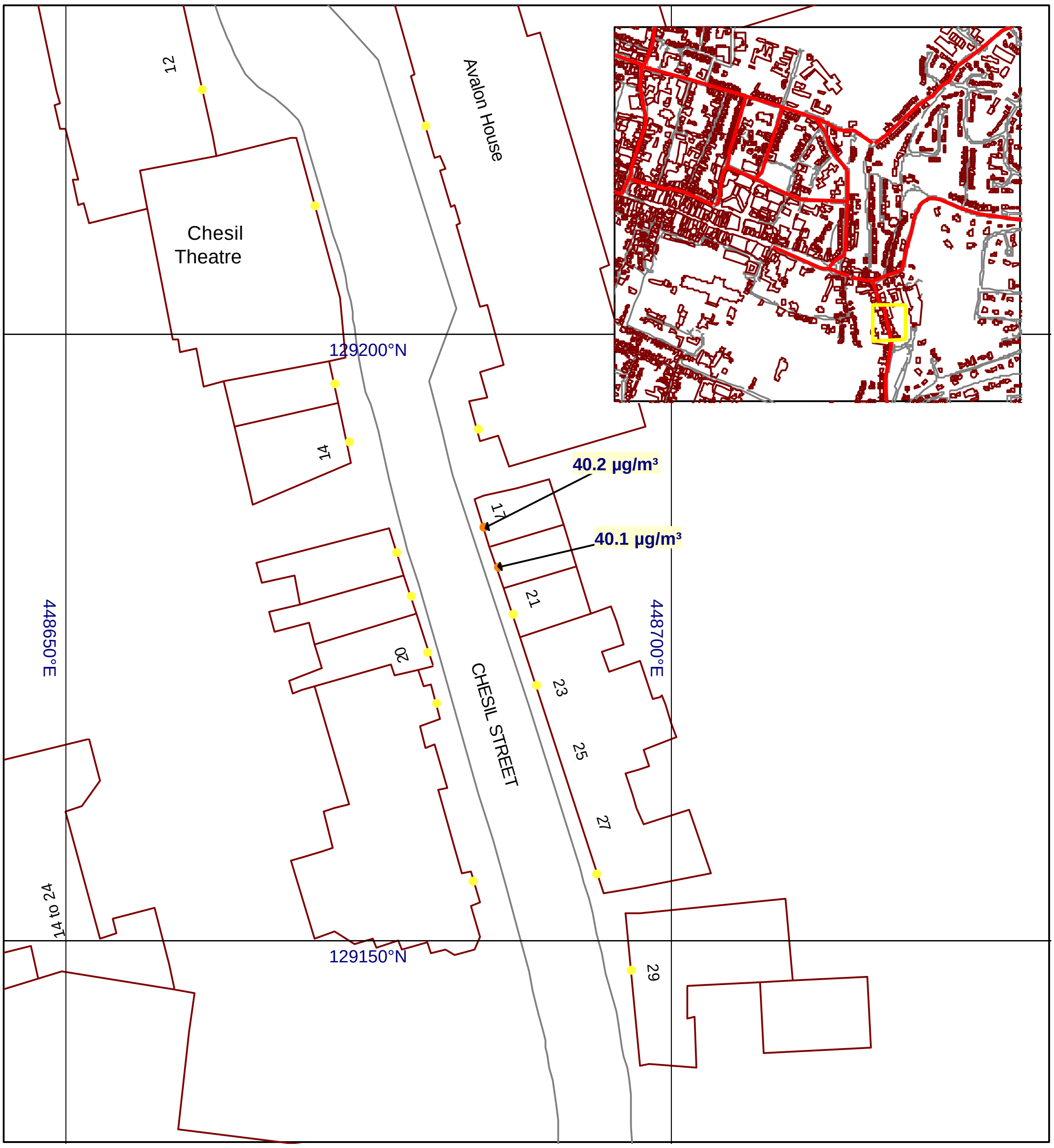


Figure 4.6: Predicted annual average NO_2 concentrations at specific receptors on Chesil Street– 2005 – all as µg/m³



The predicted exceedences on St. Cross Street and Chesil Street are marginal and concentrations at many locations along both streets are predicted to be just below the annual mean air quality objective in 2005 (as shown in Figure 4.4).

Current diffusion tube monitoring (sites V10 and V11) on Southgate Street to the north of St. Cross Road indicates that there are current and projected exceedences of the annual mean NO_2 objective. On Chesil Street, to the north of the predicted exceedence locations, a diffusion tube (site V18) does not indicate current or future exceedences of the annual mean objective.

It is recommended that the number of diffusion tubes be increased along Southgate Street and Chesil Street to help determine the additional need to declare an AQMA in these areas.

5 CONCLUSIONS

In order to facilitate the declaration of an AQMA, separate line contours have been drawn representing both the 40 $\mu g/m^3$ and 36 $\mu g/m^3$ contour. While concentrations greater than 40 $\mu g/m^3$ represent exceedences of the annual average NO_2 objective, Winchester City Council may wish to consider using the 36 $\mu g/m^3$ concentration as the outer extent of the AQMA. Some uncertainty in the dispersion modelling has already been identified in Section 3 of this report. Whilst systematic under or over-predictions can be accounted for through model verification procedures, random errors still occur with the consequence that uncertainty still exists, even in corrected data. Although technical guidance indicates that model uncertainty in respect of random error is not required to be accounted for when declaring an AQMA. However, in order to take account of additional uncertainty associated with predicting concentrations in the future it is recommended that 10% of the annual mean air quality objective or 4 $\mu g/m^3$ is used when defining the extent of the NO_2 exceedences thus representing a conservative approach.

Figure 4.7 shows the 36 and 40 $\mu g/m^3$ contour for 2005 in the Winchester City centre area.

It may be useful for Winchester City Council to view those buildings within the City Centre, and along the approaching roads, for which predicted concentrations in 2005 exceed 40 $\mu g/m^3$, and 36 $\mu g/m^3$ in 2005. This will facilitate the authority in defining the extent of any AQMA(s) and confirming that the exposure criteria with respect to the annual mean objective is fulfilled.

Figure 4.8 shows those properties with predicted concentrations greater than 36 $\mu g/m^3$ annual average NO_2 in 2005.

Figure 4.7: Predicted annual average NO_2 36 and 40 $\mu g/m^3$ contours in Winchester City in 2005 – all as $\mu g/m^3$

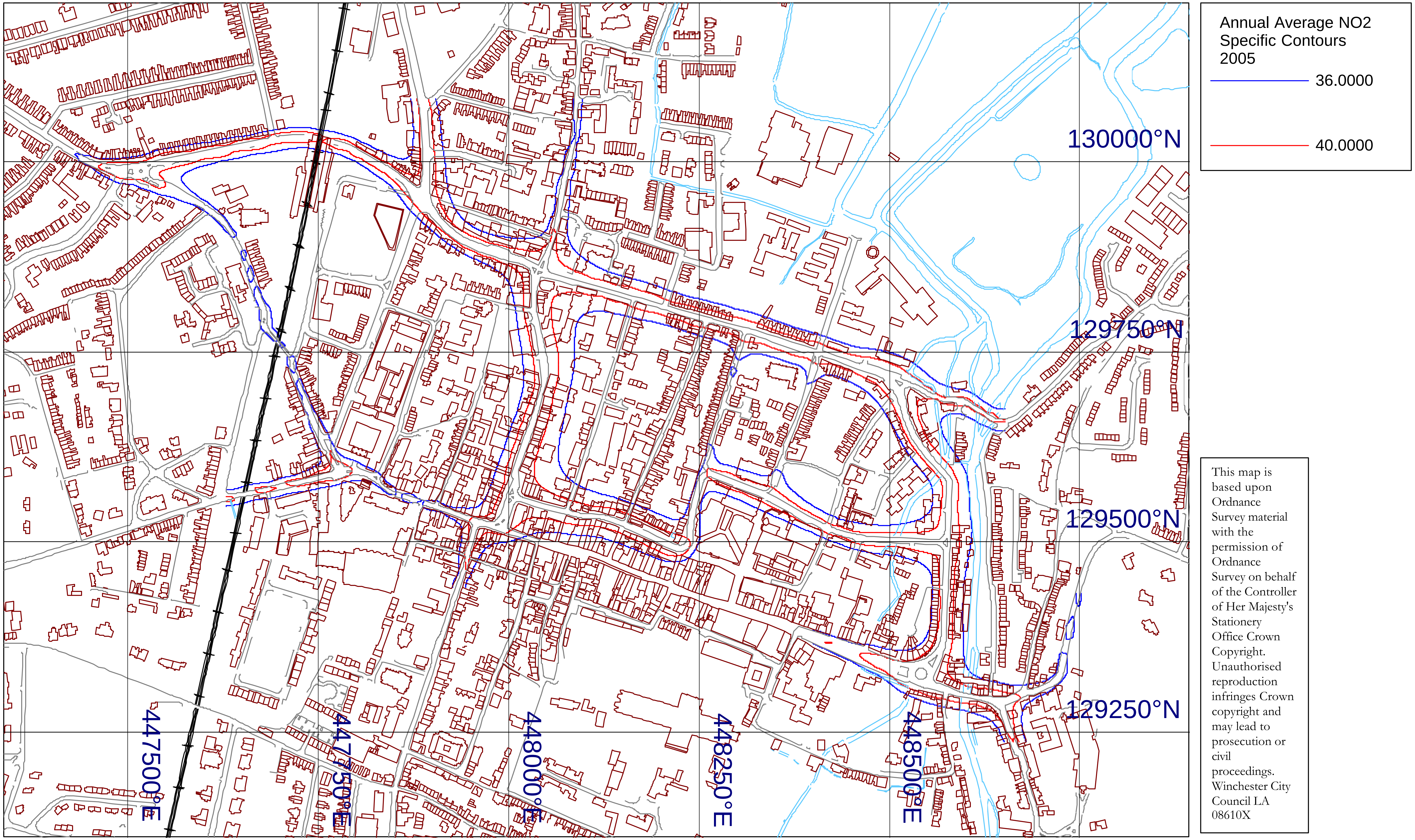
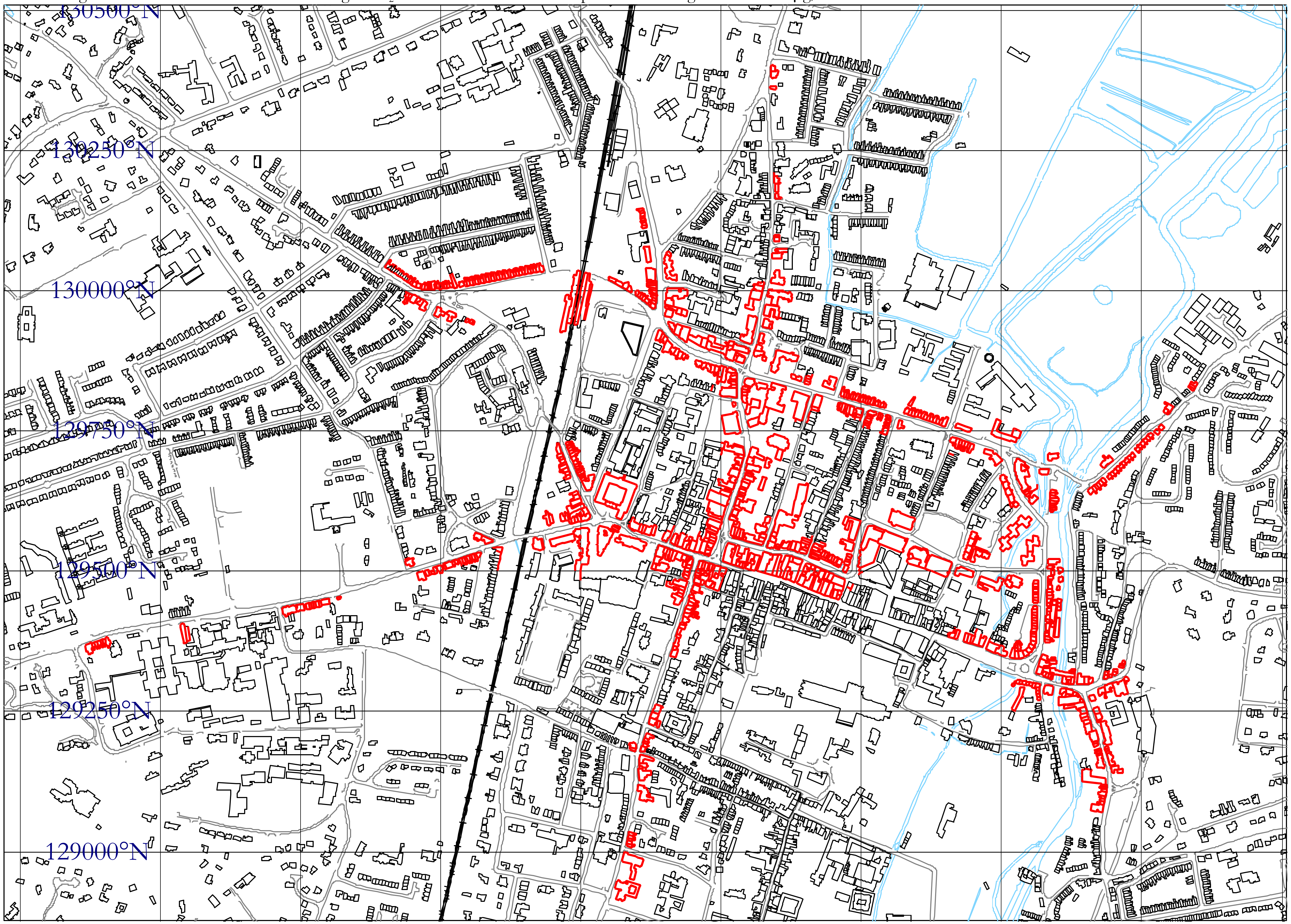


Figure 4.8: Buildings in Winchester at which annual average NO_2 concentrations in 2005 are predicted to be greater than 36 $\mu g/m^3$



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APPENDIX 1

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