TECHNICAL NOTE

Job Name: Sharpness

Job No: 332210067

Note No: 332210067-701-TN001

Date: 25 July 2024

Prepared By: Lauren Wright

Subject: **M5 Junction 14 VISSIM Modelling**

1. Introduction

1.1. Stantec have been appointed by Sharpness Development LLP to provide transport support for the Sharpness Vale Development of 2,400 dwellings and 10ha of employment land, in the Stroud District of Gloucestershire. Transport evidence was considered at the Stroud District Draft Local Plan Examination in Public in May 2023. Subsequent to this, the Planning Inspector has requested further information in support of the Draft Local Plan, which forms the basis of a joint action plan produced by Stroud District Council. A key element of this joint action plan is an agreement on the plans for the strategic road network to accommodate the planned growth of the Draft Local Plan.

1.2. A proportion of the Sharpness Development generated traffic is anticipated to traverse through the M5 Junction 14. Therefore, Stantec has engaged with National Highways to obtain their VISSIM microsimulation model of the M5 Junction 14, for the purpose of assessing the impact of these trips on the M5 Junction 14.

1.3. Further to the above, Stantec has assessed the potential for Sharpness Development traffic to be accommodated at the M5 Junction 14 and the neighbouring A38/B4509 junction, and the associated highway mitigation likely to be required to alleviate the impact of those additional development trips on the highway network.

2. Model Background

2.1. Stantec received a package of VISSIM model files and a Local Model Validation Report from National Highways in October 2023, these included:

- 2021 Base AM
- 2021 Base PM
- 2024 Park Farm AM
- 2024 Park Farm PM
- M5 J14 VISSIM Model LMVR v5

DOCUMENT ISSUE RECORD

Technical Note No	Rev	Date	Prepared	Checked	Reviewed (Discipline Lead)	Approved (Project Director)
332210067-701-TN001	0	25/07/2024	LW	PLG	SI	LS

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2.2. The 2021 Base AM and Base PM models were developed by WSP on behalf of National Highways. The 2024 Park Farm AM and PM models were developed by Stantec (Bristol Office), using the National Highways 2021 Base model, where the traffic flows were increased from 2021 to 2024 using TEMPro factors, and the Park Farm development trip generation added to the background traffic growth. The Park Farm model also includes a physical mitigation agreed as part of that development, for the extension in length of the M5 northbound off-slip.

2.3. Stantec commissioned traffic surveys across a wide range of junctions in September 2023, which included the A38/B4509 junction and the M5 Junction 14. It was initially our intention to re-base the 2021 National Highways VISSIM model with the 2023 traffic flows from our surveys, so any future scenarios being tested would be compared to the most up-to-date traffic data. However, following engagement with National Highways, it was requested that we use the 2021 traffic flows as the base flows, and not to re-base the model.

Signal Controllers

2.4. The signal controllers in the Park Farm model are the same as the controllers initially set up by WSP for the 2021 Base model, based on PC-MOVA files provided by National Highways.

2.5. The signal controllers in the model have been changed to operate with fixed timings in the 2032 Do Nothing and 2032 Do Something with Mitigation models. In reality, the signals are anticipated to operate under MOVA control on site, therefore likely to provide efficiency and improved performance in comparison to the robust and worst-case assessment provided in this Technical Note.

2.6. In order to model the existing method of control at both the A38/B4509 and M5 Junction 14 accurately, the latest signal controller specification and signal layout drawings for the A38/B4509 junction were obtained from South Gloucestershire Council, who also confirmed the operation of the junctions are are not linked together. National Highways provided the signal controller specification and signal layout drawings for the M5 Junction 14.

3. Stantec Modelling Assessment for Sharpness

3.1. Stantec's modelling approach has been to use the Park Farm VISSIM model received from National Highways, but all the forecast traffic flows have been based on the 2021 Base model matrices. This is because the Park Farm model includes the physical mitigation described in Paragraph 2.2, being delivered by the Park Farm development as per their Section 278 agreement which will be complete before the proposed Sharpness development forecast year scenario.

Forecast flows

3.2. The forecast scenarios have been tested for horizon year 2032, when 1,000 dwellings at Sharpness are anticipated to be built by, following a build out rate of 200 dwellings per year from construction beginning in 2028. It is worth noting that the build out rate may be less than 200 dwellings per year, therefore this assessment is robust, as the development trips in 2032 may be less than the trip generation calculated.

3.3. TEMPro Version 8.1 has been used to generate growth factors for 2032 for the Stroud District Area. The local growth figure for motorway and A-road types has been used, where all flows originating from and ending at the M5 north or south have been increased by the motorway growth factor, and all other flows have been increased by the A-road growth factor.

3.4. The trip generation from the committed development in Charfield is included in the TEMPro growth, therefore has not been added manually to avoid double counting trips.

Table 3.1 – 2032 TEMPro growth factors

TEMPro Growth Factor Assumptions	2021-2032
	Stroud District Area
	NRTP 2022 Core Scenario
TEMPro Alternative Assumptions	Park Farm 595 future households removed, to avoid double counting as the trip generation matrices are already included in the Park Farm model
Motorway Local Growth Figure	1.1645
A Road Local Growth Figure	1.0732

Development trip generation and distribution

3.5. The development trip generation is based on a quantum of 1,000 dwellings, c.7,500sqm of Class E(g)(ii) office and c.7,500sqm of B2 General Industrial.

3.6. The following methodology has been used:

- Calculation of person trip generation for residential and employment uses based on person trip rates from the TRICS database,
- Application of journey purpose data from the TEMPro database to the residential person trip generation,
- Person trips for each journey purpose have been split by internal/ local trips (i.e. those within the red line boundary and local area) and external trips (i.e. those which beyond the local area),
- External person trips have been distributed by journey purpose based on likely destinations,
- Mode share of external person trips has been calculated for each journey purpose and destination based on mode share data from the National Travel Survey, and
- Vehicle trips have been assigned onto the highway network based on an assessment of the likely routes which will be taken by development traffic.

3.7. The trip generation and associated flow input used to develop the VISSIM Do Something models is largely based on existing car mode share characteristics of 66%, however it does account for increased bus use attributed to the express coach services proposed to be provided by the development.

3.8. The trip generation analysis for the Sharpness development indicates that of the development traffic that will be passing through the A38/B4509 junction and the M5 Junction 14, the main increase in traffic will be in the following ways:

- Southbound (AM peak) – from the A38 to the B4509 (eastbound), over the motorway bridge and onto the M5 (southbound) via the entry slip road, and
- Northbound (PM peak) – from the M5 (northbound) exit slip road to the B4509 (westbound) and onto the A38 (northbound)

3.9. These main movements are shown in **Figures 3.1** and **3.2** below, in addition to the other traffic flows to/from Sharpness in both the AM and PM peaks. The width of the arrows is indicative of the number of vehicles making that movement, where the wider the arrow is, the more vehicles there are making that movement. The development trip generation of the vehicles that will pass through these two junctions is included too.

3.10. The modelling assessment undertaken to support the proposed Sharpness development does not take into consideration any reassignment of trips on the highway network due to background traffic growth or the introduction of the proposed development, therefore this assessment provides a robust worst-case consideration of impact of the proposed development.

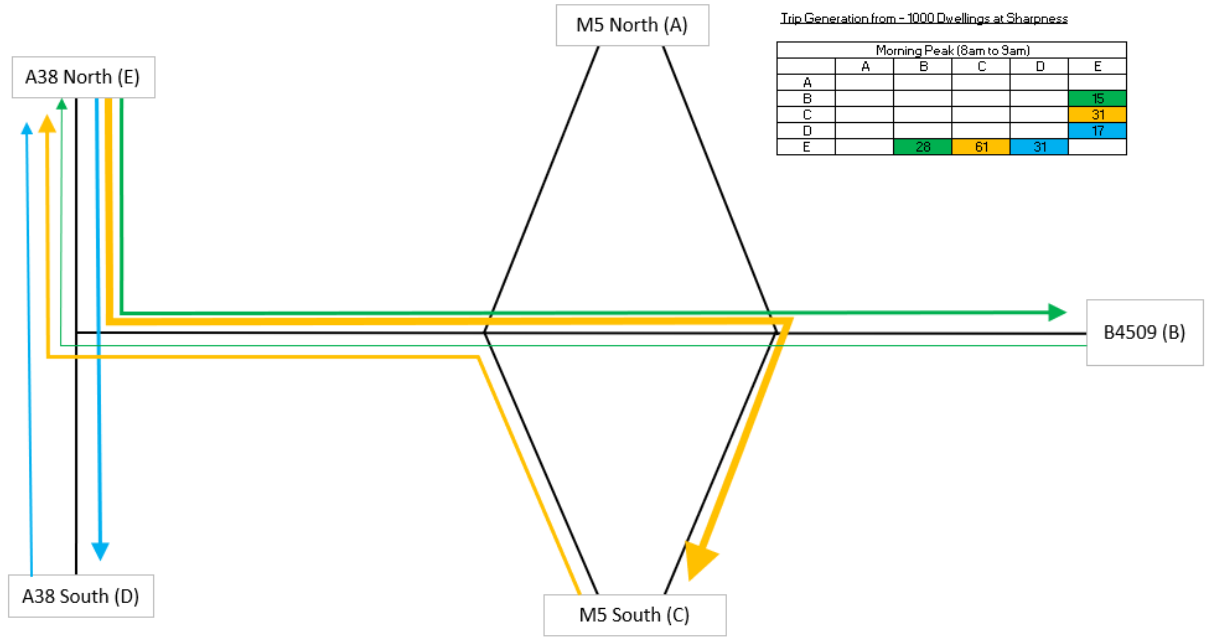


Figure 3.1 – Traffic flows to/from Sharpness Development – AM Peak

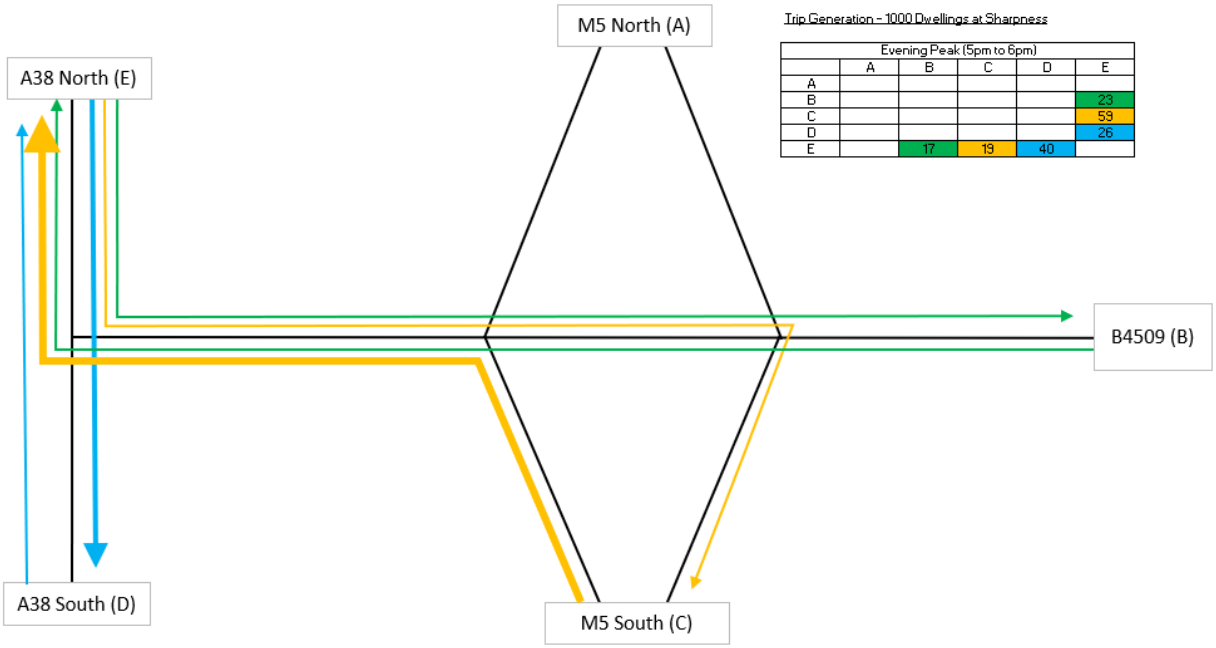


Figure 3.2 – Traffic flows to/from Sharpness Development – PM Peak

3.11. This increased traffic puts pressure on the existing highway network, and a wider traffic modelling assessment indicates it causes increased congestion and delay at the following locations:

- The A38 southbound left turn lane on the approach to A38/B4509 junction,

- The eastbound traffic lane on the B4509 between the A38 and the M5 Junction 14 southbound junction,
- The eastbound traffic lane on the B4509 between to M5 Junction 14 southbound and northbound junctions,
- Along the M5 Junction 14 northbound exit slip road on the approach to the junction with the B4509, and
- The right turn on the B4509 approaching the A38 junction to go north.

Forecast Scenarios

3.12. **Table 3.2** sets out the AM scenarios whilst **Table 3.3** sets out the PM scenarios that Stantec have assessed using LinSig and VISSIM software.

Table 3.2 – AM Modelling Scenarios and Proposed Mitigation

AM Scenarios	Proposed Mitigation	Scenario Details
2032 Do Nothing AM	N/A	No Sharpness development
		Signalised A38/B4509 junction
		Non-signalised M5 Junction 14
2032 Do Something with Mitigation AM	175m westbound flare on B4509 at A38/B4509	Sharpness 1000 dwellings trip generation
	115m southbound flare on A38 at A38/B4509 junction	Signalised A38/B4509
	Extension of traffic splitter islands on both the M5 J14 north and southbound on-slips, to allow for left and right turning onto the motorway at the same time.	Signalised M5 Junction 14
	Method of signal control across both junctions has been upgraded.	

Table 3.3 – PM Modelling Scenarios and Proposed Mitigation

PM Scenarios	Proposed Mitigation	Scenario Details
2032 Do Nothing PM	N/A	No Sharpness development
		Signalised A38/B4509 junction
		Signalised M5 Junction 14
2032 Do Something with Mitigation PM	175m westbound flare on B4509 at A38/B4509	Sharpness 1000 dwellings trip generation
	115m southbound flare on A38 at A38/B4509 junction	Signalised A38/B4509
	Extension of traffic splitter islands on both the M5 J14 north and southbound on-slips, to allow for left and right turning onto the motorway at the same time.	Signalised M5 Junction 14
	Method of signal control across both junctions has been upgraded.	

4. Improved Junctions Concept Design

4.1. The M5 Junction 14 is currently signalised part-time, where during the morning peak period, the signals are switched off and it operates by priority, and during the evening peak period the signals are switched on. As identified by the 2021 Base and the 2024 Park Farm modelling, and consequent mitigation, the northbound off-slip is an area of interest due to the propensity of queues forming that could back onto the main carriageway.

4.2. The A38/B4509 junction is signalised, however, the current method of control for this junction is not coordinated with the method of control for the signals at the M5 Junction 14. Therefore, more traffic is released onto the B4509 eastbound frequently, causing delays and queuing downstream on the B4509, particularly over the motorway bridge. The A38 north and southbound approaches also face delays at this junction.

4.3. To improve the efficiency of these junctions in 2032 with the trip generation associated with Sharpness, Stantec have developed a 'Proposed Mitigation' concept design as shown in **Appendix A**.

4.4. To improve the A38/B4509 junction, it is proposed that the B4509 westbound left turn flare be extended from 85m to 175m, as shown below in **Figure 4.1**. This will accommodate additional vehicles queuing on this arm to turn right to the A38 north, without blocking entry to the flare for the vehicles turning left to the A38 south.

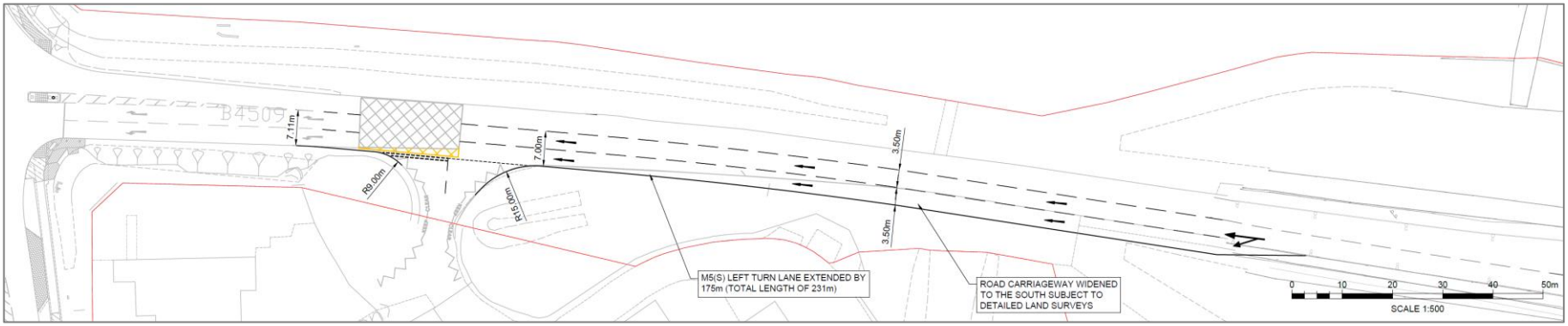


Figure 4.1 – Proposed mitigation extending the B4509 westbound flare length

4.5. The improvements proposed on the A38 southbound approach include extending the left turn flare to 115m and introducing KEEP CLEAR markings to avoid blocking vehicles exiting Heneage Lane, this is shown below in **Figure 4.2**.

4.6. The main movement of traffic from the A38 north, is left turning at the A38/B4509 junction towards the motorway, where the extension of the flare length will mean the vehicles going straight on can move through the junction without having to wait behind the queue of vehicles turning left, as they would without the flare extension.

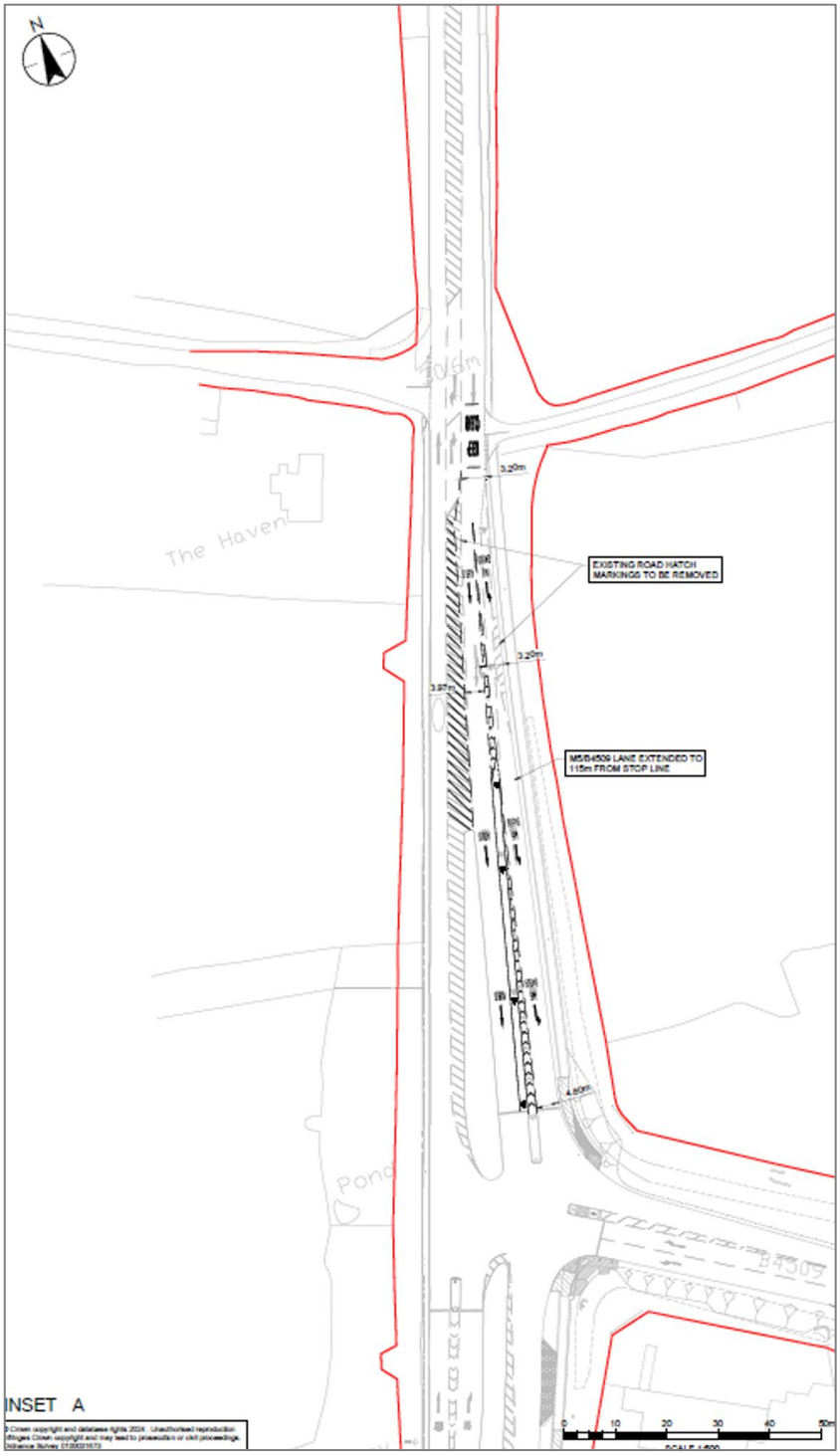


Figure 4.2 - A38 southbound flare length extension

4.7. The signal programme and method of control of the signals at this junction has also been improved, to allow for an additional phase allowing only the left and right turning movements from the B4509. The signal programme alteration at this junction also improves the operation of the M5 Junction 14, through holding traffic on the A38 for longer than it currently is. Signal method of control and phasing diagrams will be discussed further in **Section 5**.

4.8. Secondly, the M5 Junction 14 can be improved through a combination of turning on the signals during the morning peak and the physical extension of splitter islands on the north and southbound on-slips to allow for left and right turning onto the motorway at the same time, shown below in **Figures 4.3** and **4.4**. The extension of the splitter islands allows for the method of control across this junction to be improved and upgraded.

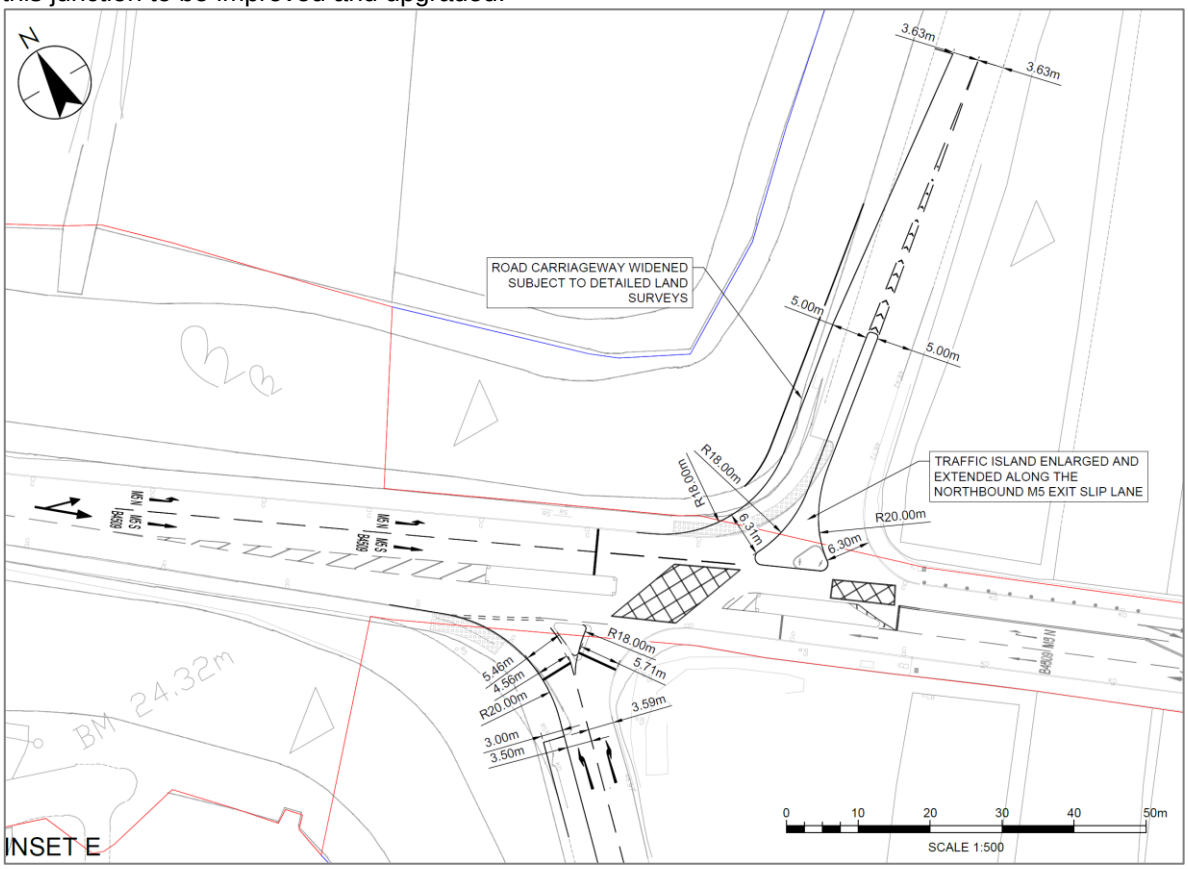


Figure 4.3 – Proposed mitigation extending the physical traffic splitter island, and associated carriageway widening on the northbound entry slip road

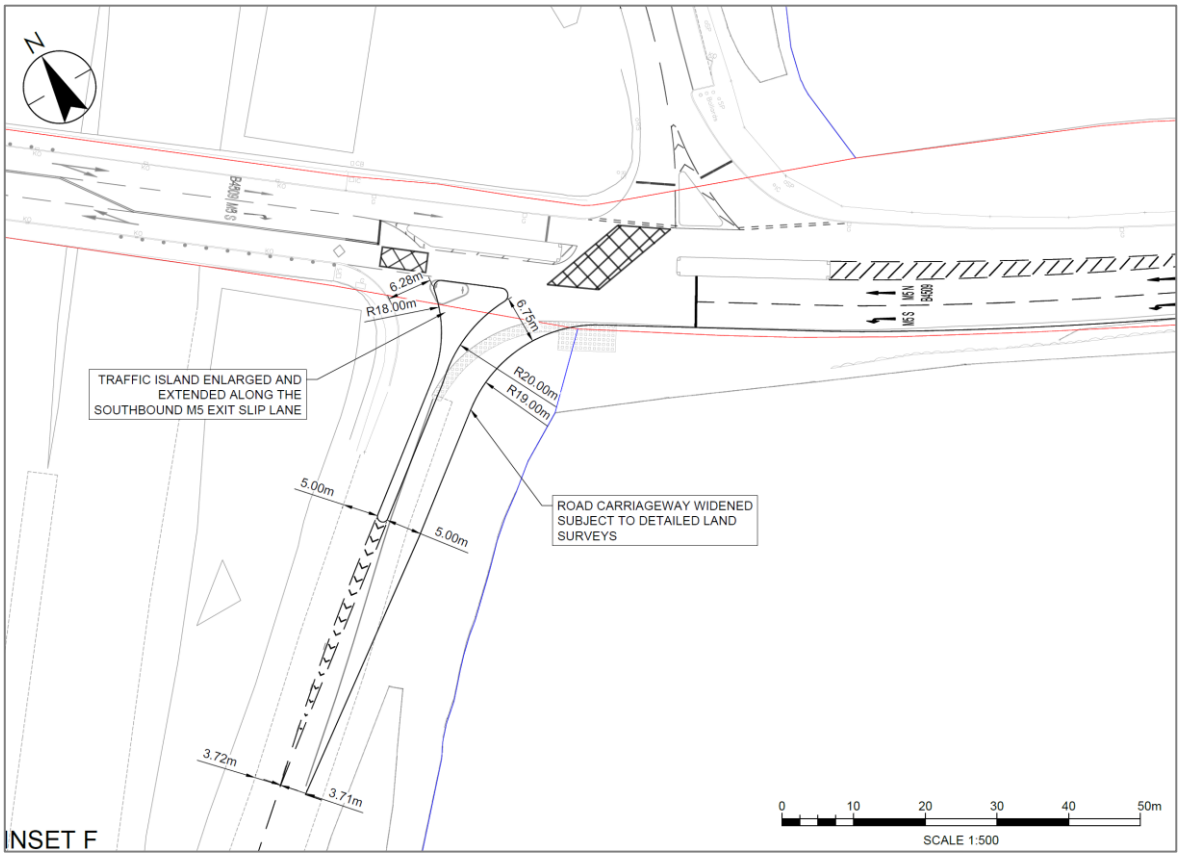


Figure 4.4 – Proposed mitigation extending the physical traffic splitter island, and associated carriageway widening on the southbound entry slip road

4.9. These high-level concept designs have been developed using OS mapping and informed by the highway boundary data obtained from South Gloucestershire County Council.

5. LinSig Modelling Output

5.1. LinSig models were developed of the A38/B4509 and M5 Junction 14, to model the existing signals and to create optimised signal programmes for the 2032 scenarios being assessed in VISSIM.

5.2. Aerial photography from Google Maps of each junction was used to measure the geometry for the model.

5.3. The 2032 Do Nothing traffic flow matrices inputted into the models were calculated using the TEMPro growth factors listed in **Table 3.1**, and the 2032 Do Something matrices had the trip generation associated with 1,000 dwellings at Sharpness included in addition to the background traffic growth.

5.4. Each forecast scenario was assessed in a separate LinSig model due to the method of signal control being different in each. In each scenario, the signal controller cycle times and green splits have been optimised, after assigning the forecast traffic flows assigned to the network. The signal programmes generated in LinSig were initially based on the internal links having a maximum Degree of Saturation of 90%. Following inputting the signal programmes into the VISSIM models and watching the signal behaviour, the programmes were manually adjusted as the modelling was showing the internal links could hold more traffic than the LinSig models were suggesting.

5.5. **Figures 5.1** and **5.2** show the LinSig network diagrams of the existing junctions in the AM and PM scenarios with the signal phases shown on the lanes. During the AM, as the M5 Junction 14 is unsignalised, there are blue circles at the ends of the lanes denoting give way behaviour.

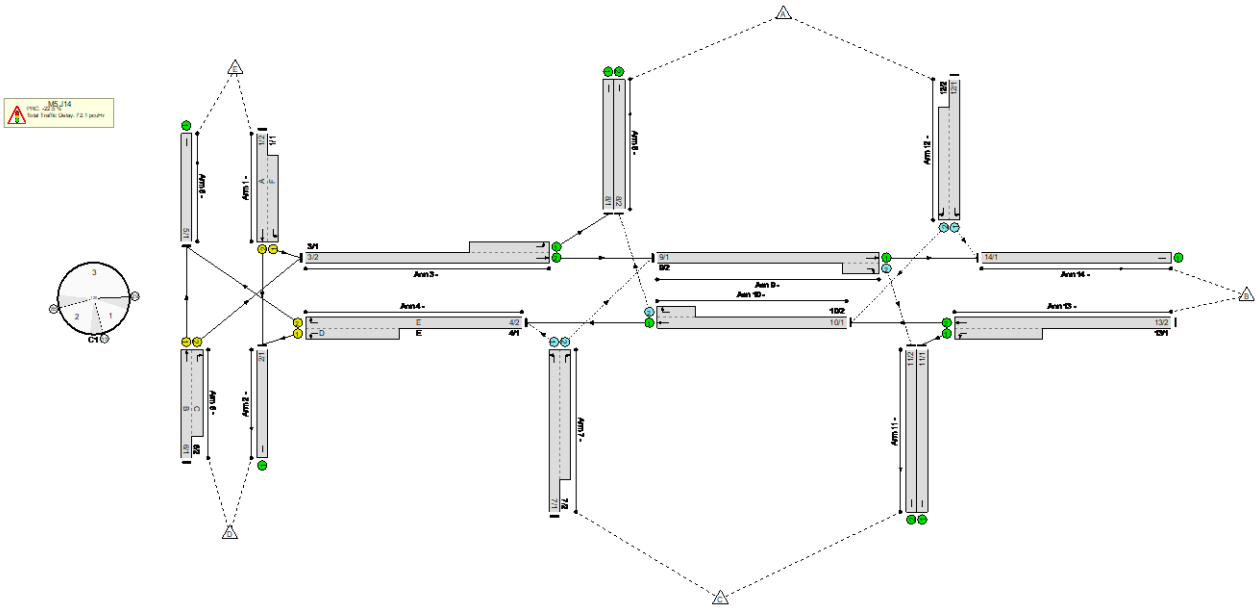


Figure 5.1 – Existing layout and phasing of A38/B4509 and the M5J14 – AM

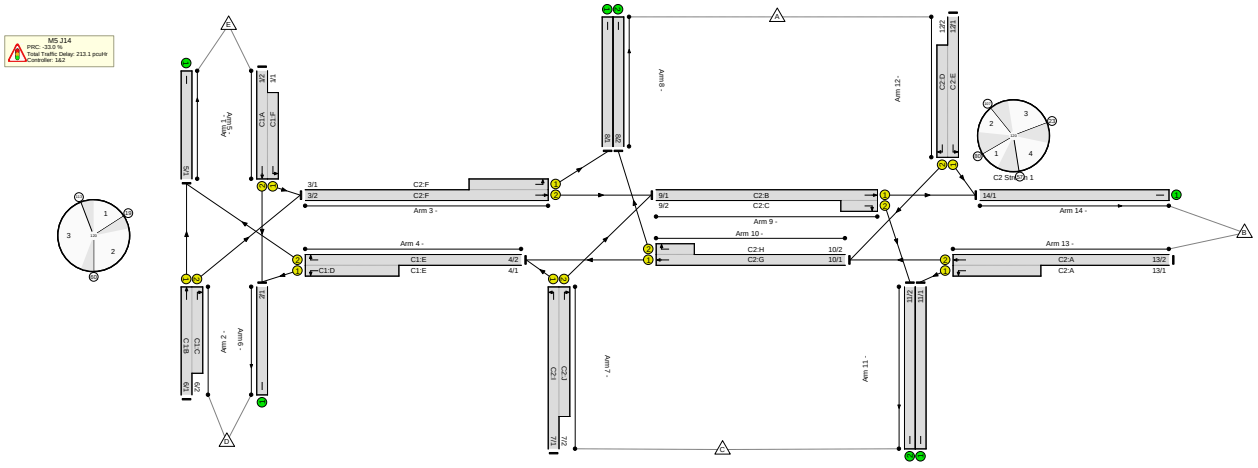


Figure 5.2 – Existing layout and phasing of A38/B4509 and the M5J14 - PM

A38/B4509 Junction

5.6. At the A38/B4509 junction, **Figure 5.3** shows the traffic signal staging diagram and the existing method of control, where Phase D currently is a left turning filter phase.

In Stages	Phases A	B	C	D	E	F	G
0*							■
1	■	■				■	
2		■	■	□			
3					■	■	

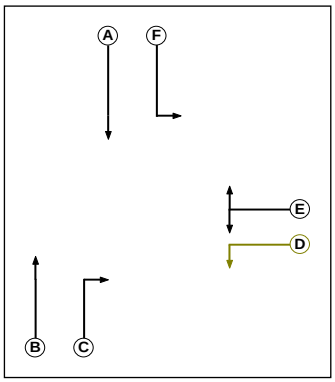


Figure 5.3 Existing A38/B4509 traffic signal staging and method of control. The star (*) donates a stage that does not run in normal, operation, a hollow square indicates a filter phase.

5.7. As stated in Paragraph 4.5, the method of control for this junction has been improved in the Proposed Mitigation scenario, and can be seen below in **Figure 5.4** with the addition of Phase 4, running only E and D, highlighted by two stars (**).

In Stages	Phases A	B	C	D	E	F	G
0*							
1	■	■				■	
2		■	■	□			
4**					■		■
3					■	■	

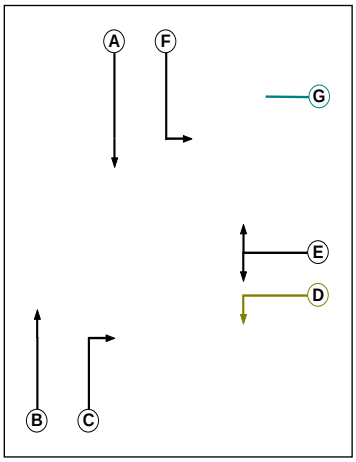


Figure 5.4 – 2032 Proposed Mitigation method of control and traffic signal staging for A38/B4509 junction. The star (*) donates a stage that does not run in normal operation, two stars (**) denotes the additional stage provided with the proposed mitigation, and a hollow square indicates a filter phase.

5.8. Both the existing method of control and the proposed mitigation method of control have been tested in LinSig to generate signal programmes for input into VISSIM, a comparison of the LinSig signal operation results is shown below in **Table 5.1**. In the table, DoS refers to Degree of Saturation, which is a measure of the percentage of a lane's green time that is used by traffic. For example, a DoS of 70%, means 70% of the green time is being utilised by traffic.

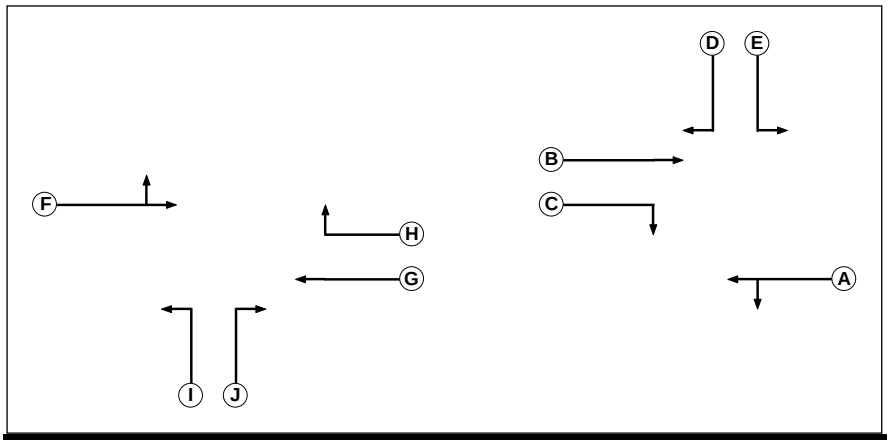
Table 5.1 – A38/B4509 junction signal phase data

	Lane	2032 Do Nothing AM		2032 Do Something with Mitigation AM		2032 Do Nothing PM		2032 Do Something with Mitigation PM	
		DoS (%)	Total Green Time	DoS (%)	Total Green Time	DoS (%)	Total Green Time	DoS (%)	Total Green Time
A38/B4509	A38 (Southbound): Ahead	59.4%	20	116.0%	27	59.1%	20	91.0%	19
	A38 (Northbound): Ahead	110.0%	49	123.1%	52	71.7%	60	89.6%	51
	A38 (Northbound): Right Turn	110.0%	23	123.1%	19	71.7%	34	89.6%	26
	B4509: Left Turn	67.7%	87	66.1%	26	80.9%	87	78.4%	88
	B4509: Right Turn	67.7%	57	66.1%	54	80.8%	46	78.4%	55
	A38 (Southbound): Left Turn	57.9%	83	116.0%	34	59.1%	72	91.0%	26

5.9. **Table 5.1** shows that the green time for the A38 (Northbound): Right Turn and A38 (Southbound): Left Turn decreases in the proposed mitigation scenario. This is because the method of control has been altered to reduce the number of vehicles that pass through each cycle, to keep the B4509 eastbound clear and free of congestion, so then the M5 Junction 14 is not constrained due to heavy traffic blocking vehicles from turning off or onto the motorway.

M5 Junction 14

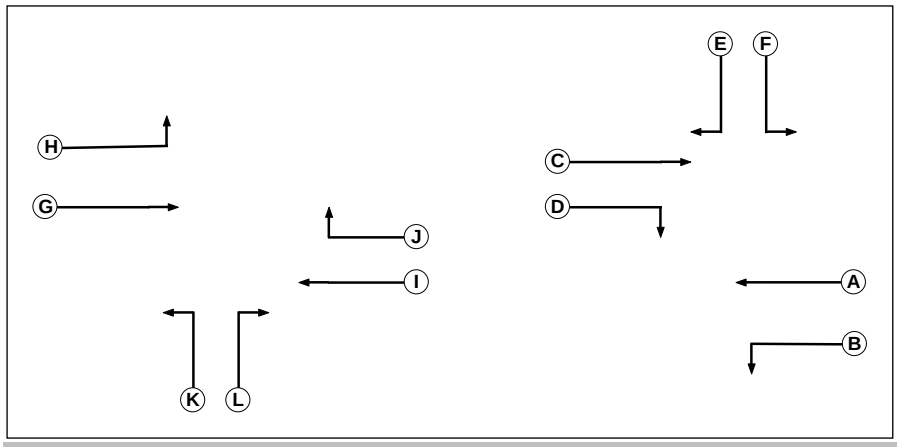
5.10. The M5 Junction 14 existing method of control and traffic signal staging diagrams are shown below in **Figure 5.5**.



In Stages	Phases A	B	C	D	E	F	G	H	I	J	K
0*											■
1				■	■	■	■				
2		■	■			■	■				
3		■	■						■	■	
4	■	■					■	■			

Figure 5.5 - Existing M5 J14 traffic signal staging and method of control. The star (*) donates a stage that does not run in normal operation.

5.11. As stated in Paragraph 4.6, the method of control for this junction has been improved in the Proposed Mitigation scenario, through the addition of new phases and a different staging order. **Figure 5.6** below shows these proposed method of control improvements.



In Stages	Phases A	B	C	D	E	F	G	H	I	J	K	L	M
0*													■
1	■	■	■				■	■	■				
2		■	■	■				■	■	■			
3		■		■		■		■		■	■		
4					■	■					■	■	

Figure 5.4 – 2032 Proposed Mitigation method of control and traffic signal staging for M5 Junction 14

5.12. **Figure 5.4** shows that the left turn movements onto the north and southbound on slip roads have been given their own Phases, B and H. This enables the method of control to be changed, so Stage 2 runs the left and right turning phases B,D, H and J onto the motorway on-slips at the same time.

5.13. Both the M5 Junction 14 existing method of control and the proposed mitigation method of control have been tested in LinSig to generate signal programmes for input into VISSIM, a comparison of the LinSig signal operation results is shown below in **Table 5.2**.

Table 5.2 – M5 Junction 14 signal phase data

	Lane	2032 Do Nothing AM		2032 Do Something Mitigation AM		2032 Do Nothing PM		2032 Do Something Mitigation PM	
		DoS (%)	Total Green Time	DoS (%)	Total Green Time	Degree of Saturation (%)	DoS (%)	Total Green Time	DoS (%)
M5 Junction 14	B4509 (Westbound): Ahead	50.0%	N/A	121.8%	27	119.7%	31	100.4%	34
	B4509 (Eastbound Internal): Ahead	78.5%	N/A	99.0%	82	94.6%	90	96.0%	79
	B4509 (Eastbound Internal): Right Turn	81.4%	N/A	81.3%	58	90.1%	51	92.8%	53
	M5 J14 Slip (Southbound): Right Turn	76.1%	N/A	90.4%	13	79.8%	14	99.8%	11
	M5 J14 Slip (Southbound): Left Turn	54.0%	N/A	86.2%	22	114.7%	14	66.2%	25
	B4509 (Eastbound): Ahead	50.6%	N/A	112.4%	44	107.6%	38	103.8%	42
	B4509 (Westbound Internal): Ahead	58.7%	N/A	94.4%	72	94.2%	77	98.6%	70
	B4509 (Westbound Internal): Right Turn	58.7%	N/A	85.2%	34	86.8%	30	98.5%	33
	M5 J14 Slip (Northbound): Left Turn	72.5%	N/A	93.9%	31	100.3%	26	90.4%	33
	M5 J14 Slip (Northbound): Right Turn	110.0%	N/A	95.7%	20	72.5%	28	87.6%	23

5.14. Table 5.2 shows that compared to the Do Nothing, the Do Something generally has higher DoS in the AM peak, but lower DoS in the PM peak. In the PM Peak, both slip roads and B4509 (Westbound): Ahead in particular show large decreases in DoS, with DoS on these lanes decreasing by more than 10%. In the AM peak, the Do Nothing runs with the signals being unsignalised. LinSig is better suited to assess the accuracy of signalised junctions and therefore VISSIM is better equipped to compare the performance of an unsignalised junction with a signalised junction.

Summary

5.15. The A38/B4509 junction method of control will be changed as part of the proposed mitigation to gate traffic on the A38, in order to prevent the B4509 from becoming heavily congested, so the M5 Junction 14 north and southbound exit slip roads can clear onto the B4509. This method of 'gating' the traffic is considered necessary as currently, vehicles are being released onto the B4509 faster than the queue to turn right onto the M5 southbound entry slip road clears. This causes significant congestion on other movements, including the exit slip roads, as the vehicles turning right onto the B4509 have very few chances to turn when the B4509 eastbound is congested, causing queues to back down the slip road onto the mainline.

5.16. The M5 Junction 14 method of control will be improved as part of the mitigation through separate phases being assigned to the left turning traffic onto the north and southbound entry slip roads. This enables the signal staging to be changed to allow the left and right turning traffic onto the motorway entry slip roads to be green at the same time.

5.17. Both the method of control changes proposed in the mitigation are considered essential to enable the M5 Junction 14 to operate safely, and more efficiently in 2032 with the Sharpness development traffic, where exit queues do not extend onto the mainline. However, in order to achieve this improvement at the M5 Junction 14, the A38/B4509 junction will face increased queueing.

5.18. The signal programmes and method of control calculated from these LinSig models have been inputted in the VISSIM models. The signal programmes were slightly manually adjusted following observation of the link capacity in the VISSIM model runs.

5.19. The results showing how the junctions will operate in 2032 with the proposed mitigation is discussed in **Section 6**.

6. VISSIM Modelling Results

6.1. The VISSIM results presented here compare the 2032 Do Nothing Model against the 2032 Do Something with Proposed Mitigation model, which show that the mitigation will be successful in improving the overall network performance, increasing the vehicle throughput at both junctions and reducing the overall delay vehicles will incur.

6.2. The signals are running with fixed time logic across each of the VISSIM scenarios, therefore it is important to note that in real life, MOVA logic will be used which will provide more efficiency than the fixed time signals currently do.

6.3. The following section will summarise the results from the modelling, showing that the proposed mitigation will improve the efficiency of the A38/B4509 junction and M5 Junction 14 in 2032, meaning the Sharpness development will not negatively affect the operation of the junctions.

Increased Vehicle Throughput

6.4. The 2032 Do Something with Mitigation models, show that in both the morning and evening peak, the proposed mitigation will increase the vehicle throughput across both the junctions, therefore improving the efficiency of the junctions, as shown below in **Figures 6.1** and **6.2**.

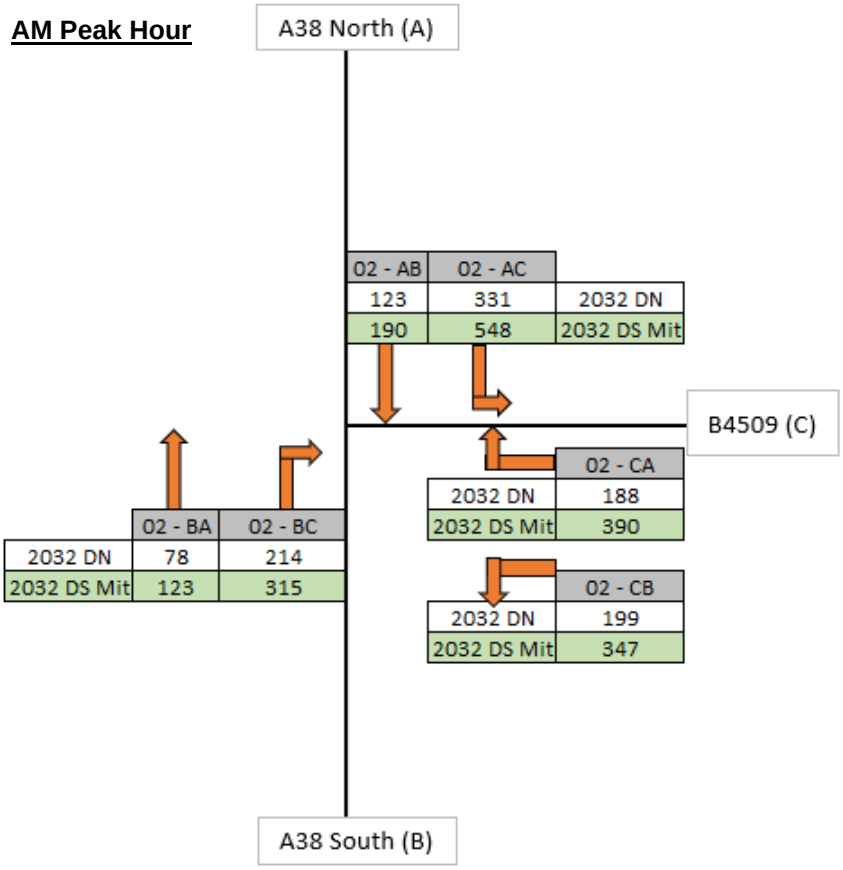


Figure 6.1 – A38/B4509 junction morning peak hour average vehicle throughput

6.5. **Figure 6.1** shows that on each movement through the A38/B4509 junction, the average peak hour vehicle throughput will increase in the 2032 Do Something with Mitigation morning scenario, in comparison to the 2032 Do Nothing scenario.

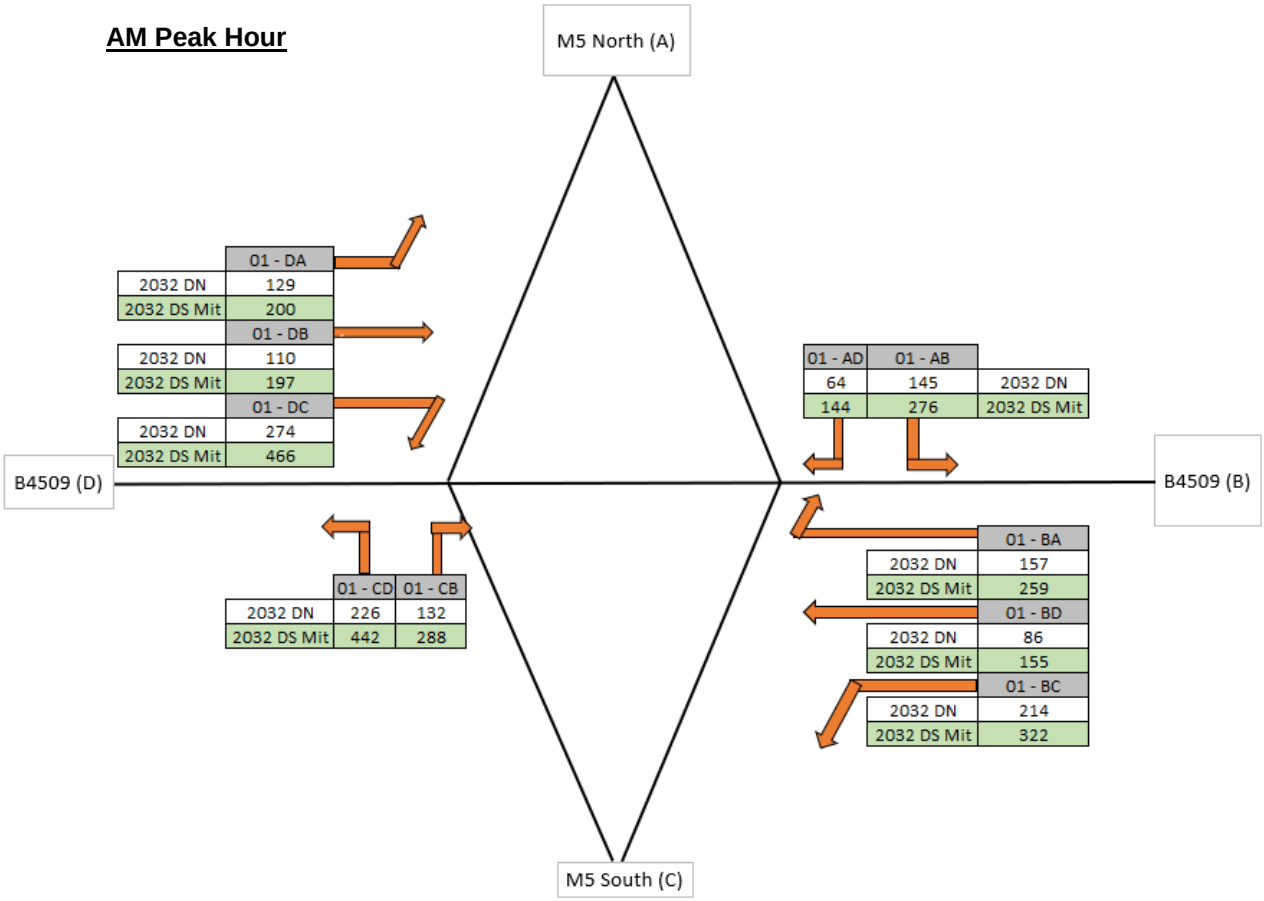


Figure 6.2 – M5 Junction 14 morning peak hour average vehicle throughput across the network

6.6. **Figure 6.2** shows that on each movement through the M5 Junction 14, the average peak hour vehicle throughput will increase in the 2032 Do Something with Mitigation morning scenario, in comparison to the 2032 Do Nothing scenario.

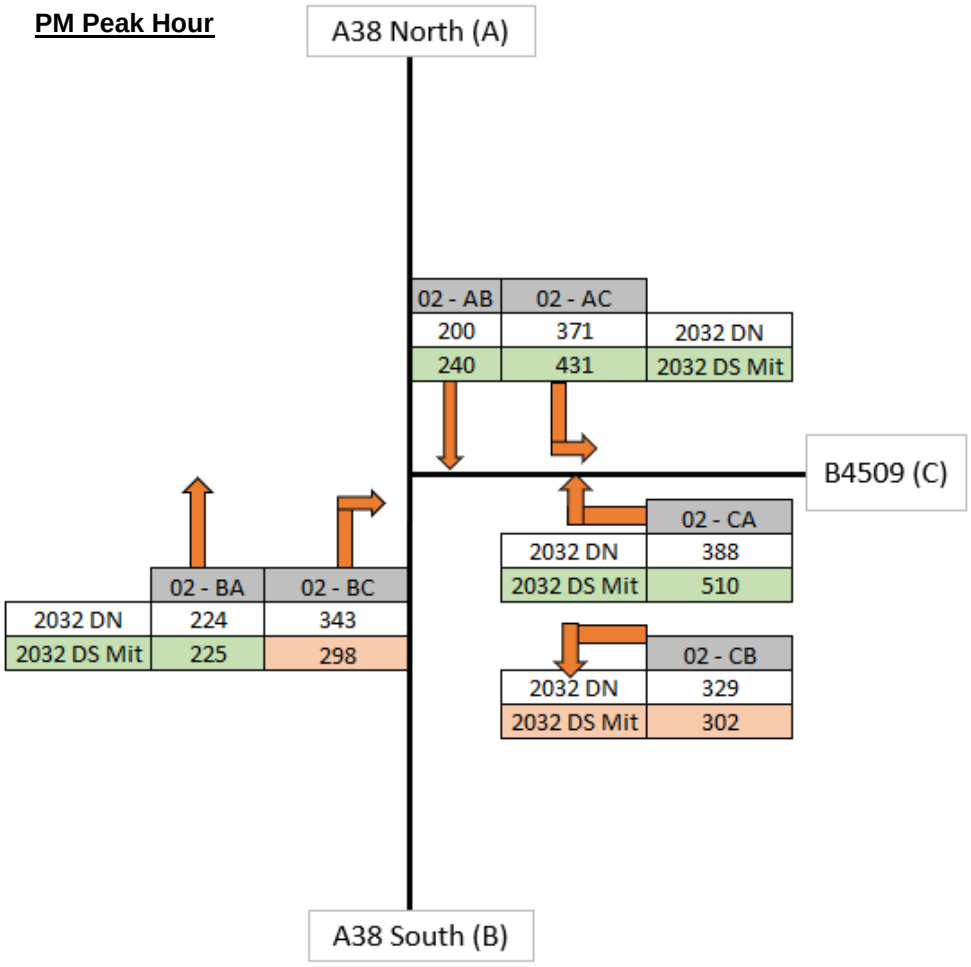


Figure 6.3 – A38/B4509 evening peak hour average vehicle throughput across the network

6.7. **Figure 6.3** shows that for nearly all movements through the A38/B4509 junction, the average peak hour vehicle throughput will increase in the 2032 Do Something with Mitigation evening scenario, in comparison to the 2032 Do Nothing scenario.

6.8. The only movements where the average throughput decreases slightly with the proposed mitigation are from the A38 south turning right to the B4509, and from the B4509 turning left to the A38 south, as highlighted in red on **Figure 6.3**. This is due to the need for the proposed mitigation to change the method of signal control to hold traffic on these movements for slightly longer, to enable reduced queues on the motorway exit slip roads.

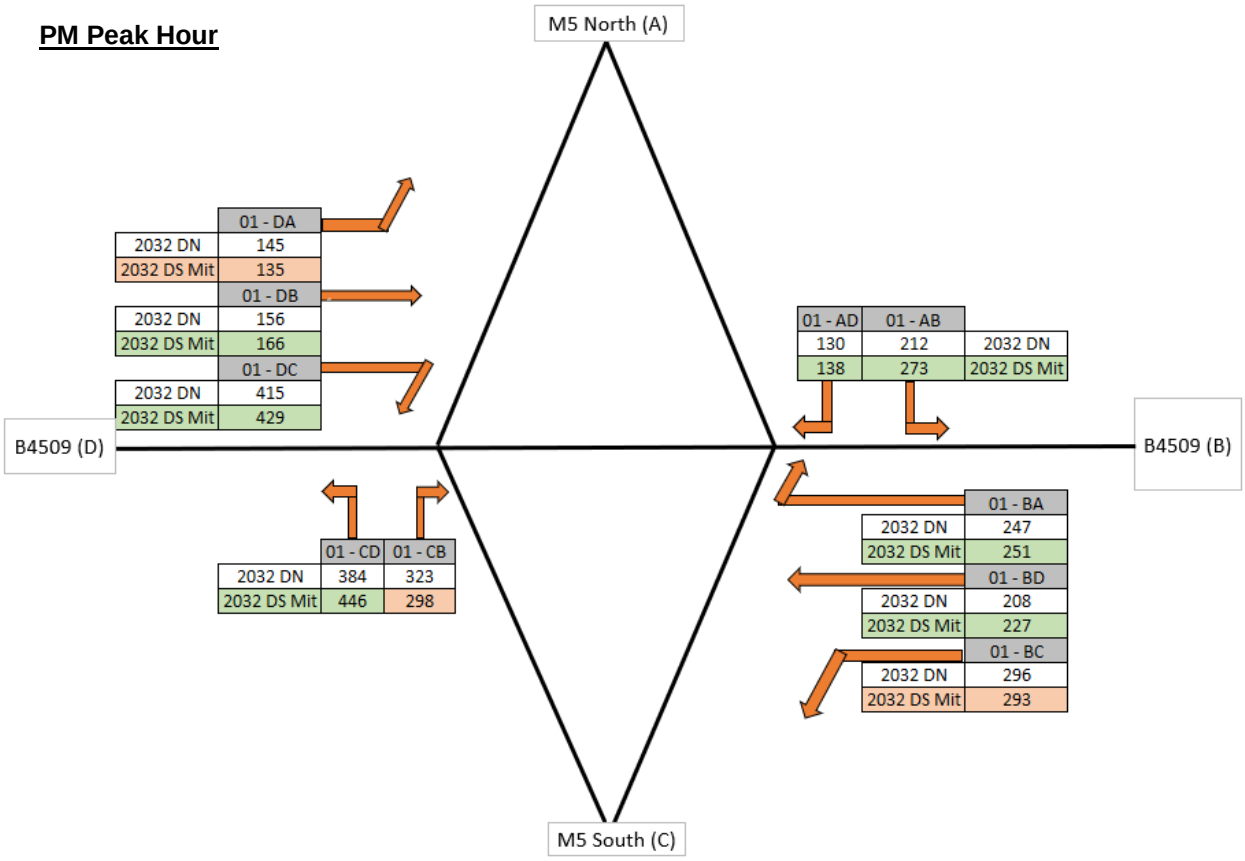


Figure 6.4 – A38/B4509 evening peak hour average vehicle throughput across the network

6.9. **Figure 6.4** shows for nearly all movements through the M5 Junction 14, the evening average peak hour vehicle throughput will increase in the 2032 Do Something with Mitigation evening scenario, in comparison to the 2032 Do Nothing scenario.

6.10. The only movements where the average throughput decreases slightly with the proposed mitigation are from the M5 south turning right to the B4509 east, from the B4509 west turning left to the M5 north, and from the B4509 east turning left to the M5 south, as highlighted in red in **Figure 6.4**. The largest decrease in throughput from these three movements is only 25 vehicles fewer from turning right from the M5 south to the B4509 east.

6.11. **Table 6.1** below shows that the average vehicle throughput for each junction will increase due to the proposed mitigation in the 2032 Do Something with Mitigation scenarios, despite some turning movements the evening peak seeing a slight increase, as detailed above.

Table 6.1 – Peak hour average vehicle throughput across both junctions in each scenario

Junction	Peak Hour Average Vehicle Throughput			
	2032 Do Nothing AM	2032 Do Something with Mitigation AM	2032 Do Nothing PM	2032 Do Something with Mitigation PM
A38 / B4509	1,131	1,912	1,854	2,007
M5 Junction 14	1,537	2,748	2,515	2,657

Summary

6.12. The results show that the proposed mitigation will increase the vehicle throughput across both junctions in the morning and evening peak hours, in comparison to the 2032 Do Nothing scenarios.

Improved Network Performance

6.13. The Vehicle Network Performance results were extracted from the models, in which the analysis presented below shows the comparison between the 2032 Do Nothing results and 2032 Do Something with Proposed Mitigation results. The results show that the proposed mitigation will improve the overall performance of both the M5 Junction 14 and the A38/B4509 junction.

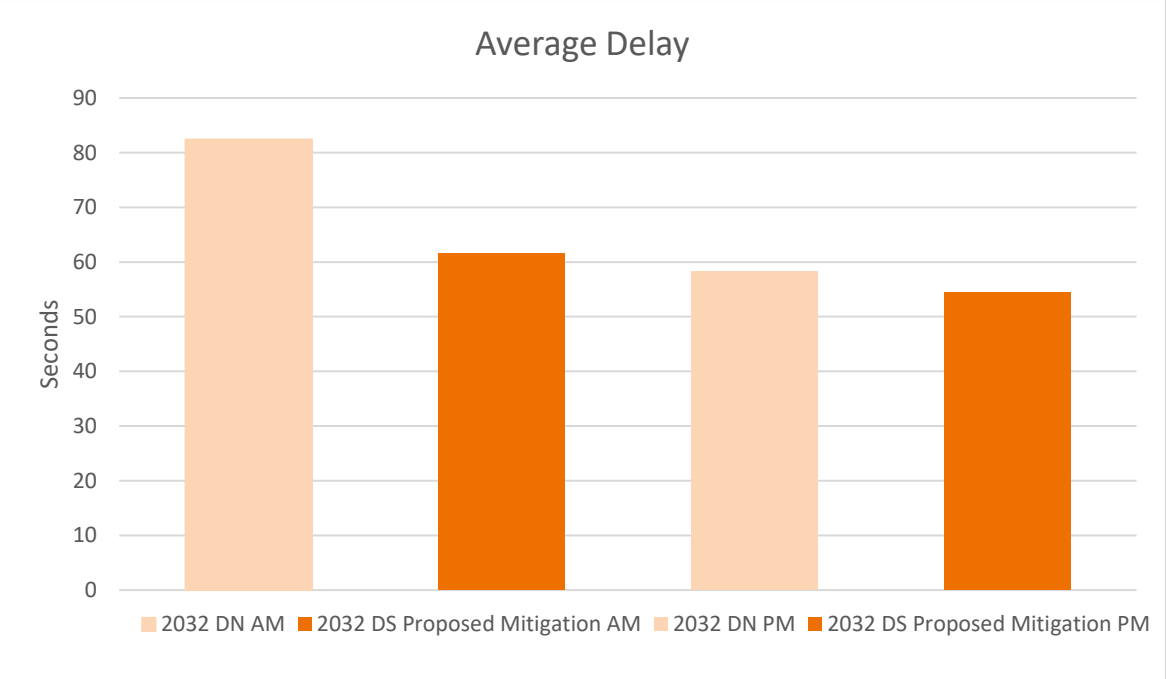


Figure 6.5 – Average delay comparison

6.14. The average delay results in **Figure 6.5** show that across both the 2032 Do Something with Mitigation AM and PM scenarios, the delays will reduce in comparison to the 2032 Do Nothing AM and PM scenarios. This reduction in delay is most noticeable in the 2032 Do Something with Mitigation AM scenario, where the average delay per vehicle will reduce from 82 seconds to 62 seconds.

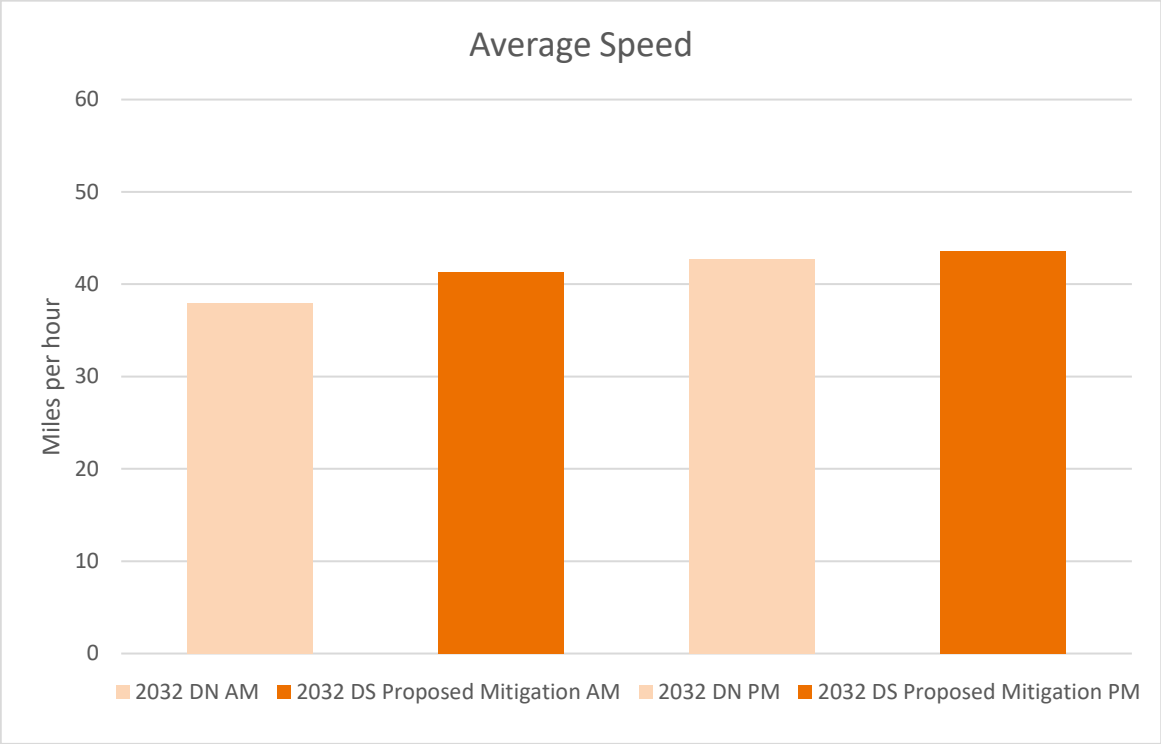


Figure 6.6 – Average speed comparison

6.15. **Figure 6.6** shows that the average speed across the network will increase in both the morning and evening 2032 Do Something with Mitigation scenarios, compared to the 2032 Do Nothing scenarios. This is consistent with the reduced average delay across the network shown in **Figure 6.5**, therefore increasing vehicle speeds.

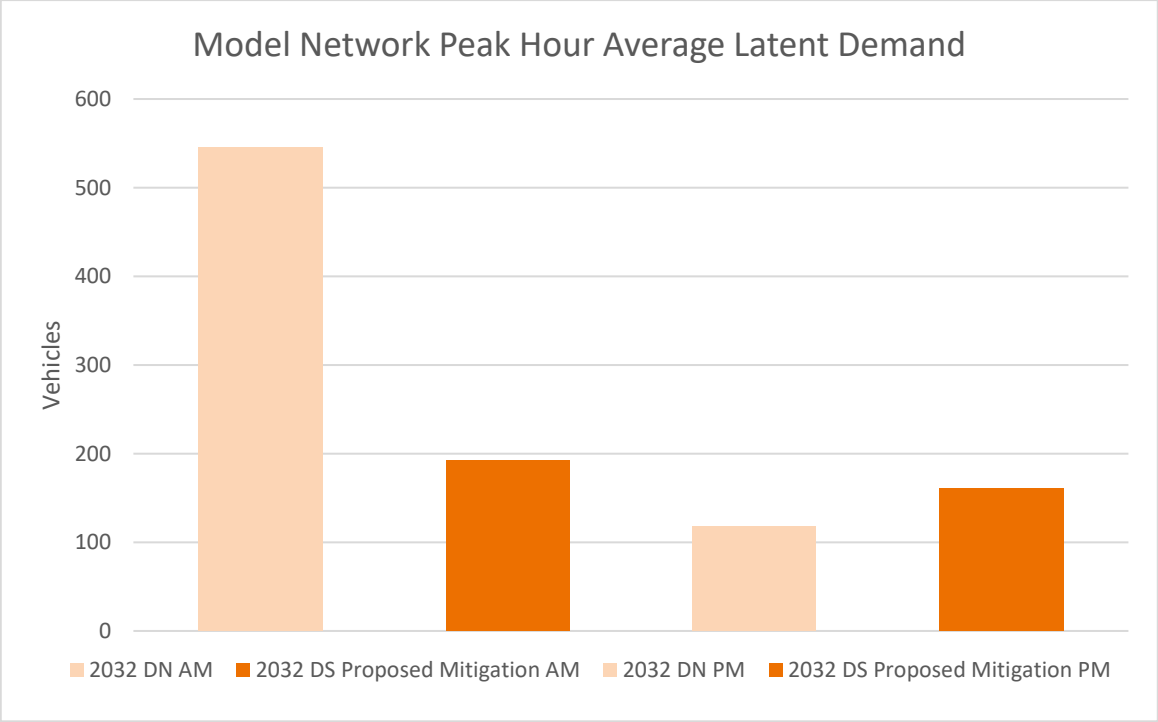


Figure 6.7 – Peak hour average latent demand across the whole network comparison

6.16. **Figure 6.7** shows that in the morning 2032 Do Nothing scenario, there is a high latent demand of 546 vehicles that are not able to enter the network. The proposed mitigation will help to reduce the latent demand by 65% in the morning peak to 193 vehicles in the 2032 Do Something with Mitigation AM scenario. The latent demand across the network in the 2032 Do Something with Mitigation evening peak scenario will increase slightly from 118 vehicles in the 2032 Do Nothing PM scenario to 161 in the 2032 Do Something with Mitigation PM scenario.

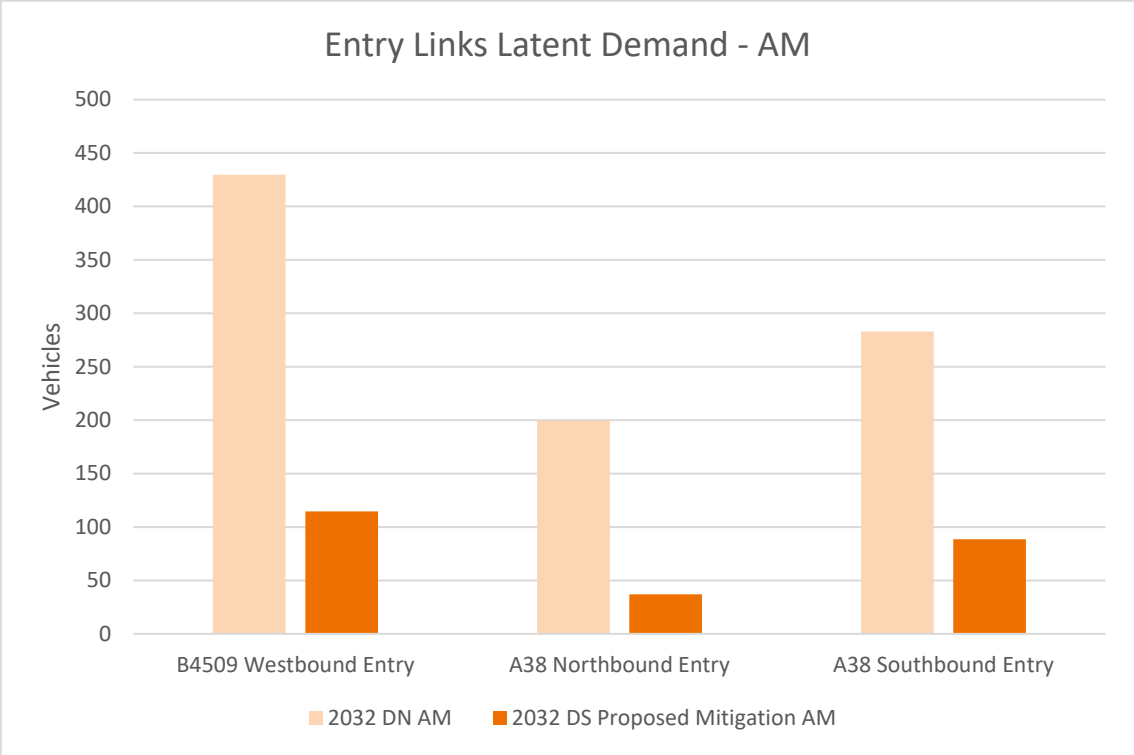


Figure 6.8 – Average latent demand on each entry link into the network across the whole simulation period - AM

6.17. **Figure 6.8** above shows the average number of unreleased vehicles at the end of the peak period that could not enter the model network on each entry link, due to congestion extending back down to the beginning of the link in the model. On each entry link, the proposed mitigation will reduce the latent demand as more vehicles are able to get through the network, as shown in the increased vehicle throughput.

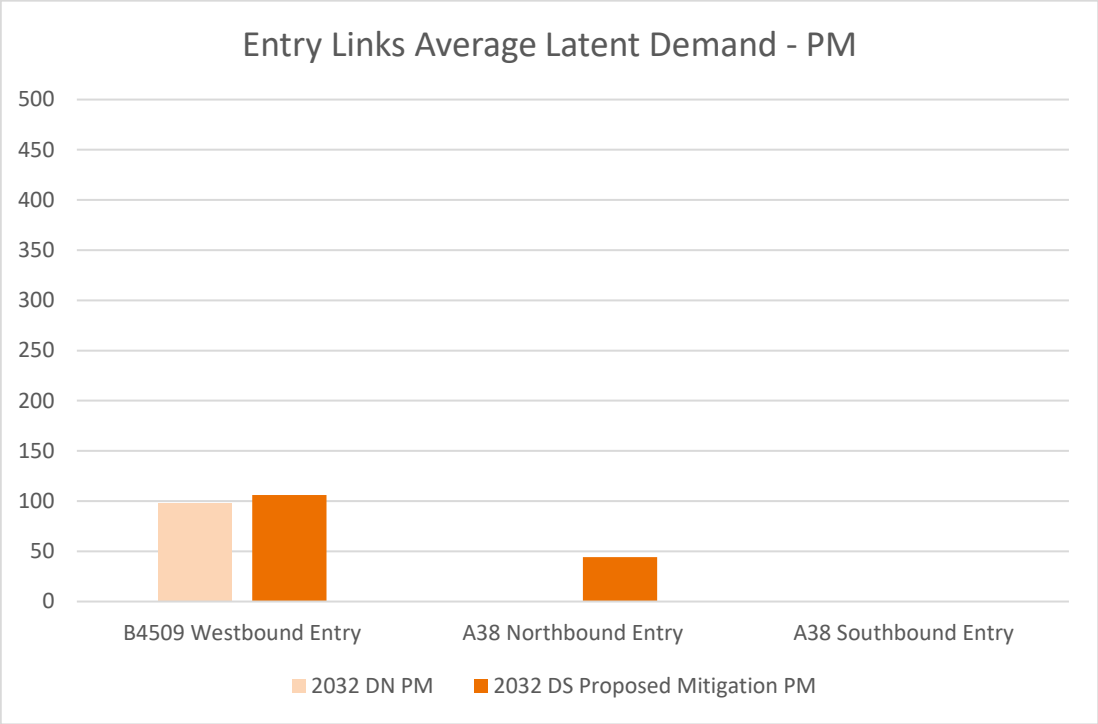


Figure 6.9 - Average latent demand on each entry link into the network across the whole simulation period - PM

6.18. **Figure 6.9** above shows the average number of unreleased vehicles at the end of the peak period that could not enter the model network on each entry link, due to congestion extending back down to the beginning of the link in the model.

6.19. **Figure 6.9** shows the proposed mitigation will very slightly increase the latent demand on the B4509 westbound entry and will create a small amount latent demand on the A38 northbound entry link. The increase in latent demand on these links is due to the optimisation of the traffic signals to increase green time to the M5 slip roads. This has been deemed necessary to ensure that queues on the slip road do not extend back to the M5 main line. The latent demand on these links during the evening peak with the mitigation will is lower than during the morning peak with mitigation. However, as detailed in Paragraph 6.11, the total vehicle throughput across the network increases, therefore the proposed mitigation improves the efficiency of the junction.

Summary

6.20. These results show that in both the morning and evening peak periods, the proposed mitigation will improve the overall network performance where the 2032 Do Something with Mitigation models will face reduced delays, increased average speeds and a significantly reduced latent demand in the morning peak period in comparison to the 2032 Do Nothing models.

Queues

6.21. The following section details the comparison between average queue lengths across the junctions in the 2032 Do Nothing model against the 2032 Do Something with Mitigation model.

6.22. The proposed mitigation will reduce the average queue length on the M5 Junction 14 exit slip roads, therefore improving the safety by preventing queues to extend on the mainline, as the results show without the mitigation in the 2032 Do Nothing scenario queues will be backing onto the mainline.

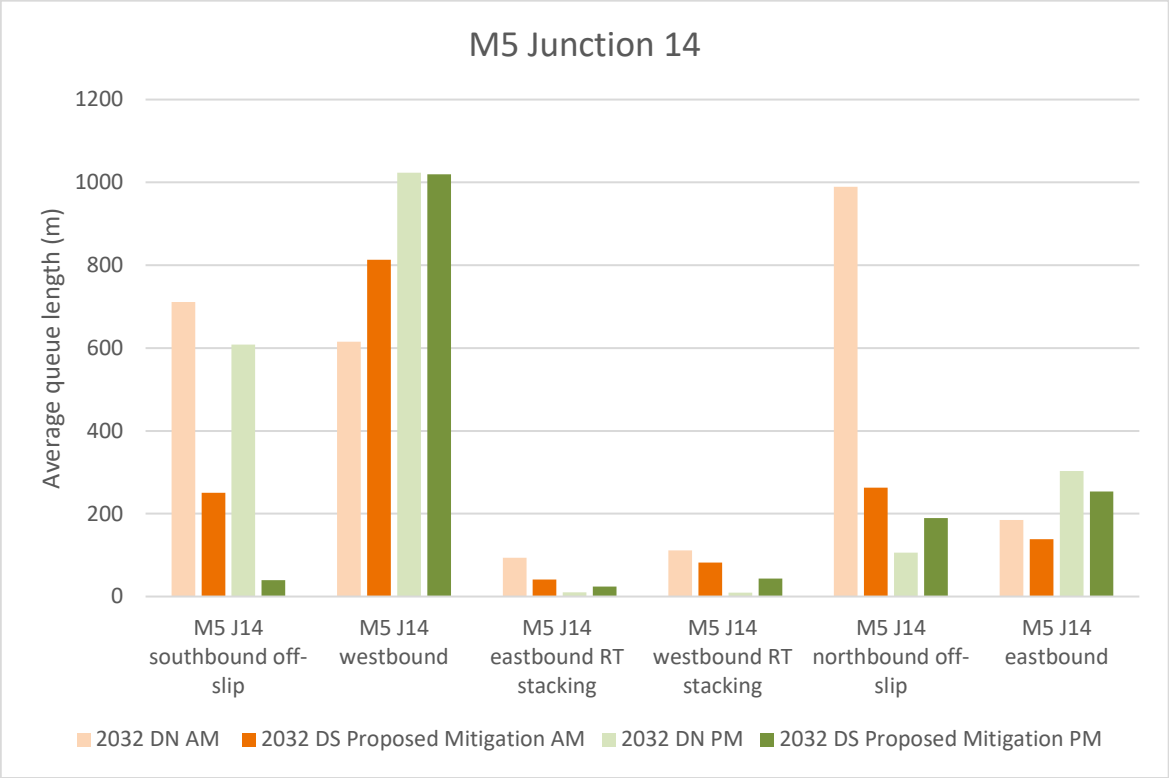


Figure 6.10 – Morning and evening peak hour average queue lengths at the M5 Junction 14

6.23. **Figure 6.10** shows the proposed mitigation significantly reduces the average queue length on both the M5 Junction 14 north and southbound exit slip roads in the morning peak. In the evening peak, the average queue length will also significantly reduce at the southbound exit slip road. Whilst the queue length on the northbound exit slip will increase by 83m in the evening peak with the proposed mitigation compared to the 2032 Do Nothing scenario, this queue is contained within the slip road. This is a key improvement that the mitigation will significantly reduce the average queue lengths on both the northbound and southbound exit slip roads, and **Figure 6.10** shows that without the mitigation, the queues would extend back onto the mainline, posing a safety risk.

6.24. Both the average queue lengths of the right and left turning movements onto the motorway entry slip roads (eastbound RT stacking and westbound RT stacking **on Figure 6.10**) and the B4509 eastbound (M5 J14 eastbound **on Figure 6.10**) will decrease with the proposed mitigation in the morning peak, with the larger reduction seen on the eastbound right turn movement onto the motorway. This is due to less traffic being released from the A38 each cycle, which helps to keep the motorway bridge free of traffic.

6.25. The average queue lengths on the B4509 westbound (M5 J14 westbound on **Figure 6.10)** will increase in the morning peak due to the proposed mitigation to turn on the signals at this junction. In the 2032 Do Nothing scenario, this movement would be free flowing as the signals are switched off at this junction in the morning peak. Therefore, any situation where you turn on signals where they were previously off will cause an increase in average queue length. **Figure 6.10** shows that this increase in the morning peak will be by 197m, however in the evening peak, the average queue length will slightly decrease.

6.26. It is important to note that with the proposed mitigation, as more vehicles are able to enter the network during the model evaluation period, there are more vehicles being evaluated in the statistics, therefore the average queues lengths recorded increase, in conjunction with the queue lengths increasing due to the change in signal control.

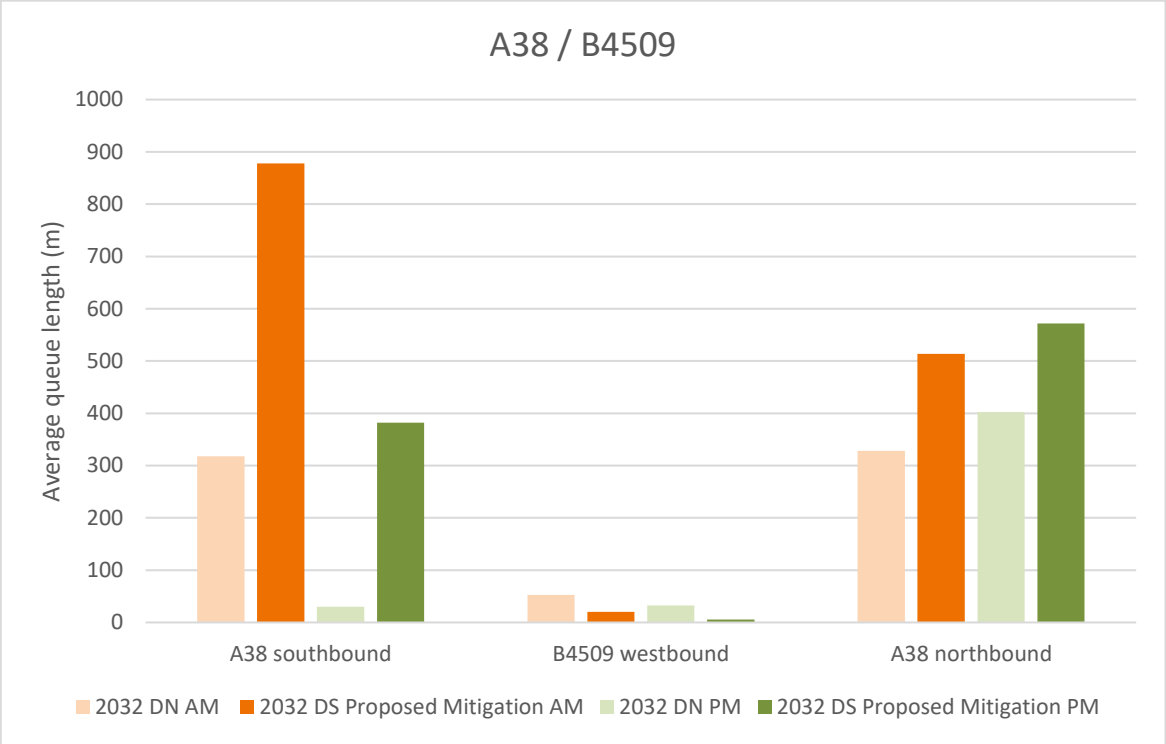


Figure 6.11 – Morning and evening peak hour average queue lengths at the A38/B4509 junction

6.27. **Figure 6.11** shows that the average queue length in the morning peak 2032 Do Something with Mitigation will increase on both the A38 south and northbound approaches at this junction. Whilst the mitigation proposed at this junction includes increasing the flare length on the A38 southbound to enable left turning traffic to wait in a filter lane for a longer distance, the increase in queue length is explained by the reduction in green time for these signals on the A38 south and northbound arms.

6.28. The average queue length in both the morning and evening peak on the B4509 westbound will also decrease with the proposed mitigation, due to the extension of the westbound flare. As shown in **Figure 3.2**, the primary movement of vehicles going to Sharpness in the evening peak will be exiting the motorway via the northbound exit slip road, turning left onto the B4509, and then turning right onto the A38 north at the A38/B4509 junction. Therefore, the decrease in average queue length on the B4509 westbound shows the proposed mitigation alleviates the Sharpness development trip generation impact.

6.29. As detailed in Paragraph 5.9, the signal method of control at the A38/B4509 junction will be changed with the proposed mitigation to hold the traffic on the A38 for longer, to enable the B4509 eastbound to be kept clear of queues backing up to the A38, so the M5 Junction 14 can operate efficiently and safely.

Summary

6.30. The queue results presented above show that the 2032 Do Something with Mitigation scenario will reduce the average queue lengths at the M5 Junction 14, in particular on the exit slip roads, where without the mitigation, the queues will extend back onto the mainline.

6.31. To enable the improvement of the operation of the M5 Junction 14 where the queues do not extend back onto the mainline, the signal method of control at the A38/B4509 junction has been changed to hold more traffic on the A38 for slightly longer than it currently is, therefore leading to an increase of the average queue length on the A38 north and southbound during the peak hour.

6.32. Across the morning peak period the latent demand will decrease with the proposed mitigation, and if the average queue length was taken across the peak period, rather than the peak hour, it would show a smaller queue increase, this would also be the case for the evening peak period despite the latent demand slightly increasing, further showing the mitigation improves the efficiency of this junction.

Journey Times

6.33. The average journey times along the A38, B4509 and the motorway slip roads have been extracted from both the 2032 Do Nothing and 2032 Do Something with Proposed Mitigation models, and a comparison between the morning peak scenarios is presented in **Table 6.2**, with the evening peak comparison shown in **Table 6.3**.

Table 6.2 – AM journey time comparison

Route Description and Distance	2032 DN AM (mm:ss)	2032 DS Proposed Mitigation AM (mm:ss)	Difference (s)
A38 Northbound (1,411m)	03:44	08:15	04:31
A38 Southbound (1,414m)	02:07	06:50	04:42
B4509 Westbound (1,217m)	05:46	07:13	01:27
B4509 Eastbound (1,217m)	04:26	09:24	04:59
M5 J14 NB Off Slip (1,463m)	04:31	04:52	00:21
M5 J14 NB On Slip (826m)	00:35	00:34	-00:01
M5 J14 SB Off Slip (835m)	04:32	04:59	00:26
M5 J14 SB On Slip (718m)	00:32	00:32	00:00

Table 6.3 – PM journey time comparison

Route Description and Distance	2032 DN PM (mm:ss)	2032 DS Proposed Mitigation PM (mm:ss)	Difference (s)
A38 Northbound (1,411m)	06:12	08:09	01:58
A38 Southbound (1,414m)	02:16	05:56	03:40
B4509 Westbound (1,217m)	01:40	01:54	00:14
B4509 Eastbound (1,217m)	03:58	03:30	-00:27
M5 J14 NB Off Slip (1,463m)	02:28	03:32	01:04
M5 J14 NB On Slip (826m)	00:35	00:34	-00:01
M5 J14 SB Off Slip (835m)	08:47	01:41	-07:05
M5 J14 SB On Slip (718m)	00:31	03:06	02:35

6.34. The key differences between the 2032 Do Nothing and 2032 Do Something with Proposed Mitigation scenarios, where there will be increased queues on the A38 north and southbound, in order to reduce the queues on the M5 Junction 14 exit slip roads, are consistent with the journey time results shown here in **Tables 6.2** and **6.3**.

6.35. The travel times along the A38 north and southbound increase in both peaks. This is expected due to the change in method of signal control used in the mitigation, which reduces the number of vehicles that get through each cycle, so their travel time is increased whilst waiting on the A38, however the throughput of the junction improves.

6.36. The other increase in travel time of note during the morning peak, in the 2032 Do Something with mitigation scenario in **Table 6.2**, is on the B4509 eastbound. This travel time increase can be explained due to the signals at the M5 Junction 14 being switched on during the morning peak, therefore increasing the travel time along the B4509, as the traffic moving eastbound will no longer be free flowing. **Table 6.3** shows that between both scenarios in the evening peak where the signals at this junction are switched on, there is only a slight difference in journey time, therefore if the signals were turned on during the morning peak in the 2032 Do Nothing scenario, the proposed mitigation would not cause as much of an increase that is shown in **Table 6.2**, like what is seen during the evening peak.

6.37. On the M5 Junction 14 exit slip roads, **Table 6.2** shows there is a very small increase in travel time between the 2032 Do Nothing and 2032 Do Something with mitigation scenarios in the morning peak. However, as the average queue lengths on the exit slip roads significantly decrease, the small increase in travel time here is not considered detrimental.

6.38. During the evening peak, **Table 6.3** shows the only noticeable increases in travel time across the routes in the network between the 2032 Do Nothing and the Do Something with Mitigation scenarios are on the A38 southbound, A38 northbound. These increases in journey time are expected given the given the average queue lengths on these arms increasing with the proposed mitigation.

6.39. The largest reduction in travel time that the mitigation will create in the evening peak is on the motorway southbound exit slip road. In the 2032 Do Nothing scenario, the travel time for this section is 8 minutes and 47 seconds, however, the mitigation will reduce this travel time by 7 minutes and 5 seconds.

7. Conclusion

7.1. The A38/B4509 and M5 Junction 14 currently face congestion in the morning and evening peaks, with particular concern about the queue lengths on the motorway exit slip roads extending back to the mainline.

7.2. Currently, the signals at the M5 Junction 14 operate on a part time basis, where the lamps are turned off from 06:45 to 09:10 during the morning peak. The A38/B4509 is signalised, however the method of control between the signals of both junctions are not coordinated therefore do not communicate with each other.

7.3. Stantec have presented a Proposed Mitigation package to mitigate the impact of the Sharpness development traffic containing the following measures:

- Extension of the A38 southbound flare at A38/B4509,
- Extension of the B4509 westbound flare at A38/B4509,
- A38/B4509 signal method of control improvement,
- Extension of splitter islands on the motorway entry slip roads, and
- M5 Junction 14 signalised continuously, and method of control improvements to allow left and right turning onto the motorway entry slip roads at the same time.

7.4. The proposed mitigation has been tested in VISSIM in the 2032 Do Something with Mitigation model scenarios, and the results have been compared against the 2032 Do Nothing model.

7.5. The results from the modelling shown in **Section 6** above, demonstrate that the 2032 Do Something with Mitigation model has reduced average delays, increased speeds and a reduced latent demand across the whole network, compared to the 2032 Do Nothing model.

7.6. The proposed mitigation will increase the vehicle throughput on each turning movement across both the M5 Junction 14 and the A38/B4509 junction during the morning peak period. There are three movements in the evening peak period where the average vehicle throughput will decrease with the proposed mitigation, and all other movements across both the junctions will increase, and the average total vehicle throughput will increase in both the morning and evening 2032 Do Something with Mitigation scenarios.

7.7. The average queue lengths on the M5 Junction 14 exit slip roads will significantly reduce due to the mitigation, however the traffic on the A38 north and southbound will face increased queues, due to the signal method of control being changed to hold traffic on the A38 for longer.

7.8. The results presented and discussed from the VISSIM modelling show that a holistic approach is needed where all the different attribute results collected are considered together, to conclude that the proposed mitigation will improve the operation of both the M5 Junction 14 and the A38/B4509 in 2032, so the Sharpness development will not negatively affect the safety of either junction.

7.9. The modelling assessment undertaken to support the proposed Sharpness development does not take into consideration any reassignment of trips on the highway network due to background traffic growth or the introduction of the proposed development, therefore this assessment provides a robust worst-case consideration of impact of the proposed development.

7.10. The trip generation and associated flow input used to develop the VISSIM Do Something models is largely based on existing car mode share characteristics of 66%, however it does account for increased bus use attributed to the express coach services proposed to be provided by the development.

7.11. The development build out rate may be less than 200 dwellings per year, therefore this assessment is robust, as the development trips in 2032 may be less than the trip generation calculated.

7.12. The highway mitigation measures package developed by Stantec look to provide safer operation of M5 J14 with improved throughput following the introduction of the proposed Sharpness development.

8. Appendix A – Proposed mitigation drawings

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KEYS:

- SOUTH GLOUCESTER COUNCIL HIGHWAY BOUNDARY
- NATIONAL HIGHWAYS' BOUNDARY
- PROPOSED KERB LINE
- PROPOSED ROAD MARKINGS

Issued/Revision	By	Appd	YYYY.MM.DD
P01 FIRST ISSUE	JAD	GD	2024.07.xx

Dwn.	Dsgn.	Chkd.	YYYY.MM.DD
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Title

A38/B4509 & M5 JUNCTION 14 SHARPNESS DEVELOPMENT PROPOSAL OVERVIEW PLAN SHEET 1 OF 4

Project No.	A1 Scale
332210067	1:500

Revision	Drawing No.
P01	STN-HSL-ZZ-DR-TR-5514

INSET A

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P01 FIRST ISSUE	JAD	GD	2024.07.xx

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A38/B4509 & M5 JUNCTION 14
SHARPNESS DEVELOPMENT PROPOSAL
PROPOSED ROAD LAYOUT (A38)
SHEET 2 OF 4

Project No.	A1 Scale
332210067	1:500

Revision	Drawing No.
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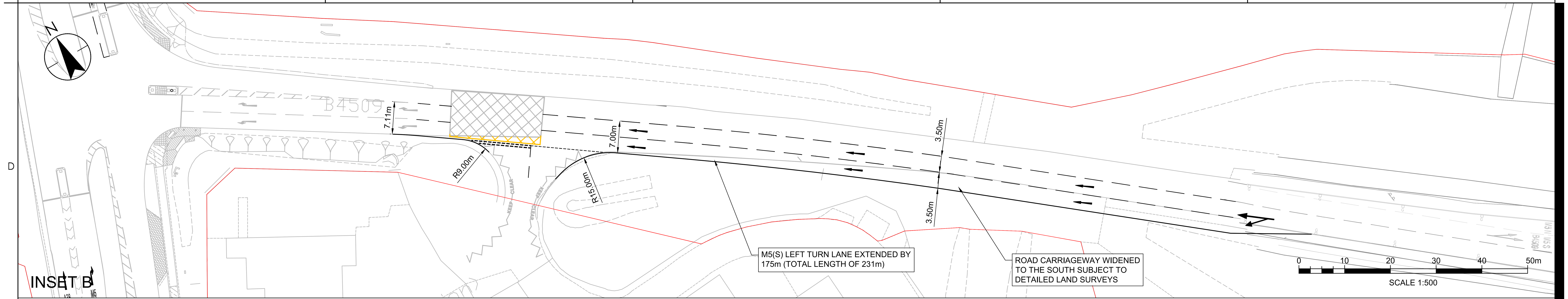

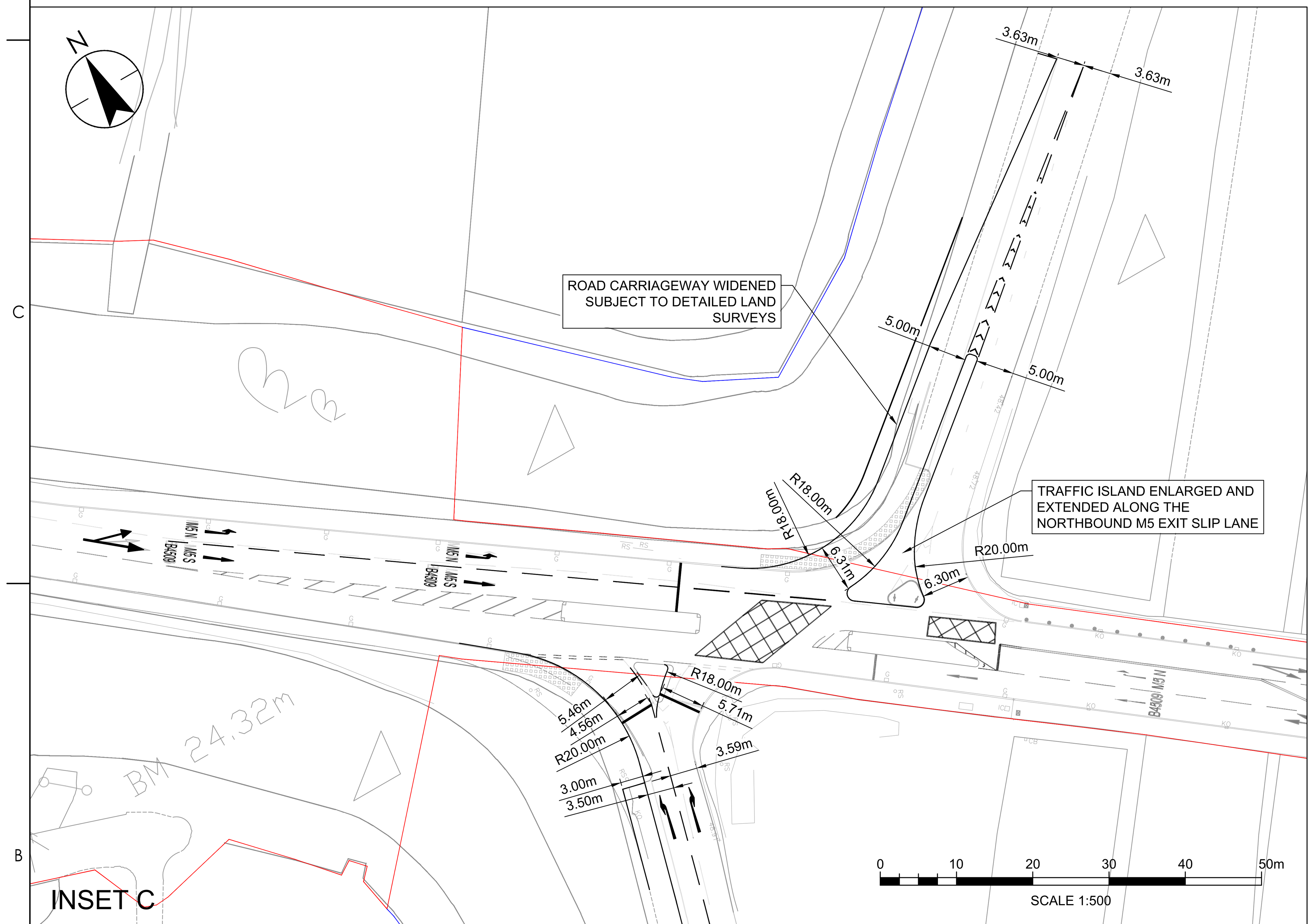

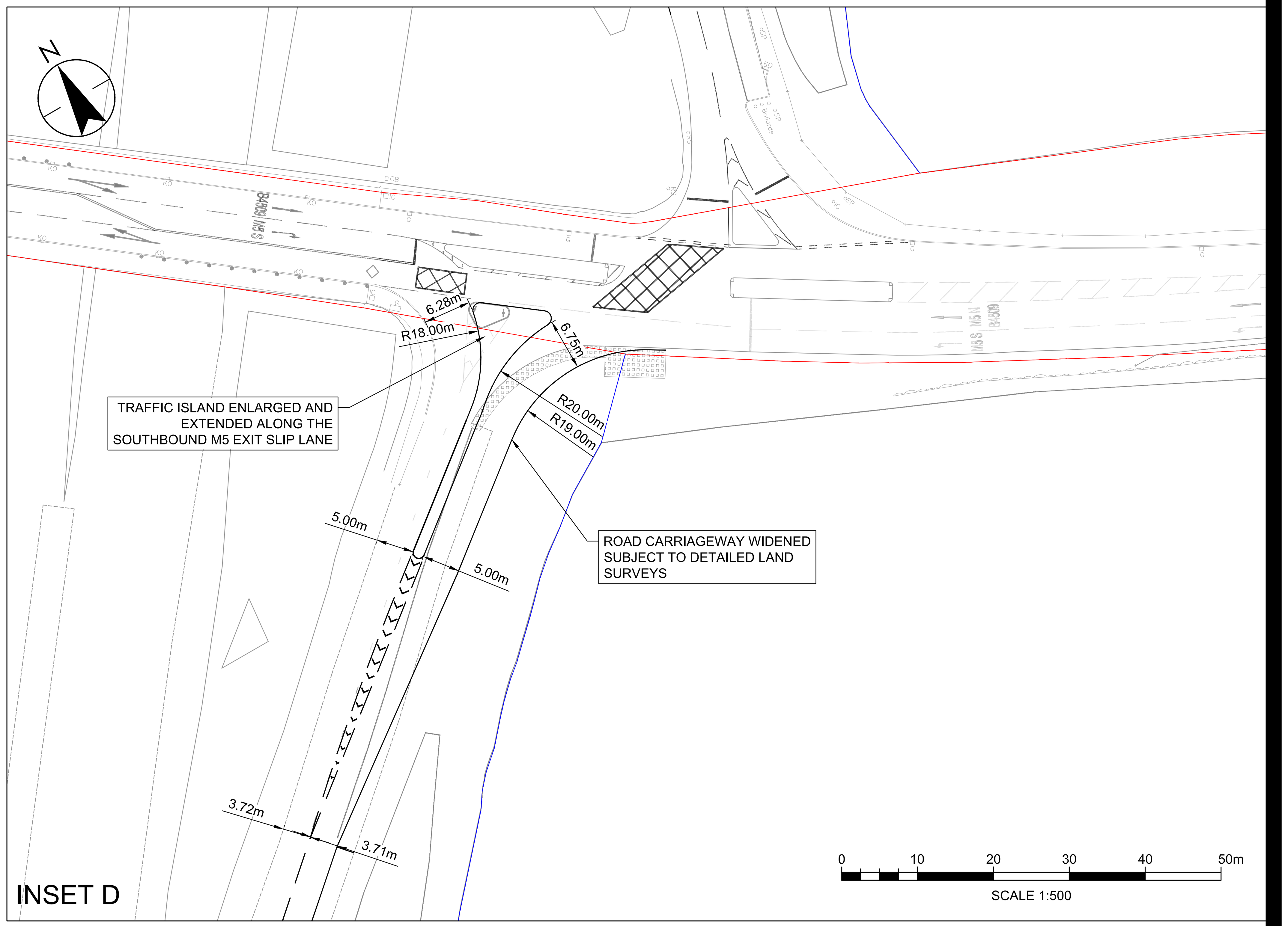

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Issued/Revision			
P01 FIRST ISSUE	JAD	GD	2024.07.xx
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JAD	JAD	GD	2024.07.19
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A38/B4509 & M5 JUNCTION 14
SHARPNESS DEVELOPMENT PROPOSAL
PROPOSED ROAD LAYOUT (B4509)
SHEET 3 OF 4

Project No.	A1 Scale
332210067	1:500

Revision	Drawing No.
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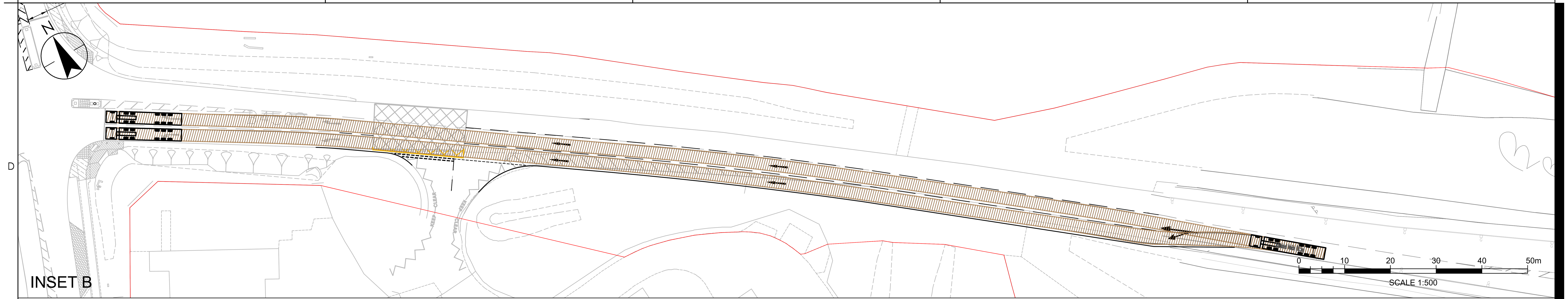

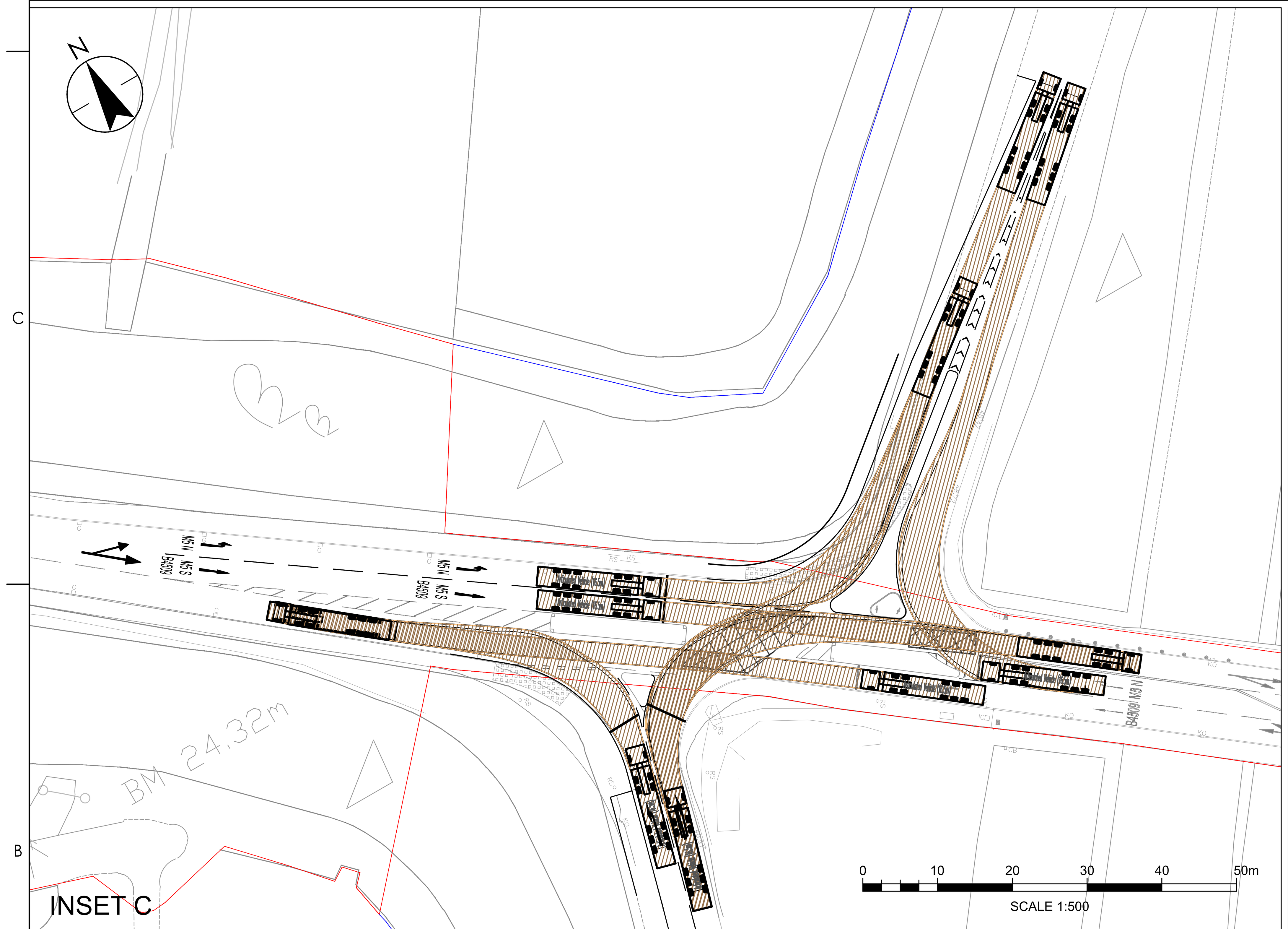

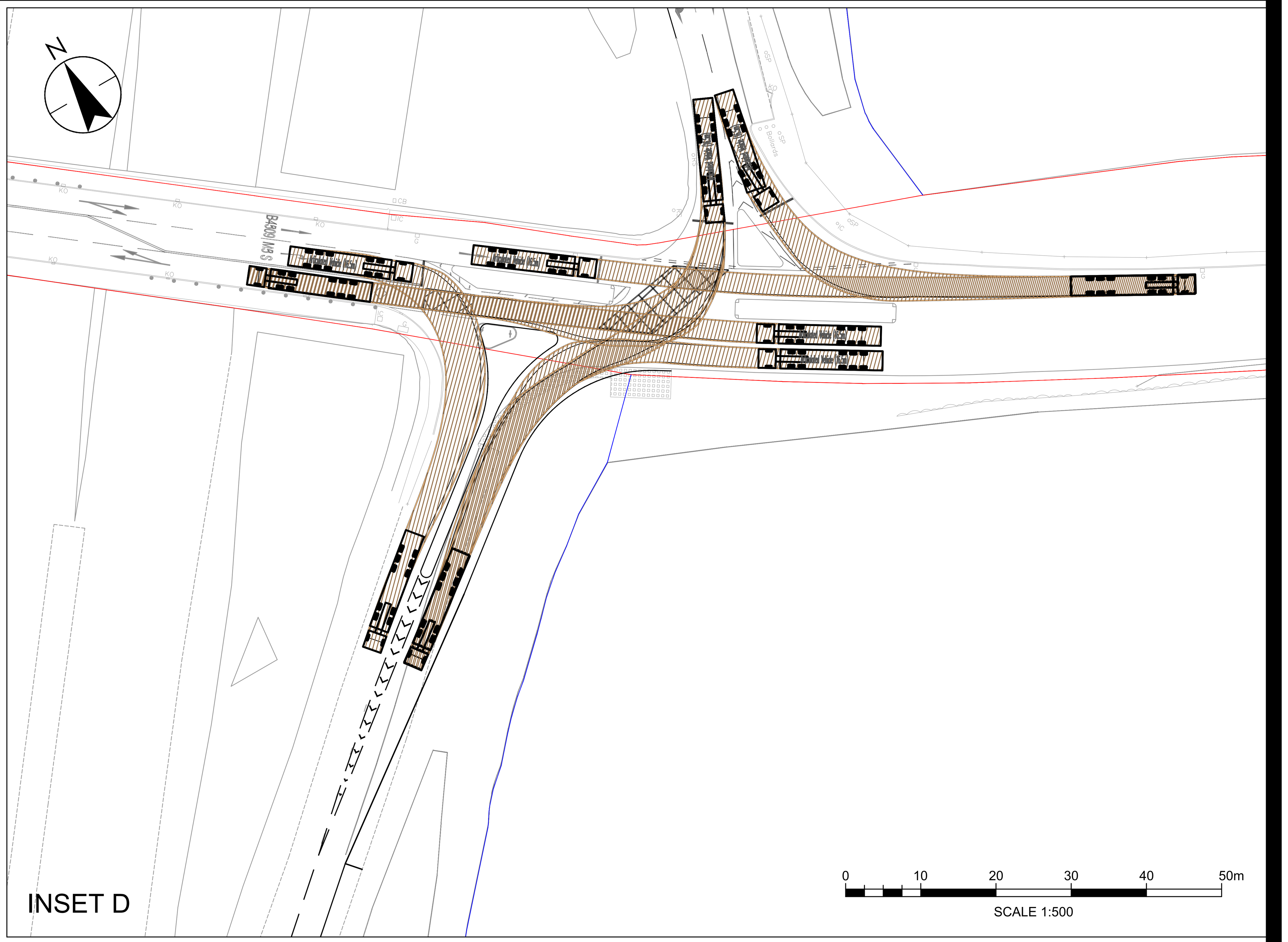

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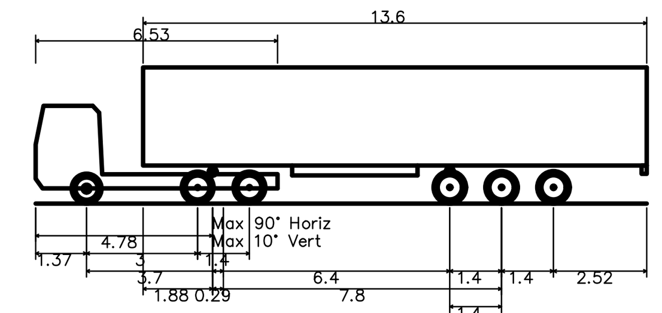
Notes

UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations.

KEYS:

- SOUTH GLOUCESTER COUNCIL HIGHWAY BOUNDARY
- NATIONAL HIGHWAYS' BOUNDARY
- PROPOSED KERB LINE
- PROPOSED ROAD MARKINGS



Articulated Vehicle (16.5m)

Overall Length	16.500m
Overall Width	2.550m
Overall Body Height	3.681m
Min Body Ground Clearance	0.411m
Max Track Width	2.500m
Lock to lock time	6.00s
Kerb to Kerb Turning Radius	6.530m

Issued/Revision	By	Appd	YYYY.MM.DD
P01 FIRST ISSUE	JAD	GD	2024.07.xx

Dwn.	Dsgn.	Chkd.	YYYY.MM.DD
JAD	JAD	GD	2024.07.19

Issue Status

S2 - FOR INFORMATION

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Use of this document for any other purpose is not permitted.

Client/Project Logo

Client/Project
SHARPNESS DEVELOPMENT LLP

SHARPNESS

Title
A38/B4509 & M5 JUNCTION 14
SHARPNESS DEVELOPMENT PROPOSAL
PROPOSED ROAD LAYOUT (A4509)
SWEPT PATH ANALYSIS - SHEET 4 OF 4

Project No. 332210067
A1 Scale 1:500
Revision P01
Drawing No. STN-HSL-ZZ-DR-TR-5517