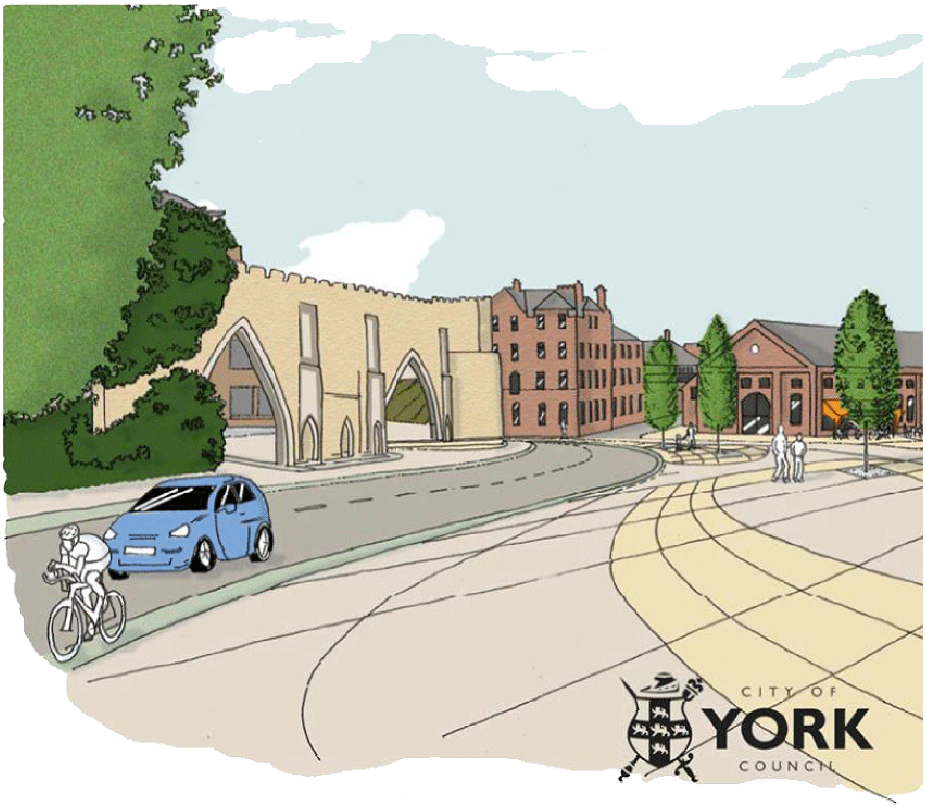
Air Quality Impact Assessment

A comparative air quality assessment of access options into the southern region of the York Central site



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Contents

List of Tables

List of Figures

Executive Summary

As part of the development of the access arrangements for the York Central site, a number of potential access points into the southern region of the site were considered in a study undertaken by Halcrow (2011).

Traffic modelling was undertaken in SATURN to identify the preferred access in relation to minimising traffic delay, cost, value for money and deliverability. This identified that Chancery Rise is the preferred access point in relation to these key criteria. Further work has since been undertaken on this access point to develop the junction arrangement at Chancery Rise and an outline design for the road alignment, bridge and approaches.

The current study considers the comparative emission and air quality impacts of the two access options into the southern region of the York Central Site, namely Holgate Park Drive and Chancery Rise. Both options assume a full closure of Leeman Road and a bus gate on the new spine road, south of its junction with Leeman Road by Marble Arch.

Annual Average Daily Traffic (AADT) flows and speeds were obtained from City of York Council's SATURN model for the road network surrounding the York Central site for a base year (2015), and a future year (2031) with and without traffic associated with the York Central scheme. Two future year, with-development, scenarios were considered, relating to the two access options respectively.

Analysis of road traffic emissions demonstrated that the two York Central Access scenarios exhibited increased overall road traffic emissions relative to the 2031 do-nothing scenario. Over three different sized geographic areas considered, the Holgate Park Drive access scenario showed increased emissions of NO_x, PM_{10} and CO_2 compared with the Chancery Rise access scenario. Across area 1 *(an area of 3km x 3km corresponding to the main study area),* emissions of NO_x, PM_{10} and CO_2 increased by 0.67 tonnes, 0.0032 tonnes and 650 tonnes respectively, over the course of a year, in the Holgate Park Access scenario when compared to the Chancery Rise Access scenario.

Air quality dispersion modelling was undertaken using ADMS-Urban to examine the impact of the two access scenarios on ambient nitrogen dioxide (NO_2) and particulate matter (PM_{10}) concentrations throughout the study area. The methodology employed for the dispersion modelling is described in this note, together with dispersion modelling results for each access scenario. The results of the dispersion modelling have been compared to the appropriate standards, guidelines and significance criteria.

Air quality modelling demonstrated that both York Central access options result in improvement of air quality along Leeman Road, due to the point closure in the vicinity of the National Railway Museum (NRM). This closure also appears to have wider positive impacts in the vicinity of George Hudson Street and Rougier Street. Previous studies have demonstrated that approximately 50% of the traffic is using Leeman Road as a through route to either access the City Centre or Water End. This traffic would be either displaced onto other routes or switch to other modes of transport not affected by the closure, for example, bus. Based on the current flow patterns observed within the model the majority of the westbound through traffic is likely to reroute onto the A59 corridor. For displaced eastbound traffic, vehicles are likely to be more evenly distributed between the A59 and A19 corridors as a means of accessing the city centre. Increases in pollution on both of these corridors are seen in the current air quality modelling study, under both access scenarios.

The study demonstrated only very slight differences in the air quality impacts between the two York Central access scenarios considered. The main differences observed are in relation to NO_2 concentrations. Differences in PM_{10} concentration are considered negligible. Differences between the two options are mainly restricted to specific locations on Holgate Road / Poppleton Road, consistent with the location of the two respective accesses.

Whilst the largest deterioration in nitrogen dioxide occurs at an isolated existing receptor near the junction of Holgate Road and the proposed Chancery Rise access road (under the Chancery Rise access scenario), this change would be considered 'negligible' in the context of current planning guidance. In general, the Holgate Park access scenario causes air quality deterioration along a greater section of the A59 corridor, with negative impacts also being seen further west into Acomb. It should be noted, however, that these impacts are also not considered significant when assessed in line with current guidance. Maximum changes in nitrogen dioxide concentration (and resultant concentrations) are similar in the respective access scenarios.

On balance, it is considered that the Chancery Rise Access option is marginally favourable in terms of air quality impact. This option results in a larger number of locations where air quality improves and a fewer number of locations where air quality deteriorates as a result of the York Central Scheme. Total road traffic emissions of NO_x, PM_{10} and CO_2 are also greater in the Holgate Park access scenario when compared with the Chancery Rise access scenario, across all areas considered.

1. Background and Study Aims

As part of the development of the access arrangements for the York Central site, a number of potential access points into the southern region of the site were considered in a study undertaken by Halcrow (2011)[1].

Traffic modelling was undertaken in SATURN to identify the preferred access in relation to minimising traffic delay, cost, value for money and deliverability. This identified that Chancery Rise is the preferred access point in relation to these key criteria. Further work has since been undertaken on this access point to develop the junction arrangement at Chancery Rise and an outline design for the road alignment, bridge and approaches.

The current study considers the comparative emission and air quality impacts of the two access options into the southern region of the York Central Site, namely Holgate Park Drive and Chancery Rise. Both options assume a full closure of Leeman Road (Arup's current Option 5) and a bus gate on the new spine road, south of its junction with Leeman Road by Marble Arch. The multi-modal access corridors will be 16.3m wide. This comprises of two 3.65m traffic lanes, two 1.5m on highway cycle lanes and two 3.0m footways.

1.1 Chancery Rise Access

Chancery Rise could provide access to York Central from the A59 Holgate Road. The majority of the land available for the access corridor is under the ownership of Network Rail, Yorkshire Forward and City of York Council.

Chancery Rise is currently a cul-de-sac with the vacant Alliance House office accommodation and parking at the northern end and currently forms a priority crossroads with the A59. The new access would connect into a new traffic signal controlled junction with Holgate Road, and would continue at ground level for approximately 180m before rising to the higher levels at the north behind Alliance House. At this point, the access corridor would rise in order to cross the Freight Avoiding Line and then continue over the rail lines by means of a bridge, before terminating at an elevated roundabout type junction. The access corridor would then ramp down to reach existing ground levels in the site.

Full details of the Chancery Rise access are provided in the document 'York Northwest Masterplanning and Infrastructure Study' (June 2011) undertaken by Halcrow. Figure 1 below provides an extract from this document and indicates the location plan for the corridor.

[1] York Northwest Masterplanning and Infrastructure Study, Halcow (June 2011)

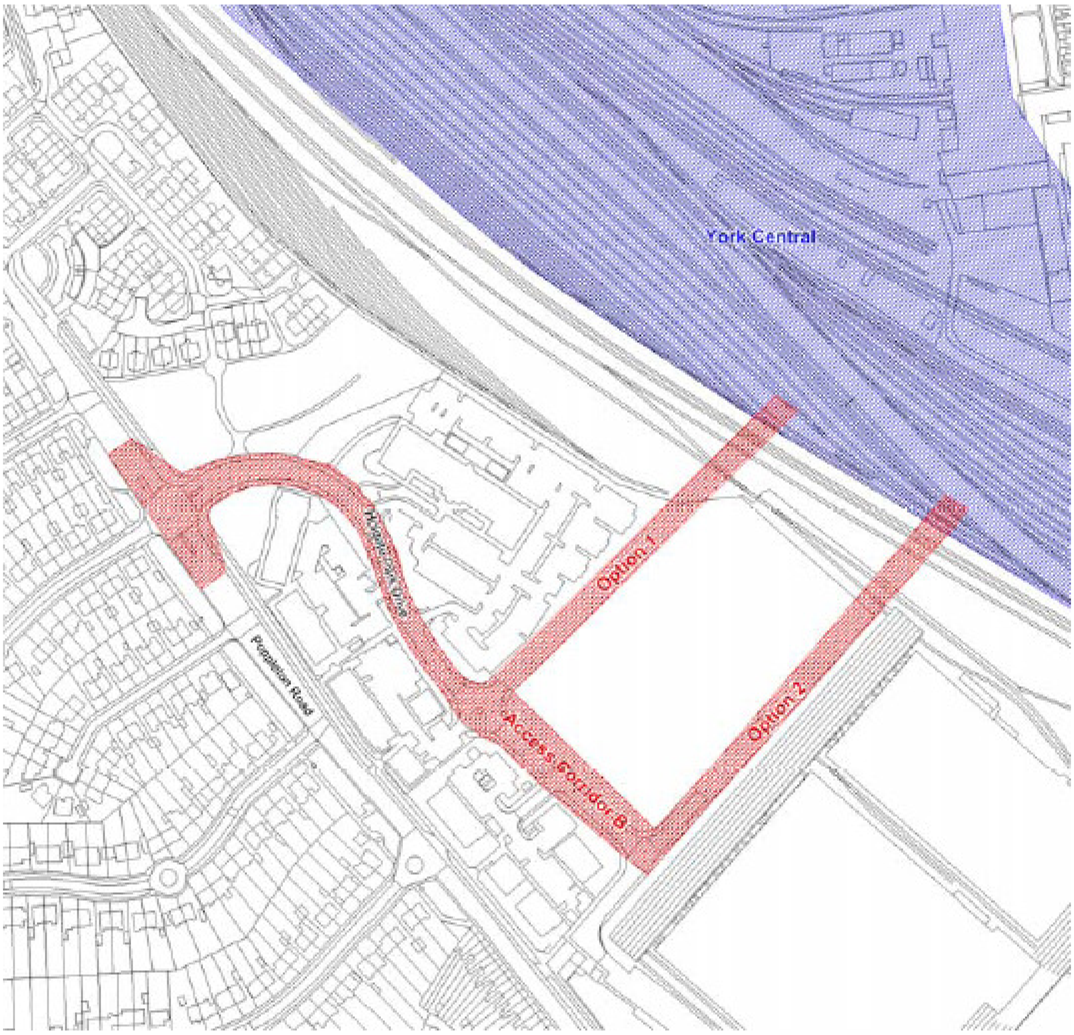
Figure 1: Chancery Rise location plan

1.2 Holgate Park Drive Access

An access to York Central via Holgate Park Drive was initially identified by Alan Baxter Associates in 2001 and further work was undertaken by Faber Maunsell in 2005 as part of a previous York Central traffic study. Holgate Park Drive currently forms a four arm signal controlled junction with the A59 Poppleton Road and Tisbury Road. The proposed access corridor would use the existing Holgate Park Drive and a number of different proposals were investigated for crossing the railway line sidings. It was demonstrated that the different alignments considered for the Holgate Park Drive access option would not yield different model flows, hence the single scenario has been considered in the current assessment for this option.

Full details of the Holgate Park Drive access are provided in the document 'York Northwest Masterplanning and Infrastructure Study' (June 2011) undertaken by Halcrow. Figure 2 below provides an extract from this document and indicates the location plan for the corridor.

Figure 2: Holgate Park location plan



2. Scenarios under consideration

Annual Average Daily Traffic (AADT) flows and speeds were obtained from City of York Council's SATURN model for the road network surrounding the site for the following scenarios:

- **Scenario 1** - 2015 Baseline scenario reflecting current network operating conditions and emission factors from 2015.
- **Scenario 2a** - 2031 future year 'do-nothing' scenario, including committed development but excluding the York Central Scheme (2030 emission factors).
- **Scenario 2b** – 2031 future year do-nothing scenario (scenario 2a) utilising background concentrations from 2014 and emission factors from 2015. The use of traffic emission factors from the baseline year (2015) for the future 2031 scenario, provides some sensitivity analysis in light of the current uncertainty in the rate of vehicle emission improvements.
- **Scenario 3a** - 2031 future year scenario including the York Central Development (utilising the Holgate Park Drive Access Option) and other committed development in the future year (2030 emission factors).
- **Scenario 3b** - 2031 future year scenario including the York Central Development (utilising the Chancery Rise Access Option) and other committed development in the future year (2030 emission factors).

A comparison of results in the above scenarios allows the air quality impacts of the proposed York Central access options to be determined. Summary information for each scenario is provided in table 1 below.

Table 1: Modelled Scenarios

Scenario number	Traffic Data	Background data*	Emission Factors#
1	2015 Base	2014	2015
2a	2031 do-nothing	2030	2030
2b	2031 do-nothing (assumes no emission improvement)	2014	2015
3a	2031 York Central (Holgate Park Drive access)	2030	2030
3b	2031 York Central (Chancery Rise access)	2030	2030

* *2030 used rather than 2031, as emission factors and background pollution maps only available up to 2030*

3. Traffic data

Traffic flow data for the 2015 baseline and future 2031 (with and without development) scenarios were extracted from CYC's SATURN model. The model was used to estimate daily traffic flows of the following vehicle sub categories: Cars, LGV, HGV and Buses. In the absence of further detailed HGV classification from the SATURN model, HGVs have been modelled as rigid 2 axle vehicles.

3.1 Traffic speeds

In line with the requirements of the air quality model, speeds under 50km/h are represented in 1km/h increments and speeds over 50km/h are represented in 5km/h increments. As such, speeds over 50km/h have been rounded to the nearest 5km/h.

The ADMS-Urban dispersion model requires roads to be split into a series of links, which represent sections where traffic conditions have reasonably homogenous flow and average speed. It should be noted, however, that average speed takes into account any slowing down due to queues and delays on that link. The representation of average speed in this way was considered appropriate for the current round of modelling, which is primarily concerned with comparing the relative air quality impacts of the two access options.

3.2 Network geometry and link re-alignment

Traffic information was input into the model as a series of links. As road links in SATURN are modelled as a series of straight segments, some manual realignment of the road network was undertaken using Ordnance Survey base maps and a Geographic Information System to ensure that the geometry of key road links and junctions were correct. This was particularly important around the new access points to ensure that nearby modelled receptors were the correct distances from road traffic emission sources.

3.3 Modelled Area

SATURN flow difference plots (AM, PM and Inter Peak hour) comparing the Holgate Park and Chancery Rise access options were examined to determine the areas of the network where the main differences in flow would be expected. These plots were used to determine the modelled area for the current study. These plots are included at Appendix 1.

4. Air Quality Modelling Parameters

4.1 Air Quality Model

For the purpose of this assessment, the ADMS-Urban air pollution dispersion model (v3.4) has been used in conjunction Emission Inventory Toolkit (EMIT) (v3.4.1). ADMS-Urban is a formally validated model, developed in the United Kingdom by Cambridge Environmental Research Consultants (CERC). The model is approved by DEFRA and used extensively in the UK. Mapping Tools used were ADMS Mapper (v.2.0), EMIT Mapper and ArcMap (v.10).

4.2 Emission Factors

The latest National Atmospheric Emissions Inventory (NAEI) 2014 emission factor dataset has been used for the current study. This forms the basis of DEFRA's current Emission Factor Toolkit.

For the detailed modelling, a network of links was developed which represented vehicle movements on the local road system. It is important to ensure the correct assessment year is selected when calculating emission rates, as emissions are forecast to reduce with time due to improvements in vehicle emission control technologies and legislative requirements.

As emission factors are currently only available until 2030, a 2030 emission year has been used for all 2031 scenarios. As this has been used consistently for all future year scenarios, this approach is considered appropriate for the current study.

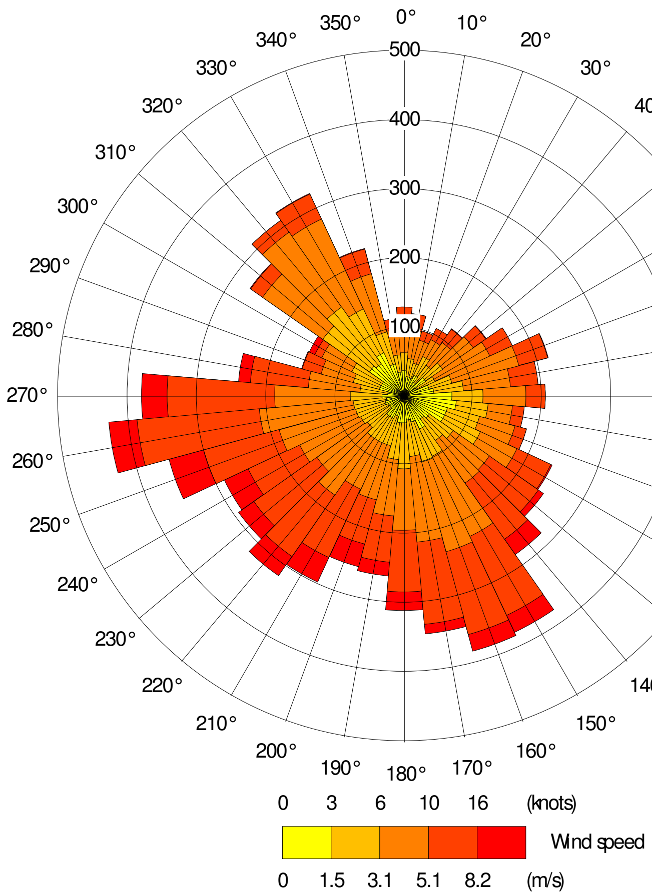
Sensitivity analysis has also been undertaken utilising 2015 emission factors in the future year. The use of traffic emission factors from the baseline year for future scenarios provides some insight into potential ambient air quality in future years, in light of current uncertainty in the rate of vehicle emission improvements.

4.3 Meteorological Data

Meteorological data provides hourly sequential data including wind direction, wind speed, temperature, precipitation and extent of cloud cover for each hour of a given year. As a minimum, ADMS-Urban requires wind speed, wind direction and cloud cover to compute dispersion of pollutants.

Hourly sequential meteorological data from Linton on Ouse were obtained for 2014 from the Met Office and formatted for use with ADMS-Urban. The meteorological data provided information on hourly wind speed and direction and the extent of cloud cover. Figure 3 below illustrates a wind rose for the meteorological data.

Figure 3: Wind rose for Linton on Ouse (2014) weather station



4.4 NO_x to NO_2 conversion

The oxidation of NO to form NO_2 is a complex process that is dependent on several factors, including the relative availability of these two gases as well as ozone, volatile organic compounds, carbon monoxide, sunlight, temperature and residence time. The ADMS-Urban model includes a Chemical Reaction Scheme (CRS) model which accounts for these factors with reference to local emissions and background contributions. An alternative approach is to use the NO_X:NO_2 conversion method referred to in LAQM.TG(09) that takes account of more recently observed trends between NO_x and NO_2. In line with current best practice and guidance, and since the latter approach is recommended by DEFRA within LAQM.TG(09), concentrations of NO_2 have been calculated using this methodology. The dispersion model was therefore run without the chemistry option (used to estimate NO_2 concentrations from NO_x emissions) to allow model verification.

4.5 Surface Roughness

The extent of mechanical turbulence (and hence, mixing) in the atmosphere is affected by the roughness of the surface over which the air is passing. Typical surface roughness values range from 1m (for cities, forests and industrial) to 0.001m (for water or sandy deserts). In this assessment, the model supplier suggested a value of 0.75m would be appropriate for the area being modelled.

4.6 Monin-Obukhov length

A measure of stability of the atmosphere is the 'Monin-Obukhov length'. A Monin-Obukhov length of 30 metres was considered to be most appropriate for this assessment[2]. This value is considered appropriate when modelling cities and small towns.

4.7 Background concentrations

Background NO_x, NO_2 and PM_{10} concentrations have been derived from the CYC operated urban background automatic air quality monitoring station at Bootham hospital, which is located on the outskirts of York inner ring road. These concentrations have been added to the modelled road contributions to estimate the ambient levels of pollution. Background concentrations used for the base year are shown in table 2 below.

Table 2: 2014 background concentrations from Bootham Hospital continuous monitor

Pollutant	2014 background Concentration used in study (µg/m^3)
NO_x	20.089
NO_2	14.329
PM_{10}	14.965

Background concentrations for the future year (2031) have been estimated by factoring the annual mean concentrations monitored at Bootham hospital using ratios obtained from the DEFRA background maps for data between 2014 and 2030. This is summarised in table 3 below.

[2] Email correspondence with Cambridge Environmental Research Consultants (CERC) 7th October 2015

Table 3: Projecting background concentrations - 2014 to 2030

Pollutant	Concentration from DEFRA background maps in µg/m^3 for York Central site (458500, 451500)		Ratio 2014 : 2030
	2014	2030	
NO_x	20.089	15.372	**0.765**
NO_2	14.329	11.197	**0.781**
PM_{10}	14.965	14.116	**0.943**

Resultant background concentrations used in the study for the future year are shown in table 4 below.

Table 4: Background concentrations assumed for study area

Pollutant	Background pollutant concentrations assumed for study area in µg/m^3		Ratio used
	2014 *(from CYC background monitoring station at Bootham Hospital)*	**2030** *(derived from background map ratios)*	
NO_x	26.80	20.51	0.765
NO_2	18.75	14.65	0.781
PM_{10}	14.99	14.14	0.943

Over recent years, background air quality concentrations have not improved as forecast, therefore the background concentrations used for the future year may be overly optimistic. Given this, background pollutant concentrations from 2014 have also been used as part of a sensitivity analysis undertaken for the future year of 2031 (scenario 2b).

4.8 Receptor Locations

The receptors considered in the assessment include a combination of CYC monitoring locations and other locations where the worst-case public exposure would be expected to arise, especially around the new access roads and areas where traffic are most affected by the York Central scheme. The receptors considered in the current assessment are shown on a map in Appendix 2. In total, 125 receptor locations were included in the model runs, covering all major roads in the vicinity of the site.

The reference number/name of all modelled receptor locations correspond with CYC monitoring sites, other than those that have been given a name corresponding to a particular building or location. The receptor height assumed has been based on the measured height of diffusion tubes / continuous monitor inlet and a height of 2.5m has been assumed for other receptors (or where this data is unavailable).

4.9 Model Outputs and Post-Processing

The ADMS-Urban dispersion model has been used to predict annual mean NO_x and PM_{10} concentrations at receptors for the different scenarios under consideration. Modelled NO_x concentrations have been used to estimate concentrations of NO_2 using DEFRA's NO_x to NO_2 calculator (v4.1)[3] to allow comparison against UK Air Quality Objectives.

In line with LAQM.TG(09), the 1-hour mean objective for NO_2 is unlikely to be exceeded at roadside locations where the annual mean NO_2 concentration is less than 60µg/m^3. The 1-hour mean objective is therefore not considered further in this assessment where the annual mean NO_2 concentration is predicted to be less than 60 µg/m^3.

[3] http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc

5. Base Model Verification

Before assessing the air quality impacts of each York Central access, it was necessary to verify the base case modelling predictions against monitoring data within the study area. This process involved a comparison between predicted and measured road-traffic contributions to ambient pollutant concentrations. This process helped to assess and understand the performance of the air quality model.

Any dispersion modelling study will always have a degree of inaccuracy due to a variety of factors. Such factors include uncertainties in traffic emissions data, differences in available met data and the specific microclimate at each modelled receptor, and simplifications made in model algorithms. In addition, there is the uncertainty when comparing modelled predictions with monitored data, based on errors and uncertainty associated with sampling and processing of data.

Guidance note LAQM.TG(09) states that in most cases, local authorities are concerned with the predictions closer to roadside sites as these are more at risk of exceeding the air quality objectives and therefore model verification is generally based on these locations. CYC monitor nitrogen dioxide concentrations at a number of locations within the study area using continuous monitors and diffusion tube monitoring. Modelled concentrations have been verified against 2014 calendar year results from 91 bias corrected roadside diffusion tubes (all roadside diffusion tubes in the study area), together with the Gillygate, Holgate Road and Nunnery Lane continuous monitoring stations. In total, 94 roadside sites within the study area have been used to verify the model.

LAQM.TG(09) states that should the model results for NO_2 be largely within ±25% of the measured values and there is no systematic over or under-prediction of concentrations, then no adjustment is necessary. If this is not the case, then the modelled values are adjusted based on the observed relationship between modelling and measured NO_x and PM_{10} concentrations to provide a better agreement. It should be noted that whilst systematic under or over prediction can be taken into account through the verification process, random errors may still occur and a degree of uncertainly may exist in corrected, 'verified' data.

The monitored and modelled NO_2 concentrations were graphed and the equation of the trendline based on linear progression through zero calculated. Summary statistics for this analysis are shown in table 5 below.

Table 5: Initial verification analysis (based on 94 roadside monitoring sites)

Agreement between modelled and monitored NO_2 values	Number of sites (% of total number of sites shown in brackets)
Within +10%	20
Within -10%	20
Within +/-10%	**40 (42.6%)**
Within +10 to 25%	6
Within -10 to 25%	38
Within +/- 10 to 25%	**46 (46.8%)**
Over +25%	0
Under -25%	10
Greater +/-25%	10
Within +/-25%	**84 (89.4%)**
Average agreement at continuous monitor locations (n=3)	**-0.88%** (from -5.6% at Nunnery Lane to 6.92% at Holgate Road)
Average agreement at diffusion tube locations (n=91)	**-8.7%**

Table 5 above demonstrates that at 89% of modelled locations, the agreement between modelled and monitored concentrations was within +/-25%. The agreement was within +/-10% at 43% of the modelled receptor locations. These are good results.

Whilst this indicated good agreement between monitored and modelled NO_2 concentrations at the majority of locations, there were 10 sites which exhibited a difference of +/- 25%. These are shown in table 6 below.

Table 6: Modelled receptors with a difference +/-25%

Receptor reference	Location	Comments on location	%Difference between modelled and monitored figure for 2014
A1	Bootham	Located within street canyon, near junction	-29
A5	Burton Stone Lane junction with Bootham	Located near junction	-28
A57	Holgate Road, near junction with Blossom St	Located within street canyon, near junction	-29
D19	Bridge St/ Micklegate Junction	Located within street canyon, near junction	-29
D35	Prices Lane	Located within street canyon (between city walls and terraced properties)	-33
D36	Bishopthorpe Road	Located next to junction, potential canyonisation effect	-31
D41	Lord Mayor's Walk	Located within street canyon, near junction	-28
D46	St Leonards Place	Located within street canyon	-26
14	Gillygate	Located within street canyon	-29
7	Gillygate	Located within street canyon	-40

Upon further examination of the sites highlighted in table 6 above, it was determined that all sites were located within street canyons and in areas that regularly experienced long periods of standing traffic, particularly during peak hours. Such areas are challenging to represent in an air quality dispersion model.

DEFRA guidance note LAQM.TG(09) states that if modelled results are within 25% of monitored results then if it not necessary to apply a verification factor. However, in order to improve the reliability of modelled predictions it was considered appropriate to derive an average verification correction factor for the above sites

LAQM.TG(09) sates that verification should be based on road-traffic NO_x, as the NO_x to NO_2 conversion efficiency is affected by the amount of NO_x to be oxidised and the availability of oxidants. Changes in the NO_x to NO_2 conversion efficiency between receptors and years can therefore be taken into account if verification is based on road NO_x. Verified NO_x concentrations are then typically converted to NO_2 using the NO_x to NO_2 spreadsheet calculator developed for Defra (2009).

The ratio between modelled road-NO_x and monitored road-NO_x varied from 2.0 (min) to 2.9 (max) across the 10 sites. An average correction factor of 2.3 has therefore been applied to modelled road-NO_x contributions at the 10 locations highlighted in table 6.

Table 7: Final summary statistics for corrected data

Agreement between modelled and monitored NO_2 values	Number of sites (% of total number of sites shown in brackets)
Within +10%	27 (28.7%)
Within -10%	22 (23.4%)
Within +/-10%	**49 (52.1%)**
Within +10 to 25%	6 (6.4%)
Within -10 to 25%	39 (41.5%)
Within +/- 10 to 25%	**45 (47.9%)**
Over +25%	0 (0%)
Under -25%	0 (0%)
Greater +/-25%	0 (0%)
Within +/-25%	**94 (100%)**
Average agreement at continuous monitor locations (n=3)	**-0.88%** (from -5.6% at Nunnery Lane to 6.92% at Holgate Road)
Average agreement at diffusion tube locations (n=91)	**-5.45%**

These results demonstrate that:

- Using a correction factor of 2.3 at the 10 locations highlighted in table 6 has improved the overall accuracy of the model.
- All modelling predictions are within +/-25% of monitored values. Indeed, 96.8% of modelling predictions were shown to be within +/-20% of monitored values. These are considered good results.
- The agreement at continuous monitoring stations ranged from -5.6% to 6.92%. These are considered very good results.
- The model is not consistently under or over predicting concentrations based on known monitored values.

These results demonstrate that the model is performing well and can be reliably used for comparing and predicting the impacts of the two York Central access options.

A full list of all modelled receptor locations used as part of the verification exercise, along with the linear regression analysis, is shown in Appendix 3.

In line with guidance provided in LAQM.TG(09), and in the absence of a suitable number of CYC operated PM_{10} monitoring locations, the road NO_x correction factor utilised for the 10 locations highlighted in table 6 has also been applied to modelled concentrations of PM_{10}.

6. Modelling Results

Results of the dispersion modelling and road traffic emissions analysis is presented in sections 6.1 and 6.2 respectively. A table of full model outputs, including modelled road NO_x / PM_{10} contributions, and modelled ambient NO_2 / PM_{10} concentrations under each scenario, is provided in Appendix 4.

6.1 Dispersion Modelling

The dispersion model has been used to predict road NO_x and PM_{10} contributions at all modelled receptors. Annual mean concentrations of NO_2 and PM_{10} have been derived by taking into account background pollutant concentrations from Bootham Hospital monitoring station as discussed in section 4.7. DEFRA's NO_x to NO_2 calculator has been used to estimate annual mean nitrogen dioxide concentrations within the study area. This takes into account the modelled road-NO_x contribution, together with background NO_2, at each of the modelled receptor locations.

6.1.1 Scenario 1 (2015 Base)

Modelled annual mean concentrations of NO_2 at modelled receptors ranged from 20.63µg/m^3 to 58.71µg/m^3 within the study area. Modelled concentrations demonstrated very good agreement with 2014 NO_2 monitoring data (see section 5 on model verification). Areas currently known to be in exceedence of the annual mean nitrogen dioxide objective (through monitoring) were correctly identified by the model within the study area.

Modelled annual mean concentrations of PM_{10} demonstrated considerably less variability, ranging from 15.04µg/m^3 to 16.23µg/m^3. No breaches of the annual mean PM_{10} objective were identified by the model. This is consistent with the findings of City of York Council's Air Quality Review and Assessment studies over the last 15 years.

6.1.2 Scenario 2a - 2031 future year 'do-nothing' scenario

Modelled annual mean concentrations of NO_2 at modelled receptors ranged from 15.25µg/m^3 to 27.89µg/m^3. The highest concentrations were predicted along Bootham, in the vicinity of Bridge Street (near junction with Micklegate) and along George Hudson Street. No breaches of the annual mean nitrogen dioxide objectives were observed.

Modelled annual mean concentrations of PM_{10} were relatively consistent over the study area, ranging from 14.15µg/m^3 to 14.30µg/m^3. No breaches of the annual mean PM_{10} objective were identified by the dispersion model.

The improvement in NO_2 and PM_{10} concentrations in this scenario, when compared with the 2015 base model, is due to the anticipated improvement in vehicle emissions and falling background concentrations. This was shown to more than offset any increase in pollution due to additional traffic as a result of committed development in the future year.

6.1.3 Scenario 2b – 2031 future year ‘do-nothing scenario’ utilising emission factors from 2015.

The use of traffic emission factors from the baseline year (2015) for the future 2031 scenario, provides some sensitivity analysis in light of the current uncertainty in the rate of vehicle emission improvements and falling background concentrations.

Modelled annual mean concentrations of NO_2 at modelled receptors in this scenario ranged from 20.68µg/m^3 to 58.99µg/m^3. In line with scenario 2a, the highest concentrations were predicted along Bootham, in the vicinity of Bridge Street (near junction with Micklegate) and along George Hudson Street. The maximum concentrations predicted by the model are slightly elevated when compared with the 2015 base due to increased volumes of traffic generated by committed development in the future year.

Modelled annual mean concentrations of PM_{10} were relatively consistent over the study area, ranging from 15.04µg/m^3 to 16.24µg/m^3. These were not considered significantly different to the 2015 base year.

This scenario should be considered very much worst case, and provides an indication as to potential ambient air quality levels around the York central site, should background pollutant concentrations and vehicle emissions not improve in line with current national forecasts. It should be noted that exceedences of the annual mean NO_2 objective are observed at a number of locations in this scenario (consistent with the locations of the current AQMA technical breach areas), even without the York Central scheme in place.

6.1.4 Scenario 3a - 2031 Holgate Park Drive Access Option

Modelled annual mean concentrations of NO_2 at modelled receptors ranged from 15.33µg/m^3 to 28.79µg/m^3. Compared with the 2031 do-nothing scenario, the maximum concentration across all modelled receptors in the study area increased by approximately 0.9µg/m^3 (28.79µg/m^3 vs 27.89µg/m^3). Concentrations of nitrogen dioxide were shown to increase in some areas and fall in others relative to the 2031 do-nothing scenario. Summary NO_2 statistics for the Holgate Park Drive access option are shown in table 8 below. The maximum areas of improvement and deterioration under this scenario are shown in table 9.

Table 8: Holgate Park Drive access - Changes in nitrogen dioxide (NO_2) relative to 2031 do-nothing scenario

Nitrogen Dioxide (NO_2)	Holgate Park Access
Number of receptors where air quality improves relative to the 2031 Do-Nothing scenario	35
Number of receptors where air quality deteriorates relative to the 2031 Do-Nothing scenario	89
Number of receptors where air quality exhibits no change relative to 2031 Do-Nothing scenario	1
Maximum improvement at modelled receptors	Δ 1.86µg/m^3 (Leeman Road)
Maximum deterioration at modelled receptors	Δ 1.53µg/m^3 (Outside Fox Pub)
Maximum modelled concentration of NO_2 in 2031	28.79µg/m^3 (Bootham)

Table 9: Holgate Park Drive access – maximum improvement and deterioration at modelled receptor locations (NO_2)

Receptor	Location	NO_2 - Top 5 areas of improvement / deterioration (µg/m^3)
40	Leeman Road	Improve by 1.86
D43	Rougier Street	Improve by 0.87
A17 & D19	Salisbury Road & Bridge St/ Micklegate Junction	Improve by 0.78
102, 103 & 104	Salisbury Terrace	Improve by 0.74
128	Livingstone Street	Improve by 0.67
A48	9 Poppleton Road	Deteriorate by 1.18
Ashton House	Facade of Ashton House	Deteriorate by 1.20

167 Holgate Road	Facade of 167 Holgate Road	Deteriorate by 1.29
A52	Holgate Road, near junction with Hamilton Drive East	Deteriorate by 1.32
Fox Pub	Facade of Fox Pub	Deteriorate by 1.53

Modelled annual mean concentrations of PM_{10} over the study area ranged from 14.15 µg/m^3 to 14.31µg/m^3. No breaches of the annual mean PM_{10} objective were identified by the model. Modelled concentrations of PM_{10} under this scenario were not considered to be significantly different to the 2031 do-nothing scenario. Summary PM_{10} statistics for the Holgate Park Drive option are shown in table 10 below.

Table 10: Holgate Park Drive access - changes in particulate (PM_{10}) relative to 2031 do-nothing scenario

Particulate (PM_{10})	Holgate Park Access
Number of receptors where air quality improves relative to the 2031 Do-Nothing scenario	38
Number of receptors where air quality deteriorates relative to the 2031 Do-Nothing scenario	87
Number of receptors where air quality exhibits no change relative to 2031 Do-Nothing scenario	0
Maximum improvement at modelled receptors	Δ 0.02µg/m^3 (various locations)
Maximum deterioration at modelled receptors	Δ 0.02µg/m^3 (various locations)
Maximum modelled concentration of PM_{10} in 2031	14.31µg/m^3 (Bootham)

6.1.5 Scenario 3b - 2031 Chancery Rise Access Option

Modelled annual mean concentrations of NO_2 at modelled receptors ranged from 15.46µg/m^3 to 28.72µg/m^3. Compared with the 2031 do-nothing scenario, the maximum concentration at modelled receptors in the study area increased by approximately 0.83µg/m^3 (28.72µg/m^3 vs 27.89µg/m^3). Concentrations of nitrogen dioxide were shown to increase in some areas and fall in others relative to the 2031 do-nothing scenario. Summary NO_2 statistics for the Chancery Rise option are shown in table 11 below. The maximum areas of improvement and deterioration under this scenario are shown in table 12.

Table 11: Chancery Rise access - Changes in nitrogen dioxide (NO_2) relative to 2031 do-nothing scenario

Nitrogen Dioxide (NO_2)	Chancery Rise Access
Number of receptors where air quality improves relative to the 2031 Do-Nothing scenario	45
Number of receptors where air quality deteriorates relative to the 2031 Do-Nothing scenario	80
Number of receptors where air quality exhibits no change relative to 2031 Do-Nothing scenario	0
Maximum improvement at modelled receptors	Δ 1.88µg/m^3 (Leeman Road)
Maximum deterioration at modelled receptors	Δ 1.96µg/m^3 (Holgate Rd, next to new access)
Maximum modelled concentration of NO_2 in 2031	28.72µg/m^3 (Bootham)

Table 12: Chancery Rise acess – maximum improvement and deterioration at modelled receptor locations (NO_2)

Receptor	Location	NO_2 - Top 5 areas of improvement / deterioration (µg/m^3)
40	Leeman Road	Improve by 1.88
D43	Rougier Street	Improve by 1.23
D19	Bridge St/ Micklegate Junction	Improve by 1.19
110	George Hudson Street	Improve by 0.90
114	Rougier Street	Improve by 0.82
22 Cleveland Street	Facade of 22 Cleveland Street	Deteriorate by 1.24
Chancery House	Facade of Chancery House	Deteriorate by 1.42
A52	Holgate Road, near junction with Hamilton Drive East	Deteriorate by 1.67
York Bridge Centre - Chancery Facade(154)	Chancery Rise - facade of 154 Holgate Road	Deteriorate by 1.74
York Bridge Centre - Holgate Facade (152)	Holgate Road - facade of 154 Holgate Road	Deteriorate by 1.96

Modelled annual mean concentrations of PM_{10} over the study area ranged from 14.15µg/m^3 to 14.31µg/m^3. No breaches of the annual mean PM_{10} objective were identified by the model. Modelled concentrations of PM_{10} under this scenario were not considered to be significantly different to the 2031 do-nothing scenario. Summary PM_{10} statistics for the Holgate Park Drive option are shown in table 13 below.

Table 13: Chancery Rise Access - changes in particulate (PM_{10}) relative to 2031 do-nothing scenario

PM_{10}	Chancery Rise Access
Number of receptors where air quality improves relative to the 2031 Do-Nothing scenario	47
Number of receptors where air quality deteriorates relative to the 2031 Do-Nothing scenario	78
Number of receptors where air quality exhibits no change relative to 2031 Do-Nothing scenario	0
Maximum improvement at modelled receptors	Δ 0.02µg/m^3 (various locations)
Maximum deterioration at modelled receptors	Δ 0.02µg/m^3 (various locations)
Maximum modelled concentration of PM_{10} in 2031	14.31µg/m^3 (Bootham)

6.2 Comparison of the air quality impacts of the two access options

Table 14 below demonstrates that, compared with the Holgate park access, the Chancery Rise access scenario results in a greater number of modelled receptors where air quality improves, and a fewer number where air quality deteriorates.

Table 14: Comparison summary of access options

Indicator	Nitrogen Dioxide (NO_2)		Particulate (PM_{10})	
	Chancery Rise Access	Holgate Park Access	Chancery Rise Access	Holgate Park Access
Number of receptors where air quality improves relative to the 2031 Do-Nothing scenario	45	35	47	38
Number of receptors where air quality deteriorates relative to the 2031 Do-Nothing scenario	80	89	78	87
Number of receptors where air quality exhibits no change relative to 2031 Do-Nothing scenario	0	1	0	0
Maximum improvement at modelled receptors	Δ 1.88µg/m^3 (Leeman Road)	Δ 1.86µg/m^3 (Leeman Road)	Δ 0.02µg/m^3 (various locations)	Δ 0.02µg/m^3 (various locations)
Maximum deterioration at modelled receptors	Δ 1.96µg/m^3 (Holgate Rd, next to new access)	Δ 1.53µg/m^3 (Outside Fox Pub)	Δ 0.02µg/m^3 (various locations)	Δ 0.02µg/m^3 (various locations)
Maximum modelled concentration in 2031	28.72µg/m^3 (Bootham)	28.79µg/m^3 (Bootham)	14.31µg/m^3 (Bootham)	14.31µg/m^3 (Bootham)

In order to more easily visualise the impacts of the two access options, differences in predicted NO_2 concentration between the 2031 do-nothing scenario (Scenario 2a) and the two York Central Access Scenarios (Scenarios 3a and 3b) have been plotted using GIS.

Receptor locations on the maps are colour coded according to the magnitude of the impacts. Yellow indicates where impacts are largely negligible, orange to red are negative impacts of increasing magnitude and light green to dark green indicate positive impacts of increasing magnitude.

Differences in nitrogen dioxide concentrations are shown in figures 4 and 5.

Figure 4: Change in nitrogen dioxide (NO_2) concentration ($\mu g/m^3$) at modelled receptors between 2031 DN and 2031 Chancery Rise access scenario

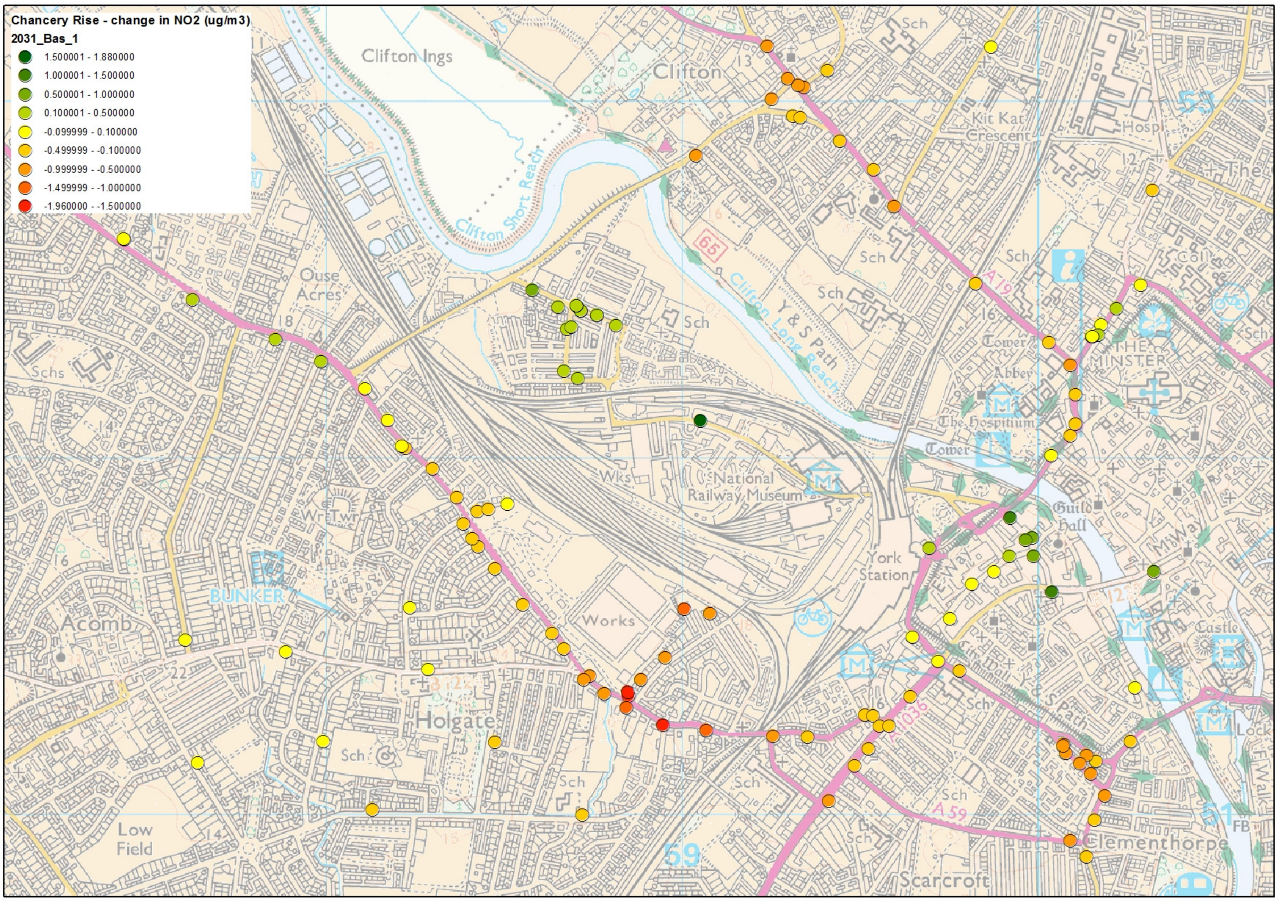
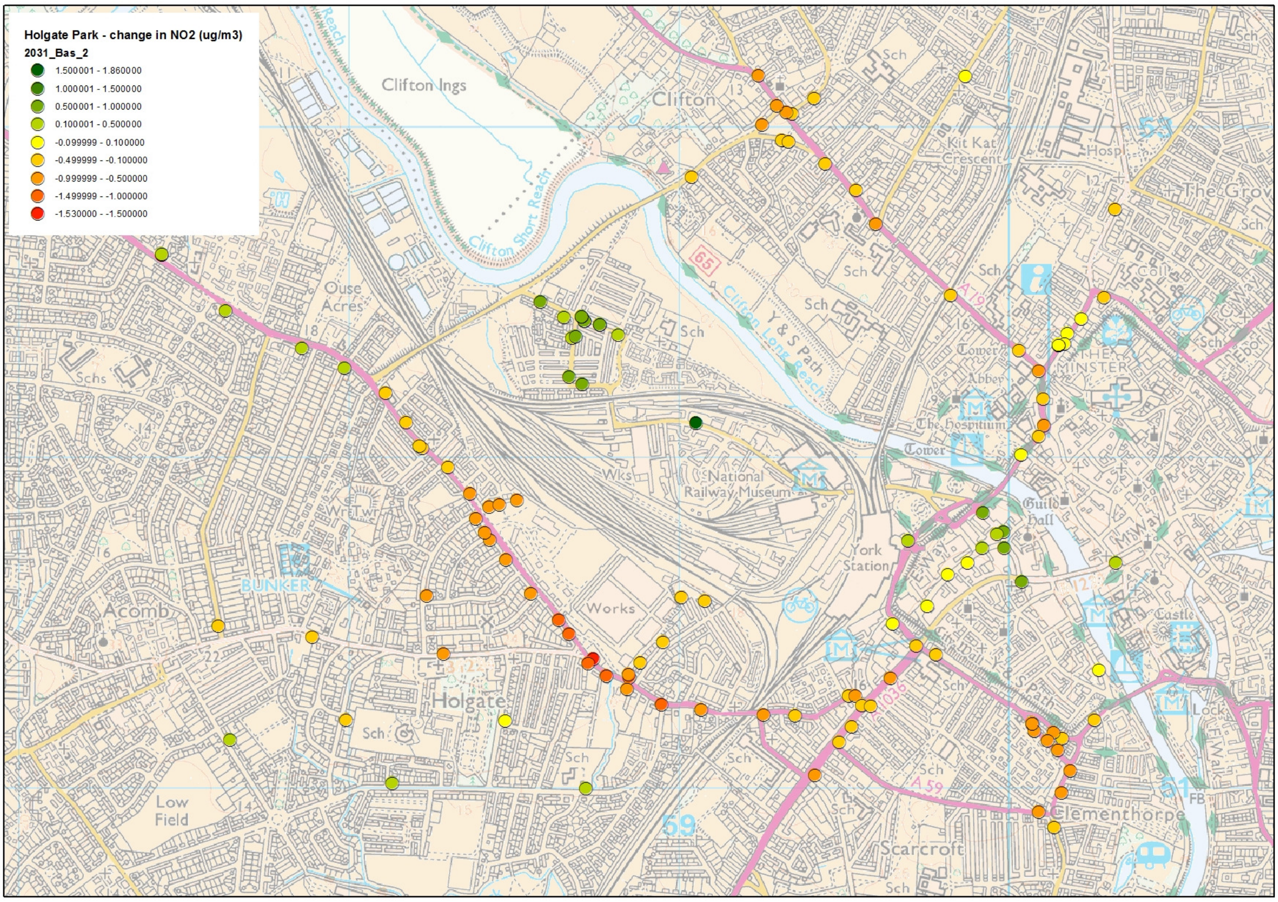


Figure 5: Change in nitrogen dioxide (NO_2) concentration ($\mu g/m^3$) at modelled receptors between 2031 DN and 2031 Holgate Park access scenario



Figures 4 and 5 above show that positive impacts are observed in both scenarios in the Leeman Road area and in the vicinity of Rougier Street, George Hudson Street and Bridge Street. This is consistent with the point closure of Leeman Road in the vicinity of the National Railway Museum, which restricts access to emergency vehicles, buses, pedestrians and cyclists. Previous studies have shown that approximately 50% of the traffic is using Leeman Road as a through route to either access the City Centre or Water End. This traffic would be either displaced onto other routes or switch to other modes of transport not affected by the closure, for example, bus. Based on the flow patters observed within the traffic model, the majority of the westbound through traffic is likely to reroute onto the A59 corridor. For displaced eastbound traffic vehicles are likely to be more evenly distributed between the A59 and A19 corridors as a means of accessing the city centre[4].

Minor positive impacts are also observed in both scenarios on Boroughbridge Road, north west of the junction with Water End.

Negative impacts are observed in both scenarios at numerous locations within the modelled network, especially along Holgate/Poppleton Road and in the vicinity of the respective access roads.

[4] York Northwest Masterplanning & Infrastructure Study, Halcrow, June 2011

With respect to the Chancery Rise access, the main increases in nitrogen dioxide concentration were seen along Holgate Road, between Dalton Terrace and the junction with the B1224 Acomb Road. Increases in concentration of nitrogen dioxide of up to 1.96µg/m^3 were observed at relevant locations in the vicinity of the new access on Holgate Road. It should be noted that existing residential properties to the rear of Wilton Rise would be considered relevant locations in the context of Local Air Quality Management and air quality was shown to deteriorate at these locations. Nitrogen dioxide concentrations were also shown to deteriorate at properties towards the end of Cleveland Street and Upper St Pauls Terrace to the south east of the new access, although this was less pronounced than at existing properties on Holgate road near the new junction. Minor negative impacts are also observed on Nunnery Lane/Price Lane, along Bootham, in the vicinity of Clifton Green, and at some locations along Hamilton Drive (although the majority of these impacts would be considered negligible).

With respect to the Holgate Park Drive access the greatest negative impacts are observed near the junction of the A59 Holgate Road and B1224 Acomb Road (~1.53µg/m^3). Increases in nitrogen dioxide concentration are also observed along Poppleton Road, between the B1224 junction and the new access along Holgate Park Drive. Minor negative impacts are also observed on Nunnery Lane/Price Lane, along Bootham, in the vicinity of Clifton Green, along Acomb Road and Grantham Drive. Negative impacts are also seen further west of Holgate Road (into Acomb) in this scenario when compared with the Chancery Rise access, although this option results in some positive benefits along Hamilton Drive (although the magnitude of such impacts would largely be considered negligible). Greater negative impacts are also seen in this scenario further along Poppleton Road, towards the junction with Water End.

Changes in particulate (PM_{10}) concentration were generally consistent with the commentary provided above for nitrogen dioxide, although the magnitude of change in PM_{10} in both scenarios was considered negligible with respect to the 2031 do-nothing scenario. For this reason, it is not considered appropriate to compare the access options on the basis of this pollutant.

Magnitude of impacts

The significance of air quality impacts is dependent upon the magnitude of change in pollutant concentrations in relation to AQ objectives and absolute pollutant concentrations in relation to AQ objectives. Some descriptors for magnitude of change and significance are discussed in guidance produced by EPUK (2015)[5]. A summary of this is provided in table 15 below:

[5] Reference for EPUK guidance http://www.iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

Table 15: Descriptors for magnitude of change and significance *(reproduced from national guidance)*

Long term average concentration at receptor	% Change in concentration relative to Air Quality Assessment Level (AQAL)			
	1	2-5	6-10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Slight	Moderate	Moderate
95-103% of AQAL	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

In order to consider a worst case scenario, changes in pollutant concentrations have been considered in the context of modelled values for the 2015 base year, as concentrations for this year will be considerably higher than the future 2031 year. This, to some extent, allows for uncertainties over absolute modelled concentrations in the future year. This analysis is considered in tables 16 and 17 below.

Table 16: Top 5 areas of deterioration - Holgate Park Access

Modelled receptor	Modelled change in ambient NO_2 concentration ($\mu g/m^3$) [% change relative to AQO shown in brackets]	2015 Base Case concentration ($\mu g/m^3$) [% of AQO shown in brackets]	Significance
A48	1.18 [3.0%]	26.06 [65.2%]	Negligible
Ashton House	1.20 [3.0%]	29.56 [73.9%]	Negligible
167 Holgate Road	1.29 [3.2%]	30.17 [75.4%]	Negligible
A52	1.32 [3.3%]	33.00 [82.5%]	Slight
Fox Pub	1.53 [3.8%]	31.98 [80.0%]	Slight

Table 17: Top 5 areas of air quality deterioration – Chancery Rise Access

Modelled receptor	Modelled change in ambient NO_2 concentration ($\mu g/m^3$) [% change relative to AQO shown in brackets]	Average of closest/most indicative monitored value in 2013/2014 ($\mu g/m^3$) [% of AQO shown in brackets]	Significance
22 Cleveland St	1.24 [3.1%]	20.98 [52.5%]	Negligible
Chancery House	1.42 [3.6%]	25.89 [64.7%]	Negligible
A52	1.67 [4.2%]	33.00 [82.5%]	Slight
York Bridge Centre - Chancery Facade(154)	1.74 [4.4%]	26.07 [65.2%]	Negligible
York Bridge Centre - Holgate Facade (152)	1.96 [4.9%]	27.73 [69.3%]	Negligible

When changes in modelled concentrations of nitrogen dioxide are considered in the context of future year ambient concentrations (2031 as opposed to 2015), the significance of all modelled changes is also either 'negligible' or 'slight' as no modelled concentration of NO_2 was greater than 70% of the Air Quality Objective level of 40$\mu g/m^3$ and all % changes in NO_2 concentrations were less than 10%[6].

[6] In line with table 14, this equates to a significance criteria of either 'negligible' or 'slight'

6.2.1 Comparison of road traffic emissions totals

In order to undertake a comparative assessment of the two access options in terms of likely impact on emissions, total traffic emissions have been calculated over specific sub-regions of city. Emissions totals under the 2031 do-nothing scenario are shown for information.

Emissions have been assessed over the areas are shown in figures 6 - 8 and tables 18 - 20 below. Results are shown in Table 21 and Figures 9 - 11.

Figure 6: Area 1 (3km x 3km grid over areas where main differences in traffic flows are observed between access options). Extent of area shown in red.

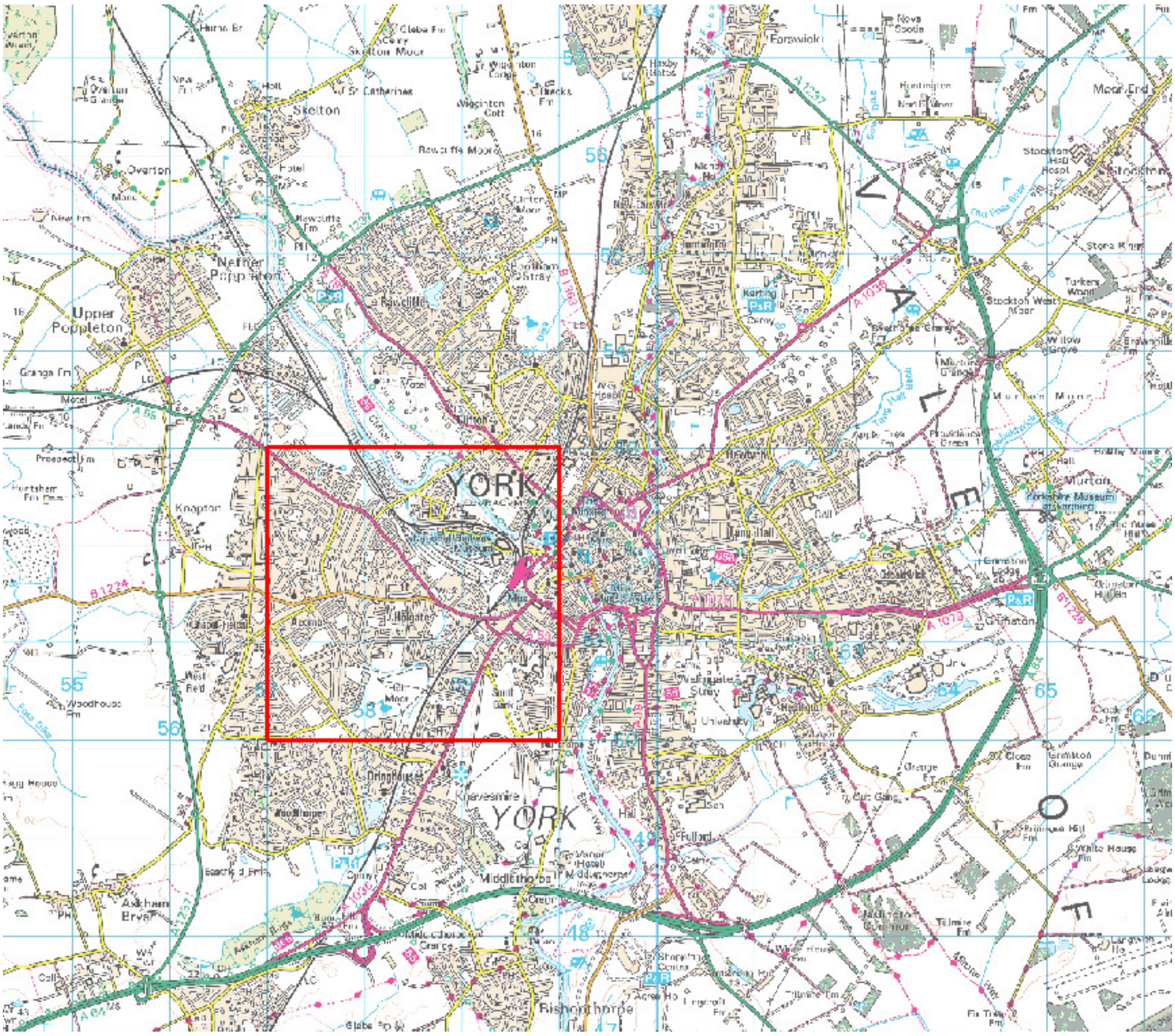


Table 18: Extent of Area 1

	Minimum (m)	Maximum (m)
X	457000	460000
Y	450000	453000

Figure 7: Area 2 (11km x 11km grid covering the extent of the city within the outer ring road). Extent of area shown in red.

Table 19: Extent of Area 2

	Minimum (m)	Maximum (m)
X	455000	466000
Y	447000	458000

Figure 8: Area 3 (4km x 6km grid covered all CYC's Air Quality Management Areas). Extent of area shown in red.

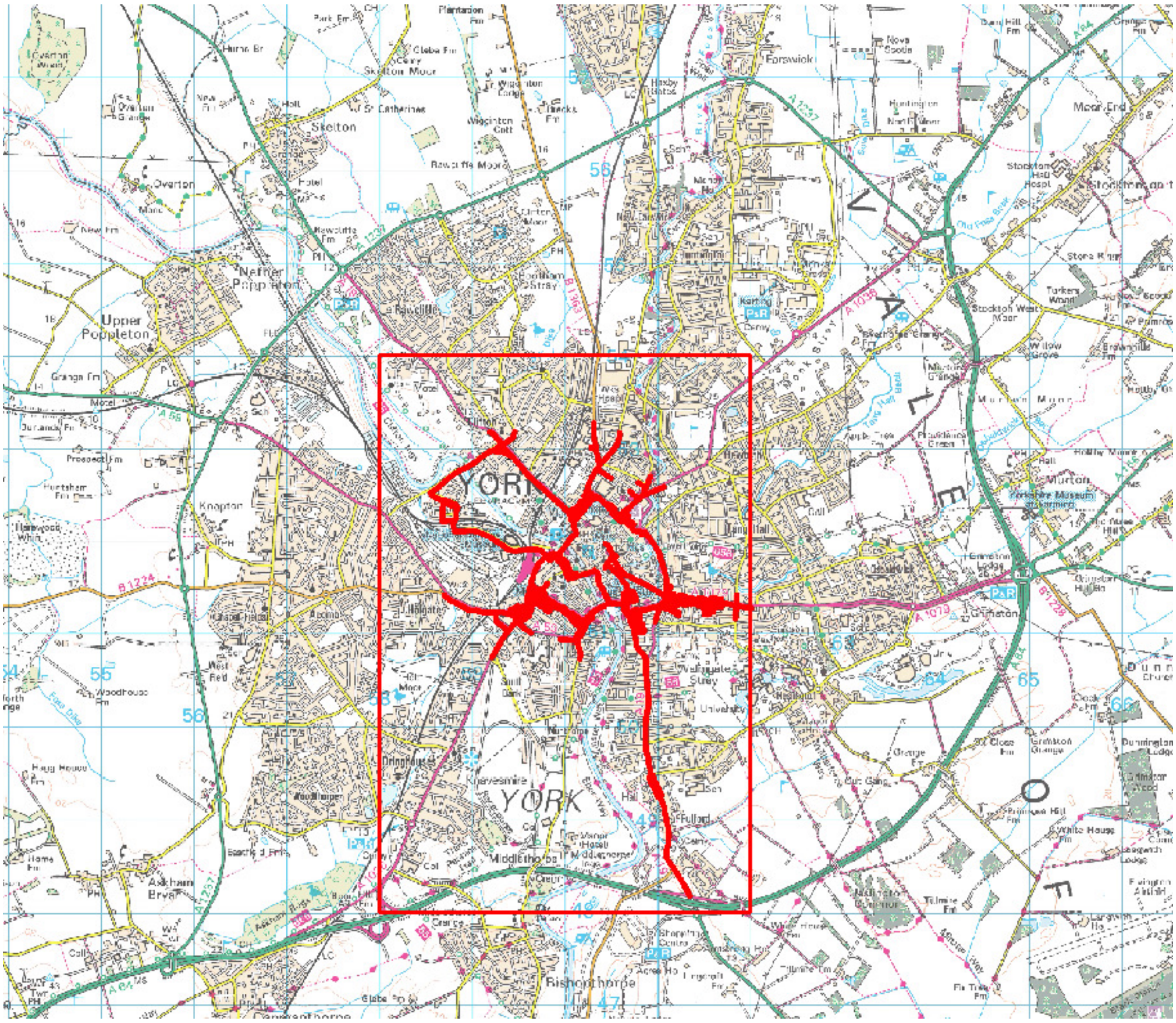


Table 20: Extent of Area 3

	Minimum (m)	Maximum (m)
X	458000	462000
Y	448000	454000

Table 21: Road traffic emissions totals by scenario and by area (tonnes per year)

Area under consideration	2031 DN	2031 DS – Holgate Park Access	2031 DS – Chancery Rise Access
	Total NO_x Emission (t/y)		
Area 1	40.84	43.47	42.80
Area 2	192.90	199.50	197.80
Area 3	81.52	85.36	84.64
	Total PM_{10} Emission (t/y)		
Area 1	0.2307	0.2444	0.2412
Area 2	1.276	1.316	1.305
Area 3	0.4891	0.5101	0.5065
	Total CO_2 Emission (t/y)		
Area 1	36,860	39,370	38,720
Area 2	181,400	188,400	185,900
Area 3	73,490	77,200	76,350

Table 21 above shows that increased emissions of NO_x, PM_{10} and CO_2 are seen across areas 1,2 and 3, under both York Central Access scenarios, relative to the 2031 do-nothing scenario.

Increased emissions of NO_x, PM_{10} and CO_2 are seen across all areas in the Holgate Park access scenario, when compared to the Chancery Rise access scenario.

These figures are shown graphically in figures 9 - 11 below.

Figure 9: Total NO_x Emissions

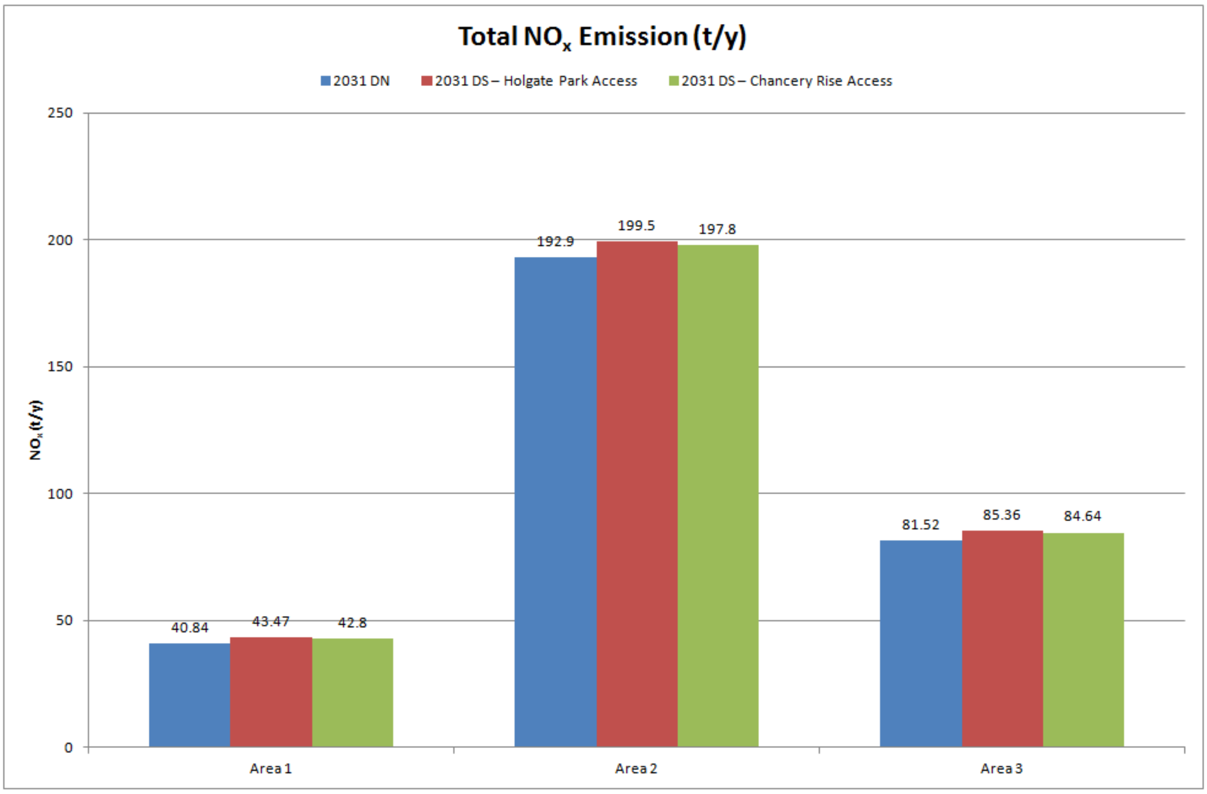


Figure 10: Total PM_{10} Emissions

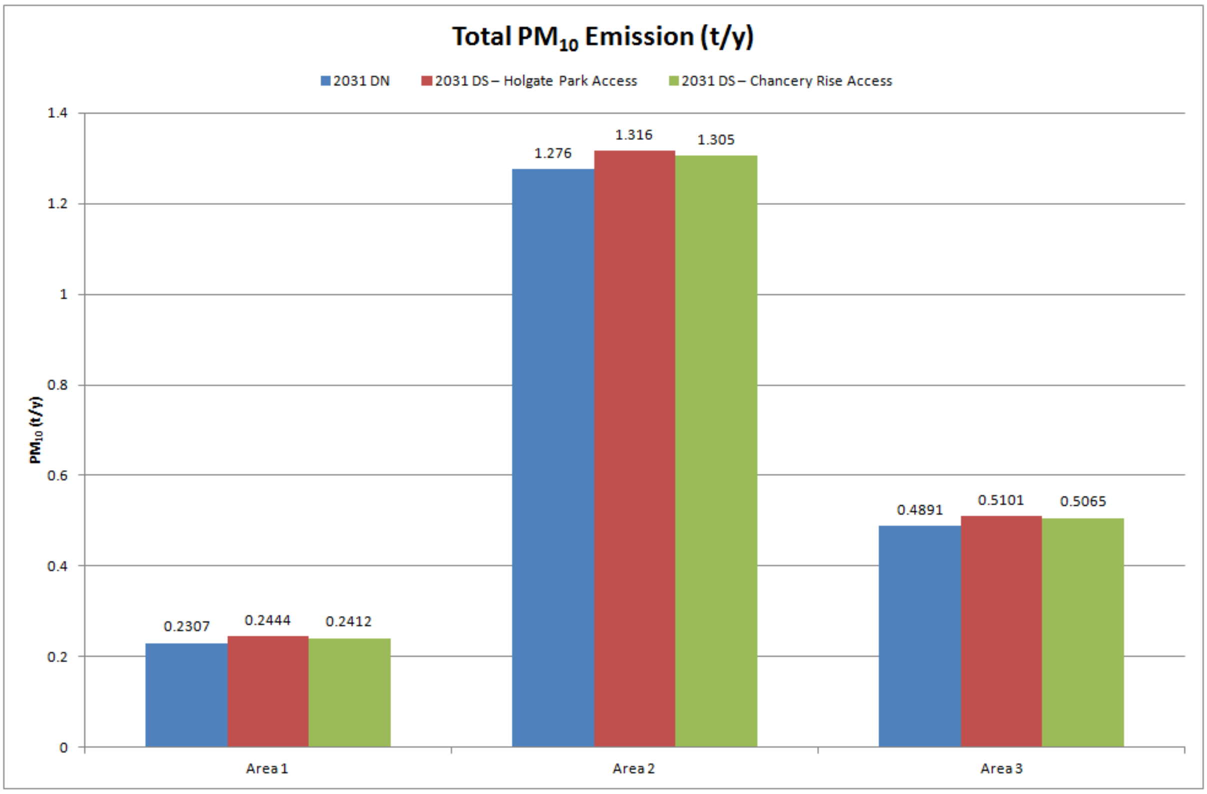
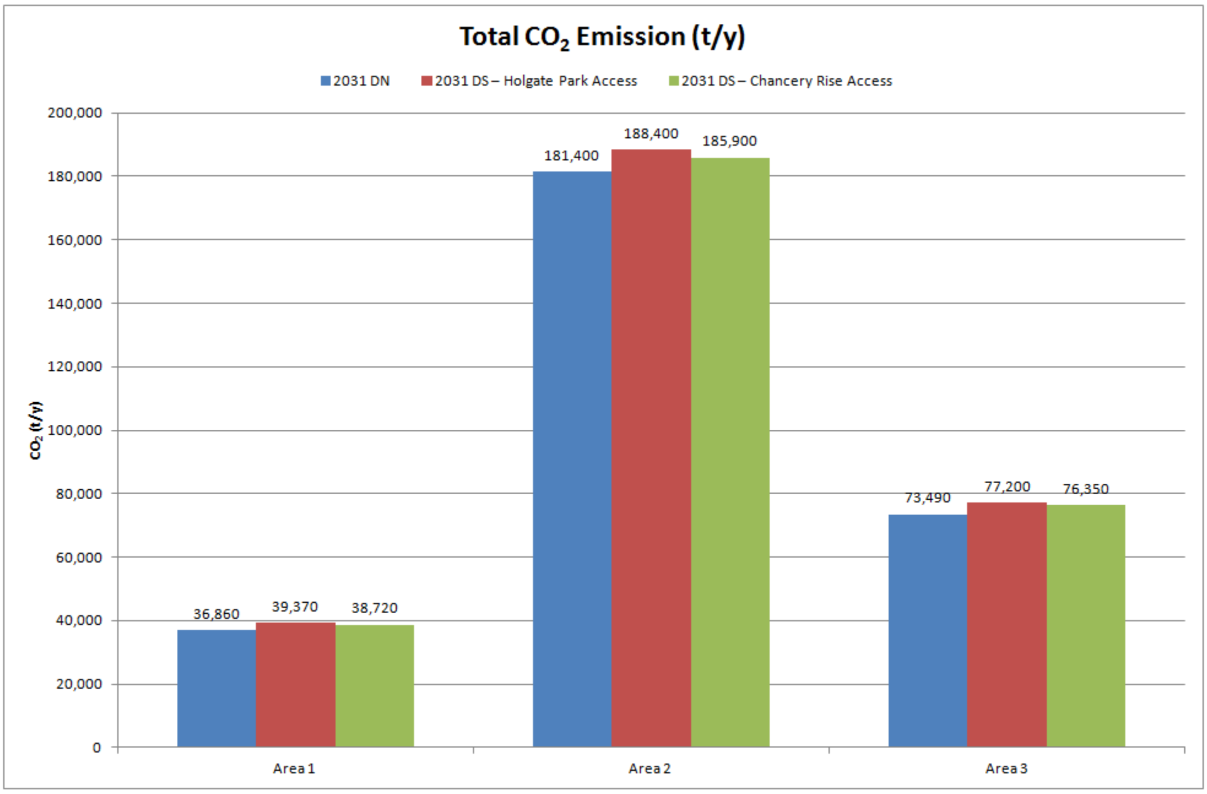


Figure 11: Total CO_2 Emissions



7. Summary and Conclusions

The main conclusions of the study can be summarised as follows:

7.1 Road traffic emissions analysis

- Analysis of road traffic emissions demonstrated that the two York Central Access scenarios exhibited increased overall road traffic emissions relative to the 2031 do-nothing scenario.

- Over the three areas considered, the Holgate Park Drive access scenario showed increased emissions of NO_x, PM_{10} and CO_2 compared with the Chancery Rise access scenario.

- Across area 1 *(an area of 3km x 3km corresponding to the main study area)*, emissions of NO_x, PM_{10} and CO_2 increased by 0.67 tonnes, 0.0032 tonnes and 650 tonnes respectively, over the course of a year, in the Holgate Park Access scenario when compared to the Chancery Rise Access scenario.

7.2 Dispersion modelling analysis

- Both access options result in improvement of air quality along Leeman Road due to the point closure in the vicinity of the National Railway Museum (NRM). This closure also appears to have wider positive impacts in the vicinity of George Hudson Street and Rougier Street. Previous studies have demonstrated that approximately 50% of the traffic is using Leeman Road as a through route to either access the City Centre or Water End. This traffic would be either displaced onto other routes or switch to other modes of transport not affected by the closure, for example, bus. Based on the current flow patters observed within the model the majority of the westbound through traffic is likely to reroute onto the A59 corridor. For displaced eastbound traffic vehicles are likely to be more evenly distributed between the A59 and A19 corridors as a means of accessing the city centre. An increases in pollution on both of these corridors is seen within the air quality modelling study, under both access scenarios.

- The greatest negative impacts are seen along Holgate / Poppleton Road in the vicinity of the respective access roads. In general, the Holgate Park access scenario causes air quality deterioration along a greater section of the corridor, with negative impacts also being seen further west into Acomb. It should be noted that in terms of modelled receptors, the largest deterioration in nitrogen dioxide concentration occurs under the Chancery Rise access scenario at an isolated receptor, but this is a consequence of relevant locations being located immediately adjacent to the new access point, on the same side of the road. The Holgate Park Drive access is located around 60m from residential properties on Damson Close, and thus the impacts of the access road on existing residential receptors (not taking into account impacts on the wider network) is considered marginally less than that seen under the Chancery Rise access. Maximum changes in nitrogen dioxide concentration (and resultant concentrations) are considered broadly similar in the respective access scenarios.

- When considering the significance of the changes in nitrogen dioxide concentrations in the future year, all modelled changes are considered either ‘negligible’ or ‘slight’. In relation to the 2031 do-nothing scenario, the magnitude of change in concentration of PM_{10} is considered negligible in both access scenarios, although the areas of change (and indeed whether PM_{10} concentrations are shown to improve or deteriorate) are consistent with NO_2 described above.

- It should be noted that, based on the sensitivity analysis undertaken in scenario 2b, future year ambient concentrations are very much dependent upon the rate at which vehicle emissions (and background concentrations) improve with time. Under a worst case scenario, where vehicle emissions are shown not to improve in line current estimates, the York Central scheme could have more widespread implications for meeting the air quality objectives in existing AQMA technical breach areas. Whilst the current modelling assessment has been undertaken in line with best practice, the true significance of the impacts of York Central scheme (and indeed other major developments in the city) can only be realised through ongoing monitoring strategies.

7.3 Comparison of access options - conclusion

- There are only very slight differences in the air quality impacts between the two York Central access scenarios considered in the current study. The main differences observed are in relation to NO_2 concentrations. Differences in PM_{10} concentration are considered negligible.

- Differences between the two options are mainly restricted to specific locations on Holgate Road / Poppleton Road, consistent with the location of the two respective accesses and adjoining roads in the immediate vicinity, particularly the A59 Holgate / Poppleton Road.

- Whilst the largest deterioration in nitrogen dioxide occurs at an isolated existing receptor near the junction of Holgate Road and the proposed Chancery Rise access road (under the Chancery Rise access scenario), this change would be considered ‘negligible’ in the context of current planning guidance. In general, the Holgate Park access scenario causes air quality deterioration along a greater section of the A59 corridor, with negative impacts also being seen further west into Acomb. It should be noted, however, that these impacts are also not considered significant when assessed in line with current guidance.

- On balance, it is considered that the Chancery Rise Access option is the most favourable option in terms of air quality. This option results in a larger number of locations where air quality improves and a fewer number of locations where air quality deteriorates. Total road traffic emissions of NO_x, PM_{10} and CO_2 are also greater in the Holgate Park access scenario when compared with the Chancery Rise access scenario, across all areas considered. The magnitude of change in concentrations would not be considered significant for either access scenario, even when considering a worst case analysis based on 2014 monitored values along this section of the A59 corridor.

7.4 Recommendations for further work

- To assess the wider air quality impacts of the York Central Scheme (as opposed to a comparison of the access options), a wider study area should be considered with a larger number of modelled receptor locations. The proximity of new access roads (and thus road traffic emissions) to new 'relevant locations' created on the site should also be assessed.

- The existing air quality model could be refined via further, more detailed classification of traffic data. Additional site surveys could also be undertaken to improve the modelled road network and representation of street canyons.

- Some site specific diffusion tube monitoring would be appropriate to refine background air quality predictions for the York Central site.

- In line with City of York Council's air quality and planning requirements, consideration should be given to damage costs associated with increases in emissions in the future year relative to the do-nothing scenario, without the York Central scheme in place. An air quality mitigation package should be designed for the site to demonstrate that such emissions are mitigated as far as practically possible.

- Consideration should be given to fugitive emissions during construction works (associated with any access arrangements for the site and indeed the wider redevelopment of the site)

- To refine predictions of ambient particulate concentrations in future years, modelling could also take into account non-exhaust emission factors, including brake and tyre wear, road wear and particulate matter re-suspension.

- To gain an understanding of air quality impacts resulting from just phase 1 of the York central development, an interim year (2021) could be modelled in terms of air quality.