reduction in VKT and VHT due to a project will indicate an improvement in network operation. A reduction in VKT and VHT will also indicate environmental benefits, in terms of reduced vehicle emissions. The vehicle kilometres travelled (VKT) and the vehicles hours travelled (VHT) were extracted for each of the model runs and are detailed in **Table 3-9**.

- **Table 3-9 Model Statistics Results**

Scenario	AM Peak			PM Peak		
	VHT (hours)	VKT (Kms)	Average Speed (Km/hr)	VHT (hours)	VKT (Kms)	Average Speed (Km/hr)
Base	520	12983	25.0	1601	34327	21.4
Full Masterplan	1868	12646	6.8	4736	21525	4.5

The results show that implementation of the Masterplan would result in a significant increase in the VHT, therefore vehicles are spending longer in the system. However, the VKT is relatively unchanged, indicating that vehicles are not travelling further, rather they are queuing in a congested network. This is also highlighted in the average speed which drops from 25 kilometres per hour to 7 kilometres per hour in the AM peak and from 21 kilometres per hour to 5 kilometres per hour in the PM peak.

These results indicate that significant infrastructure upgrades to the existing road network or modal shift is required to accommodate the increased number of trips generated by the Hurstville Masterplan. Infrastructure upgrades, such as extending right turn bays along Queens Road and Forest Road, would improve the overall operation of the network. However, to accommodate an additional 4,000 trips and 5,000 trips in the AM and PM peak hours respectively, an additional lane in each direction would be required on Forest Road, Queens Road, Park Road and The Avenue. However this level of road infrastructure development is unsustainable in the long term. Therefore to accommodate the Hurstville Amended Masterplan significant mode shift to more sustainable modes is required.

3.3. Summary and Conclusions

There are currently approximately 5000 JTW trips to Hurstville City Centre and 50% of these trips originate from surrounding SLAs, including Hurstville, Kogarah and Rockdale. In addition, 70% of existing trips are by car which suggests that there is a high degree of car dependence by commuters and workers travelling to Hurstville City Centre. There is evidence that existing traffic levels and congestion has already caused major impacts on the attractiveness and urban amenity of the Hurstville City Centre.

To accommodate the Hurstville Amended Masterplan the road network would require significant investment to accommodate an additional 4,000 trips and 5,000 trips in the AM and PM peak hours respectively. It should be noted that this is a conservative estimate as it does not include the development opportunities of Council's Civic Precinct and the redevelopment of Westfields Precinct, or full opportunities for increased residential development within the precinct, all of which would result in increased trip generation. Notwithstanding the conservative approach, the Hurtsville Amended Masterplan would require an additional traffic lane in each direction on Forest Road, Queens Road, Park Road and The Avenue as well as localised intersection widening and a range of traffic management measures such as partial or full removal of medians, full or partial removal of parking/loading, narrowing of footpaths and removal of landscaping, traffic signal optimisation, etc. . However this level of road infrastructure development is unsustainable in the long term. Therefore to accommodate the Hurstville Amended Masterplan significant mode shift is required to more sustainable modes. It should be noted that no future year models were prepared and hence no "future-background" traffic was included in the assessment. Typically this would be in the order of 2-3% per annum over a 20 year period and can be a significant proportion of overall traffic. Thus the traffic impacts presented in the remainder of the report are considered to be very conservative.

Public transport (comprising rail and bus) contributes 18% of the current total JTW mode share. Rail operates at high frequencies during the AM and PM peaks and Hurtsville is an important regional hub for buses with a significant number of strategic bus corridors operating through the centre. It is unlikely that public transport could be substantially improved in the short to medium term, although modest increases in public transport to serve Hurstville City Centre, including increased service frequency, would increase overall public transport capacity.

Of all JTW trips within 2km catchment to Hurstville City Centre, only 20% are by walk and cycle, which is significantly lower when compared to Chatswood (40% JTW trips within 2km catchment are by walk and cycle). It would appear that polices to encourage more sustainable modes of travel, including walk and cycle, could result in a significant reduction in car traffic.

In summary the 2009 road network cannot accommodate the additional trips generated by the Hurstville Amended Masterplan, without any background growth, which would exacerbate traffic congestion in the Hurstville area. Substantial demand was unable to be released onto the network providing further evidence that the proposed development could not be accommodated. Therefore, significant mode shift is required to more sustainable modes. Whilst there may be an opportunity to accommodate a portion of this mode shift to walking and cycling, there is an existing constraint to the switch to public transport given the quantum on mode shift required and anticipated improvements planned in the networks.

Therefore the road and public transport networks cannot accommodate the volume of additional trips generated by the Hurstville Amended Masterplan and Hurstville City Centre would encounter significant accessibility issues across all modes should the Hurstville Amended Masterplan be developed in its current format.

4. Masterplan Development Options

Given the findings of the assessment described in the preceding sections, a sensitivity analysis on what level of development could be accommodated by the current road and public transport networks was carried out.

4.1. Road Network Sensitivity Analysis

The impact of the Hurstville Amended Masterplan is described in **Section 3**. To assess what level of development could be accommodated by the current network, an initial sensitivity analysis of the percentages of development and the corresponding network impacts, was undertaken. This indicates the impact of different levels of development on the Hurstville City Centre network. This analysis also indicates the mode shift required to achieve an acceptable level of service of operation of the road network. This sensitivity analysis was completed for the AM and PM peaks for the following development scenarios:

- 75% of the Proposed Masterplan Development
- 66% of the Proposed Masterplan Development
- 50% of the Proposed Masterplan Development

These development scenarios resulted in the demand matrices totals as detailed in **Table 4-1**.

Table 4-1 Scenario Testing: Demand Totals

Scenario	AM Peak Demand (Vehicles)	PM Peak Demand (Vehicles)
2009 Base	13,058	14,438
Full Masterplan	17,052	21,051
75% Masterplan	15,718	18,845
66% Masterplan	15,273	17,741
50% Masterplan	14,384	16,638

The AM and PM peak model were run and the results extracted. The demand release analysis is detailed in **Table 4-2**. The results indicate that to achieve an acceptable demand release with the current mode split the Masterplan development needs to be reduced by approximately 30% or that an additional 3,000 trips per hour are required to switch modes to public transport, walking or cycling. Alternatively additional localised road infrastructure may be provided to accommodate the proposed development traffic.

- **Table 4-2 Sensitivity Analysis Demand Release results**

Scenario	AM Peak			PM Peak		
	Total Demand	Unreleased Demand		Total Demand	Unreleased Demand	
		(Vehicles)	%		(Vehicles)	%
2009 Base	13,058	0	0%	14,438	0	0
Full Masterplan	17,052	3,054	18%	21,051	2430	12%
75% Masterplan	15,718	756	5%	18,845	1,112	6%
66% Masterplan	15,273	288	2%	17,741	495	3%
50% Masterplan	14,384	168	1%	16,638	207	1%

The network statistics were also extracted and compared to the 2009 models. The vehicle kilometres travelled (VKT) and the vehicles hours travelled (VHT) were extracted for each of the model runs and are detailed in **Table 4-3**.

- **Table 4-3 Modelling Results: Network Statistics**

Scenario	AM Peak			PM Peak		
	VHT (hours)	VKT (Kms)	Average Speed (Km/hr)	VHT (hours)	VKT (Kms)	Average Speed (Km/hr)
2009 Base	520	12,983	25.0	1,601	34,327	21.4
Full Masterplan	1,868	12,646	6.8	4,736	21,525	4.5
75% Masterplan	1,197	14,755	12.3	2,879	35,255	12.2
66% Masterplan	2,188	32,593	14.9	2,586	45,258	17.5
50% Masterplan	678	15,009	22.1	2,671	49,583	18.6

The results show that significant delays continue to be experienced in the network as a result of the various levels of development. The results demonstrate that to minimise delays the Masterplan development needs to be reduced or additional road infrastructure would be required. The results also show that for the 66% development localised infrastructure upgrades, such as extending right turning bays, may assist in the network operating more efficiently.

The Paramics model visualisation shows how the network operates as a whole. It does not however give any detail on individual intersection performance. Therefore, Intersection analysis software, SIDRA was used, to analyse the key intersections within the study area. SIDRA is a Signalised & Unsignalised Intersection Design & Research Aid. SIDRA provides estimates of capacity and performance statistics (queue length, delay, etc) for intersections, using inputs such as traffic

volumes and signal phase times. Six key intersections were assessed and analysed using the SIDRA software.

A range of criteria can be used to evaluate the capacity of intersections. The RTA Guide to Traffic Generating Developments indicates the following criteria for non-signalised intersections:

- Degree of Saturation should be less than 1.0; and
- The Level of Service, determined by the average vehicle delay for the worst movement. Generally it is desirable to aim at achieving a Level of Service of C, or better, at all intersections. However, in practice, it is reasonable to operate at Level of Service D at peak times. Intersections should not be operating at Levels of Service lower than Level of Service D. A qualitative rating and its corresponding Level of Service are applied to the average delay per vehicle as shown in **Table 4-4**.

Table 4-4: Performance Criteria for Intersections

LoS	Average Delay per Vehicle (seconds)	Traffic Signals, Roundabouts	Give Way and Stop Signs
A	Less than 15	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals incidents will cause excessive delays	At capacity, requires other control mode
F	Greater than 70	Roundabouts require other control mode	

Source: RTA Guide to Traffic Generating Developments, October 2002

The level of service of the operation of key intersections in the study area was also assessed for the 66% Masterplan option. For each model run, thirteen key intersections in the network were assessed and analysed to examine in more detail the performance of the network at a local level. The thirteen intersections assessed were:

- Dora Street/Queens Road
- Gloucester Road/Forest Road
- King Georges Road/Forest Road
- Park Road/Queens Road
- The Avenue/Queens Road

- Cross Street /Park Road
- Park Road /Forest Road
- The Avenue/Forest Road
- The Avenue/Railway Parade
- Lily Street /Railway Parade
- The Avenue/Cross Street
- Forest Road /Wright Street
- Forest Road /Queens Road

The intersection analysis results for the AM peak can be seen in **Table 4-5** for the PM peak can be seen in **Table 4-2**. The SIDRA analysis shows that the Lily Street and Railway Parade intersection is operating at Level of Service (LoS) 'F' in the AM and PM peak and requires an upgrade with or without the proposed Masterplan. The Forest Road intersection with Wright Street LoS drops to 'D' in the AM peak with the Masterplan, indicating that the intersection may require signalisation in the longer term, specifically if background growth were to be incorporated.

The Avenue and Railway Parade and the Lily Street and Railway Parade intersections also operate with a LoS of 'F' in the PM peak, with or without the proposed Masterplan. This indicates that the intersection requires additional capacity in the PM peak with or without the proposed Masterplan.

The Queens Road and Dora Street intersection will deteriorate from LoS 'D' in the PM peak to LoS 'F' in the PM peak should the proposed Masterplan be developed. This LoS can be improved by adding a right turn slip lane to Dora Street south this would improve the operation of the intersection to LoS 'C'.

The intersection of Forest Road and the Avenue deteriorate from LoS 'B' in the PM peak to LoS 'F' in the PM peak should the proposed Masterplan be developed. This LoS can be improved by removing parking on the west side of the Avenue to allow two through lanes from north to south as the intersection; this would improve the operation of the intersection to LoS 'D'.

The King Georges Road and Forest Road intersection is over saturated in the PM Peak and the delay is exacerbated with the proposed Masterplan. The Forest Road intersection with Queens Road is also approaching capacity in the PM peak and again the delay is exacerbated with the proposed Masterplan.

- **Table 4-5 AM intersection analysis results using SIDRA[10]**

Intersection	2009 Base Model		2009 with 66% Masterplan	
	Level of Service	Average Delay	Level of Service	Average Delay
Dora St/Queens Rd	B	27	C	42
Gloucester Road/Forest Rd	A	13	A	11
King Georges Rd/Forest Rd	C	32	C	29
Park Rd/Queens Rd	B	25	C	33
The Avenue/Queens Rd	B	18	C	42
Cross St/Park Road	B	22	C	38
Park Rd/Forest Rd	B	22	C	42
The Avenue/Forest Rd	B	16	C	29
The Avenue/Railway Parade	C	35	C	29
Lily St/Railway Parade	F	>70	F	>70
The Avenue/Cross St	A	7	A	11
Forest Rd/Wright St	B	17	D	53
Forest Rd/Queens Rd	B	17	B	18

- **Table 4-6 PM Peak intersection analysis results using SIDRA**

Intersection	2009 Base Model		2009 with 66% Masterplan	
	Level of Service	Average Delay	Level of Service	Average Delay
Dora St/Queens Rd	D	46	F	>70
Gloucester Road/Forest Rd	A	10	B	16
King Georges Rd/Forest Rd	E	61	F	>70
Park Rd/Queens Rd	C	32	C	35
The Avenue/Queens Rd	B	18	C	28
Cross St/Park Road	C	32	C	32
Park Rd/Forest Rd	C	30	C	32
The Avenue/Forest Rd	C	40	F	>70
The Avenue/Railway Parade	F	>70	F	>70
Lily St/Railway Parade	F	>70	F	>70
The Avenue/Cross St	A	13	B	20
Forest Rd/Wright St	B	19	D	43
Forest Rd/Queens Rd	D	44	D	45

[10] Generally it is desirable to aim at achieving a Level of Service of C, or better, at all intersections.