Table 2.1. Results of intersection modelling – existing situation.

Intersection	Sidra			
	AM		PM	
	AVD	LOS	AVD	LOS
Oxford St - Darlinghurst Rd	27.7	B	32.4	C
Burton St - Darlinghurst Rd	24.5	B	25.1	B
Liverpool St - Darlinghurst Rd	23.5	B	23.3	B
Oxford St - Victoria St	45.8	D	52.8	D
Burton St - Victoria St	23.2	B	24.0	B
Liverpool st - Victoria St	20.9	B	19.1	B
West St - Liverpool St	15.9	B	16.0	B
West St - Burton St	11.1	A	12.1	A
West St - West Ave	9.0	A	9.0	A
Chaplin St - Liverpool St	10.0	A	12.8	A

Intersection	Aimsun			
	AM		PM	
	AVD	LOS	AVD	LOS
Oxford St - Darlinghurst Rd	32.4	C	27.5	B
Burton St - Darlinghurst Rd	24.3	B	20.7	B
Liverpool St - Darlinghurst Rd	15.4	B	16.9	B
Oxford St - Victoria St	40.3	C	39.1	C
Burton St - Victoria St	10.4	A	9.5	A
Liverpool st - Victoria St	13.0	A	12.7	A
West St - Liverpool St	7.0	A	6.1	A
West St - Burton St	2.0	A	1.3	A
West St - West Ave	0.1	A	0.4	A
Chaplin St - Liverpool St	1.0	A	2.6	A

Intersection	Scates 2008					
	AM			PM		
	AVD	LOS	DS	AVD	LOS	DS
Oxford St - Darlinghurst Rd	39.4	C	0.72	50.4	D	0.71
Oxford ST - Victoria St	28.2	B	0.82	36.2	C	1.01

AVD - average delay; LOS - Level of Service; DS - degree of saturation

Level of service criteria for intersections

Level of Service	Average Delay per Vehicle (secs/veh)	Traffic Signals, Roundabout
A	< 14	Good operation
B	15 to 28	Good with acceptable delays & spare capacity
C	29 to 42	Satisfactory
D	43 to 56	Operating near capacity
E	57 to 70	At capacity; at signals, incidents will cause excessive delays Roundabouts require other control mode

Source: RTA (2004)

2.2.2 Public transport

The Precinct is very well serviced by public transport. Kings Cross railway station is located some 500 m from the Precinct (about 5 to 8 minutes walk). This well within the 800 m distance typically considered as convenient for walking to train stations. Train services run at approximately 5 minute intervals during the peak commuter periods.

There are a number of bus routes within convenient walking distance from the Precinct. Of these, routes 311 and 389 have bus stops near the site, as shown in **Figure 5**. These services run at 8 to 15 minute intervals during the peak commuter periods and at 15 to 20 minute intervals at other times during the day. In addition, frequent bus services run along Oxford Street. **Figure 6** shows locations of the bus stops in relation to a 400 m radius circle from the Precinct centre. This distance is typically accepted as convenient for walking to bus stops.

2.2.3 Pedestrian and bicycle linkages

Pedestrians are well provided for, with all streets in the vicinity of the site featuring footpaths. The walking path from Kings Cross station to the Precinct is under shop awnings for most of its length. **Figure 6** shows pedestrian linkages to the bus stops and the train station.

Bicycle Plans for the area surrounding the Precinct have been developed by the City of Sydney and Woollahra Councils. Most of the cycleways around the site have been implemented. The cycleway network is shown in **Figure 6**. There are bicycle linkages in all directions to and from the Precinct.

LEGEND

- Bus route No. 311
- Bus route No. 389
- Bus routes No. L82, 352, 378, 380
- Bus stop

Figure 5. Existing bus services.

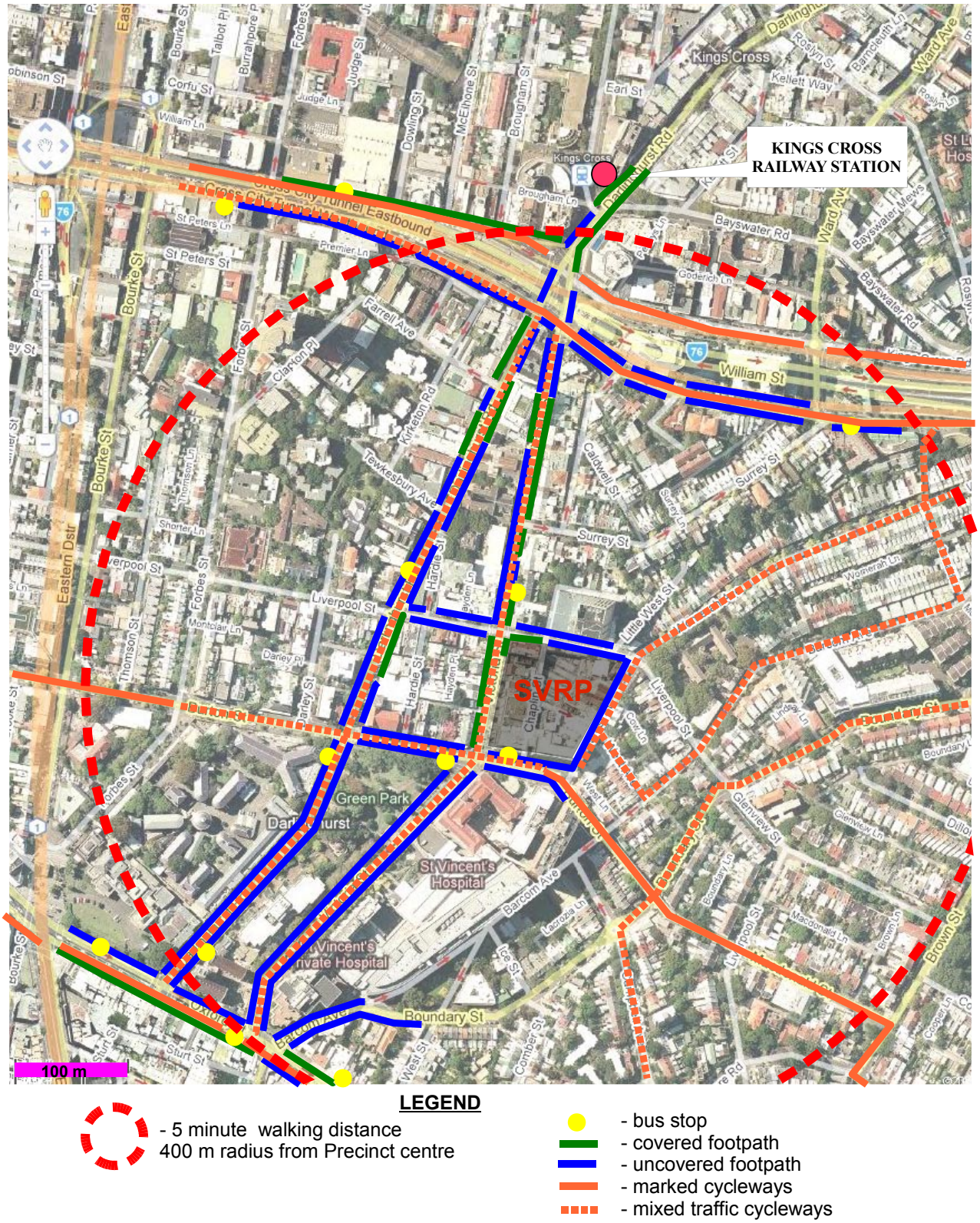


Figure 6. Pedestrian and bicycle linkages.

2.3 Existing parking provision and demand

2.3.1 On street parking situation

A great variety of parking restrictions exists in the streets surrounding SVRP. A map showing these restrictions is included in **Figure 7**.

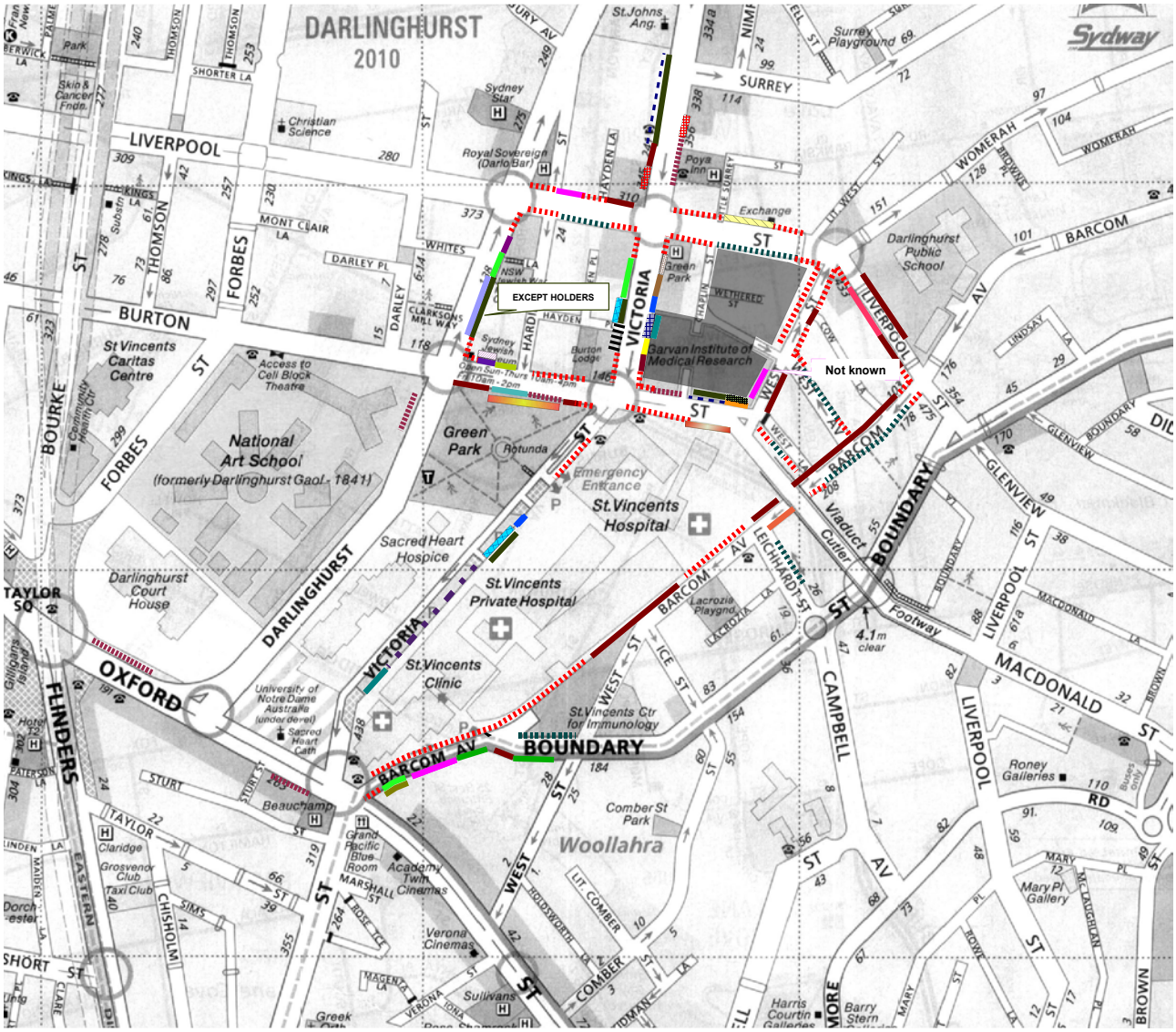
Observations of on-street parking accumulation were undertaken by TEF Consulting on a number of occasions. The results of these observations confirmed the conclusion made in URaP-TTW (2005a) that most streets are being well utilised while some period parking spaces are still consistently available during the day.

2.3.2 Off-street parking provision

At present, a total of 52 off-street car parking spaces are provided on the SVRP site. Of these, 26 spaces are located on the surface level, with access through the loading dock, whilst the other 26 spaces are located in the basement car park. Both car parking areas have driveways in West Street, next to each other. **Figure 8** contains a photograph showing the existing driveways in West Street.

The surface car parking area was observed to be well occupied throughout the day based on a number of observations. The basement car parking area was not fully operational on the day of the survey and other occasions during the data collection period for the present study.

A number of studies have been carried out in recent years, by TEF Consulting and others, investigating the parking provision at St Vincent's Campus. A general conclusion from these studies is that the existing parking supply on Campus is well below the required level, with some 300 Hospital cars parking on the streets in the vicinity of the Campus.



LEGEND

No parking	Bus zone	Loading Zone
1P 8am-10pm except residents	P 8am-6pm motor bikes only	4p ticket 6pm-10pm (Mon-Fr); 10am-10pm Sat; 8am-10pm Sun &Publ.Holiday
NP 8am-6pm(Mon-Fr)	4p ticket 8am-10pm	Load.Zone 7am-6pm (Mon-Fr); 7am-10am Sat
unrestricted	2p ticket 8am-6pm (Mon-Fr)	Work Zone 7am-6pm (Mon-Fr); 8am-2pm Sat
NO STOPPING	4p ticket 6pm-10pm(Mon-Fr); 8am-10pm Sat-Sun & Publ. Holiday	2p ticket 2pm-6pm (Mon-Fr); 8am-6pm Sun
NP 8:30am-6pm (Mon-Fr)	DISABLED	Bus Zone 7am-6pm (Mon-Fr); 8am-2pm Sat
1P 8am-11pm except residents	2 P 8am-6pm (Mon-Fr) except residents	No parking 4pm-6pm(Mon-Fr)
Load. Zone 8:30 am-6pm(Mon-Fr)	1P ticket 8am-6pm except residents	No parking 10pm-4pm (Mon-Fr) buses exc.15 min limit
1p 8:30am-12:30pm Sat	2p motor bikes only	2p 8.30 pm-4 pm (Mon-Fr)
Load Zone ticket 8.30 am-6 pm(Mon-Fr);8.30pm-9.30am Sat		½ P 8am-6pm(Mon-Fr)
Mail Zone 8am-9.30pm (Sun-Fr)		No Parking (Consular vehicles excepted)
Load Zone ticket 8:30am-6pm(Mon-Fr),8:30am-12:30pm(Sat)		No Parking (Ambulance vehicles excepted)
4P 6pm-10pm (Sat-Sun & Pub.Holiday)		No Parking 7am-6pm(M-Sat)Telstra vehicles excepted

Figure 7. On-street parking restrictions.

Figure 8. Existing driveways in West Street. View to the west from West Avenue.

3 TRAFFIC AND PARKING IMPACTS OF THE PROPOSED DEVELOPMENTS

3.1 Concept Plan proposal

The current Concept Plan proposes to construct two new buildings within the Research Precinct. The University of NSW (UNSW) proposes to develop the UNSW Institute of Virology (UNSWIV). A joint venture between the Garvan Institute and St Vincent's Hospital proposes to develop the Campus Cancer Centre (GSVCCC). The sites proposed for UNSWIV and GSVCCC are shown in **Figure 9**.

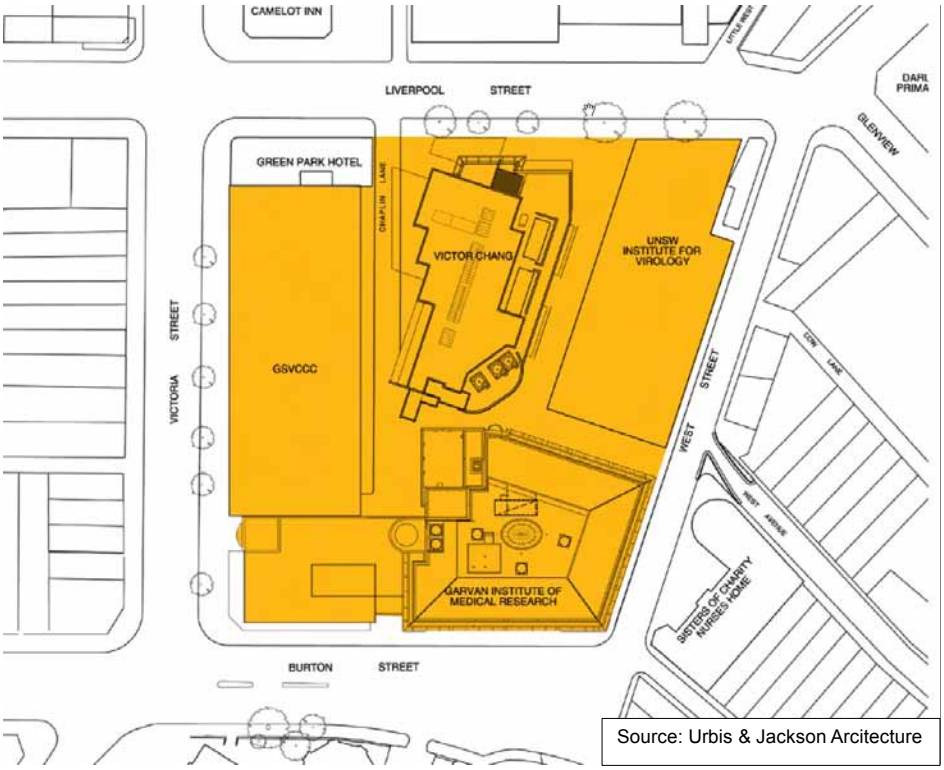


Figure 9. Proposed development.

Table 3.1 provides information about the existing and proposed floor areas and number of storeys for each building within the Precinct. For the UNSW Institute of Virology the floor area is the maximum possible and may not be achieved at the project application stage.

Table 3.1. Existing and proposed floor areas.

		Gross Floor Area (GFA), m^2		Number of storeys
EXISTING	Victor Chang Cardiac Research Institute **(VCCRI)**	8,152	(actual)	8
	Garvan Institute of Medical Research **(Garvan)**	10,000	(estimated actual)	9
PROPOSED	Garvan St Vincent's Campus Cancer Centre **(GSVCCC)**	13,942	(proposed)	12
	UNSW Institute of Virology **(UNSWIV)**	8,500	(proposed)	10
	Total	**40,594**		

3.2 Parking provision requirements

Sydney City Council's (SSC) parking provision requirements are set out in Development Control Plan 11 - Transport Guidelines for Development. It must be noted that, unlike most other Councils, SSC sets out maximum, rather than minimum, parking requirements. These requirements are referred to in DCP 11 as guidelines rather than rigid car parking rates; however, parking provision above these rates is penalised by adding the "excess" parking area to the floor space, thus affecting the floor space ratio.

There are no specific requirements for the medical research facilities in DCP 11. In the present author's opinion, in terms of traffic and parking generating activities this type of land use is similar to office / commercial land use. The DCP allows for one (1) car parking space per 125 square metres of Gross Floor Area (GFA) for the latter type of land use. There is also a requirement for bicycle parking provision at a rate of one (1) space per 20 staff as a minimum.

It must be noted that the current parking provision for the Garvan Institute is inadequate in that there is no specific parking provision for the Garvan Institute on site. Some 40 spaces are currently allocated for the Garvan elsewhere on St Vincent's Campus, whilst an additional 18 spaces are leased at a commercial car park located in Bayswater Road. It must be taken into account, however, the Development Consent for the Garvan Institute required that 80 off-street car parking spaces were provided. The 52 spaces currently provided on SVRP site appear to have been constructed as part of the VCCRI project, which has an approval for 65 car parking spaces.

The Garvan Institute and VCCRI, together with the proposed UNSWIV and GSVCCC, will form an integrated Research Precinct. It is the opinion of the present author that the Precinct's parking requirements should be considered together with the existing Institutes. The level of parking provision for the Precinct, calculated in accordance with DCP 11, is shown in **Table 3.2**.

The proposed parking provision will fully comply with the requirements of DCP 11.

Table 3.2. Precinct parking entitlements based on DCP 11 provisions

	GFA, m^2		DCP 11 control	
VCCRI	8,152	(actual)	65	by previous approval
Garvan	10,000	(estimated actual)	80	by previous approval
GSVCCC	13,942	(proposed)	112	
UNSWIV	8,500	(proposed)	68	
Total			**325**	

3.3 Other parking demand and supply considerations

It is important to note that the current parking demand generated by the St Vincent's Campus as a whole, including St Vincent's Public and Private Hospitals and St Vincent's Clinic, is greater than the existing parking supply by some 300 to 400 cars (refer to Aurora Projects (2005)). These cars create an undue pressure on parking availability in the surrounding streets.

Note that notwithstanding the poor parking supply, St Vincent's staff continue to drive their cars to work. Whilst measures will be proposed (in a separate Transport Management and Accessibility Plan (TMAP)) to reduce single occupancy car travel for the Precinct, the already existing parking demand overspill is not expected to be mitigated by these measures only. It is therefore proposed to use the opportunity presented by the new construction at the Research Precinct to provide additional parking to cater for some of the existing on-street parking demand generated by the St Vincent's Campus. It is proposed that 75 additional parking spaces be constructed at SVRP. These spaces are proposed to be for use by staff only. The total proposed parking

provision, comprising these 75 spaces and 325 spaces designed to cater for SVRP (refer to **Table 3.2** of this report) is thus 400 spaces.

The need to address the currently insufficient parking supply at the St Vincent's Campus is further supported by a comparison with similar health care facilities. The existing car parking provision rate at the St Vincent's Campus is substantially lower than that at comparable hospitals. A comparison with Prince of Wales (PoWH) and Royal North Shore (RNSH) Hospitals is shown in **Table 3.3**. Both have more than double the rate of parking provision of St Vincent's, even accounting for the 400 proposed additional spaces at SVRP. It is also of importance that the current parking provision at St Vincent's is substantially lower than that allowed under the provisions of DCP 11.

It is important to emphasise that the proposed additional 75 car parking spaces will partially address the following existing issues.

- Safety concerns associated with nursing staff working in night shifts. Due to late night arrivals/departures, public transport or cycling is not a feasible option for this category of staff. Note that most nurses are females and that the nearest train station is the Kings Cross station.
- Most nearby streets have time controlled parking and hence staff must absent themselves from work to move cars frequently during the day. This situation affects the level of health care for patients.
- Although the current off-street parking provision is not sufficient, many staff members have no option but to drive to work due to inadequate public transport at their place of residence (refer to Aurora Projects (2005)).
- The proposed additional parking at SVRP will also cater for doctors on call who require immediate access to the Campus and thus need to be provided with dedicated parking spaces.

It must be noted that the proposal to introduce 75 spaces for the existing staff of St Vincent's Campus does not seek to fully address the existing deficiency of 300 to 400 spaces; rather it aims to address the most pressing needs related to staff safety and emergency access for doctors.

Table 3.3. Comparison of car parking provision ratio

	Staff Numbers	Existing Parking	Staff to parking ratio
Prince of Wales	4,500	2,240	2.01:1
Royal North Shore	4,000	2,600	1.54:1
St Vincent's Campus	4,100	1,000	4.1 :1
St Vincent's Campus (+400 proposed at SVRP)	4,650	1,400	3.32 :1

3.4 Access design considerations

It must be noted that under the current project development program Stage 3 GSVCCC will be built first, together with its proposed 218 car parking spaces. After this stage, there will be no need to introduce any changes to the existing access arrangements. However, the ultimate car parking provision will require changes discussed further in this report.

It is proposed that the ultimate car parking provision of 400 spaces be accommodated in two multi-level basement car parking areas under the Precinct, one under the GSVCCC building and the other under the UNSWIV building.

Apart from the parking demand requirements, the maximum level of parking provision is governed by the capacity of the access points as well as by the environmental capacity of the streets on the approaches to the car park. These issues will be considered in **Section 3.5** of the present report.

Access options have been analysed with regard to the previous investigations and community consultations, carried out primarily by UraP-TTW and complemented by further assessment carried out by TEF Consulting. The following considerations have been taken into account.

- The existing access from West St operates at a good level of service and has substantial un-used capacity. This section of West St carries very low volumes of through traffic (not associated with the Precinct). West St access is regarded as the preferred option for the proposed Precinct development.
- Vehicular access from Victoria Street is constrained by urban design and impacts on significant vehicular and pedestrian traffic flows in Victoria Street.
- Vehicular access to Burton Street is constrained by the existing built form of the Garvan Institute building.
- The existing access via Chaplin Lane may be considered for further use; however, its capacity is limited by interaction with the traffic flows and queuing at the Victoria St / Liverpool St intersection. A left in / left out access would result in a lesser impacts on the intersection operation, however it would require a physical barrier (a median island) along Liverpool St to prevent illegal right hand turns. This, in turn, would result in a loss of on street parking. As an option for left in / left out access, it may be relocated from Chaplin St further to the east. The secondary access from Liverpool St could be beneficial in eliminating unnecessary travelling around the block for vehicles arriving from the east, however it is difficult to achieve due to design constraints (difference in levels between the street and the basement car park and car park layout requirements).
- One particular issue of concern of residents of surrounding area was the use of West Avenue by the Precinct staff, visitors and delivery vehicles to access the loading docks and the car park across West Street. As part of the previous development of the Cardiac Research Institute within the Precinct, traffic management devices were installed at the intersection of West Street and West Avenue. These included extension of the kerb return on the southeastern corner of the intersection and installation of a traffic island to separate entering and exiting movements at the basement car park entry and to prevent through movements into the car park from West Avenue. The following considerations have been given to this issue
    - the traffic island on the Precinct site (currently separating the entry and exit lanes of the basement car park driveway) does not perform as designed to eliminate through movements and can be removed without any detrimental effect
    - the "All Traffic Turn Right" sign shall remain as well as the kerb extension preventing the left hand turns and through movements. This is the best solution in the circumstances.
    - note that the perceived problem of vehicles using West Avenue for direct access to St Vincents appears to be exaggerated given that surveys do not show such a situation.
    - anecdotal evidence suggests that some courier vehicles attempting to use West Avenue do so being guided by GPS systems. St Vincents will approach the main GPS mapping providers with a request to rectify this situation.

The car parking design of the ultimate car park configuration has been sufficiently developed for the Concept Plan, enabling an assessment to be carried out of the possibility of the design to comply with AS/NZS2890.1-2004 (car parking) and AS 2890.2-2002 (loading/unloading areas).

Requirements of the Australian Standard have been applied to the access design. AS/NZS 2890.1-2004 requires two lanes for an entry driveway for car parking structures with 301 to 600 spaces. Exit driveway is required to be separated and can be between 4.0 and 6.0 m wide. Provision for queuing was assessed, firstly, based on the generalised rates from the Standard and then based on the microsimulation modelling, using the entry flow estimates and boomgate parameters obtained from surveys at the St Vincent's Public Hospital car park. The required queuing length was thus calculated between 6 and 8 car lengths, or three to four cars per lane (18 to 24 metres). A number of options for the entry driveway design were considered. The author of the present report is satisfied that a workable design is achievable, satisfying the requirements of the Australian

Standard. The current concept design, with vehicle turning templates, is included in **Appendix B**. No queuing is expected to spill into West Street.

The exit driveway is proposed to be located in West Street, between the entry driveway and Liverpool Street.

Concept design drawings were checked against the requirements of the above Standards in terms of dimensions and gradients of parking spaces, parking aisles and ramps. Checks of vehicle manoeuvring were carried out using AutoTrack 8 swept path prediction software. The checks revealed that complying design was achievable with minor modifications of the drawings. Subsequently, recommendations were provided to the architects regarding the required amendments. The author of the present report is satisfied that, should the final design drawings change from the Concept design, it would not be difficult to make them comply with the Standards. Results of the design checks are contained in **Appendix B**.

3.5 Traffic generation and distribution

The likely traffic generation from the proposed development has been assessed based on the results of staff questionnaire surveys carried out by TEF Consulting in October 2008 at the Garvan Institute and VCCRI. A copy of the questionnaire form used in the survey is attached in **Appendix C** of this report. The respondents were asked questions about their work classification, mode of travel, time of arrival and departure, and, for car drivers, their parking location and approach and departure streets.

A total of 141 questionnaire forms were completed by staff of both Institutes, representing some 30% of the total staff present on a typical day.

The results of the analysis of the questionnaire survey indicated the following.

Public transport, cycling and walking are the preferred modes of travel to work, with their combined share greater than that of a private car. Travel mode percentages for both survey days are shown in **Figure 10**. The "other" category includes people travelling by ferry, motorcycle and skateboard.

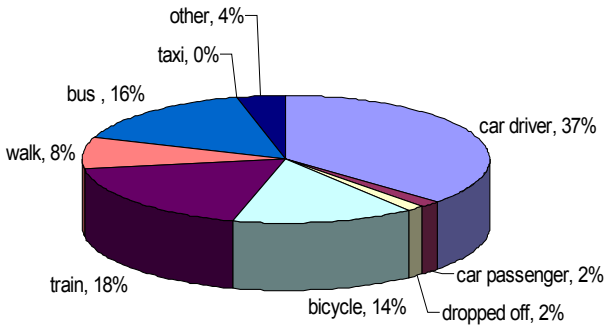


Figure 10. Travel modes of staff of the Garvan Institute and VCCRI.

It is of note that a similar survey of staff of the St Vincent's Darlinghurst Campus (except the Research Precinct) carried out by TEF Consulting in 2005 revealed that 54% of St Vincent's staff drove to work.

Of particular importance for the traffic impacts assessment is the proportion of car drivers arriving to and departing from work during the commuter peak hours. These have been calculated as 39% and 34% of all car drivers in the morning and afternoon peak hours respectively. These proportions have a direct effect on the likely traffic generation to and from the proposed car parking area.

The other important information derived from the survey results was the directional distribution of arrivals and departures on the street network. The trip distribution map

is included in **Figure 11**.

A number of car park size options were considered at the Master Plan stage of the Precinct planning, in terms of their impacts on the traffic situation. The main criteria adopted for this purpose were performance of the key intersections, environmental capacity of the approach streets and the queuing area requirements at the car park entry. It was found, through this analysis, that a car park with up to 500 car parking spaces would be comfortably sustainable in the given circumstances. The analysis was based on one main access point in West Street. The Concept Plan proposes a 400-space car park.

The following parameters and assumptions were used to estimate traffic generation and distribution resulting from the proposed Precinct development.

- An assumption has been made that the practical capacity of the car park (the maximum number of cars parked at any one time) will be 95% of the total number of the available car spaces. This is a typical situation in most large car parks, where up to 10% of car parking may be found vacant at any one time. Five percent underutilisation (95% practical capacity) is regarded as a conservatively high figure.
- In terms of trip generation, the proposed development will operate similarly to an office, with most staff arriving to work in the morning and leaving in the afternoon, with a very low number of trips in between. Assuming that all cars arrive in the morning and leave in the afternoon, 39% and 34% of the total site traffic generation would arrive and leave in the morning and afternoon peak hours.
- It was further assumed that the number of departing trips in the morning peak hour would comprise 10% of incoming trips. In the afternoon peak hour, the number of incoming trips was assumed to be 20% of the outgoing trips. For the purposes of the current analysis, these trips were added to the traffic generation calculated as described above.
- It must be noted that only approximately 180 new car parking spaces, out of total parking provision, will generate traffic additional to the existing traffic levels. The remaining spaces will accommodate cars which already park either on site or in the surrounding area. The latter cars will not add to the existing traffic flows on the road network, rather some redistribution of their movements will occur at the intersections adjacent to the Precinct. For the purposes of the analysis, to represent a worst case scenario, additional traffic volumes were calculated based on the full practical capacity of a 400-space car park. The resulting traffic generation was distributed on the road network in addition to the existing traffic, without any discount for the Precinct and St Vincent's traffic already present in the area. Additional sensitivity analysis was performed for traffic generation from a 500-space car park.

The results of traffic generation calculations, carried out as described above, are shown in **Table 3.4**.

Additional traffic volumes have been distributed on the road network based on the directional distribution shown in **Figure 11**.

3.6 Street capacity

Most of the streets, except the streets bounding the Precinct, will carry essentially the same volumes of traffic after the development. The estimated increase in traffic volumes in the area is generally between 3% and 8 %.

Environmental capacity of the streets bounding the precinct has been considered as follows.

RTA requirements

RTA (2002) provides the following guidance for the assessment of environmental capacity of streets, in terms of peak hour traffic volumes. Environmental capacity is defined as the volume of moving vehicles which can be accommodated in a street or area, having regard to the need to maintain environmental standards.

Road Class	Road type	Maximum peak hour volume veh/hr
Local	Street	200 EG 300 maximum
Collector	Street	300 EG 500 maximum

Note: EG – environmental goal

It must be noted that values in the table above relate to streets with direct access to residential properties. Trunk collector and spine roads with no direct property access can carry higher traffic flows. In such cases assessment of traffic conditions is based on the maximum traffic flow which can be accommodated. In traffic engineering this maximum traffic flow is called simply "capacity" as opposed to "environmental capacity".

In urban conditions, street midblock capacity is typically in the order of 900 veh/hr per lane. Two lanes in the same direction of travel have the double capacity, that is some 1800 veh/hr, whereas two lanes in the opposite direction of travel may have a reduced total capacity, down to some 1,500 veh/hr depending on various parameters (lane widths, parking in the next lane, etc.)

Victoria Street

Victoria Street will not have direct access to residential properties and the above environmental capacity benchmarks are therefore not applicable.

Traffic volumes between Liverpool and Burton Streets would increase by 11% in the morning (from 746 to 826 veh/hr) and by 11% in the afternoon (from 921 to 1,018 veh/hr). This is well within the two-lane carriageway capacity of 1,800 veh/hr.

Burton Street

Burton Street between Darlinghurst and West Streets has no direct access to residential properties and the above environmental capacity benchmarks are therefore not applicable.

Traffic volumes between Victoria and West Streets would increase by 19% in the morning (from 601 to 718 veh/hr) and by 12% in the afternoon (from 500 to 560 veh/hr). This is well within the two-lane carriageway capacity of 1,500 to 1,800 veh/hr.

Traffic volumes between Victoria Street and Darlinghurst Road would increase by 7% in the morning (from 678 to 728 veh/hr) and by 2% in the afternoon (from 608 to 618 veh/hr). This is well within the two-lane carriageway capacity of 1,500 to 1,800 veh/hr .

Traffic volumes west of Darlinghurst Road are currently slightly below the maximum environmental capacity at 427 veh/hr and 478 veh/hr in the morning and afternoon peaks respectively. The volumes would increase by 2% in the morning (from 427 to 437 veh/hr) and by less than 1% in the afternoon (from 478 to 481 veh/hr). These increases are insignificant and will not affect the existing conditions. The resulting volumes will remain within the maximum environmental capacity.

Liverpool Street

Liverpool Street between Darlinghurst and West Streets has no direct access to residential properties and the above environmental capacity benchmarks are therefore not applicable.

Traffic volumes to the east of West Street would increase by 2% in the morning (from 530 to 541 veh/hr) and by 4% in the afternoon (from 485 to 504 veh/hr). These increases are very small and will not affect the existing conditions. It is noted that the existing traffic volumes in Liverpool Street are already at and above the maximum environmental capacity level defined in the RTA guidelines. It must be taken into account, however, that firstly, residential properties are located only on one side of the street. It is thus appropriate for the maximum acceptable level to be slightly increased. Secondly, Liverpool Street is recognised in the "City East Traffic Study" as "the principal road" with an important collector function. Traffic volumes in the order of 600 veh/hr recorded in the "City East Traffic Study" for similar conditions in Liverpool Street east of Forbes Street were not regarded as unacceptable.

Traffic volumes between Victoria and West Streets would increase by 3% in the morning (from 508 to 522 veh/hr) and by 6% in the afternoon (from 513 to 542 veh/hr). This is well within the two-lane carriageway capacity of 1,500 to 1,800 veh/hr.

Traffic volumes between Victoria Street and Darlinghurst Road would increase by 2% in the morning (from 573 to 587 veh/hr) and by 6% in the afternoon (from 479 to 508 veh/hr). This is well within the two-lane carriageway capacity of 1,500 to 1,800 veh/hr.

Traffic volumes west of Darlinghurst Road would increase by 2% in the morning (from 694 to 705 veh/hr) and by less then 1% in the afternoon (from 583 to 584 veh/hr). These

increases are insignificant and will not perceptibly affect the existing conditions.

West St

West St is a local street; its desirable environmental capacity is 200 veh/hr and the maximum capacity is 300 veh/hr, based on RTA (2002). Note that these values are for residential streets with direct access to properties. It appears that only two residential properties have access to West St; it also appears that their use is limited. The western side of West St is not residential. Based on the above, it can be argued that the environmental capacity of West St is greater than 300 veh/hr. For a 400 space car park, the estimated total number of movements in West St (together with the existing through traffic) would be in the order of 180 to 190 veh/hr in the morning and afternoon commuter peak hours respectively. This will be well within the environmental capacity of the street.

Road network

Notwithstanding the above considerations of traffic conditions in terms of midblock street capacity and demand, the efficiency of urban street networks is defined by the efficiency of intersections rather than by midblock capacities. The operation of the intersections in the vicinity of SVRP is discussed in **Section 3.7**.

3.7 Operation of intersections

RTA (2002) and Austroads (2005) set out assessment criteria for the intersection operation. The main criterion is the average delay, expressed in seconds per vehicle. A table below from RTA (2002) shows definitions of Levels of Service currently adopted by RTA.

Level of service criteria for intersections

Level of Service	Average Delay per Vehicle (secs/veh)	Traffic Signals, Roundabout
A	< 14	Good operation
B	15 to 28	Good with acceptable delays & spare capacity
C	29 to 42	Satisfactory
D	43 to 56	Operating near capacity
E	57 to 70	At capacity; at signals, incidents will cause excessive delays Roundabouts require other control mode

Source: RTA (2004)

It must be noted that the ranges of average delay defining each Level of Service should not be regarded as strict cut off points. For example the actual traffic conditions when the average delay is 42 seconds (LoS "C") do not differ much from traffic conditions at the 43 second delay (LoS "D"). For a motorist in the traffic flow the transition between different LoS is experienced as gradual with the increase in average delays.

Various computer based intersection analysis programs are used for a traffic impact assessment, each of them having their specific strengths and weaknesses. In order to test the sensitivity of the results with regard to particular capabilities of certain modelling software, three different models were utilised for the present assessment, namely SIDRA, SCATES and Aimsun. All three programs are adopted for use by NSW RTA and NSW Department of Transport.

For the purposes of the analysis, to represent a worst case scenario, additional traffic volumes were calculated based on the full practical capacity of a 400-space car park. The resulting traffic generation was distributed on the road network in addition to the existing traffic, without any discount for the Precinct and St Vincent's traffic already present in the area. Additional sensitivity analysis was performed for traffic generation from a 500-space car park.

In both cases it has been found that the key intersections in the area will continue to operate at the same or similar level of service as at present, with only minor increase in average delays. Such a result would have been expected considering that additional traffic, when distributed on the road network, constitutes a very minor proportion of the existing traffic flows. The three computer models utilised for traffic impact assessment show slightly different results, due to different calculation methods used in them. However the outcomes are very similar and consistent and lead to the same conclusion: the proposed SVRP would not have a detrimental effect on the intersection operation.

The results of the analysis are presented in **Table 3.5**.

Details of traffic distribution, SCATES and SIDRA modelling results and screen shots of the Aimsun microsimulation model results are included in **Appendix D**.

The data contained in **Table 3.5** indicate the following specific results for critical intersections.

The four intersections at the corners of SVRP currently operate at good Levels of Service (LoS) with acceptable delays and spare capacity ("A" and "B" as per RTA classification). They will continue to operate at the same Levels of Service after the Precinct development. Average delays at these intersections will experience only minor changes, generally between 0.1 and 3.9 seconds per vehicle. This is insignificant in traffic engineering terms and is not noticeable in practice for an observer. Note that LoS is defined by the value of average delay per vehicle, for all movements combined for signalised intersections and for the most delayed movement for unsignalised intersections.

Similarly, other intersections under consideration will continue to operate at the same LoS as at present. The intersections of Oxford Street with Victoria Street and Darlinghurst Road were of particular interest for the present study because of their location on the main arterial road. Due to their close proximity, phasing coordination, high pedestrian demand and vehicles queuing across the intersections at times, modelling of these two intersections presented a particular challenge. All three computer models showed that additional traffic from the proposed SVRP would not have a detrimental effect on the operation of these intersections. All results are in the same range, indicating LoS between C and D before and after the development. The additional average delays are also minor. This would be expected considering that the estimated additional traffic volumes from SVRP would constitute only 1% to 2% increase compared with the existing total volumes at the two Oxford Street intersections. Although Aimsun results indicate a change from LoS "C" to LoS "D" with an increase in average delay by 8.9 seconds, such change is not supported by the other two models which show more realistic results considering a very minor relative change in traffic volumes. It is also noted that the avergae delay of 39.1 seconds is at the upper cut off level of LoS "C" and is very close to "D". Considering the results obtained from the other two programs, it not unreasonable to conclude that the Oxford St / Victoria Street intersection currently operates at LoS "C" to "D" and will continue to operate at the same LoS after the full development of SVRP.

The proposed SVRP with a car parking structure with 400 spaces can thus be comfortably supported on traffic engineering grounds.

Table 3.4. Estimated traffic generation.

		AM PEAK	
Parking capacity		400	500
% utilisation		95%	95%
Number of cars		380	475
% arrivals AM Peak hour		39%	39%
Number of trips	**IN**	**148**	**185**
	OUT	**15**	**19**

		PM PEAK	
Parking capacity		400	500
% utilisation		95%	95%
Number of cars		380	475
% departures PM Peak hour		34%	34%
Number of trips	**OUT**	**129**	**162**
	IN	**26**	**32**