1 INTRODUCTION

1.1.1 In January 2016, Surrey County Council's Transport Studies team were asked to model the impact of making network changes at the signalised junction of A308 Staines Road West and A244 Windmill Road/Cadbury Road (J233).

1.1.2 The network changes were comprised of introducing additional formal pedestrian facilities across both sides of the A244, reducing the number of approach lanes on A244 Windmill Road and removing the banned right turn from A244 Cadbury Road to A308 Staines Road West.

2 METHODOLOGY

2.1.1 The modelling package LinSig was used for this assessment (version 3.2.22). LinSig is a UK industry standard software package, developed by JCT Consultancy Ltd, for the assessment and design of traffic signal junctions.

2.1.2 The LinSig model used for this project was built from scratch. All network geometries were measured from site drawings and all signal information was taken from the controller specification. The base model (known as Do-Nothing) was built and then audited by a member of the Transport Studies team. Once this was approved, the network changes associated with the proposed junction layout were added to the model. This model is known as the Do-Something option.

2.1.3 Mitigation measures were also modelled that considered small changes to the proposed drawing. These were assessed in the Do-Something Mitigation option.

2.1.4 The modelled time periods are as follows: weekday AM peak hour (07:30 – 08:30) and PM peak hour (16:30-17:30). These time periods represent the worst case scenario, when the highest flows and the highest number of pedestrians crossing the junction were recorded. This was based on the observed traffic counts and pedestrian counts collected in November 2015.

3 SCENARIOS

3.1.1 Four LinSig models were used to evaluate the impact of the proposals. The Do Nothing model reflects the existing layout while the Do Something model has included the proposed changes as shown in **Appendix II**.

3.1.2 The existing layout drawing and the proposed layout as supplied in drawing PC0564-J233 by Ed Smith can be found in **Appendices I** and **II** respectively. Revised intergreens were also supplied by Ed Smith and are shown in **Appendix III**.

3.1.3 As stated above, the proposed scheme changes are as follows:

- the addition of two staggered pedestrian crossings on the A244 Cadbury Road and A244 Windmill Road arms of the junction;
- the reduction in the number of approach lanes on the A244 Windmill Road from 4 to 3 to accommodate the larger pedestrian crossing island; and
- the banned right turn from A244 Cadbury Road to A308 Staines Road West has been removed.

3.1.4 Mitigation options have also been assessed. This relates to the request from Ed Quartey (on 09/02/2016) to suggest possible changes to the proposed junction layout that will ensure that the junction operates within capacity.

3.1.5 The options tested are outlined below in **Table 3.1**.

Model	Model Description
2015 Do Nothing	Base model - Existing layout (**Appendix I**)
2015 Do Something	Proposed layout (**Appendix II**)
2015 Do Something Mitigation Option 1	Proposed layout with mitigation applied - A244 Cadbury Road nearside lane 1 set to left and ahead and offside lane 2 set to ahead and right.
2015 Do Something Mitigation Option 2	Proposed layout with mitigation applied - right turn from A244 Cadbury Road to A308 Staines Road West banned

Table 3.1: Model descriptions

3.1.6 Traffic growth has not been incorporated within the model. As such, all scenarios tested relate to the 2015 observed data.

3.1.7 To calculate the number of vehicles that would subsequently use the right turn movement once the ban has been removed, the strategic county model was used. This takes into account zone to zone movements and will include vehicles that are attracted to the junction as the right turn is now possible.

3.1.8 The model used was Surrey's Integrated Transport Model (SINTRAM 7 v1.04). Currently this is only an AM model and as such, the flows for the right turn movement from SINTRAM 7 have been used in both the AM and PM scenarios of the LinSig model. Vehicle proportions from the observed data were applied to the modelled data and flows were then converted into Passenger Car Units (PCU) following the methodology outlined by Kimber *et al.* (1982)[1] in RR67.

3.1.9 Each model also looks at different cycle times for each time period. Observed cycle times for the junction were collected by remotely monitoring the on-street stage changes. These were used in scenarios 1 and 2 of each model. LinSig has a cycle time optimisation tool, which can be used to ascertain the optimum cycle time. The tool uses a graph to show the effect of altering the cycle time on junction performance. These timings were used in scenarios 3 and 4 of each model.

3.1.10 There are some limitations to using LinSig as it models signals on fixed time and is therefore unable to model pedestrian stages being called at random as they would be on street. It should also be noted that this junction operates under Split Cycle Offset Optimisation Technique (SCOOT) control on-street. This means that it is part of a network of signals (known as a region) which have coordinated control. Unfortunately, this LinSig model does not replicate this situation.

[1] Kimber, R. M. et al., 1982. Saturation flows at traffic signal junctions: studies on test track and public roads, Institute of Electrical Engineers Conference on Road Traffic Signalling.

3.1.11 This means that the model outputs presented in the next sections will represent the 'worst case scenario' as the signals are likely to operate better on street than in the LinSig model. This is due to the adaptive technology within the signals and the rest of the SCOOT region in which the junction sits.

4 RESULTS

4.1 Introduction

4.1.1 Results from the modelled options are presented in this section. Each model option and the associated scenarios are displayed. Metrics presented include the Practical Reserve Capacity (PRC) which is a measure of the amount that traffic can grow before practical capacity (100%) of the junction is reached. A positive PRC value indicates that there is spare capacity available, whilst a negative PRC value shows the degree of overload at the junction.

4.1.2 Other related metrics used to consider junction performance are the total delay in PCU per hour, Degree of Saturation (DoS) and the Mean Max Queue (MMQ). DoS is the ratio of demand flow to the maximum flow that can cross the stopline from a specific approach. A practical operating level of 90% is considered acceptable, therefore an approach with a degree of saturation greater than 100% is said to be 'over-saturated'. MMQ gives the length of the longest queue at the junction in PCU. As such, these values have been multiplied by 5.75m, the average length of a vehicle, to generate the actual length in metres.

4.1.3 As mentioned above, the SCOOT control of the signalised junction means that the model outputs will appear to be worse than the current on-street conditions. As such, the results and analysis presented in **4.2** will look at the percentage changes in junction performance between the base model and the option tests, rather than the specific values presented. This means that it is not possible to state how far back the queues will exactly extend as a result of the modelling. However, if the queue blocks an upstream junction, it has been marked in red.

4.2 Presentation of results

4.2.1 **Table 4.1** shows the models, scenarios, stage sequences and cycle times for each model type as described in **Section 3**.

4.2.2 **Table 4.2** presents the results from each model along with the percentage change in reference to the Do Nothing model.

Model	Scenario Number	Scenario Description	Stage Sequence	Cycle Time (s)
2015 Do Nothing	1	AM peak hour - observed	1,2,3,4	84
	2	PM peak hour - observed	1,2,3,4	112
	3	AM peak hour - optimised	1,2,3,4	114
	4	PM peak hour - optimised	1,2,3,4	112
2015 Do Something	1	AM peak hour - observed	1,2,3,4	84
	2	PM peak hour - observed	1,2,3,4	112
	3	AM peak hour - optimised	1,2,3,4	114
	4	PM peak hour - optimised	1,2,3,4	117
2015 Do Something Mitigation Option 1	1	AM peak hour - observed	1,2,3,4	84
	2	PM peak hour - observed	1,2,3,4	112
	3	AM peak hour - optimised	1,2,3,4	114
	4	PM peak hour - optimised	1,2,3,4	118
2015 Do Something Mitigation Option 2	1	AM peak hour - observed	1,2,3,4	84
	2	PM peak hour - observed	1,2,3,4	112
	3	AM peak hour - optimised	1,2,3,4	114
	4	PM peak hour - optimised	1,2,3,4	118

Table 4.1: Modelled scenarios with cycle times

	MODEL						
	Do Nothing	Do Something	Mitigation Option 1	Mitigation Option 2	Do Something	Mitigation Option 1	Mitigation Option 2
Scenario - Time period - cycle time	**PRC (%) value**				**Percentage change from Do Nothing**		
1 - AM - observed	-73	-109	-88	-88	48%	20%	20%
2 - PM - observed	-16	-64	-53	-40	293%	230%	148%
3 - AM - optimised	-22	-71	-53	-43	219%	140%	94%
4 - PM - optimised	-16	-61	-50	-45	274%	211%	175%
Scenario - Time period - cycle time	**Total Delay (PCU/Hr)**				**Percentage change from Do Nothing**		
1 - AM - observed	425	1028	883	796	142%	108%	87%
2 - PM - observed	135	682	560	418	405%	315%	210%
3 - AM - optimised	219	843	655	521	286%	200%	138%
4 - PM - optimised	135	681	568	457	404%	320%	238%
Scenario - Time period - cycle time	**DoS (%)**				**Percentage change from Do Nothing**		
1 - AM - observed	156	188	169	169	20%	8%	8%
2 - PM - observed	105	147	138	97	41%	32%	-8%
3 - AM - optimised	110	154	138	137	40%	25%	25%
4 - PM - optimised	105	145	135	102	38%	29%	-2%
Scenario - Time period - cycle time	**MMQ (PCU)**				**Percentage change from Do Nothing**		
1 - AM - observed	161	257	232	232	59%	44%	44%
2 - PM - observed	39	142	122	97	266%	215%	149%
3 - AM - optimised	70	211	169	137	201%	141%	96%
4 - PM - optimised	39	141	123	102	265%	219%	164%
Scenario - Time period - cycle time	**MMQ (m)**				**Percentage change from Do Nothing**		
1 - AM - observed	927	1475	1333	1333	as above		
2 - PM - observed	223	815	700	555			
3 - AM - optimised	403	1211	970	790			
4 - PM - optimised	223	812	709	588			

Table 4.2: Results summary with percentage change

4.2.3 As stated above in **3.1.11**, the model results show considerable delays at the junction, giving the overall impression that the junction operates poorly. This is in part due to the LinSig model reflecting the 'worst case scenario'. It is acknowledged that the current on-street conditions are also poor but the model has over-estimated these statistics. This is particularly apparent when considering the DoS. As stated in **4.1.2**, any value above 90% suggests that the junction is operating over capacity. With a DoS of 156% in scenario 1 at the existing junction (Do Nothing), it is clear to see that the model is over-estimating the impact the signals have on the flow of vehicles through the junction.

4.2.4 Nevertheless, some very helpful observations can be drawn from the percentage change data presented in **Table 4.2**. Across all the metrics presented, it is clear to see that the proposed option (Do Something) has a negative impact on junction performance. Percentage increases of nearly 300% between the PRC value for the Do Nothing and Do Something model in scenario 2 (PM observed) and a 405% increase in total delay at the junction in the same scenario are also shown in **Table 4.2**.

4.2.5 These results suggest that the original proposed layout, presented in **Appendix II,** has a negative impact on the junction. However, the removal of the banned right turn movement from A244 Cadbury Road to A308 Staines Road West is likely to take flow away from and therefore relieve pressure on other nearby junctions, which is not assessed in this model.

4.2.6 In comparison to the Do Something option test, the operation of the junction is enhanced by considering the two mitigation options as described in **Table 3.1**. The Mitigation Option 1 results do show a considerable improvement in junction performance. This is particularly noticeable for the total delay outputs presented. In nearly all scenarios (2-4), the percentage changes reduce up to 80%.

4.2.7 The most marked percentage change relates to a percentage decrease in the DoS results when comparing the Do Nothing with the Mitigation Option 2 model. In scenario 2 (PM observed), the junction layout changes lead to a decrease of 8% and therefore an improvement in the DoS. This means that the junction operates within its capacity (below 100%) and is no longer over saturated.

5 FURTHER MITIGATION SUGGESTIONS

5.1.1 As stated above, the proposed mitigation options demonstrate a reduced impact on the junction performance, when compared with the original proposed layout (Do Something). It is clear to see that a change in the lane markings on A244 Cadbury Road increases the flow of vehicles across the stopline, specifically for the ahead movement.

5.1.2 By re-introducing the banned right turn, the junction performance improves even more. For the DoS metric in mitigation option 2, the results actually show an improvement when compared with the base model.

5.1.3 Additional capacity can also be introduced at the junction using phase delays. The improvements will only bring a small increase in capacity as they tend to be very small changes. Phase delays exist to extend either the terminating or proceeding phase beyond the stage into the interstage period. Phase delays could be considered to provide additional green to movements on the main arms, specifically A308 Staines Road West, as this is where the largest amount of delay occurs. These phase delays should only be considered when the signals are being validated on street.

6 OVERVIEW AND CONCLUSIONS

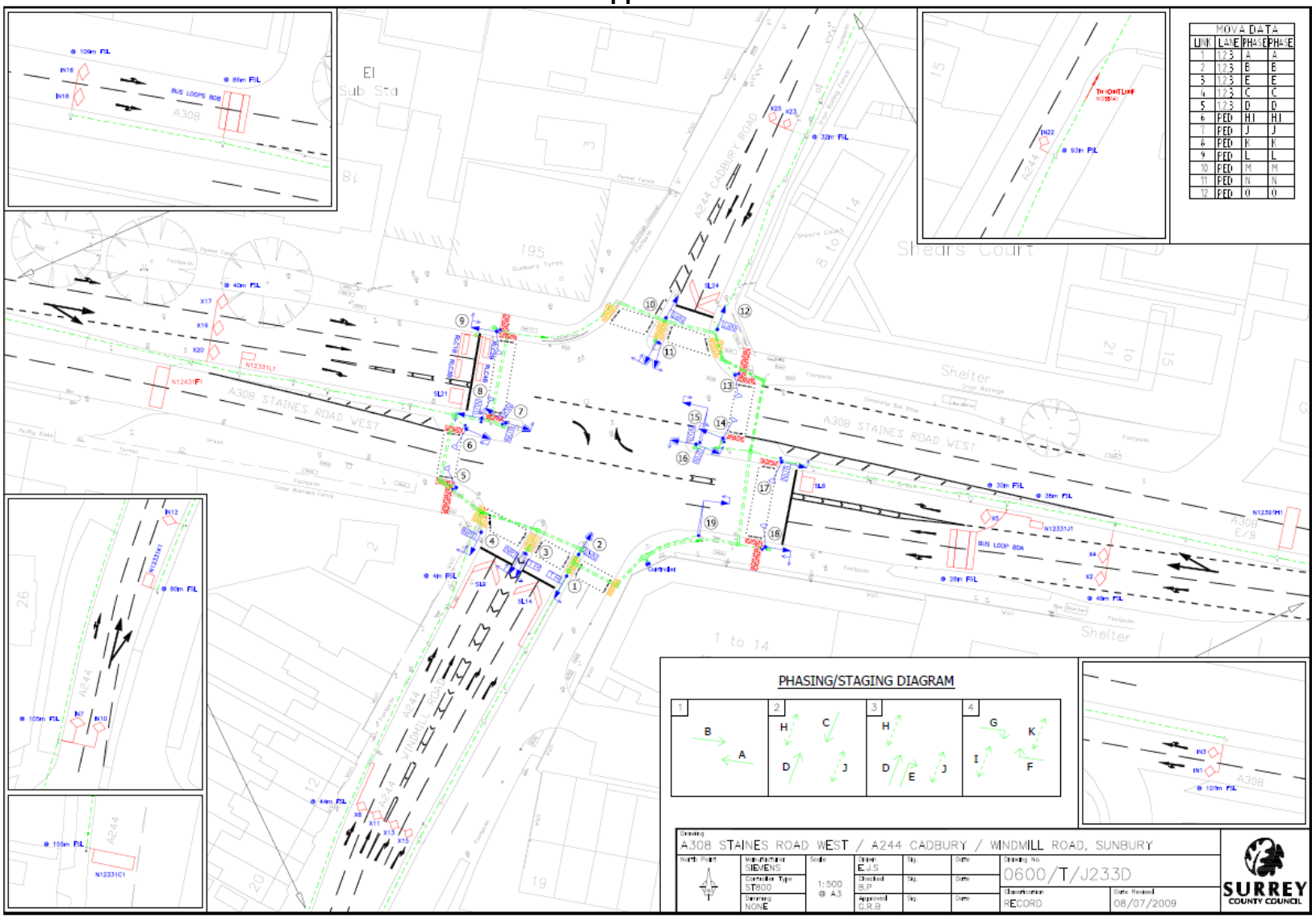
6.1.1 The modelling undertaken for this study considers the percentage change in junction performance outputs. This was due to the modelling not being able to fully reflect the on-street capabilities of SCOOT control. As such, this modelling represents the 'worst case scenario' and the results table showing the absolute values for comparing junction performance should be treated with caution.

6.1.2 The model outputs indicate that the proposed changes in **Appendix II** will increase delay at the junction by up to 400%. However, by considering various mitigation options as stated in **Table 3.1**, the junction performance can be much improved when compared back to the original proposed layout in the Do Something model. Furthermore, some outputs from the modelling demonstrate that the junction operation will be better than the current on-street arrangement.

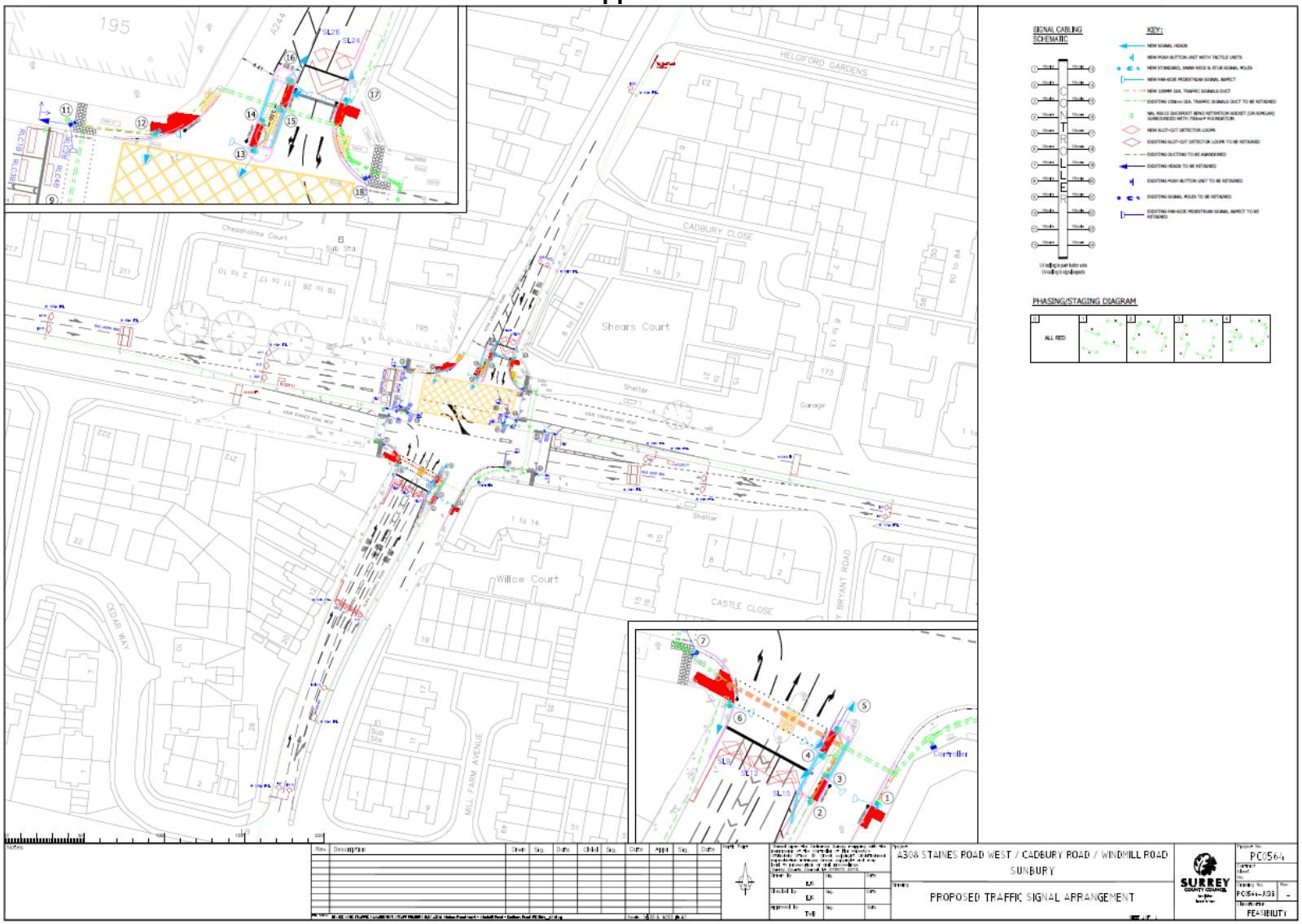
6.1.3 However, it should be noted that the benefits arising from the changes to the junction layout including the introduction of formal pedestrian crossings on either arm of the A244 and the removal of the banned right turn movement are not considered within this assessment. In particular the introduction of the right turn movement is likely to relieve pressure off nearby junctions, the benefits of which have not be assessed.

6.1.4 Overall, it can be concluded from this model assessment that the most appropriate option, with the least impact on the current network, is the Mitigation Option 2 model. This involves adding in the controlled pedestrian crossings on both arms of the A244 and reducing the number of approach lanes on Windmill Road to three, whilst retaining the right turn ban from Cadbury Road to Staines Road West.

Appendix I


MOVA DATA
LINK LANE PHASE PHASE
1 123 A A
2 123 B B
3 123 E E
4 123 C C
5 123 D D
6 PED H1 H1
7 PED J J
8 PED K K
9 PED L L
10 PED M M
11 PED N N
12 PED O O
PHASING/STAGING DIAGRAM
1 B A
2 H C D J
3 H D E J
4 G K I F
A308 STAINES ROAD WEST / A244 CADBURY / WINDMILL ROAD, SUNBURY
0600/T/J233D
SURREY COUNTY COUNCIL

Appendix II


SIGNAL CABLING SCHEMATIC
KEY:
PHASING/STAGING DIAGRAM
ALL RED
A308 STAINES ROAD WEST / CADBURY ROAD / WINDMILL ROAD
SUNBURY
PROPOSED TRAFFIC SIGNAL ARRANGEMENT
SURREY COUNTY COUNCIL
PC0566
FEASIBILITY
HELGIFORD GARDENS
CADBURY CLOSE
Shears Court
Willow Court
CASTLE CLOSE
CEDAR WAY
MILL FARM AVENUE
Chessholme Court
Sub Sta
Shelter
Garage
Controller

Appendix III

MCH1827B
Draft Issue

TRAFFIC SIGNAL CONTROLLER, WORK SPECIFICATION and CONFIGURATION FORMS

PHASE INTER-GREEN TIMINGS

To Phase

From Phase #1	A	B	C	D	E	F	G	H	I	J	K	L	M	N
A			5	9		5		10	5			10		
B			7	5	5		5			9			8	
C	5	5		8	5	6		13		8		11		5
D	5	6	8		5	5		8		12	5		9	
E		7	5	5									11	
F	5		5	5								12		
G		12				12								
H	8		8	8										
I	12				12									
J		9	9	9										
K				14										
L			6			6								
M		9		9	9									
N			6											

Minimum Inter-green limit

Enter required global value in seconds. Where not specified, this will default to 5 seconds. For specific limit values between individual phases use Form IX

5 Seconds

Starting Inter-green

Start up time MUST NOT include the Amber period.

10 Seconds

Comments

Notes: #1 Phase Inter-green times
Enter Inter-green times in seconds between conflicting phases

Site reference J233 | Specification Issue No. | Form Issue 1 | Originators Initials EJS | Date 26.01.16 | i