A428 Black Cat to Caxton Gibbet improvements

TR010044

Volume 9

9.68 Junction Model Sensitivity Test Results

Planning Act 2008

Rule 8(1)(k)

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A428 Black Cat to Caxton Gibbet improvements

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9.68 Junction Model Sensitivity Test Results

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1 Summary

1.1.1 This document has been prepared in response to an action identified at Issue Specific Hearing 2 (ISH2) held on transport and highways matters on 23 September 2021. The action was as follows:

Report on the possibility, process and outcomes of greater sensitivity testing of the strategic traffic model with regard to stated concerns from Local Highway Authorities (LHAs), in locations highlighted in Local Impact Reports, at minimum:

a. Great north road (and side roads) leading to Wyboston Roundabout, St Neots

b. Caxton Gibbet Roundabout

c. A1/A603 Roundabout, Sandy

1.1.2 This document reports on the results and findings of a number of local junction capacity model sensitivity tests undertaken in response to the action identified above. It should be read with the document 9.44 'Scope of Junction Model Sensitivity Test' **[REP3-029]** which sets out the Applicant's initial response to the action above and, in particular, the case for carrying out sensitivity tests to alternative sources and methods of deriving traffic flows for use in the junction capacity models at a selection of local junctions, adopting alternate driving behaviour parameters wherever applicable and the rationale for not carrying out such sensitivity tests in respect of other junctions.

1.1.3 Junction modelling for the Scheme has been the subject of extensive discussions between the Applicant and the local highway authorities. The basis of the local highway authorities' concerns in relation to junction modelling is set out in detail in their Relevant Representations **[RR-013, RR-023]** and Written Representations **[REP1-048]**, to which the Applicant has provided a full response in 9.10 Junction Modelling Technical Note **[REP3-030]**, including an explanation on the rational for adopting the chosen methodology as a robust, reasonable and proportionate approach to the assessment of impacts of the Scheme.

1.1.4 During ISH2, Cambridgeshire County Council (CCC), Huntingdonshire District Council (HDC), South Cambridgeshire District Council (SCDC) and Central Bedfordshire Council (CBC) raised concerns regarding the methodology for the junction modelling for the Scheme.

1.1.5 The key concerns relate to the following forecast model items:

a. The demand development methodology, specifically the direct use of strategic model flows in the junction models

b. The coding of driving behaviours, vehicle types and priority rules in the Vissim junction models

c. The model inputs used in the ARCADY junction models, particularly relating to the derivation of the traffic flows used in the junctions modelled.

1.1.6 Further to the discussion at ISH2, CCC has provided their preferred method for deriving the junction model flows for future years. CCC has suggested an approach would be acceptable where base models are not developed, but where the observed traffic data is used to derive future year flows (referred to as 'Option 2'). The Applicant agrees with this approach for deriving future year flows, where sensitivity testing is identified as being required following the screening exercise (see below).

2 Selection Criteria for Sensitivity Test Modelling

2.1.1 The Applicant has reviewed the work originally carried out in the preparation of the Transport Assessment **[APP-241]** and **[APP-242]** and Transport Assessment Annex **[APP-243]**, and the concerns raised in the Local Impact Reports **[REP2-003]** and **[REP2-004]** in order to identify the most appropriate locations for sensitivity testing. The approach to this screening exercise is reported in document 9.44 'Scope of Junction Model Sensitivity Test' **[REP3-029]**.

2.1.2 Following the screening undertaken, the Applicant has identified six locations on and around the Scheme where it is considered that Sensitivity Testing should be undertaken. These junctions and the reasons for considering it appropriate to carry out further junction capacity modelling in this way, are listed in **Table 2-1** below.

2.1.3 These include the three principal Scheme junctions, where it was considered necessary to show that the junctions concerned would have a layout suitable to accommodate the traffic flows likely to arise from the Scheme under an alternative set of assumptions; and three other locations where there appeared to be a significant discrepancy between observed and SATURN base model turning flows, for which the Applicant considered that it would be reasonable and proportionate to carry out Sensitivity Tests of the type requested, to quantify the risk that the Scheme might result in a materially different outcome than reported in the Transport Assessment **[APP-241]** and **[APP-242]** and Transport Assessment Annex **[APP-243]**.

2.1.4 At the other junctions, the Applicant did not agree that there was a need to carry out further Sensitivity Testing. The rationale for including some junctions and not others is set out in some detail in document 9.44 'Scope of Junction Model Sensitivity Test' **[REP3-029]** and not repeated here.

Table 2-1 Junctions Selected for Sensitivity Testing in [REP3-029]

Junction Ref:	Issue Raised	Applicant's response	Proposed course of action
Black Cat Junction Caxton Gibbet Junction Cambridge Road Junction	CCC has raised concerns as no base models have been developed for these junctions. Traffic flows used in local junction models taken directly from the Strategic Model. Some Vissim model parameters have also been questioned by CCC.	The junction layout changes fundamentally and the future layout does not resemble the existing layout. A base model would not be relevant and would not provide useful information. Taking into account observed traffic count data may have some impact on the turning flows of the forecast year models.	Sensitivity test to be undertaken by the Applicant for these junctions

Junction Ref:	Issue Raised	Applicant's response	Proposed course of action
		As these are the three main Scheme junctions, sensitivity tests are proposed, for the 2040 AM and PM Do Something scenarios, using traffic count data to derive future year traffic flows – following the 'Option 2' approach recommended by CCC. The sensitivity tests are only required for 2040, as traffic flows are higher in 2040 compared to 2025, so this will demonstrate that the junctions will operate acceptably. The Vissim parameters (such as look ahead distance of priority markers, the HGV disaggregation between OGV1 and OGV2, etc.) which have been questioned are not likely to have a significant impact on model results. However, as a sensitivity test is being run to take into account survey data, then the parameters can be adjusted to test the impact of different Vissim parameters.	
Wyboston Junction	Several issues raised. CCC assert that their preferred approach to modelling would show a deterioration in junction performance compared to the Applicant's model.	The Applicant maintains that the impact of the Scheme on this junction will still be beneficial whatever modelling approach is used. Nevertheless, the Applicant has agreed to undertake sensitivity test at this junction to address the issues raised by CCC and to re-assess the net impact of the Scheme on the Local Road Network at this junction.	Sensitivity test to be undertaken by the Applicant for this junction for both 2025 and 2040 horizon years

Junction Ref:	Issue Raised	Applicant's response	Proposed course of action
Barford Road junction	CCC assert that the base flows used are low relative to observed data from 2017.	The Applicant maintains that the impact of the Scheme on this junction will still be beneficial whatever modelling approach is used. With the modelling undertaken, by 2040, this junction will remain within capacity (max RFC=0.80). Source: TAA **[APP-243]** Table 3-52. Whilst the modelling shows a small increase (of the order of 3% - 6%) in flows using Barford Road (north), the Barford Road (north) arm of the junction remains well within capacity (max RFC=0.64) and it is unlikely that a higher level of base flows would result in this giving rise to a queue-back problem on the Local Road Network. It would not normally be appropriate for National Highways to carry out further, more detailed modelling to assess the performance of this junction, where the overall impact is so clearly beneficial. Nevertheless, the Applicant has agreed to undertake sensitivity testing to quantify the net impact of the Scheme on the Local Road Network at this junction using a set of traffic flow forecasts based on the observed flows – following the 'Option 2' approach recommended by CCC.	Sensitivity test to be undertaken by the Applicant for this junction for both 2025 and 2040 horizon years
Biggleswade North Junction	CBC noted that a hybrid of model and observed flows were used to assess the operation of the	The Applicant notes the existence of a more reliable set of observed base flows and observed queue lengths from CBC.	Sensitivity test to be undertaken by the Applicant for this junction for

Junction Ref:	Issue Raised	Applicant's response	Proposed course of action
	Biggleswade North junction (A1/Hill Lane), and that the base model was not validated. In addition, junction surveys associated with recent planning applications show higher levels of queuing than modelled within the Transport Assessment Annex for this junction, which raises queries over the confidence that can be given to the modelling. Traffic surveys available on public file (as part of these planning applications) include queue lengths - it is considered they represent a suitable data source for model validation – the applicant has been provided with links to the relevant data and CBC request that a validation exercise is undertaken. CBC would further request that a sensitivity test based upon observed turning movements to provide an updated base, with the addition of modelled growth for forecast assessment, is undertaken. Whilst reference is made to the reduction of flows or improved operation, this is not the case for junctions on the A1, where flows are predicted to increase following the opening of the scheme. In addition, the	Whilst the overall impact on traffic flows at this junction is predicted to be minimal, the Applicant acknowledges the concerns expressed by CBC and is proposing to undertake sensitivity testing to quantify the net impact of the Scheme on this junction using a set of traffic flow forecasts based on the observed flows – following the 'Option 2' approach recommended by CCC.	both 2025 and 2040 horizon years

Junction Ref:	Issue Raised	Applicant's response	Proposed course of action
	junctions in question are over capacity and subject to congestion and delay. As such accurate modelling of the junctions current and future operation is considered to be essential. The junctions of concern within CBC are not new 'Scheme' junctions and therefore existing baseline operation can be assessed. The junctions of concern in the CBC area (those on the A1 within CBC and at M1 J13) are also expected to experience increases in flow as a result of the proposed scheme and are predicted to operate over capacity. In addition, the operation of the local road approaches to these junctions are considered to be sensitive to increases in flow on the A1 Strategic Route, and as such the schemes impact upon individual turning movements is considered to be both relevant and important for CBC to have a full understanding of potential scheme impacts.		

3 Scope of sensitivity testing

3.1.1 As reported in Section 2, the Applicant has undertaken sensitivity tests for the following junction models:

a. Black Cat Vissim model (Scheme junction – Transport Assessment) AM and PM 2040 Do Something.

b. Cambridge Road Vissim model (Scheme junction – Transport Assessment) AM and PM 2040 Do Something.

c. Caxton Gibbet Vissim model (Scheme junction – Transport Assessment) AM and PM 2040 Do Something.

d. A1/A428 Wyboston Junctions9 (ARCADY) model – (Transport Assessment Annex) AM and PM 2025/2040 Do Minimum and Do Something.

e. A1/A6001/B658 Biggleswade North Junctions9 (ARCADY) model – (Transport Assessment Annex) AM and PM 2025/2040 Do Minimum and Do Something.

f. A428/Barford Road St Neots Junctions9 (ARCADY) model – (Transport Assessment Annex) AM and PM 2025/2040 Do Minimum and Do Something.

3.1.2 Sensitivity test models were developed for the junctions assessed as part of the Transport Assessment **[APP-241]**. These models included the following changes to the models developed as part of the DCO application for the Scheme, to assess the impact of the changes to parameters requested by the Local Highway Authorities.

a. Black Cat, Cambridge Road and Caxton Gibbet Vissim models (developed for 2040 Do Something AM and PM peak hours):

i. Driving behaviours were changed to the Vissim Software defaults, with a standstill distance of 1.5m, as suggested by CCC (based on the National Highways guidance for high-speed roads).

ii. HGVs vehicle class changed to include two vehicle types - OGV1 and OGV2 with the proportion determined from survey data. OGV2 vehicle type represents articulated vehicles of 16.5m length.

iii. The Vissim models were run for 10 random seeds to increase the confidence in average speed results as requested by CCC.

iv. The observed traffic count data from 2016/ 2017 was used to identify the AM and PM peak hours.

v. AM and PM peak hour base year matrices for all vehicle types were developed for existing movements.

vi. Absolute flow changes were calculated for existing movements retained in the proposed layout, using the forecast year and base year SATURN models. The absolute flow changes were applied to the observed turning flows, for existing movements which are retained in the proposed layout.

vii. For new movements, which didn't previously exist, the SATURN flows are directly used.

viii. Where the new layout includes the new dual carriageway, but the existing A428 is still retained – the existing A428 flows are assumed to use the new dual carriageway/existing A428 following the proportions predicted in SATURN.

b. Wyboston, Biggleswade North and Barford Road junctions (ARCADY models):

i. The latest available pre-Covid observed traffic count data from 2016, 2017 and 2019 was obtained and used where appropriate.

ii. The actual AM and PM peak hours for each junction were identified.

iii. AM and PM peak hour matrices were created for all vehicles and for heavy vehicles for the base year.

iv. The ARCADY models of the junctions were run with these sets of traffic flows.

v. The results of the models were compared with observed queue length data (where available), or with pre-Covid screen shots from Google traffic which illustrate the extent of slow-moving traffic conditions on the approach to the junctions.

vi. Where the modelled and observed queue lengths were found to be broadly aligned, the models can be confirmed as 'validated' in the terms defined in the Junctions9 manual (final paragraph of section 13.13).

vii. Where the modelled and observed queue lengths were not aligned, alternative ways of modelling the junctions were considered, for example, to adjust the lane simulation parameters and/or the use of exit capacity restrictions within the models. No attempt was made to calibrate lope and intercept values, as this requires considerably more data to be collected than is currently available and is not considered proportionate for a sensitivity test of this nature.

viii. Growth factors were calculated to obtain 2025 DM and 2040 DM traffic flows from the observed peak hour matrices – these were obtained by comparing the 2015 SATURN model base with the 2025 DM and 2040 DM SATURN model output turning flows for the junctions concerned and calculating a proportional factor to derive the new 2025 and 2040 Do Minimum matrices from the observed data.

ix. 2025 and 2040 DS matrices for the junctions were derived by comparing the 2025 DM vs 2025 DS and the 2040 DM vs 2040 DS SATURN model output flows and applying absolute changes in peak hourly flows to the 2025 and 2040 DM matrices derived from the observed data to obtain the 2025 and 2040 DS matrices.

x. The ARCADY models for each junction were re-run using the newly derived 2025 DS, 2025 DM, 2040 DM and 2040 DS traffic flow matrices.

4 Outcomes of sensitivity test

4.1.1 This section compares the outputs presented in the Transport Assessment **[APP-241]** and Transport Assessment Annex **[APP-243]** with the sensitivity test outputs.

4.1.2 The following results are provided for the sensitivity test results at each location:

a. Black Cat, Cambridge Road and Caxton Gibbet junctions: The average speed results provided in Appendix 5.1 (TN 44) of the Transport Assessment **[APP-241]** show the extent of congestion/ queues in the model area, and these will be compared to the sensitivity test outputs to show the impact caused by addressing the concerns raised.

b. Wyboston, Barford Road and Biggleswade North Junctions: The ARCADY model outputs in terms of the RFC (Ratio of Flow to Capacity), Average Delay and Maximum Queue will be extracted from the sensitivity test models and compared with the similar results provided in the Transport Assessment Annex **[APP-243]**.

4.2 Black Cat Junction

4.2.1 **Figure 4-1** and **Figure 4-2** show comparison of average speed plots of the Black Cat junction for the 2040 AM and PM peak scenarios respectively. In addition, **Figure 4-3** provides a zoomed in speed plot of the BP garage egress in the 2040 PM scenario.

4.2.2 The average speeds across all approach arms and the gyratory of the junction are similar for the DCO submitted results and the sensitivity test results for both AM and PM peak, showing that the changes tested do not significantly change the assessment. The sensitivity test results show slightly longer queues forming on Bedford Road approach arm, but these still dissipate quickly. The BP Garage egress results are similar in both the versions of the models.

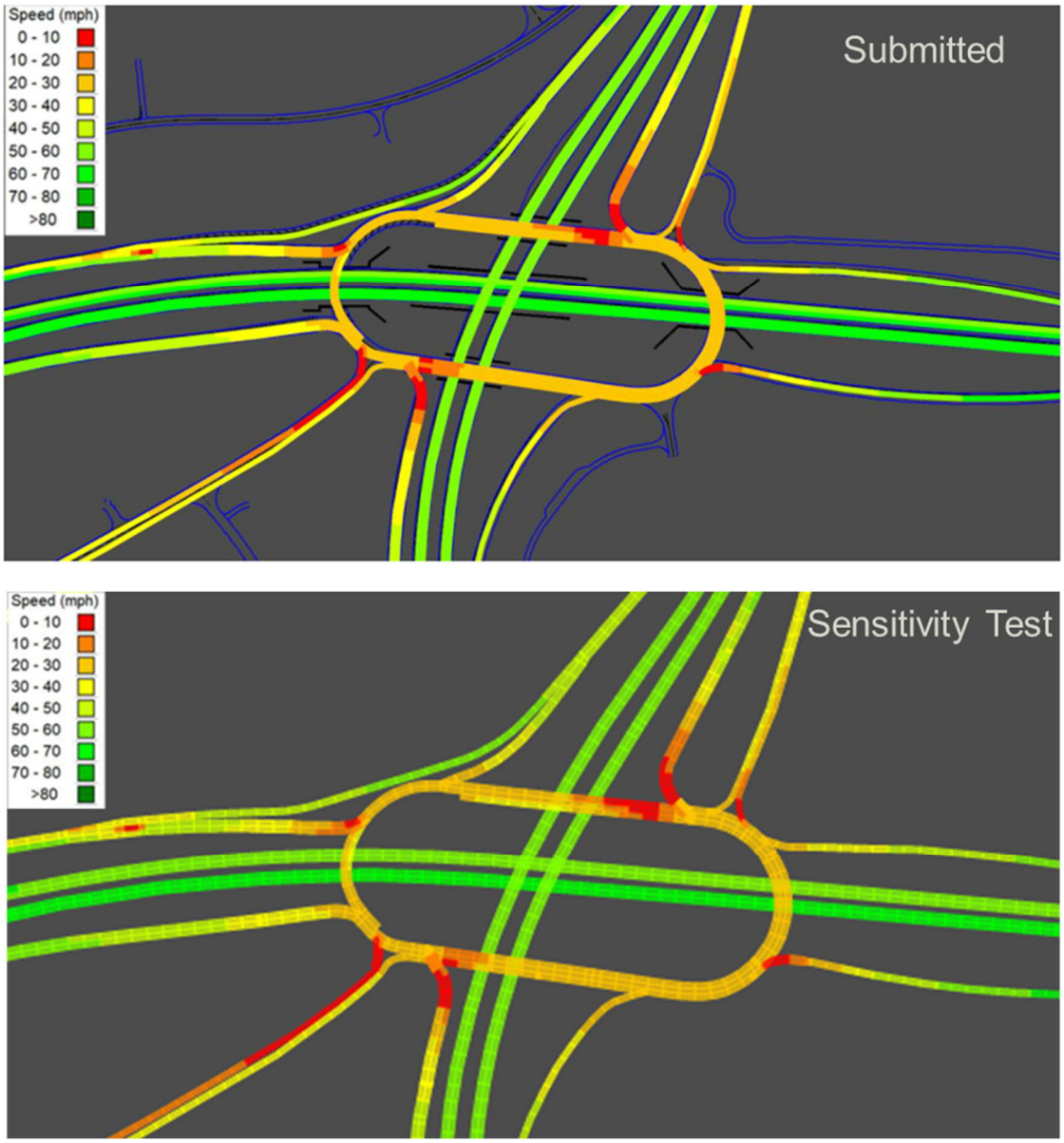


Figure 4-1 – Black Cat Junction – 2040 AM

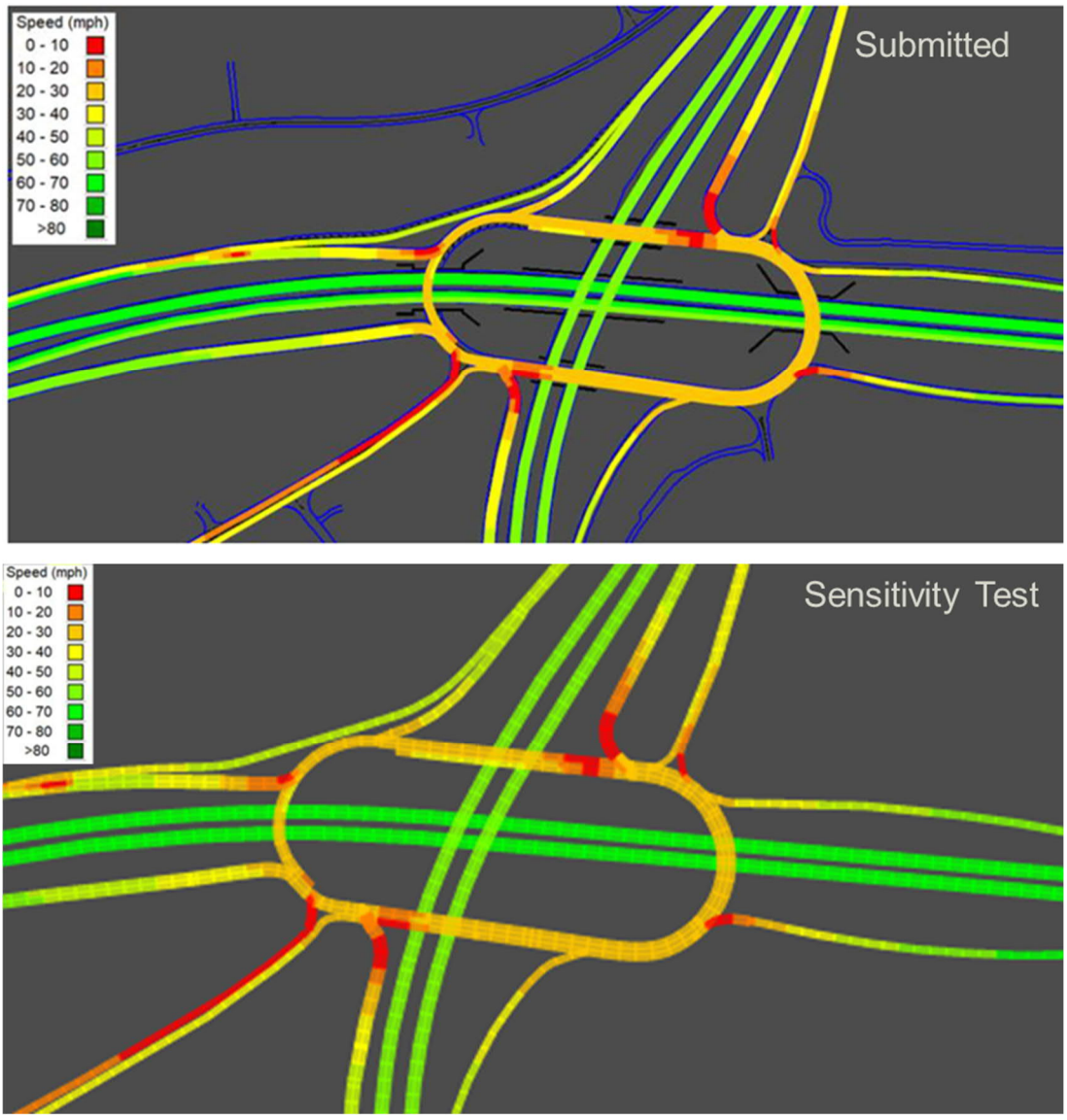


Figure 4-2 – Black Cat Junction – 2040 PM

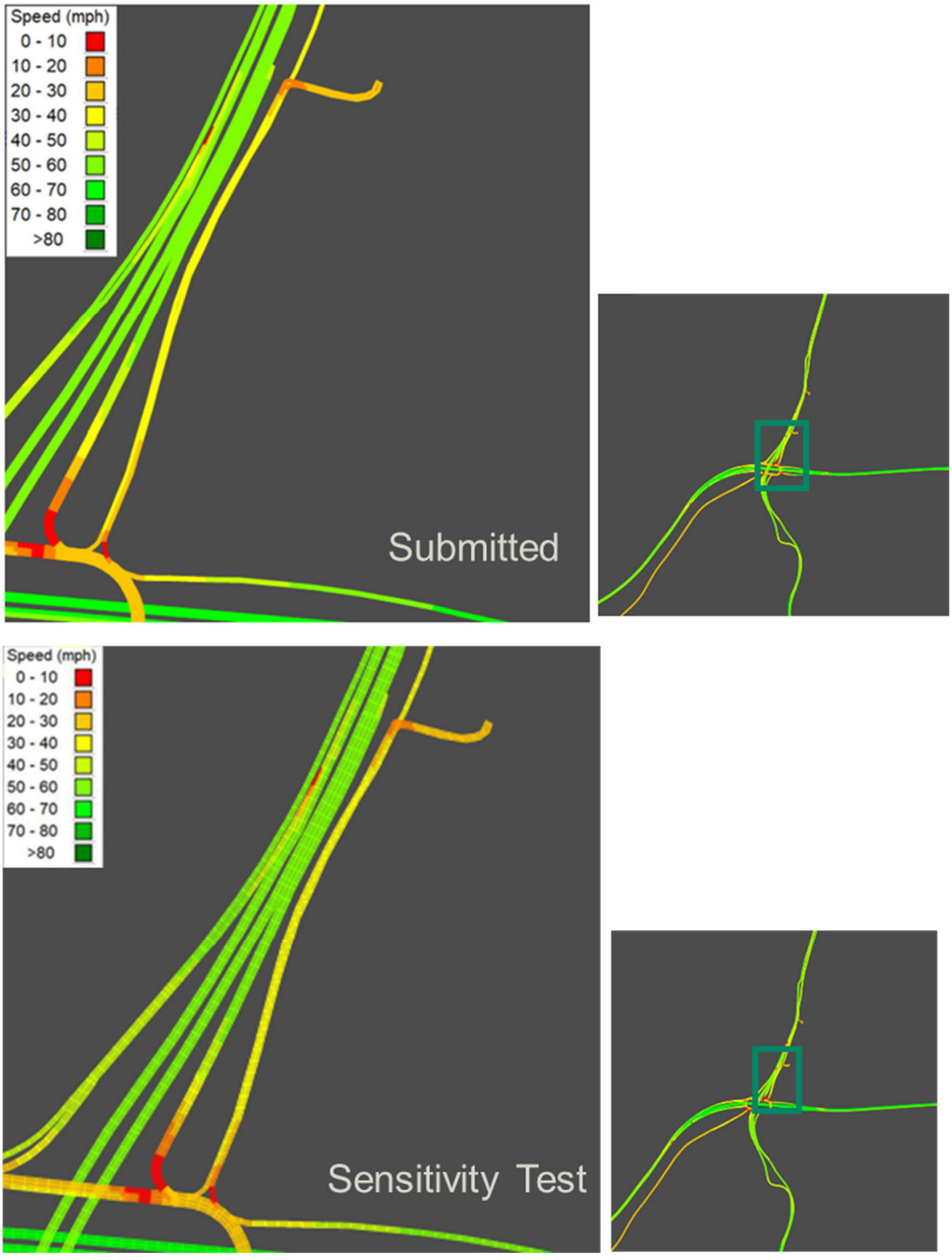


Figure 4-3 – Black Cat Junction – BP Garage Egress – 2040 PM

4.3 Cambridge Road Junction

4.3.1 **Figure 4-4** and **Figure 4-5** show speed plots for the 2040 AM peak at the Cambridge Road junction, at the newly proposed roundabouts and the existing roundabout respectively. **Figure 4-6** and **Figure 4-7** show the results for the same locations in the PM peak.

4.3.2 The average speeds across all the approach arms of the newly proposed roundabouts are similar between DCO submission and the sensitivity test results in both AM and PM peak scenarios.

4.3.3 The sensitivity test results show lower speeds on the western approach (existing A428 link) to the existing roundabout in both the AM and PM peak hours, indicating longer queues. However, the queues only form for a small proportion of the peak hour and can be accommodated without any impact on other junctions.

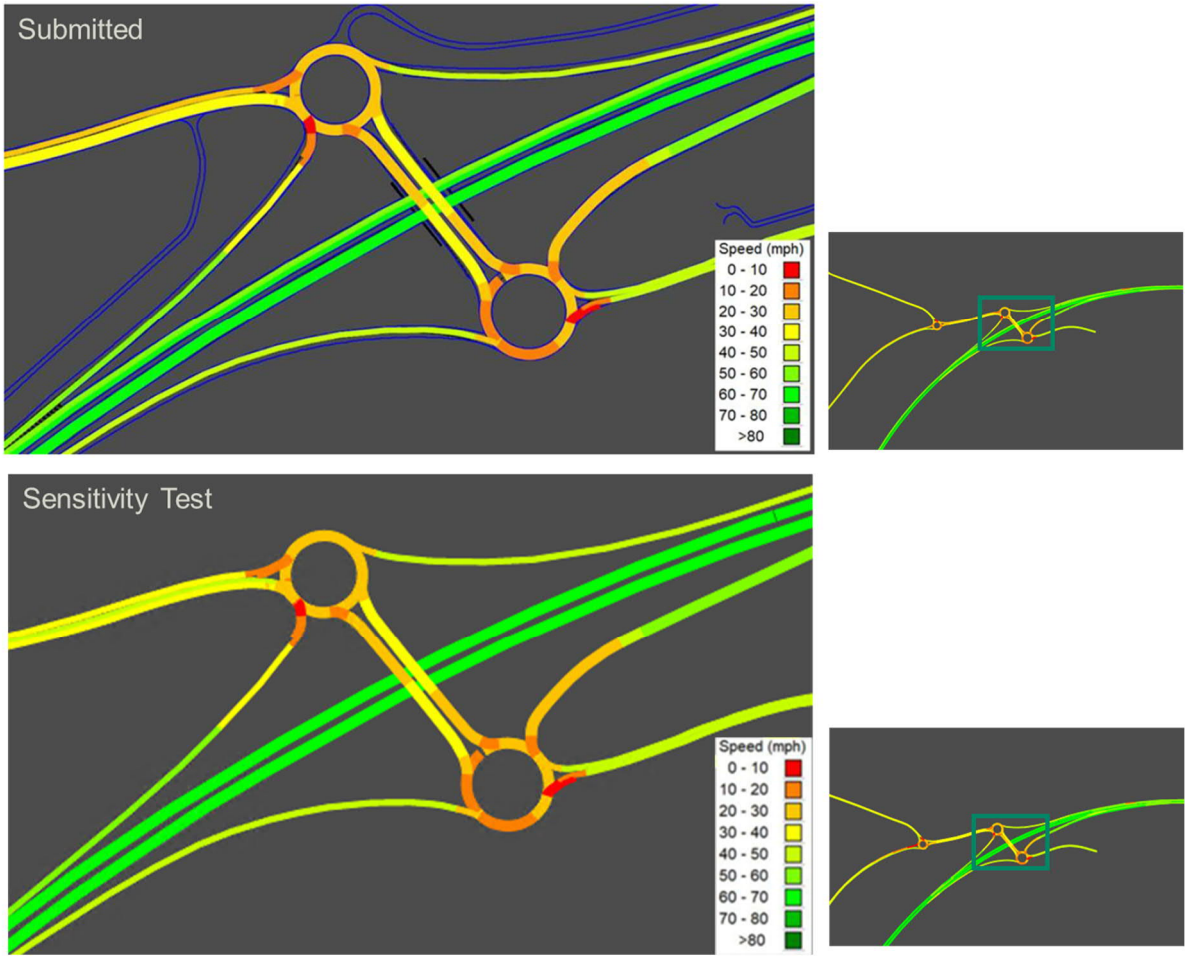


Figure 4-4 – Cambridge Road Junction – New Roundabouts – 2040 AM

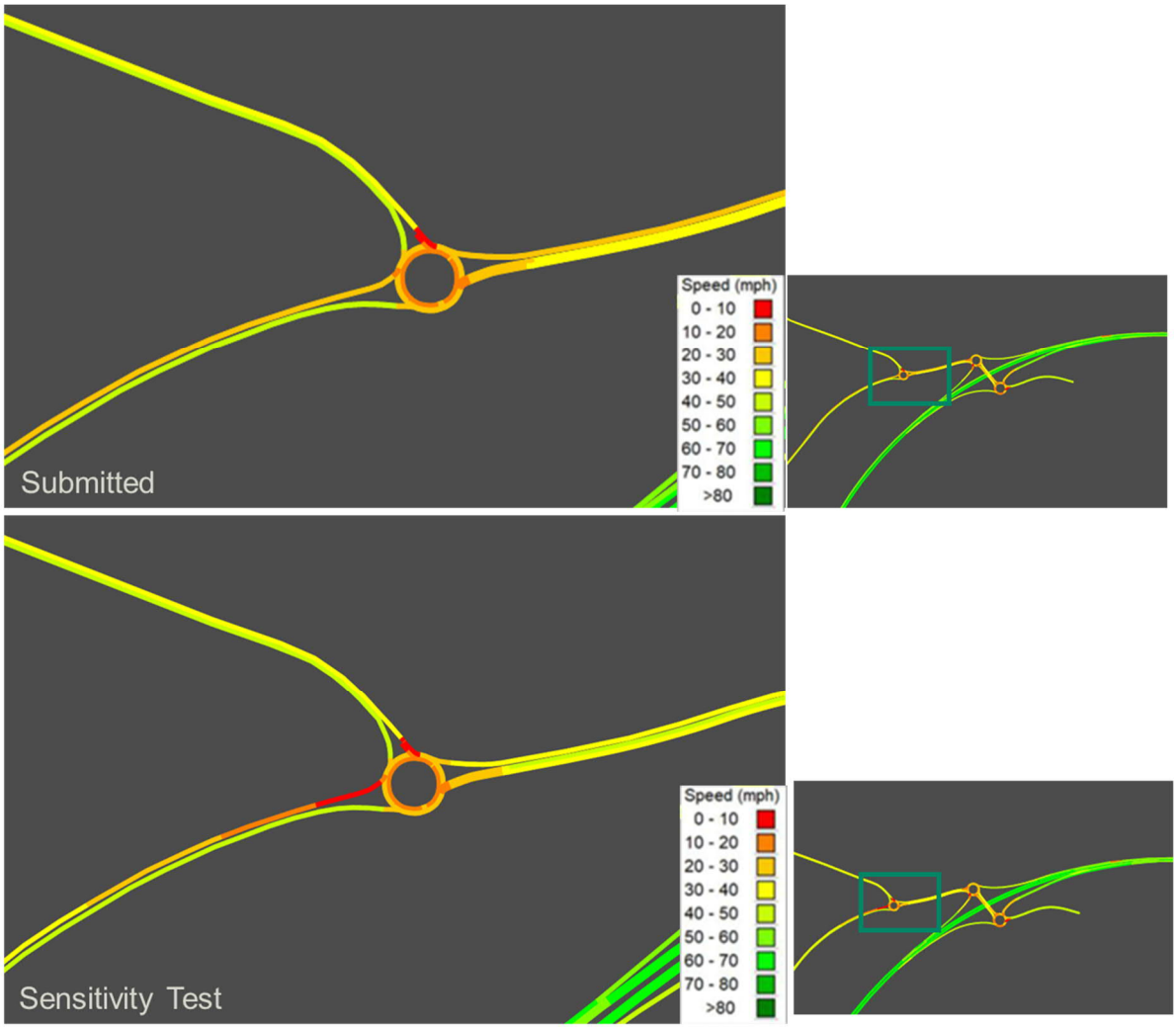


Figure 4-5 – Cambridge Road Junction – Existing Roundabout – 2040 AM

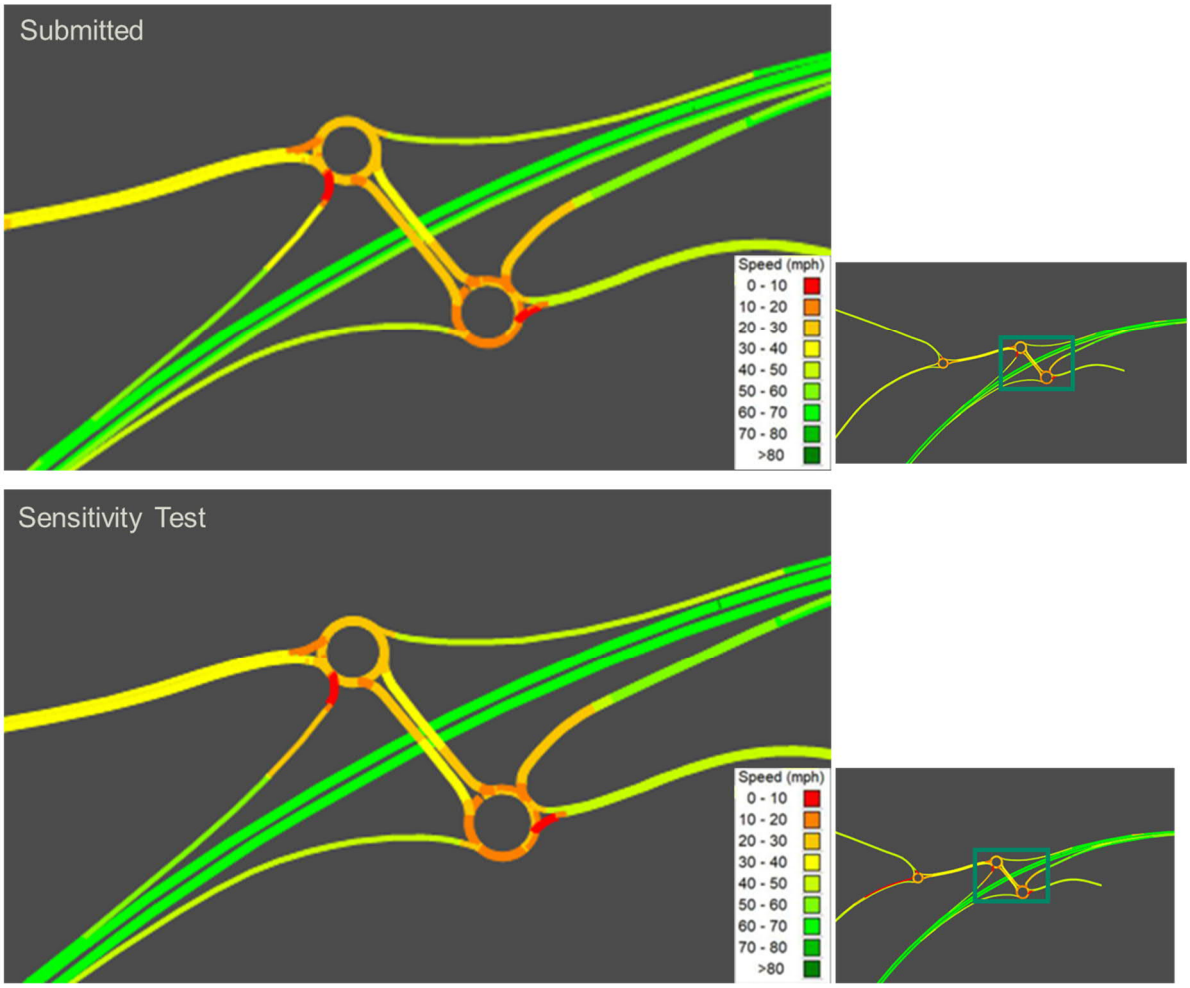


Figure 4-6 – Cambridge Road Junction – New Roundabouts – 2040 PM

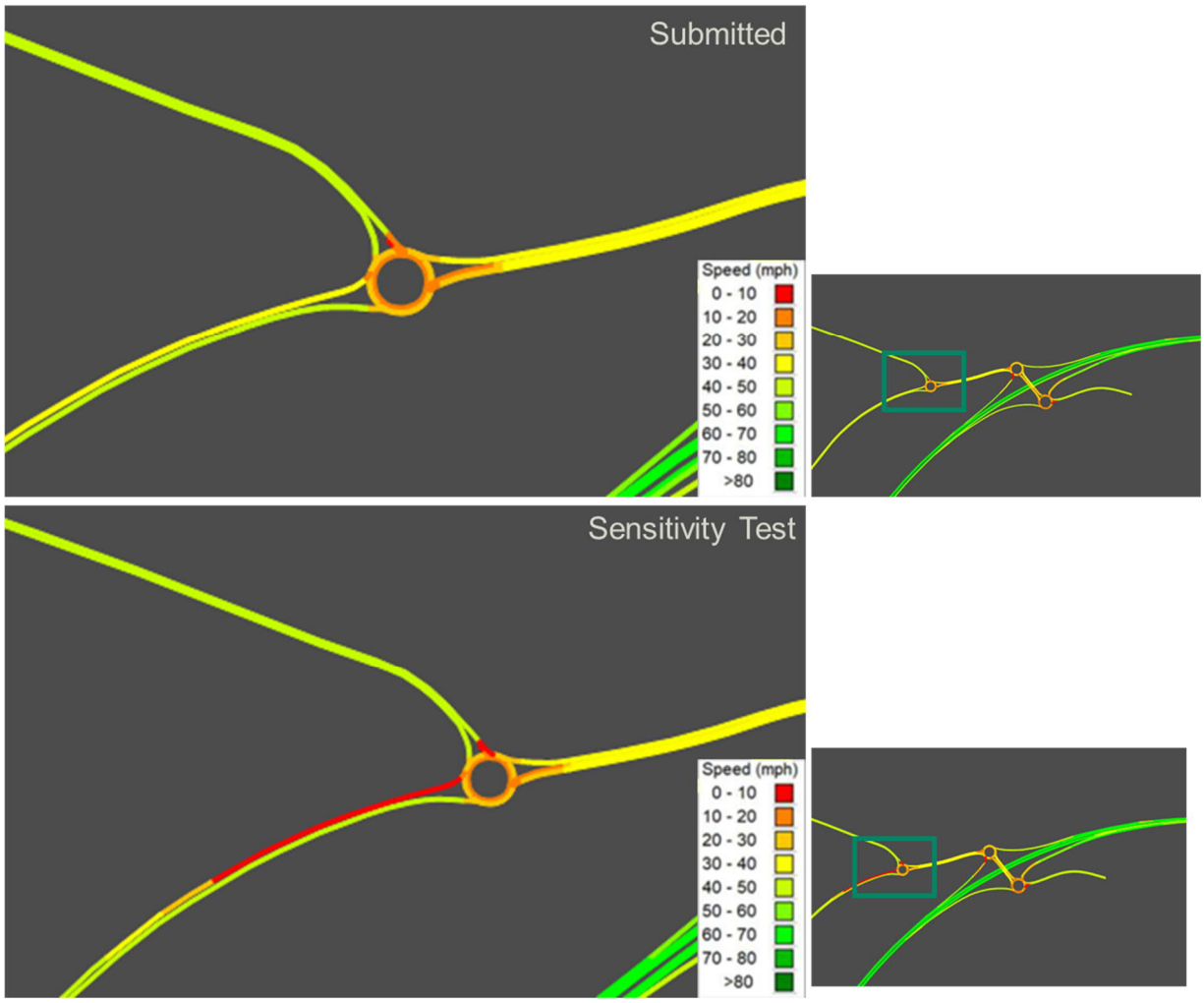


Figure 4-7 – Cambridge Road Junction – Existing Roundabout – 2040 PM

4.4 Caxton Gibbet Junction

4.4.1 **Figure 4-8** and **Figure 4-9** show the average speed plots of the Caxton Gibbet junction for the 2040 AM and PM scenarios respectively.

4.4.2 There are only slight differences in the average speed results between the DCO submitted and sensitivity test results on nearly all the approach arms at Caxton Gibbet junction. The sensitivity results show longer queues on the eastbound off-slip from the new dual carriageway, but these dissipate quickly and remain well within the queueing space.

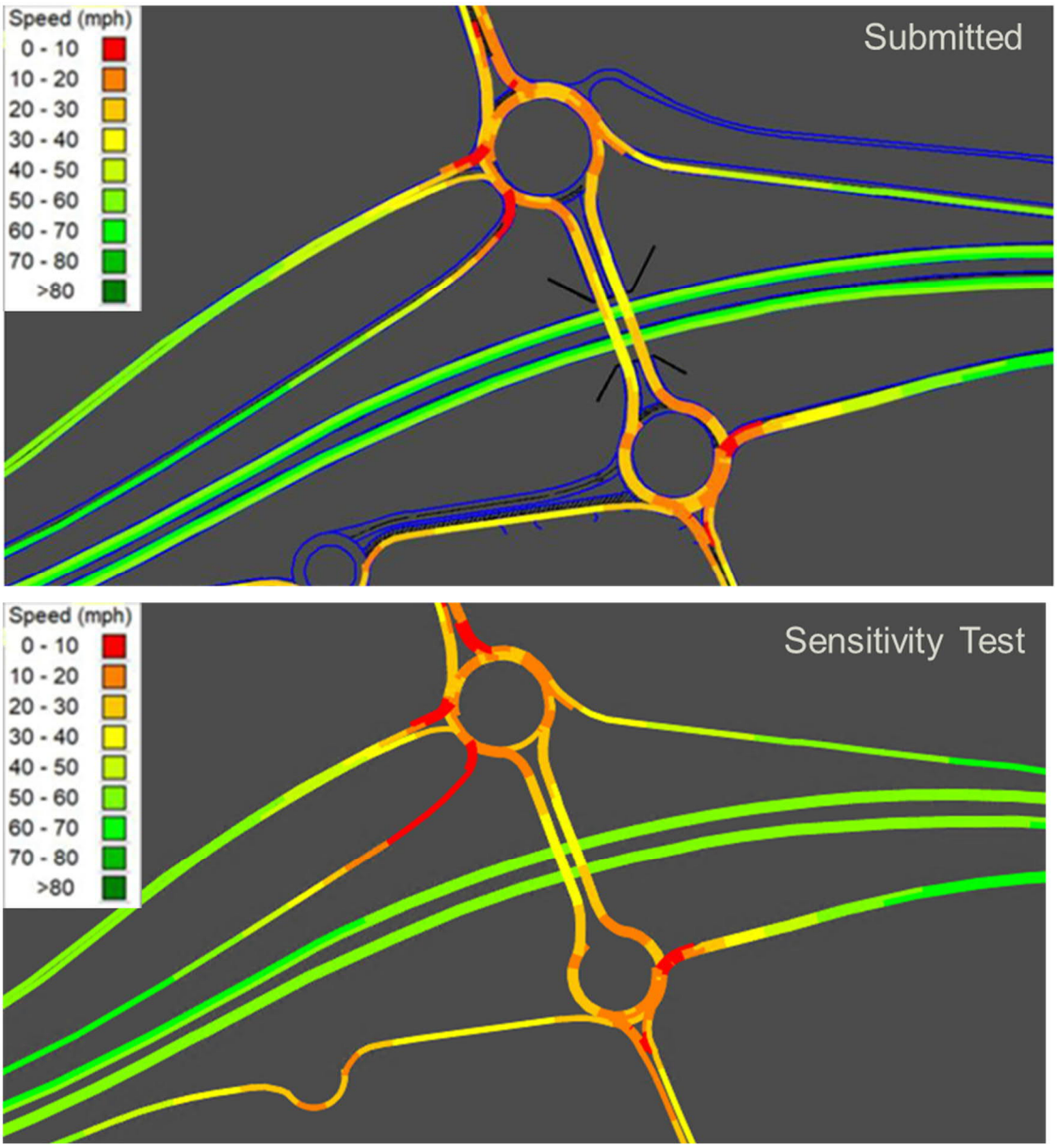


Figure 4-8 – Caxton Gibbet Junction – 2040 AM

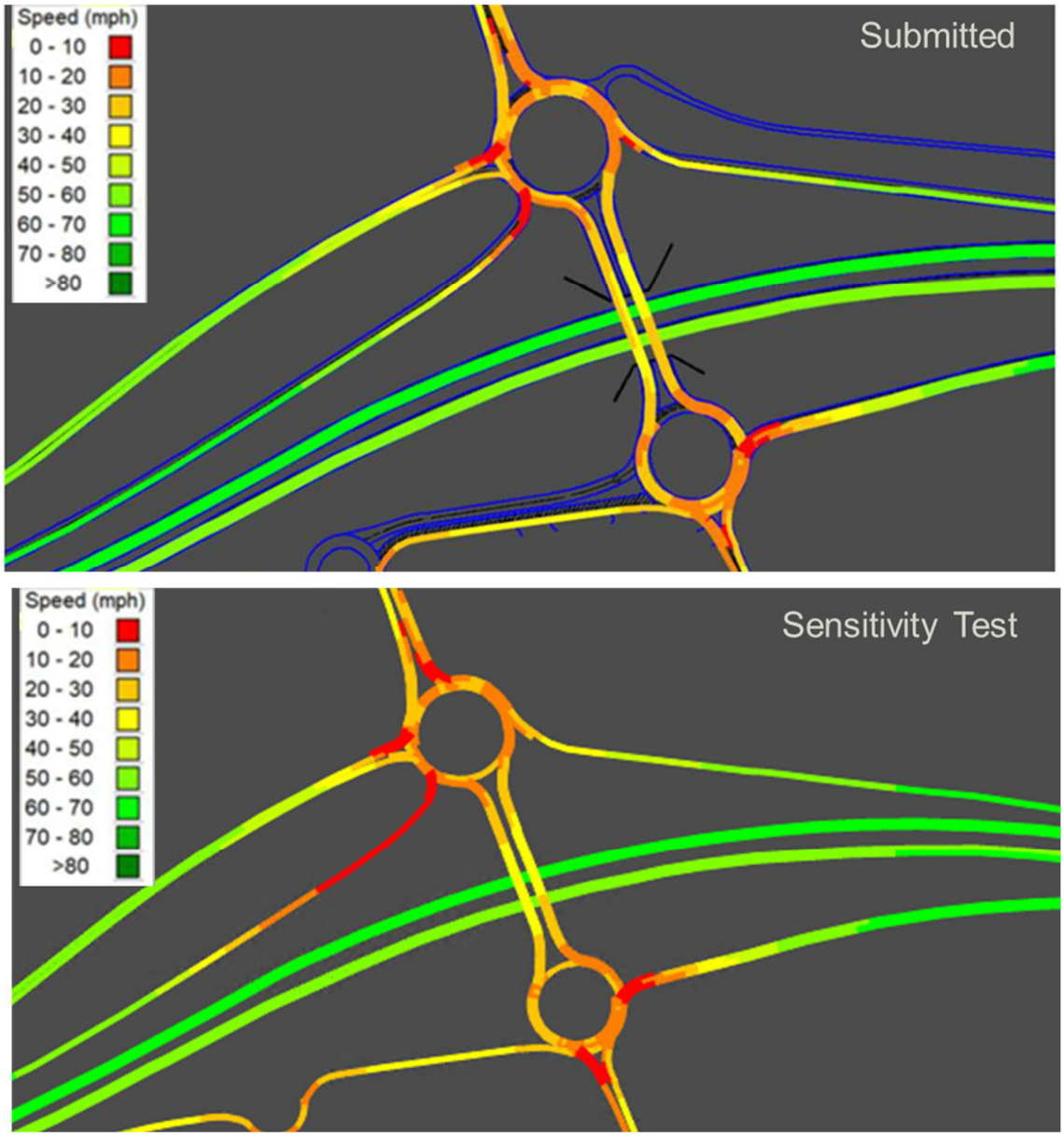


Figure 4-9 – Caxton Gibbet Junction – 2040 PM

4.5 Wyboston Junction

4.5.1 The comparative results of the sensitivity testing of the Wyboston Junction model are set out in **Table 4-1** below and the queue lengths resulting from the 2040 Do Something runs are illustrated at **Figure 4-10** and **Figure 4-11**.

Table 4-1 Results of Sensitivity Testing: Wyboston Junction

Results as submitted in the Transport Assessment Annex

Results quoted in the Transport Assessment Annex

	AM PEAK			PM PEAK		
	RFC	Delay (sec)	Queue (veh)	RFC	Delay (sec)	Queue (veh)
2025 Do Minimum						
Great North Road (N)	0.73	15	3	0.81	18	4
A428 (E)	0.60	9	4	0.70	11	5
Great North Road (S)	0.97	53	17	0.90	25	9
Premier Inn Access	0.08	10	0	0.34	13	1
A1 S'bound off-slip	0.43	10	1	0.33	9	1
2025 Do Something						
Great North Road (N)	0.76	12	3	0.77	12	3
A428 (E)	0.59	9	2	0.74	12	4
Great North Road (S)	0.40	6	1	0.58	8	2
Premier Inn Access	0.05	6	0	0.31	12	1
A1 S'bound off-slip	0.40	7	1	0.35	9	1

	AM PEAK			PM PEAK		
	RFC	Delay (sec)	Queue (veh)	RFC	Delay (sec)	Queue (veh)
2040 Do Minimum						
Great North Road (N)	0.73	14	3	0.86	23	6
A428 (E)	0.67	10	4	0.70	12	5
Great North Road (S)	1.00	73	24	0.93	37	12
Premier Inn Access	0.08	10	0	0.34	14	1
A1 S'bound off-slip	0.48	10	1	0.38	10	1
2040 Do Something						
Great North Road (N)	0.81	20	6	0.85	18	6
A428 (E)	0.65	10	3	0.81	17	5
Great North Road (S)	0.54	7	2	0.68	10	3
Premier Inn Access	0.06	6	0	0.35	14	1
A1 S'bound off-slip	0.45	8	1	0.43	11	1

Results of the Sensitivity Test

Results from the Sensitivity Testing

	AM PEAK			PM PEAK		
	RFC	Delay (sec)	Queue (veh)	RFC	Delay (sec)	Queue (veh)
2016 Base (Observed flows)						
Great North Road (N)	0.92	42	10	0.96	46	15
A428 (E)	0.72	14	5	0.72	13	5
Great North Road (S)	0.91	30	10	0.94	33	12
Premier Inn Access	0.09	12	0	0.38	20	1
A1 S'bound off-slip	0.88	65	13	0.36	13	1

	AM PEAK			PM PEAK		
	RFC	Delay (sec)	Queue (veh)	RFC	Delay (sec)	Queue (veh)
2025 Do Minimum						
Great North Road (N)	0.92	44	9	0.99	94	32
A428 (E)	0.74	15	7	0.90	26	13
Great North Road (S)	1.03	81	31	1.07	121	47
Premier Inn Access	0.11	14	0	0.41	19	1
A1 S'bound off-slip	0.97	143	33	0.40	14	1
2025 Do Something						
Great North Road (N)	0.92	37	10	0.96	50	16
A428 (E)	0.78	15	5	0.83	17	7
Great North Road (S)	0.61	7	2	0.85	13	5
Premier Inn Access	0.07	8	0	0.40	19	1
A1 S'bound off-slip	0.88	48	11	0.43	14	1

	AM PEAK			PM PEAK		
	RFC	Delay (sec)	Queue (veh)	RFC	Delay (sec)	Queue (veh)
2040 Do Minimum						
Great North Road (N)	0.90	45	9	0.99	141	48
A428 (E)	0.82	21	11	0.90	28	15
Great North Road (S)	1.09	133	50	1.13	198	73
Premier Inn Access	0.12	14	0	0.39	18	1
A1 S'bound off-slip	0.98	165	39	0.41	14	1
2040 Do Something						
Great North Road (N)	0.97	97	29	1.01	138	53
A428 (E)	0.84	21	7	0.89	31	13
Great North Road (S)	0.70	9	3	0.94	29	11
Premier Inn Access	0.08	10	0	0.49	34	1
A1 S'bound off-slip	0.96	104	26	0.56	18	2

Note: RFC = Ratio of Flow to Capacity. RFC, Delay and Queue values can be unreliable once RFC values exceed 1.0, the model is less able to predict accurate results and excessively high results may be produced.

In the Table above, amber highlight represents a junction which is operating at an RFC between 0.85 and 1.00; a red highlight, a junction operating at an RFC of 1.0 or above

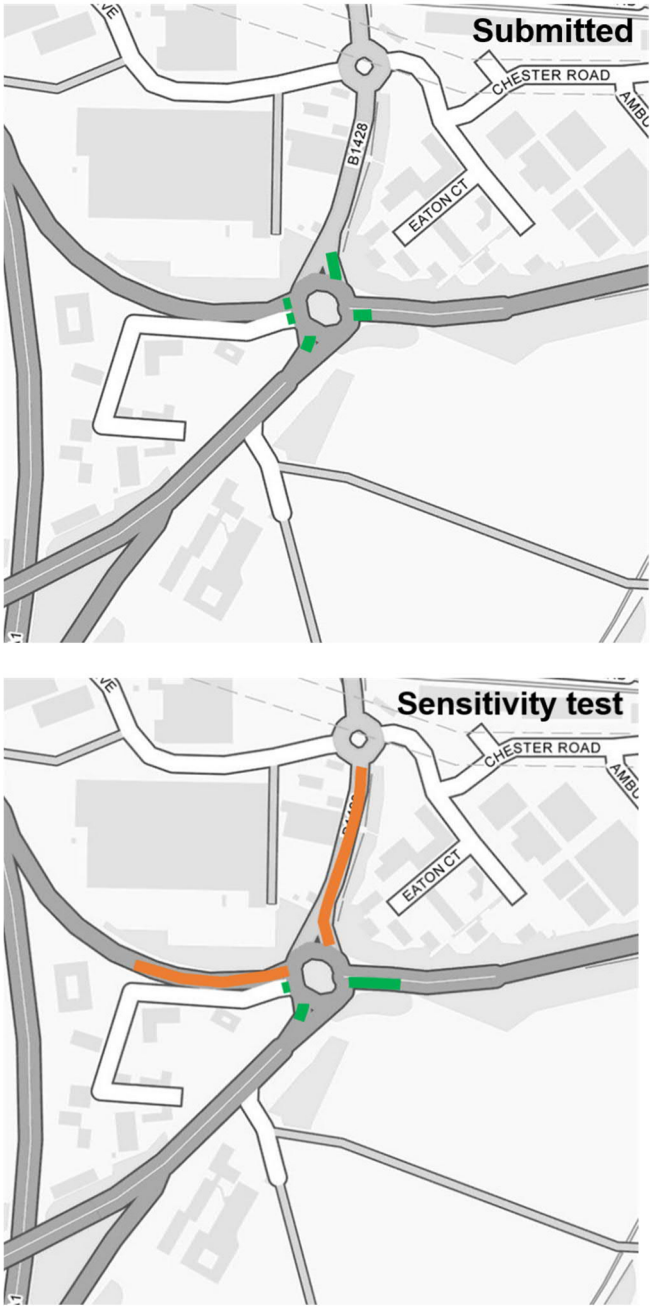


Figure 4-10 Wyboston Junction 2040 DS AM

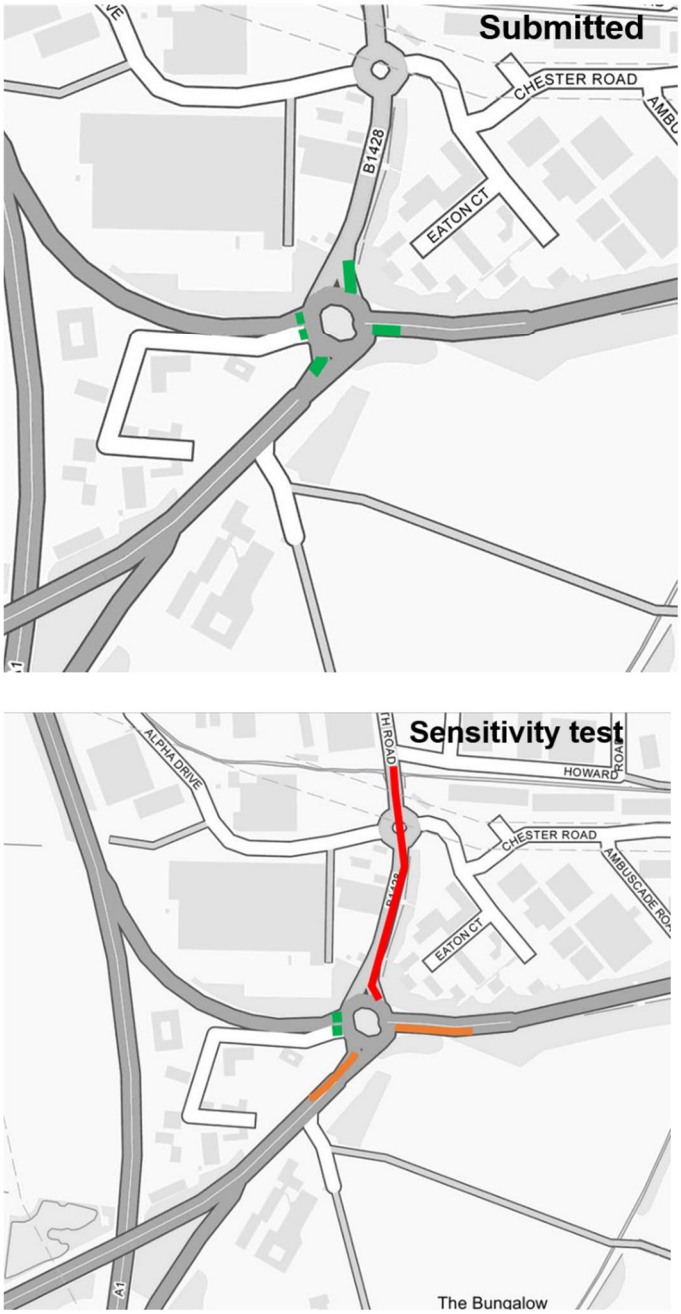


Figure 4-11 Wyboston Junction 2040 DS PM

In the figures above green highlight represents an arm which is operating at an RFC below 0.85; amber highlight represents an arm which is operating at an RFC between 0.85 and 1.00; a red highlight, a junction operating at an RFC of 1.0 or above

4.5.2 The results of the sensitivity testing for the Wyboston junction can be summarised as follows.

4.5.3 The sensitivity tests outputs demonstrate that four out of five approach arms of the junction are benefitted by the Scheme in both 2025 and 2040 for both AM and PM peak hours. One arm has been marginally disadvantaged due to the Scheme in 2040 AM peak.

4.5.4 The junction is already operating at or beyond its capacity in the base year. As the turning flows for the forecast years are built up on the base year demand, the Sensitivity Test model shows conditions at the junction that are worse than the TAA model reported.

4.5.5 In particular, the sensitivity test model indicates more queueing than the TAA model on the Great North Arm approach due to the re-routeing of local traffic to access the new dual carriageway. However, it should be noted that the queues are predicted to be significantly high on certain arms (e.g. Great North Road approach arms), even without the Scheme.

4.5.6 Comparing the two sets of results, the arms with the most significant overcapacity and queueing problems are similar between the TAA results and the Sensitivity Test results.

4.5.7 Overcapacity problems are evident at Wyboston in the base year and, without the Scheme, they become significantly worse over time with the growth in traffic. The sensitivity model has shown that the Scheme is likely to bring in benefits to the local roads in 2025, e.g. on Great North Road (North) queues are predicted to be reduced from 32 to 16 vehicles and the queues on the Great North Road (South) queues reduce from 47 vehicles to 5 vehicles.

4.5.8 The Scheme has a significantly beneficial impact on the junction overall in both 2025 and 2040. This is reflected in both the TAA and Sensitivity Test results.

4.5.9 The operation of the Great North Road (N) arm of the junction is a particular concern raised by CCC. The Sensitivity Test results show that, in 2025, the B1428 Great North Road (N) arm of the junction will perform better overall as a result of the Scheme. However, in 2040, there is a marginal deterioration in queueing on the Great North Road (N) arm of an additional 5 vehicles between the Do Minimum and Scheme cases.

4.5.10 However, in Great North Road (S) approach arm, the Scheme is predicted to bring in significant benefits by reducing the queues from 73 vehicles to 11 vehicles in 2040 PM peak.

4.6 Barford Road Junction

4.6.1 The comparative results of the sensitivity testing of the Barford Road Junction model are set out in **Table 4-2** below and the queue lengths resulting from the 2040 Do Something runs are illustrated at **Figure 4-12** and **Figure 4-13**.

Table 4-2 Results of Sensitivity Testing: Barford Road Junction

Results as submitted in the Transport Assessment Annex

Results quoted in the Transport Assessment Annex

	AM PEAK			PM PEAK		
	RFC	Delay (sec)	Queue (veh)	RFC	Delay (sec)	Queue (veh)
2025 Do Minimum						
Barford Road (N)	0.63	13	3	0.60	10	2
A428 (E)	1.00	552	140	1.01	629	171
Barford Road (S)	0.37	9	1	0.57	13	2
A428 (W)	0.93	41	15	0.74	13	5
2025 Do Something						
Barford Road (N)	0.57	9	3	0.56	8	2
A428 (E)	0.47	8	1	0.57	10	2
Barford Road (S)	0.07	6	0	0.30	8	1
A428 (W)	0.51	6	2	0.68	9	3

	AM PEAK			PM PEAK		
	RFC	Delay (sec)	Queue (veh)	RFC	Delay (sec)	Queue (veh)
2040 Do Minimum						
Barford Road (N)	0.62	13	3	0.64	12	3
A428 (E)	1.02	869	244	1.00	860	263
Barford Road (S)	0.51	11	1	0.70	18	3
A428 (W)	0.96	61	25	0.87	23	11
2040 Do Something						
Barford Road (N)	0.58	9	2	0.64	9	2
A428 (E)	0.70	13	2	0.80	16	5
Barford Road (S)	0.09	7	0	0.42	11	1
A428 (W)	0.64	8	3	0.72	10	4

Results of the Sensitivity Test

Results from the Sensitivity Testing

	AM PEAK			PM PEAK		
	RFC	Delay (sec)	Queue (veh)	RFC	Delay (sec)	Queue (veh)
2017 Base (Observed flows)						
Barford Road (N)	0.93	31	10	0.78	15	4
A428 (E)	1.00	331	62	0.97	91	22
Barford Road (S)	0.26	9	1	0.52	16	3
A428 (W)	0.85	21	9	0.76	15	7

	AM PEAK			PM PEAK		
	RFC	Delay (sec)	Queue (veh)	RFC	Delay (sec)	Queue (veh)
2025 Do Minimum						
Barford Road (N)	0.94	41	12	0.87	30	7
A428 (E)	1.02	807	190	1.01	434	114
Barford Road (S)	0.37	10	1	0.91	95	24
A428 (W)	0.93	44	19	0.99	123	66
2025 Do Something						
Barford Road (N)	0.83	17	5	0.79	17	4
A428 (E)	0.42	11	2	0.48	8	1
Barford Road (S)	0.15	8	0	0.62	16	3
A428 (W)	0.52	6	2	0.75	14	5

	AM PEAK			PM PEAK		
	RFC	Delay (sec)	Queue (veh)	RFC	Delay (sec)	Queue (veh)
2040 Do Minimum						
Barford Road (N)	0.96	39	11	0.89	34	7
A428 (E)	1.01	1229	344	1.01	848	271
Barford Road (S)	0.57	12	2	0.98	948	252
A428 (W)	1.00	132	65	1.01	769	317
2040 Do Something						
Barford Road (N)	0.87	22	6	0.96	61	14
A428 (E)	0.69	18	4	0.79	17	5
Barford Road (S)	0.21	8	1	0.97	281	78
A428 (W)	0.73	10	4	0.96	117	62

Note: RFC = Ratio of Flow to Capacity. RFC, Delay and Queue values can be unreliable once RFC values exceed 1.0, the model is less able to predict accurate results and excessively high results may be produced.

In the Table above, amber highlight represents a junction which is operating at an RFC between 0.85 and 1.00; a red highlight, a junction operating at an RFC of 1.0 or above

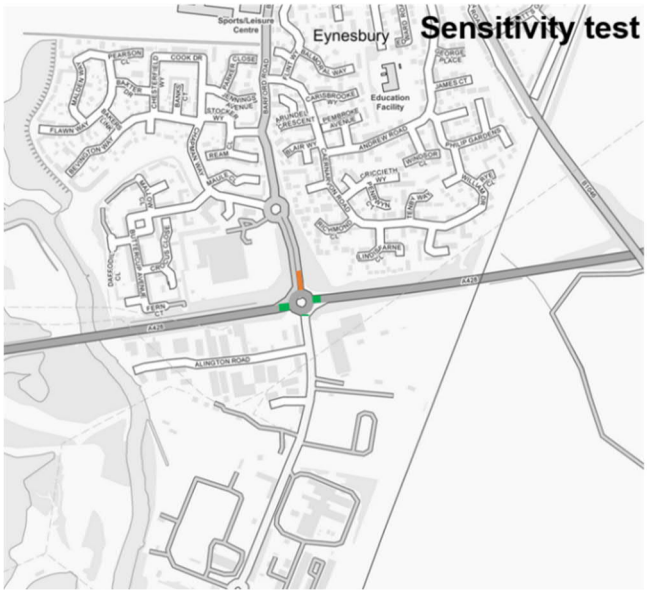
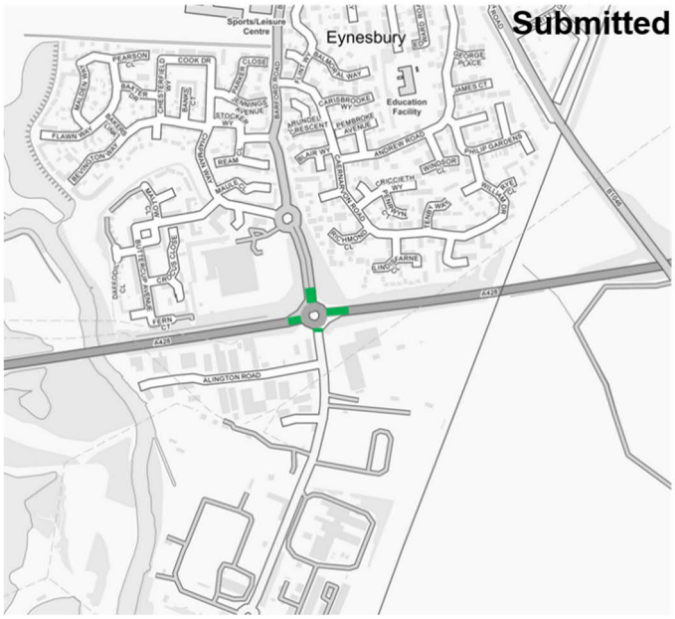


Figure 4-12 Barford Road DS AM



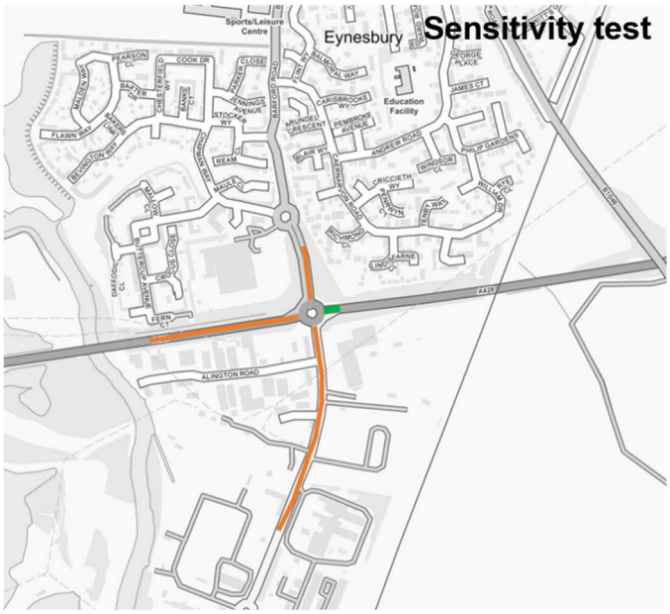


Figure 4-13 Barford Road DS PM

In the figures above green highlight represents an arm which is operating at an RFC below 0.85; amber highlight represents an arm which is operating at an RFC between 0.85 and 1.00; a red highlight, a junction operating at an RFC of 1.0 or above

4.6.2 The results of the sensitivity testing for the Barford Road junction can be summarised as follows.

4.6.3 The junction is already operating at or beyond its capacity in the base case. This was the case to an extent in the TAA model, however, the Sensitivity Test model shows conditions at the junction that are worse than the TAA model reported, for both without and with Scheme options.

4.6.4 Comparing the two sets of results, the identity of the arms with the most significant overcapacity and queueing problems are broadly the same between the TAA results and the Sensitivity Test results.

4.6.5 Overcapacity problems are evident at Barford Road in the base case and, without the Scheme, they become worse over time with the growth in traffic, in both the horizon years.

4.6.6 The Scheme has a significantly beneficial impact on the junction overall in both 2025 and 2040. This is reflected in both the TAA and Sensitivity Test results, and the junction is predicted to return to being within capacity in 2025 with the implementation of the Scheme.

4.6.7 The Sensitivity Test results show that, in 2025, the Barford Road (N) arm of the junction will perform better overall as a result of the Scheme. In 2040, there is predicted to be a marginal increase in queueing of seven vehicles on Barford Road (N) arm of the junction between the Do Minimum and Scheme cases. However, in Barford Road (S) approach arm the Scheme is predicted to bring in significant benefits by reducing the queues from 258 vehicles to 73 vehicles between without and with Scheme scenarios.

4.7 Biggleswade North Junction

4.7.1 The comparative results of the sensitivity testing of the Biggleswade North Junction model are set out in **Table 4-3** below and the queue lengths resulting from the 2040 Do Something runs are illustrated at **Figure 4-14** and **Figure 4-15**.

Table 4-3 Results of Sensitivity Testing: Biggleswade North Junction

Results as submitted in the Transport Assessment Annex

Results quoted in the Transport Assessment Annex

	AM PEAK			PM PEAK		
	RFC	Delay (sec)	Queue (veh)	RFC	Delay (sec)	Queue (veh)
2025 Do Minimum						
A1 (north)	0.90	22	11	0.88	16	9
A6001 Hill Lane	0.57	13	2	0.47	9	1
A1 (south)	0.85	12	7	0.95	24	15
B658 Hill Lane	1.56	695	123	1.45	579	92
2025 Do Something						
A1 (north)	0.95	31	18	0.91	21	11
A6001 Hill Lane	0.58	14	2	0.41	8	1
A1 (south)	0.83	12	6	0.92	20	12
B658 Hill Lane	1.34	435	70	1.40	458	70

	AM PEAK			PM PEAK		
	RFC	Delay (sec)	Queue (veh)	RFC	Delay (sec)	Queue (veh)
2040 Do Minimum						
A1 (north)	0.88	18	10	0.99	48	27
A6001 Hill Lane	0.71	18	4	0.65	14	3
A1 (south)	1.00	47	30	0.99	45	29
B658 Hill Lane	1.73	152	152	1.71	928	168
2040 Do Something						
A1 (north)	0.91	22	13	1.00	56	37
A6001 Hill Lane	0.64	14	3	0.53	11	2
A1 (south)	1.01	54	36	0.99	47	31
B658 Hill Lane	1.73	841	119	1.67	816	133

Results of the Sensitivity Test

Results from the Sensitivity Testing

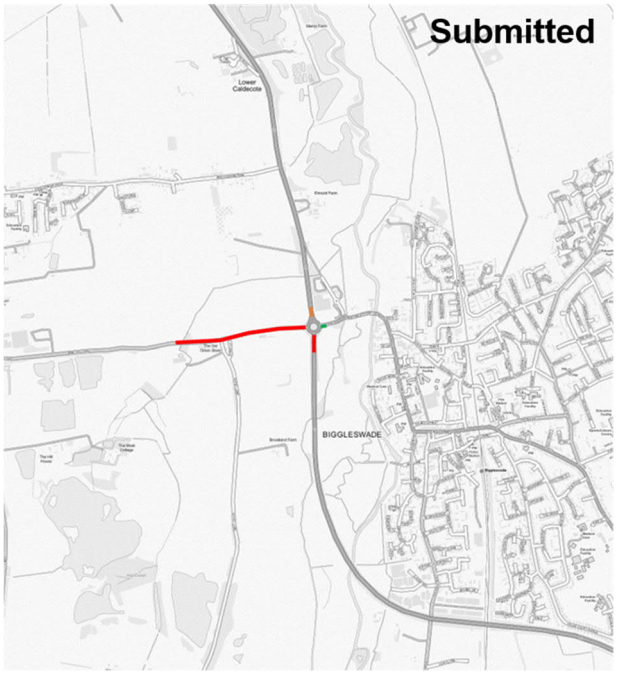
	AM PEAK			PM PEAK		
	RFC	Delay (sec)	Queue (veh)	RFC	Delay (sec)	Queue (veh)
2019 Base (Observed flows)						
A1 (north)	1.12	193	125	0.88	14	7
A6001 Hill Lane	0.68	24	4	0.76	19	4
A1 (south)	0.76	9	4	0.96	32	20
B658 Hill Lane	1.18	255	51	0.99	149	16

	AM PEAK			PM PEAK		
	RFC	Delay (sec)	Queue (veh)	RFC	Delay (sec)	Queue (veh)
2025 Do Minimum						
A1 (north)	1.13	217	140	0.96	30	18
A6001 Hill Lane	0.70	29	5	0.85	32	10
A1 (south)	0.92	23	13	1.15	216	139
B658 Hill Lane	1.99	1326	284	1.20	347	40
2025 Do Something						
A1 (north)	1.16	313	187	0.98	40	26
A6001 Hill Lane	0.74	28	5	0.86	35	11
A1 (south)	0.94	24	14	1.14	179	124
B658 Hill Lane	1.83	1051	197	1.07	203	24

	AM PEAK			PM PEAK		
	RFC	Delay (sec)	Queue (veh)	RFC	Delay (sec)	Queue (veh)
2040 Do Minimum						
A1 (north)	1.09	167	115	1.13	238	154
A6001 Hill Lane	0.76	33	7	1.02	1354	443
A1 (south)	0.97	37	22	1.39	924	529
B658 Hill Lane	2.00	1306	260	1.09	197	38
2040 Do Something						
A1 (north)	1.11	191	132	1.17	275	171
A6001 Hill Lane	0.72	28	5	1.00	984	303
A1 (south)	1.00	50	32	1.44	1041	618
B658 Hill Lane	2.04	1237	218	0.98	106	19

Note: RFC = Ratio of Flow to Capacity. RFC, Delay and Queue values can be unreliable once RFC values exceed 1.0, the model is less able to predict accurate results and excessively high results may be produced.

In the Table above, amber highlight represents a junction which is operating at an RFC between 0.85 and 1.00; a red highlight, a junction operating at an RFC of 1.0 or above



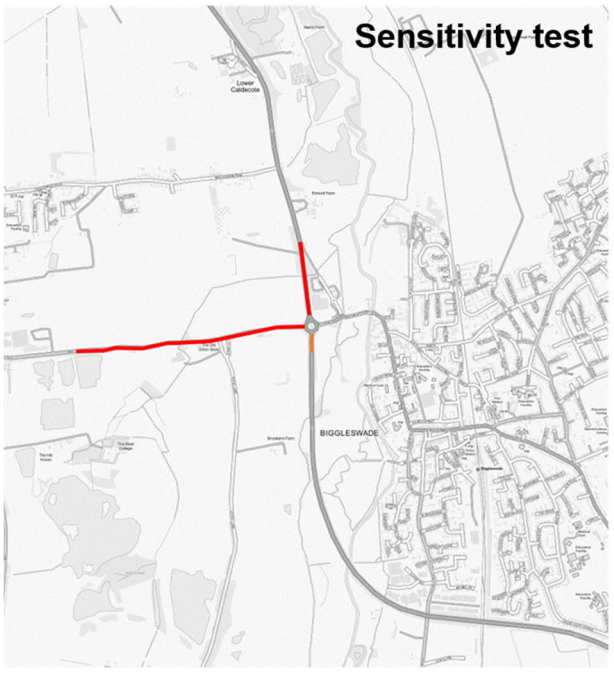


Figure 4-14 Biggleswade North DS AM

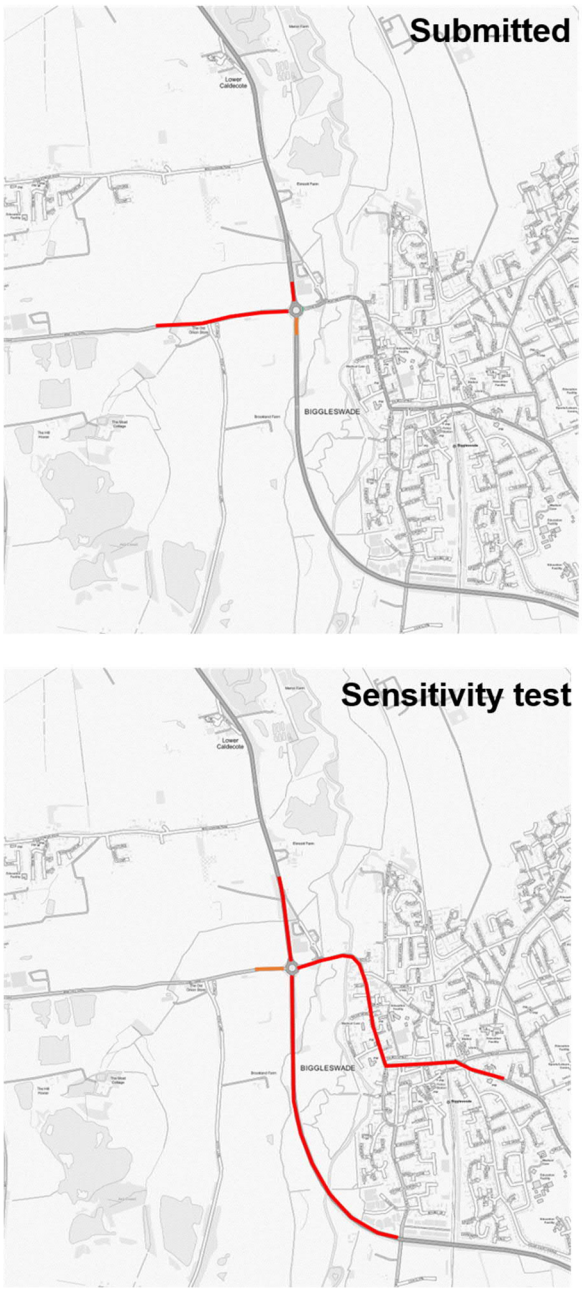


Figure 4-15 Biggleswade North DS PM

In the figures above green highlight represents an arm which is operating at an RFC below 0.85; amber highlight represents an arm which is operating at an RFC between 0.85 and 1.00; a red highlight, a junction operating at an RFC of 1.0 or above

4.7.2 The results of the sensitivity testing for the Biggleswade North junction can be summarised as follows.

4.7.3 The junction is already operating at or beyond its capacity in the base case. This was the case to an extent in the TAA model, however, the Sensitivity Test model shows conditions at the junction that are worse than the TAA model reported.

4.7.4 In particular, the sensitivity test model indicates more queueing than the TAA model due to re-routeing of traffic willing to access the new dual carriageway.

4.7.5 Comparing the two sets of results, the identity of the arms with the most significant overcapacity and queueing problems are broadly the same between the TAA results and the Sensitivity Test results.

4.7.6 Comparing the Sensitivity Test model with queue length data collected by CBC in 2018, the model over-predicts queueing in the AM peak on the A1 but under predicts queueing on the local roads and in the PM peak relative to the observed flows.

4.7.7 Overcapacity problems are evident at Biggleswade North in the base case and these become worse over time with the growth in traffic.

4.7.8 The impact of the Scheme is considered to be small relative to the overall picture of queueing and delay.

4.7.9 The Scheme therefore has a marginal impact on a junction that is predicted to have significant problems whether the Scheme goes ahead or not.

5 Summary Findings

5.1.1 **Table 5-1** below summarises the overall findings of the Sensitivity tests undertaken.

Table 5-1 Updated Junction Modelling – Summary of Findings

Junction	Model	Year	Main Findings
Black Cat	Vissim	2040	The junction performance of the sensitivity test models is similar to the DCO submitted models. The average speeds across all approach arms and the gyratory of the junction are similar between DCO submission with no approach arms indicating excessive queues.
Cambridge Road	Vissim	2040	The average speeds at the proposed new junction and the existing roundabout are similar between DCO submission and the sensitivity test indicating no significant change in reported results. At the existing Cambridge Road junction in the PM peak, there are longer queues on A428 approach arm, but these dissipate quickly and can be accommodated with no impact elsewhere.
Caxton Gibbet	Vissim	2040	The sensitivity test shows similar results to those submitted in the DCO as the average speeds remain similar. There are slightly longer queues on the A428 eastbound off-slip approach arm to the roundabout. However, the queues are not excessive and are well within the available queueing space.
Wyboston	ARCADY	2016 2025 2040	The junction is already operating at or beyond its capacity in the base case. The sensitivity test model indicates more queueing and delay than the TAA model submitted in DCO. However, the sensitivity test still shows that the Scheme will have a significantly beneficial impact on the junction in both 2025 and 2040. The sensitivity test outputs show that the Scheme is predicted to bring in significant benefits to the local road network both in 2025 and 2040, particularly the Great North Road South approach arm.

Junction	Model	Year	Main Findings
Barford Road	ARCADY	2017 2025 2040	The junction is already operating at or beyond its capacity in the base case. The sensitivity test model indicates more queueing and delay than the TAA model submitted in DCO. However, the sensitivity test shows that the junction still significantly benefits from the Scheme in both 2025 and 2040.. The sensitivity test outputs show that the Scheme is predicted to bring in significant benefits to the local road network both in 2025 and 2040, on both Barford Road (North) and Barford Road (South) approach arms.
Biggleswade North	ARCADY	2019 2025 2040	The junction is already operating at or beyond its capacity in the base case. The sensitivity test model indicates more queueing and delay than the TAA model. However, both the 2025 and 2040 sensitivity test results confirm that the Scheme has a marginal impact on a junction that is predicted to have significant problems whether the Scheme goes ahead or not.

6 Conclusions and Way Forward

6.1.1 National Highways have undertaken sensitivity tests of six junction models following CCC's recommended methodology of demand forecasting and model input parameters.

6.1.2 For all of the junctions taken forward for sensitivity tests, each and every junction has been forecasted to experience better operation in the "with scheme" scenario" compared to "without scheme" at overall junction levels for both the forecast years of 2025 and 2040.

6.1.3 For all the Scheme junctions the outputs of the sensitivity tests showed very similar trends as the original DCO submission. Albeit at a couple of junctions at the peakiest time slice the queues were predicted to be longer than the DCO submitted models, but they are not forecasted to cause any safety risk nor any unacceptable levels of additional delays, compared to "without scheme" scenario.

6.1.4 For all the junctions covered under sensitivity tests in the wider network, though the queues have been predicted to be longer on certain arms of the junctions, compared to DCO submission models, the overall junction operations show improvements in both 2025 and 2040**.**

6.1.5 As the sensitivity tests have demonstrated that there are no fundamental changes in findings from the assessments undertaken in the DCO submission, the Applicant doesn't consider undertaking any more sensitivity tests of any other junctions are necessary or proportionate.

6.1.6 The Applicant will give consideration to monitoring the impacts in this area post Scheme opening. As with previously consented schemes the Applicant proposes to finalise the scope of the scheme benefits review after the DCO decision has been made. This is because the examination and decision process can alter the benefits delivered. Monitoring could either form part of the Post Opening Project Evaluation (POPE) programme undertaken by the Applicant, or as an additional monitoring programme that would supplement local monitoring the Applicant assumes all LHA's, as responsible authorities, are routinely undertaking on local routes. The Applicant will consult Local Authorities on the scope of pre and post scheme monitoring prior to the start of construction. If found necessary consideration will be given to the potential need for interventions.