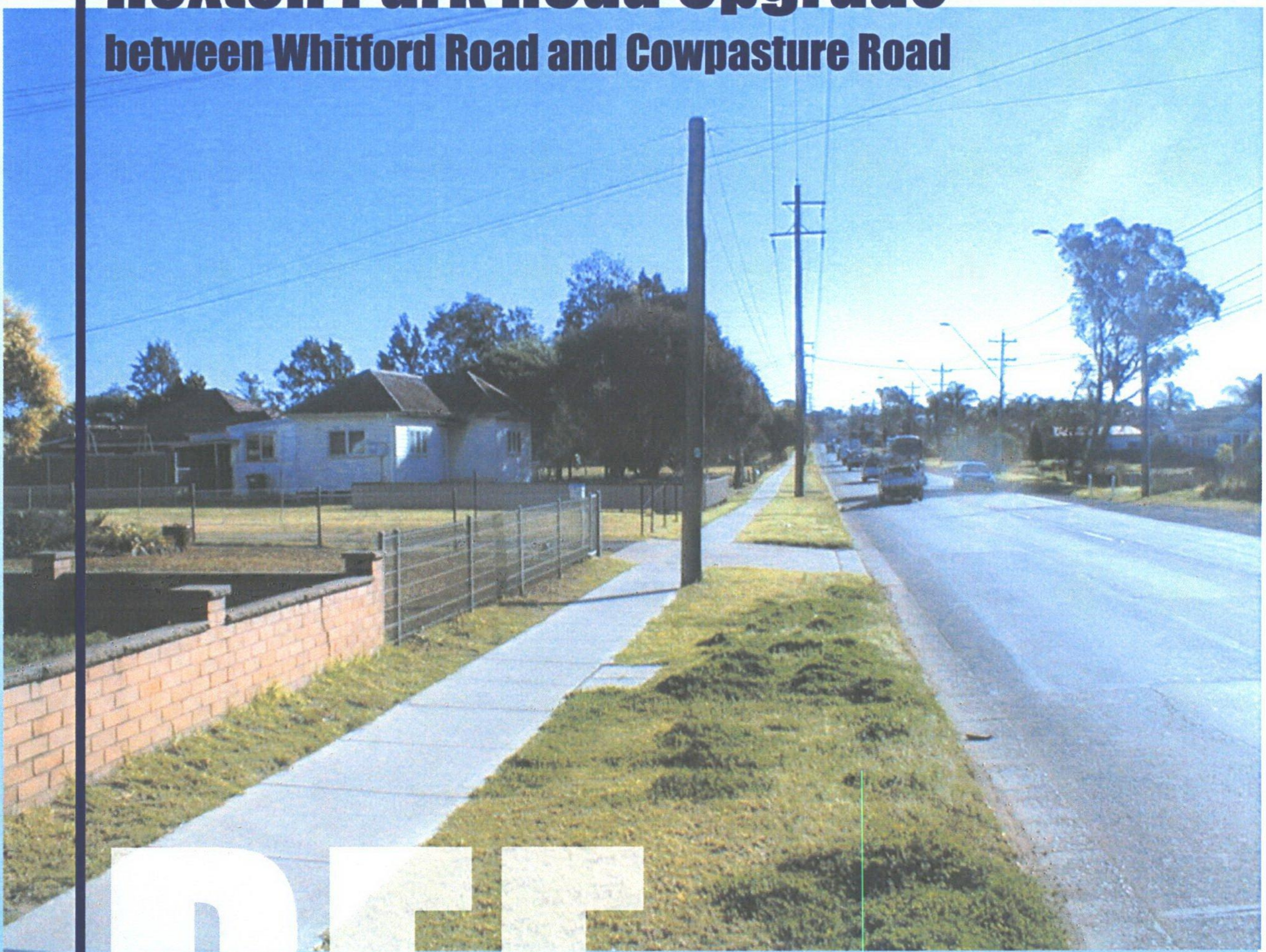
Connell Wagner

Hoxton Park Road Upgrade

between Whitford Road and Cowpasture Road



REF

Review of Environmental Factors

Appendices

November 2004

Appendices

Appendix A

Summary of State Agency Responses

Summary of Responses from Stakeholder Consultation

Organisation	Comments	Action	REF reference
Integral Energy	Existing power lines will need to be relocated	RTA undertaking negotiations with Integral Energy	
	Recommend relocation works be included in Upgrade REF		
	Contact Integral Energy Customer Connections Branch re Relocations		
	Request RTA provide plan so Integral Energy can co ordinate plans for installation of additional electrical infrastructure with the road upgrading		
	Questions re Comments contact		
NPWS	NPWS Environmental Impact Assessment guidelines and Activities Adjoining NPWS Estate guidelines provided for your information. The guidelines recommend assessment by suitable qualified person where areas of native vegetation of potential value or places of potential Aboriginal cultural heritage or archaeological significance occur.	Assessments undertaken by suitably qualified persons.	6.7 6.9
Sydney Water	Avoid impact on Sydney Water infrastructure where possible	RTA to consult with Sydney Water and accommodate requirements at detailed design stage.	
	Maintain safe access to infrastructure		
	Assess liability and costs where infrastructure relocation proposed		
	Create or extend Sydney Water easements where necessary		
	At detailed design stage RTA required to appoint a Water Servicing Co-ordinator to apply for Section 73 Certificate and ensure compliance.		
	Sewer mains cross Hoxton Park Road		
	Four water mains lie within the project area		
	Consultation with Sydney Water's water and waste water group required during detailed design.		
DIPNR	Demonstrate how proposal meets the requirements of Acts and policies.		
	Proposal may require a Part 3A Permit under the Rivers and Foreshores Improvement Act 1948	Permit application required prior to construction	
	Consideration of NSW State Rivers and Estuaries Policy required		
	Minimise site disturbance from bridge construction by: ▪ Minimise number of crossings; ▪ Road widths to be as narrow as possible; ▪ Crossing at right angles; ▪ Minimise vegetation removal; ▪ No piers within the bed or bank of the water course.	RTA to incorporate in detailed design	2.2 5.2 6.4 6.6 6.7
	Accommodate natural flow regimes and geomorphic processes by: ▪ Retain natural streambed and bank profile; ▪ Avoid the use of fill; ▪ Prevent scour and erosion to the streambed and banks in storm events; ▪ Do not inhibit bank full or floodplain flows; ▪ Do not inhibit sediment transport; ▪ Do not increase water levels upstream; ▪ Do not inhibit movement of natural woody debris.	RTA to incorporate in detailed design	2.2 5.2 6.7
	Avoid detrimental impacts on ecological processes and wildlife corridors by: ▪ Provide adequate height beneath structures to allow growth of local native shrubs and ground covers and assist in fish passage; ▪ Provide adequate lighting to enable growth of local native shrubs and ground covers and assist in fish passage; ▪ Provide adequate moisture to allow growth of native		6.7 7 6.10

Organisation	Comments	Action	REF reference
DIPNR (cont)	shrubs and ground covers; ▪ Provide adequate span widths to ensure a suitable riparian width is maintained and to enable passage for flora and fauna; ▪ Provide protection for migrating fauna; ▪ Demonstrate consistency with NSW Fisheries Bridges, Roads, Causeways and Culverts Policy and Guidelines.		
	Development on flood prone should be considered in accordance with NSW Flood Policy and the NSW Government Floodplain Development Manual 2001.	RTA undertaking detailed investigation	2.2 5.2 6.6
	Proposal to be consistent with NSW Biodiversity Strategy	Investigation by suitable qualified professional	2.2 5.2 6.7
	Need to address soil erosion and sedimentation issues	DLWC published information, Geotechnical investigations and EMP requirements	6.1 6.3 6.4 6.10 7.2
	Acid Sulphate Soils	DLWC published information, Geotechnical investigations	6.4
	Salinity issues investigated and addressed by a water cycle management study which: Assesses conflicting issues of infiltration and groundwater rise; Minimises variation to subsoil drainage; Investigation of alternative drainage and construction methods where modifications to subsoil drainage; Implementation of a groundwater monitoring and reporting system;	Required to be approved prior to construction	6.4 7.1 7.2
	Preparation of a detailed erosion and sediment control plan.	Required to be approved prior to construction	6.4 7.1 7.2
	Consistency with the Native Vegetation Conservation Strategy by no net loss of native vegetation	Landscaping plan and Plan of Management for Hoxton Park Reserve prior to commencement.	6.7 6.10
	Threatened Species Issues to be addressed	Investigated by suitably qualified professional	6.7
	Integration of native vegetation establishment with surrounding remnant vegetation.	Investigated by suitably qualified professional Further development during detailed design stage by RTA	6.7 6.10 7
EPA (now DEC)	Management of Construction noise	Investigated by suitably qualified professional	6.12 7
	Management of operational noise	Investigated by suitably qualified professional	6.11 7
	Water quality and sediment loads in Hinchinbrook Creek	To be included in detailed design and EMP for project. Consultation with DLWC.	6.6
	Management of dust	To be included in detailed design and EMP for project	6.5
	Consideration of Hazards	Improved road conditions reduce hazards	2
	Waste management	To be included in EMP	2.3.2 7
	Spoil management	To be included in EMP	2.3.2 6.4

Organisation	Comments	Action	REF reference
EPA (cont)	Extractive industries Environmental Protection Licence under Schedule 1 of the POEO Act may be required if fill materials required from a borrow pit.	Detailed design stage	
	Detailed assessment of ecological impact required	Investigation by suitable qualified professional	2.2 5.2 6.7
	EMP recommended	RTA requires EMP	7
NSW Fisheries	Main issues of concern are: ▪ Bridges across Hinchinbrook Creek ▪ Channel work in Hinchinbrook Creek		
	REF should include: ▪ Proposal description; ▪ Details and location of all aspects of proposal; ▪ Area affected by channel works and bridge clearly identified on appropriately scaled map; ▪ All waterways clearly identified; ▪ Description of aquatic vegetation and habitats; ▪ Identification of fishing grounds and other waterway users; ▪ Aspects to be included in project EMP; ▪ Land tenure and land uses; ▪ Hydrological and stream morphology information.	Addressed in REF based on current information, EMP to be developed post REF following detailed design.	2 6 7
	Dredging and Reclamation Activities to address: ▪ Purpose; ▪ Marine vegetation; ▪ Methods to be used; ▪ Timing and duration; ▪ Dimension and depth of area to be dredged; ▪ Nature of sediment; ▪ Method of marking works areas; ▪ Environmental safeguards; ▪ Measures to minimise harm to fish; ▪ Spoil type and sources; ▪ Method of disposal of material; ▪ Stockpile management; ▪ Volume to be extracted.	Addressed generically in REF, detailed design subsequent to REF. Safeguards to be included in EMP.	2 6.4 6.7 7
	Maintain channel flow and morphology		6.6
	Impact on threatened species	Investigation by suitable qualified professional	2.2 5.2 6.7
	Identification of protected areas	No protected areas identified.	
	Initial site assessment including description of habitat and potential impacts	Investigation by suitable qualified professional	2.2 5.2 6.7
	Assessment of potential impacts	Investigation by suitable qualified professional	2.2 5.2 6.7
	Ameliorative measures	Investigation by suitable qualified professional. EMP required for project.	2.2 5.2 6.7 7
Agility Services Pty Ltd (AGL)	Gas Services located within project area	RTA undertaking negotiations with Agility. Issues to be managed at detailed design stage.	
Busabout	Support concept, object to Wilson Road intersection treatment.	Concerns unable to be accommodated in road design.	6.2

Appendix B

Traffic Study

TRAFFIC REPORT

Hoxton Park Road

September 2003

Prepared for
Roads and Traffic Authority, NSW

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Contents

1. Introduction

This report examines the traffic and transport implications of the proposed upgrade to Hoxton Park Road between Cowpasture Road and Banks Road.

Hoxton Park Road is to be upgraded between the Hume Highway and Cowpasture Road in three stages. This project relates to Stage 2, the section between Cowpasture Road and Banks Road, where a four lane divided road with median is proposed in place of the existing two lane road.

2. Existing Situation

2.1 Site Location

Hoxton Park Road is located in the Liverpool Local Government Area. The proposed upgrade which is the subject of this report is between Cowpasture Road and Banks Road. This is shown in Figure 1.

2.2 Road Network

It is usual to classify roads according to a road hierarchy, in order to determine their functional role within the road network. Changes to traffic flows on the roads can then be assessed within the context of the road hierarchy. Roads are classified according to the role they fulfil and the volume of traffic they should appropriately carry. The Roads and Traffic Authority of New South Wales (RTA) has set down the following guidelines for the functional classification of roads.

- **Arterial Road** - typically a main road carrying over 15,000 vehicles per day and fulfilling a role as a major inter-regional link (over 1,500 vehicles per hour)
- **Sub-arterial Road** - defined as secondary inter-regional links, typically carrying volumes between 5,000 and 20,000 vehicles per day (500 to 2,000 vehicles per hour)
- **Collector Road** - provides a link between local roads and regional roads, typically carrying between 2,000 and 10,000 vehicles per day (250 to 1,000 vehicles per hour). At volumes greater than 5,000 vehicles per day, residential amenity begins to decline noticeably.
- **Local Road** - provides access to individual allotments, carrying low volumes, typically less than 2,000 vehicles per day (250 vehicles per hour).

The major roads in the vicinity of the study area are described below:

Hoxton Park Road is a sub-arterial road which connects the Hume Highway in the east to Cowpasture Road in the west. In the study area, Hoxton Park Road is one lane in each direction.

Cowpasture Road is a sub-arterial road which runs north-south at the east end of Hoxton Park Road. It has one lane in each direction in the vicinity of the study area and intersects with Hoxton Park Road at a single lane roundabout.

Banks Road, Whitford Road and **Wilson Road** are collector roads which run north from Hoxton Park Road and serve the residential area of Hinchinbrook. Banks Road intersects with Hoxton Park Road at a signalised intersection while the intersections with Whitford Road and Wilson Road are priority controlled.

The **Liverpool to Parramatta Transitway** runs parallel and to the west of Banks Road, intersecting with Hoxton Park Road at a signalised intersection which is incorporated with the signals at Banks Road. The transitway then continues to the east into Liverpool along Hoxton Park Road. The section east of the Banks Road that will accommodate the transitway is still under construction, but once complete, the transitway will run in its own lanes in the centre of Hoxton Park Road.

Joadja Street is a collector road which, together with Jedda Road and Bernera Road, provides a link from Hoxton Park Road to the south through Prestons.

2.3 Traffic Flows

Automatic "tube" counts were undertaken at two locations on Hoxton Park Road in July 2003 for one week and peak hour intersection turning movement surveys were conducted at a number of intersections in the study area on 12 December 2002.

Daily traffic flows on Hoxton Park Road are summarised in Table 2.1.

Table 2.1 – Hoxton Park Road Average Weekday Traffic Flows (vehicles per day)

Location	Eastbound	Westbound	Combined Directions
East of Glen Innes Rd	9,460	7,760	17,220
East of Illaroo Rd	11,890	14,000	25,890

An urban arterial road would typically be able to carry an AADT of 12,500 vehicles per lane per day. Volumes above that level are likely to result in peak hour congestion. It can be seen that east of Illaroo Road, Hoxton Park Road would be close to capacity during peak hours.

Peak hour traffic flows at various locations are summarised in Table 2.2 and in Figures 2 and 3.

Table 2.2 – Peak Hour Traffic Flows (vehicles per hour)

Location	AM Peak		PM Peak	
	N/B or E/B	S/B or W/B	N/B or E/B	S/B or W/B
Fifteenth Av W Cowpasture Rd	434	201	299	268
Hoxton Park Rd E of Cowpasture Rd	413	432	418	577
East of Illaroo Rd	1,060	1,206	834	1,206
East of Banks Rd	1,229	950	1,004	1,230
Cowpasture Rd N of Hoxton Park Rd	830	703	799	1,091
Banks Rd N of Hoxton Park Rd	369	384	311	466

According to AUSTROADS Guide to Traffic Engineering, the nominal capacity of an urban arterial traffic lane is 900 vehicles per hour. In practice it is possible to exceed this volume where the main road is given a high proportion of traffic signal green time at intersections and where supplementary turning lanes are provided. Notwithstanding this, traffic flows in excess of 1,000 vehicles per hour per lane represents a situation with little or no spare traffic capacity.

Traffic volumes east of First Avenue indicate that Hoxton Park Road had little or no spare traffic capacity. Cowpasture Road is close to capacity north of Hoxton Park Road.

2.4 Intersection Operation

Intersections are the critical points which control the capacity of the road network. This is due to the need for conflicting traffic movements to share the same road space at these locations.

The intersections in the vicinity of the subject site have been analysed using the INTANAL and SCATES intersection analysis programs. The programs determine the average delay that vehicles encounter and the level of service. They provide analysis of the operating conditions which can be compared to the performance criteria set out in **Table 2.3**.

Table 2.3 – Level of Service Criteria

Level of Service	Average Delay per Vehicle (secs/veh)	Traffic Signals, Roundabout	Give Way & Stop Signs
A	less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays & spare capacity	Acceptable delays & Spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity & accident study required
E	57 to 70	At capacity; at signals, incidents will cause excessive delays Roundabouts require other control mode	At capacity, requires other control mode
F	> 70	Extra capacity required	Extreme delay, traffic signals or other major treatment required

Adapted from RTA Guide to Traffic Generating Developments, 1993.

The intersection of Hoxton Park Road and Banks Road is currently being reconstructed as part of the Liverpool to Parramatta Transitway construction. It currently has only one through lane in each direction on Hoxton Park Road. When the intersection is complete, it will have two lanes in each direction through the intersection. It has been analysed in the existing and future configurations below.

The results of the INTANAL intersection analysis are summarised in **Table 2.4**.

Table 2.4 – Existing Peak Hour Intersection Operation, Hoxton Park Road

Intersection	Control	AM Peak Hour		PM Peak Hour	
		LoS	Av. Del	LoS	Av. Del
Cowpasture Rd	Roundabout	C	31	F	>150
Glen Innes Rd	Priority	A	10	A	12
Dorrigo Rd	Priority	A	11	B	17
First Av	Roundabout	A	13	A	13
Wilson Rd	Priority	B	15	B	15
Whitford Rd/Illaroo Rd	Priority	F	>150	F	>150
Banks Rd (Existing)*	Signals	F	>150	B	28
Banks Rd (T-way complete)*	Signals	B	17	A	12

* Existing has one lane each direction on Hoxton Park Road, when the Transitway is complete, it will have two lanes in each direction.

Note: LoS = Level of Service.
Av. Del = Average delay per vehicle for whole intersection for signalised or for worst movement for priority and roundabout controlled intersections.

The intersection analysis indicates that the Cowpasture Road intersection operates satisfactorily in the morning peak but requires extra capacity in the evening peak.

The analysis indicates that the intersections of Hoxton Park Road with Glen Innes Road, First Avenue and Wilson Road all operate satisfactorily in both morning and evening peaks.

The analysis indicates that the intersection of Hoxton Park Road with Whitford and Illaroo Roads requires extra capacity.

The Banks Road intersection currently has one lane in each direction on Hoxton Park Road. Lengthy delays and queues for eastbound traffic on Hoxton Park Road are experienced at this intersection in the morning peak. Queues have been observed extending back almost to Cowpasture Road. The operation of the intersection in the evening peak is satisfactory although it is noted that the Joadja Road intersection to the east causes lengthy delays for westbound traffic in the evening peak.

The Banks Road and Joadja Road intersections are currently being reconstructed as part of the construction of the Liverpool-Parramatta transitway. Existing traffic volumes have been analysed with the new intersection configurations and the operation is forecast to be satisfactory.

2.5 Travel Times

The RTA has an objective[1] that 70 percent of the major road network should achieve travel speeds in excess of 35 kilometres per hour during peak periods. Because of inner city congestion, it is desirable that travel speeds on outer sections of the road network exceed this speed.

Surveys of travel time along Hoxton Park Road were undertaken during peak periods to determine travel times through the study area. The surveys measured the time taken to travel between Cowpasture Road and Banks Road. This is a distance of some 2.2 kilometres.

[1] 1991 – 1992 Central Region Objectives and Strategies – RTA Business Plan, Sydney Central Region

In the eastbound direction, the travel times include the time taken to travel through the Banks Road intersection and hence delay caused by that intersection. In the westbound direction, the travel times include the time taken to travel through the Cowpasture Road intersection and hence the delays at this intersection.

The intersection delays were included because of difficulty in determining the back of the queue from those intersections, particularly in the eastbound direction. The queue back from the Banks Road intersection eastbound in the morning peak was observed to extend back some 2 kilometres, almost to Cowpasture Road.

Table 2.5 – Hoxton Park Road Average Peak Travel Time and Speed: Cowpasture Road to Banks Road

	AM Peak		PM Peak	
	Eastbound	**Westbound**	**Eastbound**	**Westbound**
Average travel time	17 minutes	3 minutes	5 minutes	4 minutes
Average speed	8 km/h	44 km/h	26 km/h	33 km/h

The average travel speed on Hoxton Park Road is less than the RTA objective except for the westbound direction in the morning peak.

As discussed above, the intersection of Hoxton Park Road and Banks Road is the major congestion point on Hoxton Park Road. When the upgrading of this intersection is complete, travel times are likely to improve considerably.

2.6 Accident Analysis

The RTA's accident records for the three year period between 1 July 1998 to 30 June 2001 have been examined to identify any safety issues with the current layout of Hoxton Park Road. The reported accidents include those which:

1. were reported to Police
2. occurred on a road open to the public
3. involved at least one moving road vehicle
4. at least one person was killed or injured, or at least one motor vehicle was towed away.

During that period there were 66 reported accidents along this section of Hoxton Park Road between Cowpasture Road and Banks Road. Intersection accidents (ten metres or less from an intersection) accounted for 41 of these, which is equivalent to 62 per cent of all accidents. Table 2.6 summarises the locations of accidents which occurred at intersections, and compares these with the intersection geometry and intersection controls.

Table 2.6 – Accidents at Intersections on Hoxton Park Road

Intersection	Number of Accidents	Geometry	Control
Cowpasture Road	4	cross junction	roundabout
Glen Innes Road	3	cross junction	priority
Dorrigo Avenue	1	tee junction	priority
First Avenue	1	cross junction	roundabout
Wilson Road	11	tee junction	priority
Whitford/Illaroo Rd	12	offset tee junctions*	priority
Banks Road	9	tee junction	signals

* due to their proximity, these intersections are considered together

The majority of intersection accidents thus occur at unsignalised intersections.

The types of accidents which occurred at the intersections have been reviewed and are discussed below for those intersections with the higher number of reported accidents.

Whitford Road, Illaroo Road and Hoxton Park Road

- Nine of the 12 accidents at this intersection were rear end accidents. Of these, six involved westbound vehicles colliding with vehicles waiting to turn right into Whitford Road, and three involved eastbound vehicles colliding with vehicles waiting to turn right into Illaroo Road.
- Two accidents involved vehicles turning right out of Whitford Road colliding with eastbound through traffic on Hoxton Park Road.
- There was one head on collision.

Wilson Road and Hoxton Park Road

- Five of the 11 accidents which occurred at the intersection of Wilson Road and Hoxton Park Road involved collisions between vehicles on adjacent approaches of the intersection. Of these, four involved vehicles turning right out of Wilson Road colliding with through traffic on Hoxton Park Road.
- Four were rear end accidents, two involving a vehicle colliding with the rear of a vehicle which was waiting to turn right into Wilson Road.
- There was one pedestrian accident at this intersection, involving a car turning right into Wilson Road colliding with a pedestrian running eastwards across Wilson Road.
- One accident involved a westbound car leaving the carriageway and colliding with a guardrail or fence.

Banks Road and Hoxton Park Road

- Three of the nine accidents at this intersection were rear end accidents between eastbound vehicles.
- Three accidents were between vehicles turning right into Banks Road colliding with eastbound through traffic on Hoxton Road Road.
- One accident involved a collision between a vehicle turning right into Banks Road and a southbound vehicle in Banks Road.
- A vehicle turning left out of Banks Road collided with a westbound vehicle in Hoxton Park Road.
- A southbound vehicle in Banks Road collided with an eastbound vehicle in Hoxton Park Road.

Cowpasture Road, Fifteenth Avenue and Hoxton Park Road

- Three of the four accidents at the intersection of Cowpasture Road and Hoxton Park Road were rear end accidents and involved a semitrailer.
- In all three accidents, a semitrailer collided with the rear of another vehicle, once between westbound vehicles, once between eastbound vehicles, and once between northbound vehicles.
- An eastbound vehicle on Fifteenth Avenue left the carriageway and collided with a utility pole.

Glen Innes Road and Hoxton Park Road

- The three accidents at this intersection were rear end accidents.
- One was between westbound through traffic and one was between eastbound through traffic.
- A westbound vehicle collided with the rear of a vehicle waiting to turn right into Glen Innes Road.

A significant number of the accidents involve vehicles colliding while executing conflicting turning movements or waiting to execute a turning movement.

2.7 Public Transport

Busabout operate a number of bus services along Hoxton Park Road. The following routes use the sections of Hoxton Park Road in the study area. Their routes are indicated in Figure 4.

853 Bringelly to Liverpool
854 Carnes Hills to Liverpool
855 Routes 853, 854 combined
856 Night Service

The peak numbers of services in each direction at First Avenue on weekdays are shown below.

Table 2.7 – Busabout Bus Frequencies (Buses per hour)

	AM Peak	PM Peak
Eastbound	6	3
Westbound	3	4
Total	**9**	**7**

The Liverpool-Parramatta Transitway runs just to the west of Banks Road. Where it intersects with Hoxton Park Road it turns onto Hoxton Park Road and (when complete) will run down the middle of Hoxton Park Road in an easterly direction towards Liverpool.

In peak periods, the transitway runs 6 services per hour in each direction.

2.8 Pedestrians and Cyclists

There are limited pedestrian and cyclist facilities provided in the study area on Hoxton Park Road. A pedestrian footpath runs along the southern side of Hoxton Park Road from Dorrigo Avenue to just east of First Avenue. There is a pedestrian crossing just east of First Avenue. There is a pedestrian footpath along the northern side of Hoxton Park Road from the Good Samaritan Catholic College opposite First Avenue to Wilson Road. Pedestrian crossings are incorporated into the traffic signals at Banks Road.

There is a 40km/hr school zone between Dorrigo Avenue and Wilson Road.

The intersection turning movement surveys undertaken on 12 December 2002 also recorded pedestrian and cyclist movements at the intersections. The total number of pedestrian and cyclists recorded at the intersections on Hoxton Park Road from 7AM to 9AM and 4PM to 6PM are summarised in Table 2.8.

Table 2.8 – Hoxton Park Road Pedestrian and Cyclist Movements

Intersection	7AM – 9AM		4PM – 6PM	
	Pedestrian	Cyclist	Pedestrian	Cyclist
Cowpasture Rd	2	0	6	0
Glen Innes Rd	21	0	39	0
First Av	51	4	71	8
Wilson Rd	57	2	34	0
Illaroo Rd	2	9	12	4

The majority of pedestrian and cyclist activity in the study area is around Glen Innes Road, First Avenue and Wilson Road. The Good Samaritan Catholic College is located opposite First Avenue and generates some pedestrian activity before and after school.

2.9 Future Road Improvements

There are a number of road improvement projects already committed to in the study area which are separate from the Hoxton Park Road upgrade which is the subject of this report.

The upgrade of the intersection of Hoxton Park Road and Banks Road is already underway as part of the Liverpool to Parramatta Transitway.

It is proposed to signalise the intersection of Hoxton Park Road, Whitford Road and Illaroo Road. This would include widening Hoxton Park Road to two lanes in each direction in the vicinity of the intersection only as well as providing turn bays.

Similarly, it is also proposed to signalise the intersection of Hoxton Park Road, First Avenue and the Good Samaritan Catholic College Access. Hoxton Park Road would be widened in the vicinity of the intersection and turn bays provided.

3. Traffic Forecasting Process

3.1 Land Use and Trip Tables

Population forecasts for Sydney statistical district are currently under preparation by the ABS. This will use the recent Census's information to improve previous forecasts. In the interim, Planning NSW now expect Sydney's population to reach 4.5 million in 2010. Which is about 3 years ahead of previous forecasts. In addition, recent Government announcements relating to new areas for potential residential development have meant that land use and associated trip tables used for the original WSO demand forecasting project in third quarter 2001 needed to be updated.

Transport NSW's Transport Data Centre have recently prepared a set of draft land use forecasts for Sydney (TDC 2002), which include the higher population figure of 4.5 million by 2010 and a distribution of future population and employment that better reflects recent announcements by government in relation to land for residential development.

For the purposes of this project, the trip tables used were based on adjustments made to reflect the draft TDC 2002 series. MWT's understanding is that this series of land use is with government stakeholders for comment and may be amended in response to comments received by TDC. At that point TDC trip tables would probably be produced and made available. A further amendment to these trip table is expected when results of the 2001 Census Journey to Work (JTW) question is available, allowing updating of the TDC's Land Use Model and their Sydney Travel Model.

It is important to note that the forecasts in this report do not reflect recent reports in the daily press about a significantly enlarged population in the Bringelly area. Apparently this potential emerged from a planning workshop held in April 2003. Further, another planning workshop is scheduled for the near future to discuss the north west of Sydney and its potential future.

MWT are of the view that the scale and nature of the potential development in Bringelly (some 90,000 households) will require careful consideration and modelling of its effects on the road network. It is not included in the NETANAL modelling primarily because there is insufficient information available to prepare a meaningful analysis. It is, however, more than likely to substantially affect the recommendations of this report (and have more far-reaching effects on traffic in Sydney's south west).

3.2 Network

The NETANAL network modelling package was used to provide the forecasts of future traffic flows on Hoxton Park Road.

The future networks used have been updated to reflect the latest list of projects used for modelling purposes by the RTA. Table 3.1 contains a list of some of the projects in the vicinity of the study area which are likely to have some impact on traffic flows on Hoxton Park Road. The list does not necessarily indicate committed RTA projects but contains projects considered likely based on discussions with RTA personnel and MWT's work on other RTA road planning.

Table 3.1 – Future Network Projects

Project	Description	Year
Western Sydney Orbital	Prestons to M2	2006*
Ash Rd extension, Prestons	Extend from Jedda Rd to Kurrajong Rd	2006
Camden Valley Way widening	Widen to 2 lanes each way from Hume Hwy to Bernera Rd	2006
Cowpasture Rd widening	Widen to 2 lanes each way, Camden Valley Way to Greenway Dr	2006
Cowpasture Rd widening	Widen to 2 lanes each way, Greenway Dr to WSO	2006
Cowpasture Rd widening	Widen to 2 lanes each way, North Liverpool Rd to Elizabeth Dr	2006
Joadja Rd Upgrade	Widen to 2 lanes each way, Jedda Rd to Hoxton Park Rd	2006
Lyn Parade extension, Prestons	Extend from Enterprise Cct to Kurrajong Rd	2006
The Horsley Drive widening Mimosa to Lily	Widen existing 2 lane section to four lanes	2006
Camden Valley Way widening	Widen to 2 lanes each way from Bernera Rd to Ingleburn Rd	2011
Cowpasture Rd widening	Widen to 2 lanes each way, WSO to North Liverpool Rd	2011
Croatia Av extension, Edmundson Park	Re-align Croatia Av to opposite Bernera Road on Camden Valley Way and extend to Campbelltown Road, Bardia Village	2011
M5 Widening	Widen to 3 lanes each way from Moorebank Av to King Georges Rd	2011
Bringelly Rd widening	2 lanes each way from Cowpasture Rd to Allenby Rd	2016
Camden Valley Way widening	Widen to 2 lanes each way Ingleburn Rd to Camden Bypass	2016
Campbelltown Rd widening	Widen to 2 lanes each way Cross Roads to Williamson Rd, Ingleburn	2016
Elizabeth Dr widening	Widen to 2 lanes each way, Cowpasture Rd to WSO	2016
F5/M5 Widening	Widen to 3 lanes each way from Narellan Road to Cumberland Hwy	2016
Hume Highway N/B off ramp, Ingleburn	Northbound off ramp to Campbelltown Rd southbound	2016
Hume Highway S/B on ramp, Ingleburn	Extend Williamson Rd across Campbelltown Rd to Hume Hwy	2016
St Andrews Rd Connection, Leppington	Connect St Andrews Road east and west to provide connection from Camden Valley Way to Campbelltown Rd	2016

* See discussion of opening date below

Western Sydney Orbital Opening

The Western Sydney Orbital is due for opening around 2006 and is forecast to have a significant impact on traffic flows on Hoxton Park Road.

In order to forecast traffic conditions on Hoxton Park Road before and after opening, the 2006 network model has been run both with and without the Western Sydney Orbital. Analysis in the following chapters has been undertaken for both cases.

M5 Casula Link Eastbound Off Ramp

The possibility of an eastbound off ramp from the M5 Casula Link to the Hume Highway is currently being investigated although seems unlikely to go ahead.

Modelling has been undertaken with and without the ramp in place. This modelling indicates that future traffic volumes on Hoxton Park Road are greatest without the ramp. Therefore this worst-case has been assumed for the analysis in this report.

4. The Proposal and Impacts

4.1 The Proposal

Hoxton Park Road is currently one lane in each direction between Cowpasture Road and Banks Road.

The proposal is to widen Hoxton Park Road to a four lane divided carriageway between Cowpasture Road and Banks Road. Auxiliary turning lanes would generally be provided at intersections. The following intersection treatments would be undertaken (either as part of this project or as separate projects):

Table 4.1 – Proposed Intersection Controls, Hoxton Park Road

Intersection	Existing	Proposed
Cowpasture Rd	Roundabout	Signals, all movements
Glen Innes Rd	Priority, all movements	Signals, all movements
Dorrigo Rd	Priority, all movements	Priority, left-in left-out
First Av	Roundabout	Signals, all movements
Wilson Rd	Priority, all movements	Priority, left-in left-out
Whitford Rd/Illaroo Rd	Priority, all movements	Signals, all movements
Banks Rd	Signals, all movements	Signals, all movements

Bus bays would be provided separate from the carriageway. A 3.0 metre wide shared pedestrian and cyclist paved path would be provided on the northern side of Hoxton Park Road. A paved footpath would also be provided along the southern side of Hoxton Park Road between Cowpasture Road and First Avenue. On the southern side of Hoxton Park Road between First Avenue and Banks Road, there is a church, detention basin and Integral Energy site. These generate limited pedestrian activity so no paved footpath would be provided in this section on the southern side but a 3.5 metre wide grassed area would be available for pedestrians.

4.2 Traffic Flows

Existing and forecast future traffic flows along Hoxton Park Road are summarised in the tables below.

Table 4.2 – AM Peak Hour Traffic Flows, Hoxton Park Road (vehicles per hour)

Location	Existing		2006 (no WSO)		2006 (with WSO)		2016	
	N/B or E/B	S/B or W/B	N/B or E/B	S/B or W/B	N/B or E/B	S/B or W/B	N/B or E/B	S/B or W/B
Fifteenth Av W Cowpasture Rd	434	201	416	304	346	307	436	348
Hoxton Park Rd E of Cowpasture Rd	413	432	533	362	466	399	855	514
Hoxton Park Rd E of Illaroo Rd	1,060	1,206	1,132	812	1,029	821	1,423	883
Hoxton Park Rd E of Banks Rd	1,229	950	1,381	1,098	1,317	1,105	1,740	1,410
Cowpasture Rd N of Hoxton Park Rd	830	703	1,131	712	1,037	407	1,663	699
Banks Rd N of Hoxton Park Rd	369	384	423	386	491	495	746	536

Table 4.3 – PM Peak Hour Traffic Flows, Hoxton Park Road (vehicles per hour)

Location	Existing		2006 (no WSO)		2006 (with WSO)		2016	
	N/B or E/B	S/B or W/B	N/B or E/B	S/B or W/B	N/B or E/B	S/B or W/B	N/B or E/B	S/B or W/B
Fifteenth Av W Cowpasture Rd	299	268	291	492	264	327	375	666
Hoxton Park Rd E of Cowpasture Rd	418	577	334	681	353	583	474	1,070
Hoxton Park Rd E of Illaroo Rd	834	1,206	677	1,202	693	1,071	905	1,563
Hoxton Park Rd E of Banks Rd	1,004	1,230	881	1,405	974	1,189	1,551	1,681
Cowpasture Rd N of Hoxton Park Rd	799	1,091	1,019	1,561	517	912	1,079	2,175
Banks Rd N of Hoxton Park Rd	311	466	364	364	445	608	562	1091

The modelling forecasts some growth in traffic volumes on Hoxton Park Road to 2006 before the Western Sydney Orbital is opened. Peak traffic volumes of up to around 1,400 vehicles per hour are forecast. The typical one-way capacity of a four lane divided road according to AUSTROADS is 1,900 vehicles per hour. The forecast traffic volumes are within this capacity.

Upon opening of the Western Sydney Orbital, there would be some redistribution of traffic which would result in a reduction of traffic volumes in the peak direction on Hoxton Park Road. The model shows that some of the reduction is due to traffic previously using Hoxton Park Road to access the M5 Motorway at the Hume Highway instead using the Western Sydney Orbital, joining it at the Bernera Road or Cowpasture Road ramps. In the counter peak direction, volumes increase. Volumes remain within the typical one-way capacity on Hoxton Park Road.

4.3 Intersection Operation

The intersections along Hoxton Park Road have been analysed with future traffic volumes in their future configuration. The results are summarised in Table 4.4 for the AM Peak and Table 4.5 for the PM Peak. The geometry assumed for the intersections are shown schematically in Figures 5 and 6.

Table 4.4 – AM Peak Hour Intersection Operation, Hoxton Park Road

Intersection	Existing		2006 Pre-WSO		2006 Post-WSO		2016 Post-WSO	
	LoS	Av. Del	LoS	Av. Del	LoS	Av. Del	LoS	Av. Del
Cowpasture Rd	C	31	B	19	B	21	C	39
Glen Innes Rd	A	10	A	6	A	6	A	5
Dorrigo Rd	A	11	A	7	A	7	A	7
First Av	A	13	A	11	A	12	A	10
Wilson Rd	B	15	A	5	A	5	A	6
Whitford Rd/Illaroo Rd	F	>150	C	28	B	23	C	36
Banks Rd (T-way complete)*	B	17	A	13	B	16	F	101

Table 4.5 – PM Peak Hour Intersection Operation, Hoxton Park Road

Intersection	Existing		2006 Pre-WSO		2006 Post-WSO		2016 Post-WSO	
	LoS	Av. Del	LoS	Av. Del	LoS	Av. Del	LoS	Av. Del
Cowpasture Rd	F	>150	B	22	B	23	C	32
Glen Innes Rd	A	12	A	5	A	5	A	7
Dorrigo Rd	B	17	A	8	A	8	A	10
First Av	A	13	A	7	A	8	A	6
Wilson Rd	B	15	A	5	A	5	A	5
Whitford Rd/Illaroo Rd	F	>150	B	26	B	26	C	31
Banks Rd (T-way complete)*	A	12	A	14	B	19	D	42

* Existing has one lane each direction on Hoxton Park Road, when the Transitway is complete, it will have two lanes in each direction.

Note: LoS = Level of Service.

Av. Del = Average delay per vehicle for whole intersection for signalised or for worst movement for priority and roundabout controlled intersections.

The analysis indicates that the intersections upgraded as part of this project operate satisfactorily to 2016 with the geometry shown in Figures 5 and 6. It is noted however that the intersection of Hoxton Park Road and Banks Road is forecast require additional capacity by 2016. Queuing back from that intersection would potentially impact on the operation of the Hoxton Park Road/Whitford Road/Illaroo Road intersection.

4.4 Travel Times

The NETANAL model has been examined to estimate the change in travel time on Hoxton Park Road. Existing and forecast future travel times are summarised in Table 4.6.

Table 4.6 – Hoxton Park Road Average Peak Travel Time and Speed: Cowpasture Road to Banks Road

	AM Peak		PM Peak	
	Eastbound	**Westbound**	**Eastbound**	**Westbound**
Existing				
Average travel time	17 minutes	3 minutes	5 minutes	4 minutes
Average speed	8 km/h	44 km/h	26 km/h	33 km/h
2006 Pre-WSO				
Average travel time	3 minutes	3 minutes	3 minutes	3 minutes
Average speed	44 km/h	44km/h	44 km/h	44 km/h
2006 Post-WSO				
Average travel time	3 minutes	3 minutes	3 minutes	4 minutes
Average speed	44 km/h	44km/h	44 km/h	33 km/h
2016 Post-WSO				
Average travel time	5 minutes	5 minutes	5 minutes	5 minutes
Average speed	26 km/h	26km/h	26 km/h	26 km/h

Future travel times would improve due to the improvements made to Hoxton Park Road. Average travel speed would be above the RTA's target of 35 km/h in 2006. By 2016 however, travel speeds would fall below this target.

4.5 Accidents

Signalised intersections typically have lower accident rates than priority intersections because they greatly reduce the number of conflicting turning movements. Given that a significant number of the recorded accidents in the study area involve vehicles colliding while executing conflicting movements, or waiting to execute a turning movent, the project is likely to reduce the accident rate at the intersection of Hoxton Park Road and Glen Innes Road when this intersection is signalised. The intersections of Hoxton Park Road/First Avenue and Hoxton Park Road/Whitford Road/Illaroo Road are separately signalised as part of other projects therefore the accident rates at those intersections would also likely reduce in the future.

The intersections of Hoxton Park Road with Dorrigo Road and Wilson Road are converted to left-in left-out by the project, reducing the number of conflicting traffic movements. Therefore the accident rates at these intersections are also likely to reduce.

Finally, the project would provide an improved standard of road with divided carriageways and two lanes in each direction. This would also likely reduce accident rates by providing greater separation of traffic travelling in opposite directions.

4.6 Public Transport, Pedestrians, Cyclists

The proposed provision of indented bus bays at bus stops along Hoxton Park Road combined with a footpath along the northern side and most of the southern side would improve pedestrian access to public transport.

A 3.0 metre wide shared pedestrian footpath and cycleway is proposed along the northern side of Hoxton Park Road, eliminating the need for cyclists to share the roadway with motor vehicles.

Signalised pedestrian crossings would be provided at the signalised intersections of Hoxton Park Road with Glen Innes Road, First Avenue, Whitford Road/Illaroo Road and Banks Road. Combined with the paved foothpaths proposed, pedestrian safety and accessibility would be greatly improved compared to the existing situation.

4.7 Project Performance

Vehicle operating cost, accident cost and travel time cost have been calculated for the study area for the base case and the project case for the purposes of undertaking and economic analysis. The cost parameters used are taken from the RTA Economic Analysis Manual (September 2002 update).

The study area for the purposes of project performance is Hoxton Park Road and intersecting roads from just east of Cowpasture Road to just west of Banks Road.

The base case is the existing Hoxton Park Road configuration plus the following improvements by 2006:

- Signalisation of Hoxton Park Road/First Avenue/School Access intersection
- Signalisation of Hoxton Park Road/Illaroo Road/Whitford Road intersection

The project case includes the base case plus the following improvements by 2006:

- Signalisation of Hoxton Park Road/Glen Innes Road intersection
- Converting Wilson Road and Dorrigo Road intersections with Hoxton Park Road to priority left in left out intersections
- Widening of Hoxton Park Road to two lanes each way between all intersections which are not otherwise widened in the intersection upgrades.

The opening of the Western Sydney Orbital (WSO) is forecast to impact on traffic flows on Hoxton Park Road as discussed above. The costs have been calculated for 2006 both before and after opening of the WSO. Costs are summarised in Table 4.7.

Table 4.7 – Total Annual Operating Costs ($ million)

	2003 Pre-WSO	2006 Pre-WSO	2006 Post-WSO	2016 Post-WSO
Existing	$1.70			
Base Case		$3.50	$2.74	$18.82
Project Case		$2.85	$2.58	$2.96

Compared with the existing, the annual operating cost increases in the future as traffic volumes increase.

The opening of the Western Sydney Orbital results in a reduction of traffic on Hoxton Park Road hence the operating costs in 2006 are lower after the WSO is opened.

Base case costs increase significantly in 2016, mainly due to the intersection of Hoxton Park Road/Illaroo Road/Whitford Road becoming oversaturated. In the base case, this intersection is signalised by 2006 but the geometry is inadequate for 2016 traffic demands. Intersection delay increases significantly resulting in a significant increase in operating cost. The project provides two continuous through lanes without downstream merging and lengthens the right turn bay for westbound to northbound movements so that it would not overflow under 2016 demands.

5. Summary and Conclusions

5.1 Summary

- Traffic volumes on Hoxton Park Road east of First Avenue indicate that Hoxton Park Road has little or no spare capacity.

- The intersection of Hoxton Park Road and Cowpasture Road requires additional capacity in the evening peak. The intersection of Hoxton Park Road with Whitford Road and Illaroo Road requires additional capacity in both morning and evening peak periods.

- The existing operation of Hoxton Park and Banks Road is poor, however the improvements currently underway will provide satisfactory performance under existing traffic flows. Congestion caused by this intersection results in low travel speeds particularly eastbound in the morning peak period.

- The majority of accidents occur at unsignalised intersections and involve vehicles colliding while executing turning movements or waiting to execute a turning movement.

- Facilities for pedestrians and cyclists are limited.

- Two improvements are already planned for the area separate from the Hoxton Park Road widening project:
    - Signalising the intersection of Hoxton Park Road, Whitford Road and Illaroo Road
    - Signalising the intersection of Hoxton Park Road, First Avenue and the Good Samaritan Catholic College Access

- The Hoxton Park Road widening project would involve:
    - Signalising the Hoxton Park Road, Glen Innes Road intersection
    - Converting the Wilson Road and Dorrigo Road intersections with Hoxton Park Road to priority left-in left-out intersections
    - Widening of Hoxton Park Road to a four lane divided carriageway between all intersections which are not otherwise widened in the intersection upgrades
    - Providing indented bus bays, a shared footpath/cycleway on the northern side of Hoxton Park Road and a footpath along most of the southern side of Hoxton Park Road

- Modelling forecasts an increase in traffic volumes to 2006 before the Western Sydney Orbital is opened. Forecast volumes would be within the capacity of Hoxton Park Road. Upon opening of the Western Sydney Orbital, traffic volumes would decrease slightly. Traffic volumes would increase to 2016 but remain within the road's capacity.

5.2 Conclusions

- Schematics of the intersection geometry required for intersection operation to 2016 are shown in Figures 5 and 6.

- While the Hoxton Park Road/Banks Road intersection upgrade is not part of this project, it is noted that analysis indicates the configuration of the as currently being constructed will require additional capacity by 2016.

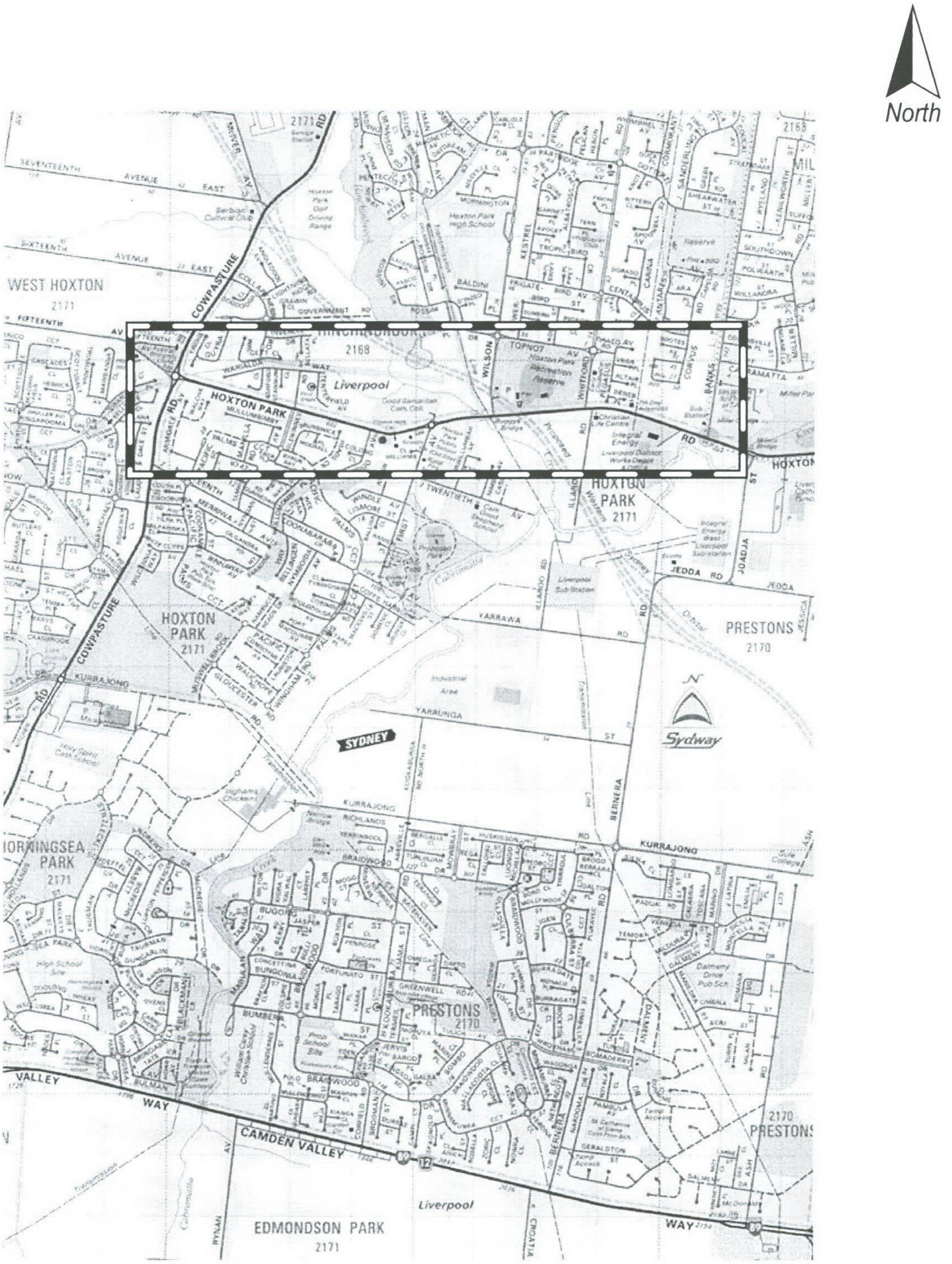
- Accident rates are likely to reduce in the future because of the signalisation of intersections and provision of divided carriageway.

- The proposed bus bays, shared footpaths/cycleways and pedestrian crossing facilities provided at signalised intersections would greatly improve pedestrian and cyclist safety and accessibility.

- It is noted that the proposed signalisation of the intersection of Hoxton Park Road/Whitford Road/Illaroo Road will be over capacity by 2016 without the widening of Hoxton Park Road. The Hoxton Park Road widening would be required (to provide the feed capacity) to achieve satisfactory operation in 2016.

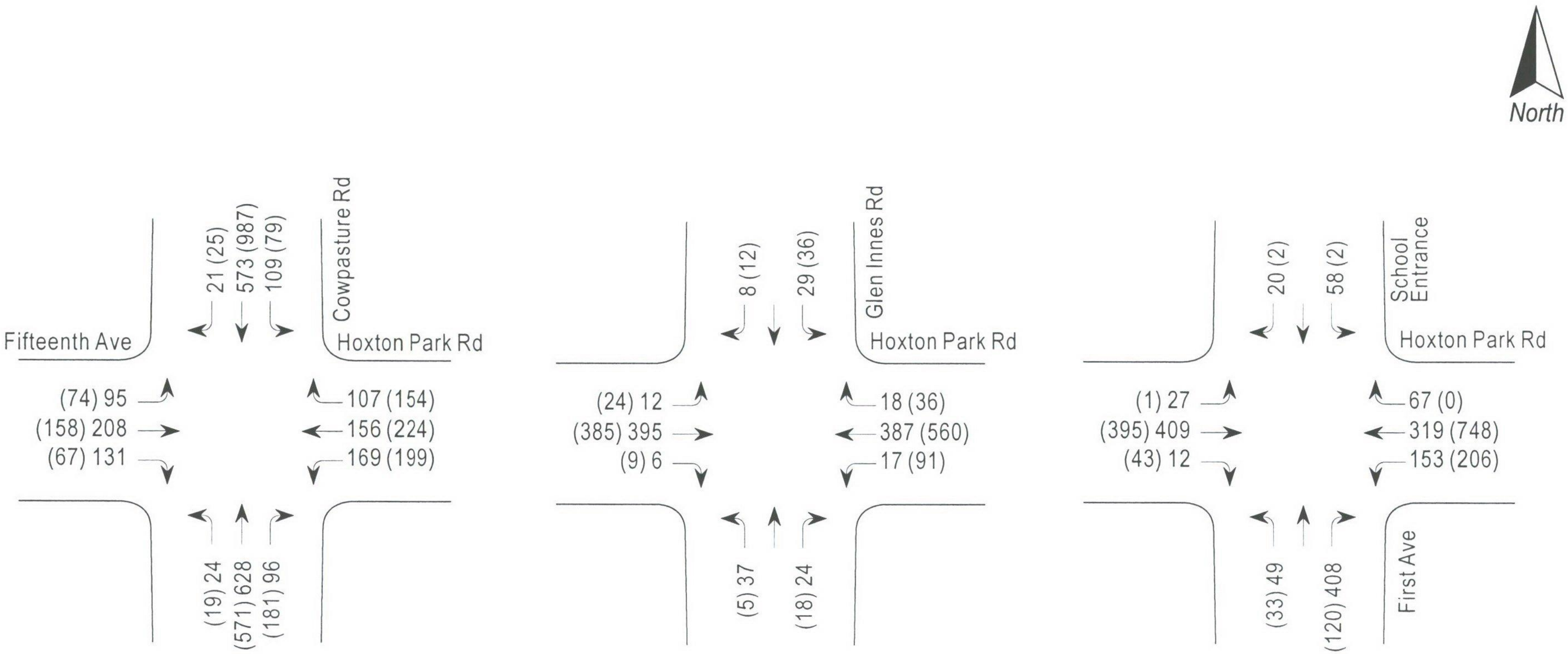
SITE LOCATION

HOXTON PARK ROAD



EXISTING TRAFFIC FLOWS

HOXTON PARK ROAD



Key

AM Peak: 8am Ð 9am

PM Peak: 5pm Ð 6pm

MASSON | WILSON | TWINEY

TRAFFIC AND TRANSPORT CONSULTANTS

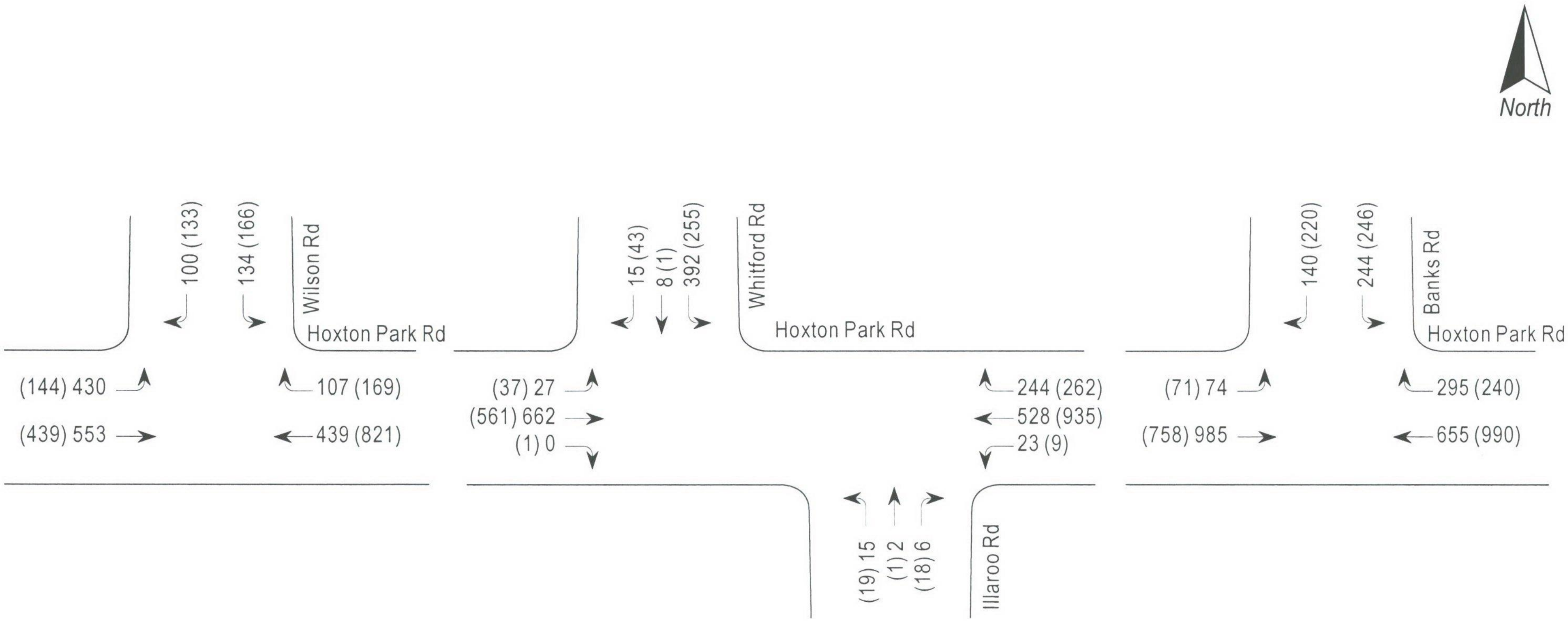
Figure 2

Filename: 011679di01.ai

Date: 28 January 2003

EXISTING TRAFFIC FLOWS

HOXTON PARK ROAD



Key

AM Peak: 8am Ð 9am

PM Peak: 5pm Ð 6pm

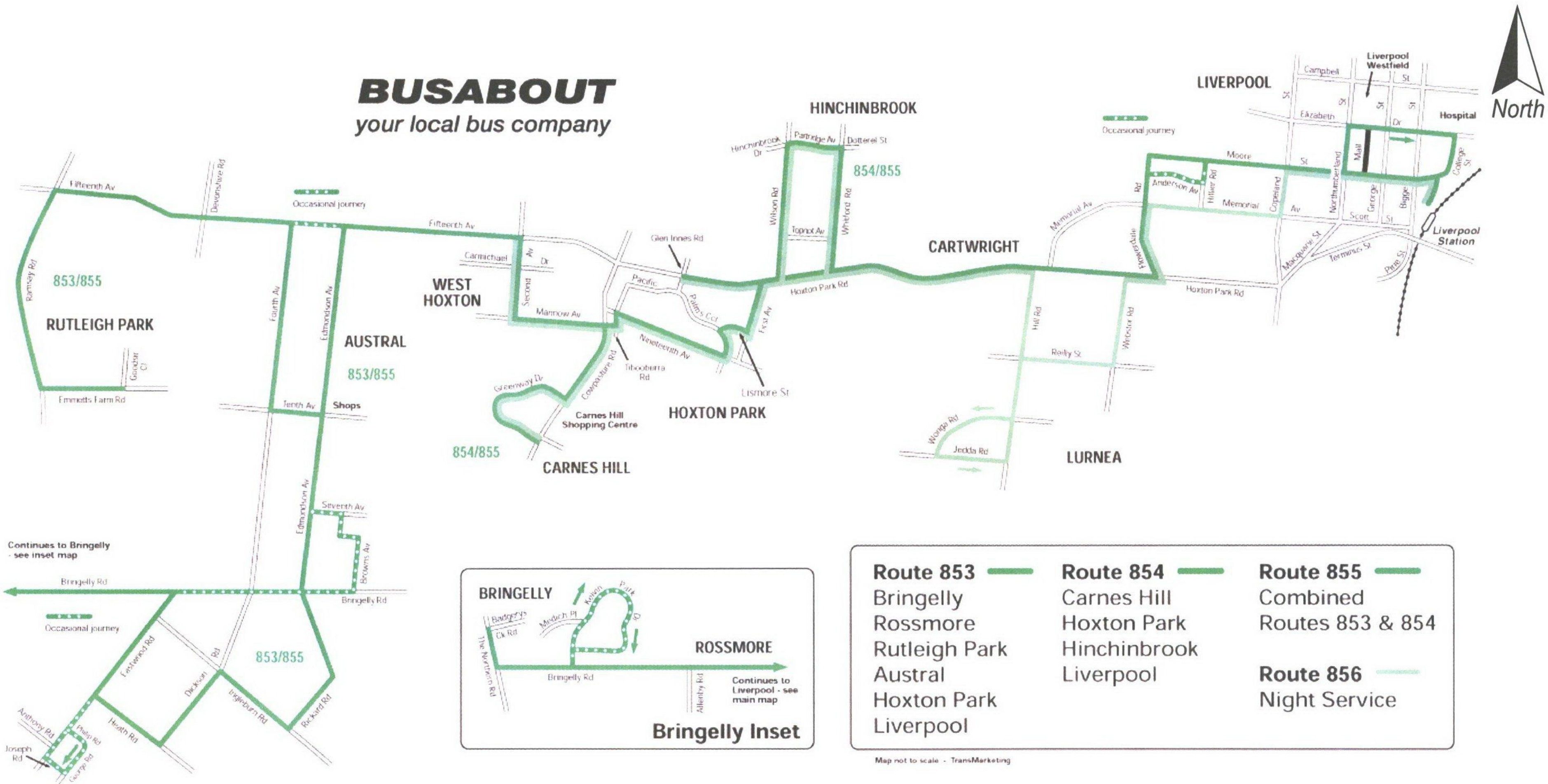
MASSON | *WILSON* | TWINEY

TRAFFIC AND TRANSPORT CONSULTANTS

Figure 3

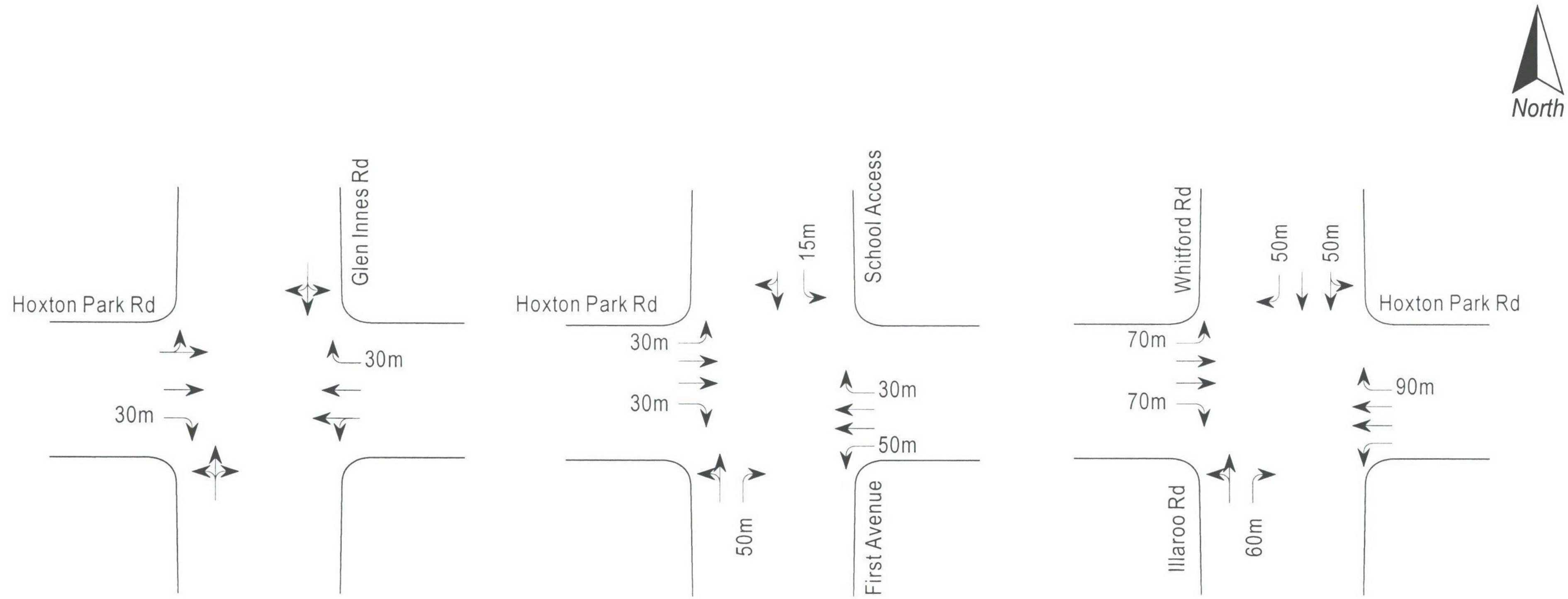
Filename: 011679di02.ai

Date: 28 January 2003


BUSABOUT
your local bus company
LIVERPOOL
HINCHINBROOK
CARTWRIGHT
WEST HOXTON
RUTLEIGH PARK
AUSTRAL
HOXTON PARK
CARNES HILL
LURNEA
853/855
854/855
Occasional journey
Liverpool Station
Liverpool Westfield
Hospital
Carnes Hill Shopping Centre
Shops
Continues to Bringelly - see inset map
North
BRINGELLY
ROSSMORE
Continues to Liverpool - see main map
Bringelly Inset
Route 853
Bringelly
Rossmore
Rutleigh Park
Austral
Hoxton Park
Liverpool
Route 854
Carnes Hill
Hoxton Park
Hinchinbrook
Liverpool
Route 855
Combined Routes 853 & 854
Route 856
Night Service
Map not to scale - TransMarketing

REQUIRED INTERSECTION GEOMETRY

HOXTON PARK ROAD



Key

30m Indicates lane storage length in metres

Appendix C

Ecological Assessment

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Hoxton Park Road Upgrade

Ecological Assessment

3 August 2004
Reference 1168.01.GE
Revision 4

Document Control

Connell Wagner

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Rev No	Date	Revision Details	Typist	Author	Verifier	Approver
0	2 May 2003	Draft	JF	JF	GM	TJP
1	15 August 2003	Draft	JF	JF	GM	TJP
1	27 August 2003	Final	JF	JF	MJ	TJP
2	23 January 2004	Final	JF	JF	GM	TJP
3	9 July 2004	Final	JF	JF	GM	TJP
4	3 August 2004	Final	JF	JF	GM	TJP

Table of Contents

1. Introduction

1.1 The Proposal

The proposed upgrade of Hoxton Park Road between Banks Road at Prestons and Cowpasture Road at Hoxton Park extends for a distance of approximately 2.3 kilometres. The proposed works are shown in Figure 1.1 and include the following components:

- widening of the existing carriageway from one lane in each direction to a four lane divided carriageway (two in each direction);
- removal of the existing bridge structure over Hinchinbrook Creek;
- provision of two new bridges over Hinchinbrook Creek;
- modification to the channel of Hinchinbrook Creek to minimise impacts on flooding;
- changes to intersections;
- bus bays at Glen Innes Road, Whitford Road, Hoxton Park Shops and the Good Samaritan School;
- provision of footways adjoining the northern and southern sides of the road;
- provision of a cycleway adjoining the northern side of the road;
- modified access to improve road safety, without significantly affecting existing street usage;
- design to accommodate the development of future Transitway lanes in both directions, following urban expansion in West Hoxton;
- upgraded drainage to accommodate the new configuration;
- landscaping improvements including extensive street tree planting;
- installation of noise walls as required to achieve environmental objectives.

The project traverses Hinchinbrook Creek, a permanently flowing major tributary of Cabramatta Creek. The proposed replacement of the existing bridge with two bridges (eastbound 18.5m wide and 30m long, westbound 15.5m wide and 30m long) in two or three spans (one or two rows of piers). Associated with this work, the project also proposes modifications to the bed and banks to minimise flood impacts over a distance of some 45m of Creek.

The proposal would require the removal of some native vegetation adjoining the existing road. This report examines the potential flora and fauna impacts arising from the proposal.

1.2 Study Area

Areas of remnant native vegetation within the study area, shown on Figure 1.1, were inspected and assessed. The study area encompasses the area to be disturbed by the proposal and adjacent areas within Hoxton Park reserve, where compensatory measures to offset the impacts of the proposal have been considered. Investigations to examine potential impacts on the aquatic environment have also been undertaken.

1.3 Topography and Drainage

The subject site is located on relatively flat land, with slope increasing to the north east of the study area (Figure 1.2). The study contains one main drainage line, Hinchinbrook Creek, and a minor drainage line running southeast through Hoxton Park Reserve. Hinchinbrook Creek flows into Cabramatta Creek some 700 metres downstream of the proposed works. Cabramatta Creek, a tributary of the Georges River also adjoins the project area at the eastern end opposite Banks Road. Drainage from the new works would direct some flows to this point with the remainder flowing to Hinchinbrook Creek.

1.4 Soil Landscapes

Inspection of the 1:100000 Soil Landscape Series Sheet 9030 for Penrith produced by Soil Conservation Service of NSW (1989) indicates that the study contains the Berkshire Park, South Creek and Blacktown group soil landscapes.

The Berkshire Park soil landscape is the result of three depositional phases of Tertiary alluvial/colluvial origin, all of which are derived from sandstone and clay. This soil landscape covers a wide area between the lower terraces of the Hawkesbury – Nepean System and west of South Creek and is located to the centre of the study area (Figure 1.2). Erosion hazard is low to moderate for non-concentrated flows and potentially high to extreme for concentrated flows.

The South Creek soil group is fluvial in origin and is typically associated with the floodplains, valley flats and drainage depressions of the channels of the Cumberland plain, such as Hinchinbrook Creek (Figure 1.2). The South Creek soil group is usually associated with flat incised channels, where soils are typically deep layered sediments over bedrock or relic/residual soil. Soil pH in this landscape varies from extremely acid to neutral, sc1 being consistently acidic whilst sc2 and sc3 range from moderately acid to neutral and extremely acid to neutral respectively. The soils are highly susceptible to erosion, which is reflected in a very high to extreme erosion hazard, as evident in the stream bank and gully erosion

The Blacktown group is residual in origin and is typically associated with gently undulating rises on Wianamatta Group Shales. The soils are typically shallow to moderately deep hard setting mottled texture soils, red and brown podsolic soils on crests grading to yellow podsolic soils on lower slopes and in drainage lines. Typically the soils are moderately reactive and highly plastic, exhibit low soil fertility and poor soil drainage. The soils have a slight to moderate erosion hazard for non-concentrated flows. The Blacktown group is located to the north of the study area near Hoxton Park Reserve (Figure 1.2).

As discussed in the REF main report, approximately 75% of the proposed upgrade has been mapped as 'Areas of Extensive Salinity Hazard. Appropriate engineering design and management of soils is required to manage potential impacts related to salinity.

No potential ASS has been identified from DIPNR (formerly DL&WC) mapping in the vicinity of the proposal. This would be confirmed during detailed RTA geotechnical investigation for the project.

1.5 Disturbance History

Much of the study area has been cleared for rural and residential development, with areas of remnant vegetation remaining along Hinchinbrook Creek and Hoxton Park Reserve (Figure 1.1). Much of the remnant native vegetation occurs in poorly drained, lower lying areas adjacent to Hinchinbrook Creek, mostly on the relatively infertile soils of the Berkshire Park landscape. Areas such as this were predominantly used for grazing cattle, which considering the low soil fertility and level of remaining native vegetation, is likely to have been of a relatively low intensity. The encroachment of residential development is likely to have led to the cessation of grazing within much of the remnant native vegetation within the last 10 to 20 years.

The native vegetation within the local area has been studied as part of the approvals process for the Western Sydney Orbital (WSO), and as part of the vegetation mapping of the Cumberland Plain by the NSW National Parks and Wildlife Service (2000). This vegetation is also part of a larger Recovery Planning exercise for the native vegetation on the Cumberland Plain. Recovery Plans are prepared by the NPWS for threatened species, populations or ecological communities and are intended to return the species, population or ecological community to a point where their survival is viable in nature.

The remnant native vegetation within the area of proposed works (the subject site) consists of remnant trees in cleared land and area of native vegetation along Hinchinbrook Creek (Figure 1.1). The area of native vegetation along Hinchinbrook Creek has been fenced off and is not subject to any ongoing maintenance regime. However, rubbish may be removed on occasion as part of council roadside cleaning activities. The canopy consists largely of semi-mature trees, which indicates that this area has been partly cleared in the past.

In the study area, outside of the subject site, the remnant native vegetation in Hoxton Park Reserve is typically mown in the western half, with the east being left to regenerate. Hoxton Park Reserve is crossed by a small number of walking trails, and contains a playing field and cleared land adjacent to Hoxton Park Road. Small amounts of rubbish are scattered throughout the Reserve.

1.6 Objectives of the Flora and Flora Study

The objectives of the study are:

- To provide a description of the flora and fauna of the area impacted by the proposal and of the area where compensatory measures are proposed;
- To identify and describe the flora and fauna habitats of these areas;
- To determine the likelihood of occurrence of any threatened species, populations and ecological communities listed under the TSC and EPBC Acts;
- To determine the habitats and likely habitat requirements of threatened species known or likely to occur;
- To provide a Conservation Significance Assessment according to guidelines provided in NPWS (2002); and
- To assess the significance of the proposal on threatened species, populations, ecological communities, and their habitats.

2. Methodology

2.1 Site Inspection

An inspection of the subject site was undertaken on 20 March 2003 to verify existing WSO mapping, identify the habitats suitable for native flora and fauna species on the subject site. Another inspection of the study area was undertaken on 11 July 2003 to provide baseline information for the Ecological Assessment of Study Area, which involved:

- the verification of existing NPWS vegetation and conservation significance mapping;
- identification of flora species; and
- description and location of habitats suitable for native flora and fauna species.

The site inspection concentrated on the vegetation to the south of Hoxton Park Road, the Hoxton Park Reserve and along the sections of Hinchinbrook Creek within and adjoining the study area.

The Random Meander Technique described in Cropper (1993) involving walked traverses of the study area, was utilised to search for threatened species and to compile a list of species observed. Habitat searches, involving the lifting of small logs, debris and so on, were also undertaken.

2.2 Ecological Assessment of Study Area

This assessment follows methodologies provided by the NSW National Parks and Wildlife Service to assess the conservation significance and recovery potential of native vegetation and the habitats of threatened species, which in turns assists in identifying the overall ecological value of the area.

These assessments are part of the recovery planning process for native vegetation on the Cumberland Plain, and as such provide an indication of what the most appropriate land use and management priority may be for the study area after the Recovery Plan is approved. To identify these areas, it is necessary to complete the following investigations:

1. To ground truth and validate the NPWS Western Sydney Vegetation Map for the Study Area, using higher resolution mapping;
2. To validate the NPWS Conservation Significance Assessment (CSA) for the vegetation of the Cumberland Plain;
3. To map and report on the habitat recovery potential of all land (both vegetated and cleared) within the study area; and
4. To map and report on the significance of habitat for threatened and regionally significant species likely to utilise the study area.

These tasks and the appropriate methods to undertake these investigations have been adopted from previous correspondence with NSW National Parks. The methods used in each investigation and the results of these studies are detailed in the following section.

2.2.1 Conservation Significance Assessment

The guidelines for the CSA have been adopted from NPWS (2002). These guidelines outline the approach used by the NSW NPWS in assessing the conservation significance of vegetation. The following is a brief description of the CSA categories used in this assessment.

Description of conservation significance categories
The decision making process used to assign a conservation significance category to remnant vegetation within the study area is described in detail in NPWS (2002). A brief description of each of the three categories is as follows <u>Core Habitat</u>

NPWS (2002) describe Core Habitat as areas that constitute the backbone of a viable conservation network across the landscape (core areas), or areas where the endangered ecological communities are at imminent risk of extinction (critically endangered communities). More specifically this category contains:

- all remnants of 10 hectares or more of the mapped vegetation category "Canopy Cover >10% (Unless Remnant >5ha, where Canopy Cover >5%)"; and
- all remnants of critically endangered communities (Castlereagh Swamp Woodland, Cooks River/Castlereagh Ironbark Forest, Blue Gum High Forest, Sydney Turpentine Ironbark Forest, Agnes Banks Woodland, Moist Shale Woodland, Elderslie Banksia Scrub Forest and Western Sydney Dry Rainforest).

Support for Core

NPWS (2002) describe Support for Core as providing a range of support values to the Core Habitat, including increasing remnant size, buffering from edge effects and providing corridor connections. Support for Core is intended to help identify areas for conservation and restoration that will enhance the biodiversity values in the region. This category contains:

- all remnants of the vegetation category "Canopy Cover < 10%" which are contiguous with the Core Habitat;
- all remnants of the vegetation category "Canopy Cover >10% (Unless Remnant >5ha, where Canopy Cover >5%)" which are less than 10 hectares and contiguous with the remnants of the vegetation category "Canopy Cover < 10%" above; and
- Urban Remnant Trees (Critically Endangered Communities)

This category contains areas of the critically endangered ecological communities which remain as remnant trees in an urban landscape (mapped as Canopy Cover < 10% (Urban Areas)).

Other Remnant Vegetation

This category contains all native vegetation that does not fall within the above significance categories

2.2.2 Anticipated Recovery Potential

Ian Perkins Consultancy Services and AES Environmental Services (2002) developed a technique to assess the capacity for vegetation to recover to a natural or near natural state based on the disturbance history. This study was restricted to a specific area at Harrington Park, and as such the techniques developed only accounted for the various disturbance histories found at that location.

When this technique was applied to a study area in Edmonson Park by EcoLogical (2002), a variety of disturbance histories were observed that were not accounted for by Ian Perkins Consultancy Services and AES (2002). In response to this, EcoLogical (2002) modified the Ian Perkins Consultancy Services and AES (2002) technique to incorporate the new disturbance histories. A summary of the In situ Resilience / Anticipated Recovery Capacity Assessment of EcoLogical (2002) is included in Appendix A.

This new assessment technique has been verified against the results of this study, and has been used to portray the In situ Resilience / Anticipated Recovery Capacity of vegetation across the study area.

2.2.3 Threatened Species Habitat Assessment

The assessment of habitat for threatened species is based on the methods described by Perkins (2002). This assessment identifies three types of habitat for each threatened species. These are:

- **Known habitats** are those where a threatened species has been recorded, and known or suitable habitats based on observations / interpretations;
- **Possible habitats** are those that are considered suitable for threatened species, however, contain no records for these species. Areas may adjoin known habitat. May include areas with a high to moderate insitu resilience / anticipated recovery capacity (ie. suitable habitat that may recover with appropriate management); and

- **Nil habitats** are those areas with no suitable habitat for threatened species, and includes area with a low to very low insitu resilience / anticipated recovery capacity.

Known and possible Habitats were distinguished from nil habitats based on the suitability of habitat for locally occurring threatened species or existing records. Locally occurring threatened species were identified from a search of the Atlas of NSW Wildlife (NPWS, March 2003 Update) and of the Environment Australia Online Database (March 2003) within 10km of the study area. The suitability of habitat on the site was based on an analysis of broad habitat types. A broader, more inclusive classification of habitats was used in recognition of the limits to the knowledge, detail in vegetation maps (as a surrogate for habitat maps) and natural variation in species preferences and movements.

Additionally, in recognition of the limited level of fauna survey, the 'precautionary principal' has been taken account. This approach is based on ESD principles, which state:

'*If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.*'

In this case, the 'lack of full scientific certainty' is due to the limited field survey. In broad terms, as field surveys cannot provide a confident assessment as to whether or not a species occurs, then it is assumed that it might occur if there is evidence to suggest this, such as suitable habitats or local area records.

3. Results and Discussion

3.1 Terrestrial Flora

3.1.1 Plant Community Structure and Floristics

Two studies have been conducted in the local area that have mapped the vegetation in the study area. Studies conducted as part of the Western Sydney Orbital EIS, identified two vegetation communities on the subject site, Cumberland Plains Woodland (CPW) and Sydney Coastal River-flat Forest (SCRFF). Both CPW and SCRFF as listed under the TSC Act as endangered ecological communities. Cumberland Plains Woodland is also listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* as an endangered ecological community.

Modelled vegetation maps of the Cumberland Plain published by NPWS (2002) have identified three vegetation communities in the study area: Shale - Gravel Transition Forest, Alluvial Woodland and Shale Plains Woodland. Alluvial Woodland is considered by NPWS (2002) to be part of SCRFF listed under the TSC Act, and as such is considered the same as the SCRFF identified by in the WSO EIS.

NPWS (2002) modelled the area of Cumberland Plain Woodland identified in the WSO as being two communities: Shale - Gravel Transition Forest and Shale Plains Woodland (Figure 3.1). Of these, only Shale Plains Woodland is part of the CPW listed under the TSC Act (NPWS 2002). Shale - Gravel Transition Forest is a distinct community, which is also listed under the TSC Act as an endangered ecological community.

The NPWS (2002) study includes a description of plant communities and a list of diagnostic species. There are two classes of diagnostic species that assist in differentiating communities, which are described as follows:

- 'Positive' indicates the species was found in plots in the community much more frequently than in plots in all the other communities; and
- 'Negative' indicates that the species is found more frequently in other communities.

Of all the species observed in the study area (Table 3.1), the vegetation mapped as SCRFF (WSO) and modelled as Alluvial Woodland (NPWS 2002) has a markedly higher number of positive diagnostic species than other nearby communities. As SCRFF and Alluvial Woodland are the same community, it is considered that the model of NPWS (2002) and the WSO mapping are accurate in the study area.

For the area mapped as CPW (WSO), or as Shale Gravel Transition Forest and Shale Plains Woodland (NPWS 2002), the distribution of positive diagnostic species does not clearly indicate that either community is not likely to occur in the study area (Table 3.2).

Table 3.1 Flora Species Observed on the Subject Site

Scientific Name	Common Name	Location
Trees		
*Acacia baileyana**	Cootamundra Wattle	Regenerating vegetation
Angophora floribunda	Rough-barked Apple	All areas
Casuarina glauca	Swamp Oak	Mown / cleared areas
*Eucalyptus microcorys**	Tallowwood	Mown / cleared areas
Eucalyptus moluccana	Grey Box	All areas
Eucalyptus tereticornis	Forest Red Gum	All areas
Shrubs		
Acacia decurrens	Black Wattle	All areas

Table 3.1 Flora Species Observed on the Subject Site		
Scientific Name	**Common Name**	**Location**
Bursaria spinosa	Blackthorn	Regenerating vegetation
Indigofera australis	Native Indigo	Regenerating vegetation
*Pyracantha sp**	Firethorn	Mown / cleared areas
*Sida rhombifolia**	Paddy's Lucerne	All areas
Ground Layer		
Aristida ramosa	Wire Grass	All areas
Aristida warburgii	Wire Grass	Regenerating vegetation
Avena sp.	-	All areas
*Bidens pilosa**	Cobbler's Pegs	All areas
*Bryophyllum delagoense**	Mother of Millions	All areas
Calotis dentax	-	Regenerating vegetation
Carex appressa	Tall Sedge	Regenerating vegetation
Cheilanthes sieberi	Poison Rock Fern	Regenerating vegetation
*Chloris gayana**	Rhodes Grass	All areas
*Cirsium vulgare**	Spear Thistle	All areas
*Cynodon dactylon**	Common Couch	All areas
Cyperus polystachyos	-	Regenerating vegetation
Danthonia sp.	-	Regenerating vegetation
Dianella longifolia	-	Regenerating vegetation
Dichondra repens	Kidney Weed	All areas
*Digitaria sanguinalis**	Crab Grass	All areas
*Duchesna indica**	Wild Strawberry	All areas
Einadia hastata	Berry Saltbush	All areas
Eremophila debilis	Winter Apple	Regenerating vegetation
Galium sp.	Bedstraw	All areas
*Hypochaeris radicata**	Flatweed	All areas
Isolepis inundata	Swamp Club-rush	Regenerating vegetation
Juncus continuus	-	Regenerating vegetation
Lomandra multiflora	Many-flowered Mat-rush	Regenerating vegetation
Microlaena stipoides	Weeping Rice Grass	All areas
*Opuntia stricta**	Prickly Pear	All areas
Panicum simile	Two Colour Panic	All areas
*Paspalum dilatatum**	Paspalum	All areas
*Paspalum urvillei**	Vasey Grass	All areas
*Pennisetum clandestinum**	Kikuyu	All areas
Plantago lanceolata	Ribwort	All areas
Pratia purpurascens	Whiteroot	Regenerating vegetation
*Protasparagus densiflorus**	Asparagus Fern	All areas
Rumex brownii	Swamp Dock	Regenerating vegetation
Senecio bipinnatisectus	-	All areas
*Senecio madagascariensis**	Fireweed	All areas
Silybum marianum	Variegated Thistle	All areas
*Solanum nigrum**	Black Nightshade	All areas
Solvia pterosperma	Bindii	All areas
*Sonchus oleraceus**	Common Sow-thistle	All areas
*Tagates minuta**	Stinking Roger	All areas

Table 3.1 Flora Species Observed on the Subject Site		
Scientific Name	Common Name	Location
*Taraxacum officinale**	Dandelion	All areas
Themeda australis	Kangaroo Grass	Regenerating vegetation
*Trifolium repens**	White Clover	All areas
Vines and Scramblers		
*Araujia hortorum**	Mothvine	Regenerating vegetation
Billardiera scandens	Apple Dumplings	Regenerating vegetation
Clematis glycinoides	Clematis	All areas
Glycine microphylla	Twining Glycine	All areas
Glycine tabacina	Twining Glycine	All areas
*Myrsiphyllum asparagoides**	Bridal Creeper	Regenerating vegetation
*Vicia sativa ssp. sativa**	Common Vetch	Regenerating vegetation
Aquatic'		
Juncus usitatus	-	Regenerating vegetation
Typha australis	-	Regenerating vegetation
Ranunculus sp.	-	Regenerating vegetation

* *Introduced species*

Table 3.2: The Number of Diagnostic Species		
COMMUNITY (NPWS 2002)	Number of Diagnostic Species (Positive/Negative)	
	Terrestrial	Riparian
Alluvial Woodland	3 / 3	9 / 0
Shale Gravel Transition Forest	11 / 0	4 / 0
Shale Plains Woodland	9 / 0	1 / 0

It is considered that the disturbance history of the study area is likely to have reduced the native floristic diversity, and consequently the distinction between communities is likely to be less clear. In addition to this, the CPW (WSO) is located across two soil landscapes, the Blacktown and the Berkshire Park. The Blacktown soil landscape is shale derived, and is more commonly associated with CPW / Shale Plains Woodland. The Berkshire Park soil landscape is characterised by tertiary alluvium, and is more commonly associated with Shale Gravel Transition Forest (NPWS 2002). The location of two soil landscapes indicates that the area is likely to be transitional, and as such, there is the possibility that the distinction between communities is likely to be relatively low regardless of the disturbance history.

Considering the number of diagnostic species, and the soil landscapes, the majority of vegetation on the subject site is likely to be Shale - Gravel Transition Forest as described in NPWS (2002). The Shale Plains Woodland is considered likely to occur on the northern periphery of the study area, or to have occurred in the residential area immediately north east of the study area. As elevation increases to the north east of the study area (Figure 3.2), the deposition of tertiary alluvium is likely to have be less, giving way to shale derived soils, with which CPW / Shale Plains Woodland is associated.

The proposal will result in the removal of approximately 1.4 ha of native vegetation, of which 0.667ha are Shale Gravel Transition Forest and 0.747ha Alluvial Woodland. This vegetation contains a variety of exotic ground layer and shrub species with a canopy of native trees (Table 3.1). The canopy consists of relatively young trees, which indicates that it has been cleared in the past and grazed until more recent times. This vegetation is part of a linear band of vegetation located alongside Hinchinbrook Creek. As with the subject site, adjoining vegetation contains a variety of introduced species and does not contain mature native vegetation.

A summary of the impacts of the proposal on these communities is provided in Section 4 of this report, with a detailed analysis provided in Appendix B.

3.1.2 Flora Species of Conservation Significance

A search of the Atlas of NSW Wildlife (NPWS, March 2003 Update) and Environment Australia Online Database (March 2002) found that several plant species occur within 10km of the subject site or have ranges that cover the subject site. These species and their habitat requirements are detailed in Table 3.3.

As described in Section 3.1.1 of this report, the subject site consists of a relatively small area of disturbed vegetation located within a largely cleared landscape. It is considered that the absence of a threatened species is an accurate reflection of its likelihood of occurrence, as re-establishment from other areas of suitable habitat is highly unlikely. As such, species not located on site are not assessed further in Appendix B.

Similarly, species with no suitable habitat on site are not considered likely to occur and are not assessed further. The habitat associations of species in Table 3.3 are reasonably well known, and as such those species with no suitable habitat on the subject site are not assessed further in Appendix B.

Species that were located on the subject site are assessed further in Appendix B. The significance of the impact is determined according to Section 5A of the *Environment Planning and Assessment Act 1979* (EP&A Act) ('8 part test of significance) and Environment Australia's administrative guidelines for determining whether an action has, will have, or is likely to have a significant impact on a matter of National Environmental Significance (NES) under the EPBC Act (Environment Australia, 2000).

Table 3.3 Locally Occurring Threatened Flora Species

Species	Habitat	Assessment
Acacia pubescens TSC - V; EPBC - V	Associated with Cumberland Plains Woodlands, Shale / Gravel Forest and Shale / Sandstone Transition Forest. Clay soils, often with ironstone gravel (NPWS 1997, Benson and McDougall 1996).	• Suitable habitat present: Shale / Gravel Forest (*subject site*) & Cumberland Plains Woodlands (*study area*). • Not located in study area. • Species is not likely to be affected and is not assessed further.
Cynanchum elegans TSC - E; EPBC - E	Dry rainforest gullies, scrub and scree slopes (NPWS 1997)	• No suitable habitat present (*Eucalypt dominated of study area vegetation is not rainforest*). • Not located in study area. • Species is not likely to be affected and is not assessed further.
Dillwynia tenuifolia TSC - E; EPBC - E	Associated with Shale/Gravel Transition Forest and Castlereagh Scribbly Gum Woodland (NPWS, 1997). Soils are typically red sandy to clayey, sometimes gravelly soils on tertiary alluvium. Occasionally on sandy loams over sandstone (Benson and McDougall 1996).	• Suitable habitat present (*Shale/Gravel Transition Forest*). • Not located in study area. • Species is not likely to be affected and is not assessed further.

Table 3.3 Locally Occurring Threatened Flora Species		
Species	**Habitat**	**Assessment**
Diuris aequalis TSC - E	Eucalypt forest with a grassy - heathy understorey on gravelly clay loams. Flowers mainly November (*sensu* Bishop 1996). Previously occurred in the Liverpool area of western Sydney, but has not been located there in over 100 years (NSW Scientific Committee 2002).	• Suitable habitat present (*Shale/Gravel Transition Forest*). • Not located in study area. • Species is not likely to be affected and is not assessed further.
Grevillea juniperina subsp. juniperina TSC – V	Restricted to red sandy to clay soils – often lateritic on Wianamatta Shale and Tertiary alluvium in Cumberland Plain Woodland and Castlereagh Woodland (NSW Scientific Committee 2000).	• No suitable habitat present in subject site (*no Cumberland Plain Woodland or Castlereagh Woodland*) but may occur in study area (*in Cumberland Plain Woodland*). • Not located in study area. • Species is not likely to be affected and is not assessed further.
Grevillea parviflora subsp. parviflora TSC - V; EPBC - V	Occurs in light clayey soils in woodlands from Prospect to Camden and Appin, with disjunct northern populations near Putty, Cessnock and Cooranbong (NSW Scientific committee 1998)	• No suitable habitat present (*soils are not light clays; vegetation structure not woodland*). • Not located in study area. • Species is not likely to be affected and is not assessed further.
Marsdenia viridiflora subsp. viridiflora TSC - E2	Associated with a range of communities, from woodland and scrub (Harden 1994) to Western Sydney Dry Rainforest and Sydney Turpentine-Ironbark Forest (NSW Scientific Committee 1998, 2000).	• Suitable habitat present (*the broad range of habitats indicate a preference for clayey soils, such as occur on site*). • Not located in study area. • Not located on site. • Species is not likely to be affected and is not assessed further.
Melaleuca deanei TSC - V; EPBC - V	Associated with woodland on broad ridge tops and slopes on sandy loam and lateritic soils (Benson and McDougall 1998; Travers Morgan 1990).	• No suitable habitat present (*Soils are not sandy loams or lateritic – these are associated with the Hawkesbury Geological Group & not the Wianamatta, site not on a broad ridge*). • Not located in study area. • Not located on site. • Species is not likely to be affected and is not assessed further.
Persoonia nutans TSC - E; EPBC – E	Associated with dry woodland, Castlereagh Scribbly Gum Woodland, Agnes Banks Woodland and sandy soils associated with tertiary alluvium, occasionally poorly drained (Benson and McDougall 2000). Endemic to the Western Sydney (Benson and McDougall 2000).	• No suitable habitat present (*vegetation is not similar to Castlereagh Scribbly Gum or Agnes Banks Woodland*). • Not located in study area. • Not located on site. • Species is not likely to be affected and is not assessed further.

Table 3.3 Locally Occurring Threatened Flora Species		
Species	**Habitat**	**Assessment**
Pimelea spicata TSC - E; EPBC - E	Associated with Cumberland Plains Woodland, in open woodland and grassland often in moist depressions or near creek lines. Have been located disturbed areas (NPWS 1997).	• Suitable habitat present (*Cumberland Plains Woodland in study area, also some potential in vegetation near creek*). • Not located in study area. • Species is not likely to be affected and is not assessed further.
Pomaderris brunnea TSC - V; EPBC - V	Associated with Open Forests in the Colo River and Upper Nepean River Areas (Harden 1994)	• No suitable habitat present (*habitats in the Colo and upper Nepean is those associated with the Hawkesbury Sandstone geological group, not those in the study area*). • Not located in study area. • Not located on site. • Species is not likely to be affected and is not assessed further.
Pterostylis saxicola TSC - E; EPBC - E	Terrestrial orchid predominantly found in Hawkesbury Sandstone Gully Forest growing in small pockets of soil that have formed in depressions in sandstone rock shelves (NPWS 1997). Known from Georges River National Park, Ingleburn, Holsworthy, Peter Meadows Creek and St Marys Tower (NSW Scientific Committee 1999).	• No suitable habitat present (*Site is not located on the Hawkesbury geological group*). • Not located in study area. • Not located on site. • Species is not likely to be affected and is not assessed further.
Pultenaea pedunculata TSC - E	Shale Gravel Transition Forest in the Wianamatta Shale - Tertiary alluvium intergrades area (NPWS 1997).	• Suitable habitat present (*Hoxton Park Reserve, where this intergrade is likely to occur*). • Not located in study area. • Species is not likely to be affected and is not assessed further.
Pultenaea parviflora TSC - E; EPBC - V	Associated with Castlereagh Woodlands in Benson (1992) (NPWS 1997), tertiary alluvium of sandy to clay soils (Benson and McDougall 1996) and the transition between Wianamatta shale and tertiary alluvium (NPWS, 1997).	• No suitable habitat present (*Castlereagh Woodlands do not occur in the study area*). • Not located on site. • Species is not likely to be affected and is not assessed further.

TSC = Threatened Species Conservation Act 1995
EPBC = Environment Protection and Biodiversity Conservation Act 1999
E = Endangered
E2 = Endangered population
V = Vulnerable

Of the threatened species known to occur in the local area, several Federal and State listed threatened species are considered to have potential to occur due to local records or the presence of suitable habitats within the subject site (Table 3.3). However, none of these were located during the flora survey and as discussed none are considered likely to occur. As such, no threatened flora species are likely to be impacted by the proposal, and none are assessed further.

3.2 Terrestrial Fauna

Faunal Habitats

A limited number of fauna habitats were located on the subject site and more broadly in the study area. The relationship between these habitats and threatened species known to occur in the local area are discussed below.

Leaf litter, debris and ground cover

Leaf litter, debris and ground cover in several vegetation communities on the Cumberland Plain is of some significance as it potentially provides foraging habitat for a number of threatened woodland birds, such as the Speckled Warbler (*Pyrrholaemus sagittatus*) and the Diamond Firetail (*Stagonopleura guttata*).

Habitat Trees

The trees on the subject site appear to be relatively young, with mature trees occurring in Hoxton Park Reserve to the north. One dead semi-mature tree was observed on the subject site that contained some potential shelter / roosting habitat. No other hollow bearing trees were observed, nor are considered likely to occur on the subject site. As such, it is unlikely that the subject site contains suitable shelter or breeding habitat for threatened arboreal and scansorial mammals or microbats known to occur in the local area.

Winter flowering trees

The vegetation in the vicinity of the proposal contains serval Forest Red Gums (*Eucalyptus tereticornis*), which flower in winter (Law *et al.* 2000). As eucalypts tend to flower in the warmer months, winter flowering species such as the Forest Red Gum provide an important resource for threatened species such as the Grey-headed Flying-fox (*Pteropus poliocephalus*), Swift Parrot (*Lathamus discolor*) and the Regent Honeyeater (*Xanthomyza phrygia*). In the local area, winter flowering resources are associated with a number of endangered ecological communities, which indicates a marked decline in these resources. The distribution of this resource is approximated by the distribution of native vegetation, as shown on Figure 3.2.

Watercourse

Aquatic habitats are discussed in more detail in Section 3.3.1. The section of creek affected by the works includes a combination of shallow riffles and deeper pools.

With the exception of the Green and Golden Bell Frog (*Litoria aurea*), threatened species of amphibians are associated with larger bushland areas that are predominantly based on substrates derived from Hawkesbury Sandstone (Ehmann 1997), and as such are highly unlikely to occur on site. Due to the open nature of much of the stream, likely presence of predators such as the Plague Minnow (*Gambusia holbrooki*) and absence of this species during WSO field surveys, it is considered that the Green and Golden Bell Frog (*Litoria aurea*) is not likely to occur on site.

3.2.1 Fauna Species of Conservation Significance

The Atlas of NSW Wildlife (NPWS 2003, March update) and the Environment Australia Online Database contained records for several threatened fauna species within 10km of the subject site. These species and their habitat requirements are detailed in Table 3.4. This Table also details whether suitable habitat was present on site, and whether the species would be potentially impacted by the proposal.

Table 3.4 Locally Occurring Threatened Fauna Species

Amphibians & Reptiles	Habitat Associations	Comment
Heleioporus australiacus Giant Burrowing Frog TSC – E; EPBC – V	Forages in woodlands, wet heath, dry and wet sclerophyll forest. Associated with semi-permanent to ephemeral sand or rock based streams (Ehmann 1997), where the soil is soft and sandy so that burrows can be constructed (Environment Australia 2000).	• No suitable habitat present (*soils are not sandy, species not associated with shale derived soils*). • Not considered likely to occur, and is not considered further.
Litoria aurea Green and Golden Bell Frog TSC – E; EPBC – V	Large ephemeral bodies of water exhibiting well-established fringing vegetation adjacent to open grassland areas for foraging (Ehmann 1997).	• No suitable habitat present (*water bodies are flowing & are likely to contain a high number of predators, namely gambusia*). • Not considered likely to occur, and is not considered further.
Mixophyes iteratus Giant Barred Frog TSC – E; EPBC – E	Found on forested slopes of the escarpment and adjacent ranges in riparian vegetation, subtropical and dry rainforest and wet sclerophyll forests. This species is associated with flowing streams with high water quality, though habitats may contain weed species (Ehmann 1997).	• No suitable habitat present (*poor water quality*). • Not considered likely to occur, and is not considered further.
Pseudophryne australis Red-crowned Toadlet TSC – V	Associated with open forest to coastal heath (Ehmann, 1997). Utilises small ephemeral drainage lines which feed water from the top of the ridge to the perennial creeks below for breeding, and are not usually found in the vicinity of permanent water (Ehmann, 1997). Breeding sites are often characterised by clay-derived soils and generally found below the first sandstone escarpment in the talus slope (NPWS 1997).	• No suitable habitat present (*species restricted to habitats associated with the Hawkesbury Sandstone group, not those of the site*). • Not considered likely to occur, and is not considered further.

Table 3.4 Locally Occurring Threatened Fauna Species		
Hoplocephalus bungaroides Broad-headed Snake TSC – E; EPBC – V	Associated with sandstone outcrops in coastal and near coastal areas of central NSW. In terms of shelter, this species requires rocky crevices and sandstone outcrops with exfoliated rock slabs, which are exposed to sunlight. In the summer months, medium to large tree hollows up to 800m from a cliff are utilised (Shine and Fitzgerald 1994).	• No suitable habitat present (*species restricted to habitats associated with the Hawkesbury Sandstone group, not those of the site*). • Not considered likely to occur, and is not considered further.
Avifauna	**Habitat Associations**	**Comment**
Burhinus grallarius Bush Stone-curlew TSC – E	Associated with dry open woodland with grassy areas (SFNSW, 1995), dune scrubs, in savanna areas, the fringes of mangroves, golf courses and open forest / farmland (Pittwater Council 2000, Marchant & Higgins, 1999). Forages in areas with fallen timber, leaf litter, little undergrowth and where the grass is short and patchy (Environment Australia 2000; Marchant & Higgins, 1999). Is thought to require large tracts of habitat to support breeding, in which there is a preference for relatively undisturbed in lightly disturbed habitat (in SFNSW 1995).	• Poor quality habitat present (*open forest & grassy understorey, however, is a small area of habitat*). • Lack of local records and threatening processes (see NPWS 1997) indicate species highly unlikely to occur. • Not considered likely to occur, and is not considered further.
Lathamus discolor Swift Parrot TSC – E; EPBC - E	Associated with dry open eucalypt forests and woodlands with winter flowering eucalypts (Marchant and Higgins 1999). In the local area, this species has utilised Spotted Gum (*Corymbia maculata*), Banksias (*Banksia integrifolia* and *B. serrata*) (SFNSW 1995). Winter flowering eucalypts in the study area include Blackbutt (*Eucalyptus pilularis*), Swamp Mahogany (*E. robusta*) and the Forest Red Gum (*E. tereticornis*) (Law et al. 2000). Often located in urban areas and farmlands with remnant eucalypts.	• Suitable habitat (*study area, the Forest Red Gum (E. tereticornis)*. • Potential to occur on site and is assessed further.
Melithreptus gularis gularis Black-chinned Honeyeater TSC – V	Predominantly associated with box-ironbark association woodlands and River Red Gum. Also associated with drier coastal woodlands of the Cumberland Plain and the Hunter, Richmond and Clarence Valleys (NSW Scientific Committee, 2001).	• Suitable habitat (*the drier woodlands of the Cumberland Plains is broadly similar to vegetation in the study area*). • Potential to occur on site and is assessed further.
Pyrrholaemus sagittatus Speckled Warbler TSC – V	Speckled Warblers occupy eucalypt and cypress woodlands on the slopes west of the Great Dividing Range, with an extension of range into the cypress woodlands of the northern Riverina. Populations also occur in drier coastal areas such as the Cumberland Plain, Western Sydney and the Hunter and Snowy River valleys. Speckled Warblers inhabit woodlands with a grassy understorey, often on ridges or gullies.	• Suitable habitat (*the drier woodlands of the Cumberland Plains is broadly similar to vegetation in the study area*). • Potential to occur on site and is assessed further.

Table 3.4 Locally Occurring Threatened Fauna Species		
Xanthomyza phrygia Regent Honeyeater TSC – E; EPBC - E	The Regent Honeyeater primarily feeds on nectar from box and ironbark eucalypts and occasionally from banksias and mistletoes (NPWS 1995). Associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland and urban areas with mature eucalypts, riparian forests of River Oak (*Casuarina cunninghamiana*) (SFNSW 1995, Garnett 1993). Reliant on locally abundant nectar sources, especially flowering eucalypts that occur mainly in dry open woodland (SFNSW 1995), on richer soil types with different flowering times to provide reliable supply of nectar (Environment Australia 2000). Areas containing Swamp Mahogany (*Eucalyptus robusta*) in coastal areas have bee observed to be utilised (NPWS 1997, SFNSW 1995).	• Suitable habitat (*study area contains a temperate eucalypt forest on richer soil types*). • Potential to occur on site and is assessed further.
Ninox connivens Barking Owl TSC – V	Associated with a variety of habitats such as savanna woodland, open eucalypt forests, wetland and riverine forest. Kavanagh et al. (1995) suggests that the species is particularly associated with coastal lowland or riparian woodland dominated by various red gum species. The diet of the Barking Owl consists of mammals, birds and insects, the percentage of which depends largely on seasonal availability (Debus 1997). Species rich habitats, such as woodlands and ecotones, are considered to important habitat for this species due to its' diverse diet (Environment Australia 2000). Usually nests in large tree hollows with entrances averaging 2-29 metres above ground, depending on the forest or woodland structure and the canopy height (Debus 1997).	• No suitable habitat (*study area - lack of recent local records indicates species is unlikely to occur; and species poor habitats due to proximity to road, cleared land and linear configuration of habitat*). • Not considered likely to occur, and is not considered further.
Tyto novaehollandiae Masked Owl TSC – V	Associated with forest with sparse, open, understorey, particularly the ecotone between wet and dry forest, and non-forest habitat (Environment Australia 2000). Known to utilise forest margins and isolated stands of trees within agricultural land (Hyem 1979) and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained (Kavanagh and Peake 1993).	• Suitable habitat (*study area*). • Potential to occur on site and is assessed further.

Table 3.4 Locally Occurring Threatened Fauna Species

Mammals	Habitat Associations	Comment
Cercartetus nanus Eastern Pygmy-possum TSC – V	Pygmy-Possums feed mostly on the pollen and nectar from banksias, eucalypts and understorey plants and will eat insects, seeds and fruit. Small tree hollows are favoured as day nesting sites, but nests have also been found under bark, in old birds' nests and in the branch forks of tea-trees (Turner and Ward, 1995).	• No suitable habitat present (*poor diversity of flowering shrubs, trees; records are associated with lager areas of habitat on sandstone based vegetation*). • Not considered likely to occur, and is not considered further.
Dasyurus maculatus Spotted-tailed Quoll TSC – V; EPBC - V	The Spotted-tailed Quoll inhabits a range of forest communities including wet and dry sclerophyll forests and rainforests (Mansergh 1984), more frequently recorded near the ecotones of closed and open forest (SFNSW 1995). Maternal den sites are logs with cryptic entrances; rock outcrops; windrows; burrows (Environment Australia 2000).	• No suitable habitat (*no den sites observed, habitats are small, degraded and are likely to only offer a limited range of prey items*). • Has the potential to use site as a movement corridor and is assessed further.
Petaurus norfolcensis Squirrel Glider TSC – V	Associated with dry hardwood forest and woodlands (Menkhorst et al. 1988, Quin 1993, and Traill 1991). Habitats typically include gum barked and high nectar producing species, including winter flower species (Menkhorst et al. 1988). The presence of hollow bearing eucalypts is a critical habitat value (Quin 1995).	• No suitable habitat present (*study area - low diversity of foraging resources, no suitable hollow bearing eucalypts*) • Not considered likely to occur, and is not considered further.
Petrogale penicillata Brush-tailed Rock-wallaby TSC - V; EPBC - V	Rocky areas in a variety of habitats, typically north facing sites with numerous ledges, caves and crevices (Strahan 1995).	• No suitable habitat present (*no ledges, caves or crevices*). • Not considered likely to occur, and is not considered further.
Potorous tridactylus Long-nosed Potoroo TSC - V; EPBC - V	Associated with dry coastal heath and dry and wet sclerophyll forests with relatively thick ground cover and light sandy soils (Strahan 1995).	• No suitable habitat present (*soils are clays, ie, not light and sandy*). • Not considered likely to occur, and is not considered further.
Chalinolobus dwyeri Large Pied Bat TSC – E; EPBC - V	The Large-eared Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests. This species roost in caves (Churchill 1998).	• Suitable habitat (*study area – foraging habitat only*). • Potential to occur on site and is assessed further.
Falsistrellus tasmaniensis Eastern False Pipistrelle TSC – V	This species is associated with forested areas with higher rainfall (Parnaby, 1983), and has been located from the highlands to the coast, appearing to be less common at low altitudes, and tending to favour the cool moist forests of the ranges (Phillips, 1998). While the Eastern False Pipistrelle roosts primarily in tree trunk hollows, individuals have also be found in caves and abandoned buildings (Klippel, 1992).	• Suitable habitat (*study area – foraging habitat only*). • Potential to occur on site and is assessed further.

Table 3.4 Locally Occurring Threatened Fauna Species

Miniopterus schreibersii Common Bent-wing Bat TSC – V; EPBC - V	Associated with a range of habitats, typically well timbered areas where it forages above and below the tree canopy on small insects (Australian Museum Business Services, 1995; Dwyer, 1995, 1981). Will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (Environment Australia 2000, Dwyer 1988). This species has been reported utilising bushland remnants in urban areas and is estimated to forage within a 20km radius in a single night.	• Suitable habitat (*study area – foraging habitat only*). • Potential to occur on site and is assessed further.
Mormopterus norfolkensis East Coast Freetail Bat TSC – V	Although the habitat preferences are unclear, most records of this species have been reported from dry eucalypt forest and woodland on the eastern side of the Great Dividing Range. Individuals have, however, been recorded flying low over a rocky river in rainforest and wet sclerophyll forest and foraging in clearings at forest edges (Environment Australia 2000, Allison & Hoye 1998). Primarily roosts in hollows or behind loose bark in mature eucalypts, but have been observed roosting in the roof of a hut (Environment Australia 2000, Allison & Hoye 1998). Examination of wing morphology indicate that cleared or open habitats are favoured, such as open habitats (woodlands), cleared forest edges and tracks through forests as well as areas above the forest canopy (Ecotone 2002).	• Suitable habitat (*study area – foraging habitat only*). • Potential to occur on site and is assessed further.
Myotis adversus Southern Myotis TSC - V	A variety of foraging habitats are used by this species although it is usually found near large bodies of water, including estuaries, lakes, reservoirs, rivers and large streams, often in close proximity to their roost site. Movements of up to 20km between roost and foraging site have however, been recorded (Caddle and Lumsden, 1999). The species apparently has specific roost requirements, and only a small percentage of available caves, mines, tunnels and culverts are used (Richards 1998). While roosting is most commonly associated with caves, this species has been observed to roost in tree hollows (Churchill 1998).	• Suitable habitat (*study area – foraging habitat only*). • Potential to occur on site and is assessed further.
Pteropus poliocephalus Grey-headed Flying-Fox TSC – V; EPBC - V	Inhabits a wide range of habitats including rainforest, mangroves, paperbark forests, wet and dry sclerophyll forests and cultivated areas (Eby 1998).	• Suitable habitat (*study area – foraging habitat only*). • Potential to occur on site and is assessed further.

Table 3.4 Locally Occurring Threatened Fauna Species		
Saccolaimus flaviventris Yellow-bellied Sheathtail-bat TSC - V	Associated with open country, mallee, eucalypt forests, rainforests, heathland and waterbodies (SFNSW 1995). Roosts in tree hollows; may also use caves; has also been recorded in a tree hollow in a paddock (Environment Australia 2000). The Yellow-bellied Sheathtail-bat is dependent on suitable hollow-bearing trees to provide roost sites, which may be a limiting factor on populations in cleared or fragmented habitats.	• Suitable habitat (*study area – foraging habitat only*). • Potential to occur on site and is assessed further.
Scoteanax rueppellii Greater Broad-nosed Bat TSC – V	Associated with moist gullies in mature coastal forest, or rainforest, east of the Great Dividing Range (Churchill, 1998), tending to be more frequently located in more productive forests. Within denser vegetation types use is made of natural and man made openings such as roads, creeks and small rivers, where it hawks backwards and forwards for prey (Hoye & Richards 1995).	• Suitable habitat (*study area – foraging habitat only*). • Potential to occur on site and is assessed further.
Invertebrates	**Habitat Associations**	**Comment**
Meridolum corneovirens Large Land Snail TSC - E	Associated with open eucalypt forests, particularly Cumberland Plain Woodland described in Benson (1992). Found under fallen logs, debris and in bark and leaf litter around the trunk of gum trees or burrowing in loose soil around clumps of grass (NPWS 1997; Rudman 1998). Urban waste may also form suitable habitat (NPWS 1997; Rudman 1998).	• Empty shells previously located on subject site. • No live snails could be located • Poor quality habitat on subject site. • Potentially affected and is assessed further.

TSC = Threatened Species Conservation Act 1995
EPBC = Environment Protection and Biodiversity Conservation Act 1999

E = Endangered
E2 = Endangered population
V = Vulnerable

Of the threatened species known to occur in the local area, several Commonwealth and State listed threatened species are considered to have potential to occur due to local records or the presence of suitable habitats within the subject site (Table 3.4). Those species that are known to occur on site, or have suitable habitat on site, are assessed further in Appendix B with respect to Section 5A of the EP&A Act ('8 part test of significance) and Environment Australia's administrative guidelines for determining whether an action is likely to have a significant effect on a matter of National Environmental Significance under the EPBC Act. A summary of the impacts of the proposal on these communities is provided in Section 4 of this report.

One threatened species, the Large Land Snail (*Meridolum corneovirens*) had been located on the subject site, in vegetation above the upper creek bank. Only two empty shells of this species were observed on site, with no live individuals being located. AMBS conducted a targeted survey of the study area south of the existing road for *Meridolum corneovirens* on the 9th January 2004 in order to, if possible, draw a conclusion regarding the likely existence of a population of Large Land Snail.

AMBS found no further evidence of the Large Land Snail. AMBS noted that, while the study area contains potential habitat for the Large Land Snail, it is not considered to be optimal habitat and is degraded to some extent by the presence of exotic vegetation. AMBS also found the introduced snail *Bradybaena similaris* throughout the subject site, an indication that the habitat for the Large Land Snail within the study area has been degraded.

AMBS was not able to draw any conclusion in regard to the shells detected earlier in this study; however, it was noted that these shells may have been evidence the Large Land Snail previously occurred. On the basis of the poor habitat value of the subject site for the Large Land Snail, AMBS concluded that the study area was unlikely to contain an extant population of the Large Land Snail.

3.2.2 Ecological Assessment of Study Area (NPWS)

This assessment follows methodologies provided by the NSW National Parks and Wildlife Service to assess the conservation significance and recovery potential of native vegetation and the habitats of threatened species, which in turn assists in identifying the overall ecological value of the area. This assessment follows methodologies provided by the NSW National Parks and Wildlife Service to assess the conservation significance and recovery potential of native vegetation on the Cumberland Plain.

Threatened Species Habitat

A limited number of fauna habitats were located on the subject site and more broadly in the study area. The relationship between these habitats and threatened species known to occur in the local area are discussed in Section 3.2.

Conservation Significance Assessment

The guidelines for the CSA have been adopted from NPWS (2002). These guidelines outline the approach used by the NSW NPWS in assessing the significance of vegetation to the conservation of communities in Western Sydney. The CSA guidelines were used by NPWS to provide a map of Core Vegetation, Support for Core and 'other' vegetation (NPWS 2002).

The study area has been mapped as containing Support for Core and Core Vegetation (NPWS 2002). NPWS (2002) differentiated Support for Core from Core Habitat in the study area on the basis that it contained a canopy cover of less than 10%. A site inspection of the study area found that the Support for Core and Core Habitat mapped by NPWS in the study area to be an accurate reflection of what occurs in the study area (Figure 3.3).

Anticipated Recovery Potential

The majority of the study area contains cleared lands with a low to very low recovery potential (Figure 3.3), which is the result of past land use practices having replaced native vegetation and habitats with exotic species and altered environmental conditions.

Areas with a moderate recovery potential occur on the subject site and to the east of Hoxton Park Reserve (Figure 3.3). These areas contain a largely natural soil profile, however, the native understorey has been significantly modified, presumably by past low intensity grazing, as described in Section 1.5 of this report.

Overall Ecological Value

The results from the assessment of threatened species habitats; conservation significance and the anticipated recovery potential were overlain on a single map (Figure 3.4). The definition (from Eco Logical) and recommended outcomes (from NPWS) for areas of High Ecological Value (HEV), Moderate Ecological Value (MEV) and Low Ecological Value (LEV) are summarised in Table 2.9.

Table 3.3: Broad Definition of Ecological Value Categories and Recommend Management Outcomes

Ecological Value Categories	Broad Definition (Eco Logical 2002)	Recommend Management Outcomes (NPWS)
High Ecological Value (HEV)	Highest number of conservation values; Generally have a high recovery potential, in good condition and are greater than 10ha; and Developments in these areas are likely to result in a significant impact as per S5A of the EP&A Act.	Highest conservation value; and Recommended outcome is for land to be managed for the principal purpose of biodiversity conservation.
Moderate Ecological Value (MEV)	Fewer conservation values than HEV; Generally in moderate condition and are either small with high recovery potential or larger areas with a moderate recovery potential; Developments in these areas may result in a significant impact as per S5A of the EP&A Act.	Areas that are a priority for restoration work in order to increase the size of and enhance the areas of high value; and Recommended outcome is for land to be managed for the principal purpose of biodiversity conservation, however, more flexibility exists in these areas for defining the boundary of the management area.
Low Ecological Value (LEV)	Few conservation values; Severely disturbed, small and isolated; and Developments in such area would need to ensure minimal impacts on any nearby areas of higher value.	Ecological values have been reduced through disturbance, isolation or small size; These areas are to be protected where possible through sensitive land uses, however are of a lower priority for conservation effort.

The subject site contains areas of Low Ecological Value (Figure 3.4). These areas have been cleared in the past and have few conservation values. After excluding these areas, a decision had to be made as to which category of Ecological Value (high or medium) was most appropriate for the remaining native vegetation. This decision had to take into account the following:

- The presence of two Endangered Ecological Communities with a moderate recovery potential;
- Potential habitat for several threatened species;
- Core and Support for Core Habitats (including wildlife linkages); and
- Vegetation with a Low Recovery Potential that are limited to less than 10ha in extent.

Considering these points, and the relevant management outcomes (Table 3.3 and Section 4.2 of this report), it is considered that LEV was the most appropriate classification for vegetation in the study area (Figure 3.4).

3.3 Aquatic Flora and Fauna Assessment

Hinchinbrook Creek is classified as a Class 2 moderate fish habitat (see Fairfull and Witheridge (2003) as it is:

- Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi - permanent to permanent waters in pools or in connected wetland areas.
- Freshwater aquatic vegetation is present.
- Known fish habitat and/or fish observed inhabiting the area.

3.3.1 Creek Morphology and Habitats

Hinchinbrook Creek is a permanently flowing creek which, when in low flow, is typically 1 to 3m wide and comprises a series of ponds up to 2m deep and 10m wide and riffles 1 to 3m wide and up to 0.5m deep. The creek is incised into a clay channel typically 1 to 2m deep, which is expected to have a soft substrate bottom.

The section of creek affected by the works includes a pond under the existing bridge with a combination of shallow riffles and deeper pools at and below the proposed crossing. The creek divides immediately below the existing bridge. The eastern branch, a straight channel riffle section appears to be the result of channelling to improve water flow when the original bridge was constructed. The western branch appears to be the original creek bed and comprises a series of ponds and dry sections and does not flow under low flow conditions.

3.3.2 Aquatic Flora and Fauna

As part of the Western Sydney Orbital (WSO) EIS (PPK 2000), Rooney & Associates investigated the aquatic habitats of Hinchinbrook Creek. This report involved a detailed assessment that covered the study area, from which this study draws on both the information presented in the above report and casual field observations.

WS Rooney and Associates surveyed Cabramatta Creek in the vicinity of Hinchinbrook Creek in 1999. Two species of aquatic macrophytes, the River Clubrush (*Schoenoplectus validus*) and Curly Pondweed (*Potamogeton crispus*) were observed during the study. A number of other sedges and rushes, such as *Juncus sp.*, *Cyprus sp.* and *Carex sp.* were also observed along the creek bank during this study.

The investigations of Rooney & Associates included observations, electrofishing and a consideration of the likely occurrence of species based on the distribution of fish species in NSW, habitats types and conditions present in the WSO study area. The results of this study and a search of the NSW FishFiles (NSW Fisheries database), indicate that several species are either known to occur are likely to occur (Table 3.4).

Table 3.4 Aquatic Fauna of the Study Area

Species	Source
Australian Bass (*Macquaria novemaculeata*)	WSO EIS (located)
Australian Smelt (*Retropinna semoni*)	WSO EIS (located)
Bullrout (*Notesthes robusta*)	WSO EIS (located)
Common Carp (*Cyprinus carpio*)	FishFiles Database
Common Jollytail (*Galaxias maculatus*)	WSO EIS (located)
Coxs Gudgeon (*Gobiomorphus coxii*)	WSO EIS (located)
Dwarf Flathead Gudgeon (*Philypnodon sp1*)	WSO EIS (located)

Table 3.4 Aquatic Fauna of the Study Area	
Species	**Source**
Estuary Perch (*Macquaria colonorum*)	WSO EIS (located)
Firetail Gudgeon (*Hypseleotris galii*)	WSO EIS (located)
Flathead Gudgeon (*Philypnodon grandiceps*)	WSO EIS (located), FishFiles Database
Empire Gudgeon (*Hypseleotris compressa*)	WSO EIS (located)
Freshwater Catfish (*Tandanus tandanus*)	WSO EIS (likely to occur); FishFiles Database
Freshwater Mullet (*Myxus petardi*)	WSO EIS (located)
Gambusia (*Gambusia holbrooki*)	WSO EIS (located); FishFiles Database
Goldfish (*Carassius auratus*)	FishFiles Database
Long-finned Eel (*Anguilla reinhardtii*)	WSO EIS (likely to occur); FishFiles Database
Short-finned Eel (*Anguilla australis*)	WSO EIS (likely to occur); FishFiles Database
Striped Gudgeon (*Gobimorphous australis*)	WSO EIS (likely to occur); FishFiles Database

3.3.3 Threatened Aquatic Flora and Fauna

Of the threatened species listed under the *Fisheries Management* (FM) *Act 1994*, Rooney & Associates considered one, the Eastern Freshwater Cod, to have the potential to occur in the study area on the basis that this falls within the historical distribution of the species. No other species that are known or likely to occur in the study area are listed as threatened under the FM Act (see Table 3.4).

The Eastern Freshwater Cod is listed as endangered under the NSW Fisheries Management Act 1994 and is thought to naturally occur only in the Mann & Nymboida river systems (NSW Fisheries 1999). There are no recent records of this species in the study area. The habitat requirements of Eastern Freshwater Cod are poorly known, but probably resemble related species (NSW Fisheries 1999). Eastern Freshwater Cod are typically found in clear flowing rivers with rocky substrate and large amounts of in-stream cover. Recent research observations have indicated that eastern cod are typically associated with deeper parts of the river near cover, especially around rocky islands and large boulders in fast-flowing water.

It is considered highly unlikely that the Eastern Freshwater Cod occurs naturally in the study area due to the absence of clear flowing rivers with rocky substrate. As such, the proposal is considered unlikely to impact on this species.

Considering that no threatened species listed under the FM Act are likely to occur in the study area, none are considered likely to be impacted by the proposal and none are assessed further.

4. Ecological Impact Assessment

4.1 Ecological Impacts

The proposal has the potential to lead to the clearing of approximately 1.4 ha of native vegetation, the composition of which of is detailed in Table 4.1.

Table 4.1 Vegetation Clearing

Community	Total	Vegetation to be Removed with Canopy Cover >10% & <10%
Shale Gravel Transition Forest (*An endangered ecological community under the TSC Act*)	6 670 m^2	287 m^2 & 6383 m^2
Alluvial Woodland (*Part of Sydney Coastal River Flat Forest, an endangered ecological community under the TSC Act*)	7 471 m^2	7 438 m^2 & 33 m^2
Total	**14 141** m^2	**7 725** m^2 **& 6 416** m^2

In addition to the amount of vegetation directly impacted, there are likely to be a number of other impacts, namely:

- indirect impacts such as edge effects;
- impacts on water quality; and
- fragmentation of habitat (along Hinchinbrook Creek).

Edge effects will extend further into the vegetation to the south of Hoxton Park road with the location of road works. The vegetation south of Hoxton Park road will also have a higher edge to interior vegetation ratio, which may leave it more susceptible to degradation.

It is anticipated that, while impacts on water will be mitigated by adherence to the appropriate environmental controls, there may be a number of short-term effects on water quality, such as increased turbidity.

Hoxton Park Road currently cuts east - west across a corridor of vegetation running north south along Hinchinbrook and Cabramatta Creeks. With the current bridge, the creek is enclosed on both sides by the bridge abutments and the steeply sloping concreted bank. As the proposal consists of a broader, elevated bridge span, it allows for the movement of terrestrial species previously impeded by the existing bridge. Fauna which may benefit include snakes, small lizards and frogs.

4.2 Mitigation Measures

A number of mitigation measures that would be implemented to reduce the impact of the proposal the natural environment are described below.

4.2.1 Vegetation Management – Subject Site

Management of vegetation during construction would limit adverse impacts on threatened species and ecological communities and their habitats. Specific management protocols for flora and fauna during pre-construction, construction and operational phases would be detailed in a Flora and Fauna Management Plan, incorporating a Revegetation Plan, that would be prepared as part of the Contractor's EMP.

General vegetation management measures to be implemented during construction include:

- Establishing protocols to minimise the extent of clearing of the remnant vegetation. These would include the temporary fencing of the proposed limits of clearing activities;
- Substantial planting of local native species to reduce edge effects and protect the integrity of the retained vegetation;
- Employing an arborist, who would be engaged to inspect and make recommendations on reducing the potential damage to trees adjacent to the proposed construction and on any proposed lopping of trees;
- Weed control measures that would be adopted to prevent infestation of undesirable plant species on road barriers and rehabilitation sites. This could include the use of shredded native plant material (removed from the road corridor), supplementary planting of native species, and the use of fibre matting or other soil stabilisation / weed control materials;
- Sediment and discharge control measures that would be implemented to limit the potential for adverse impacts on vegetation communities and aquatic habitats adjacent to the proposal; and
- Prohibition on the stockpiling of materials around retained trees and parking of vehicles beneath trees. Disturbance to the soil within the drip zone of retained trees should be avoided where practicable.

4.2.2 Vegetation Management – Study Area

The proposal has the potential to destroy a small area of habitat, as shown on Figure 3.3. To mitigate this impact, a plan of management for the better quality habitat in the Hoxton Park Reserve, as shown on Figure 3.3, to address the following should be prepared and implemented:

- Substantial planting of local native species to reduce edge effects and protect the integrity of the vegetation;
- Weed control measures to remove and control undesirable plant species. This could include the use of shredded native plant material (removed from the road corridor), supplementary planting of native species, and the use of fibre matting or other soil stabilisation / weed control materials;
- Maintenance of vegetation including maintaining the cover of logs and the cover of eucalypt leaves and bark;
- Management of vehicle and pedestrians access; and
- Removal of weeds by means that does not include the use of herbicide (as this area is Large Land Snail *Meridolum corneovirens* habitat).

4.2.3 Landscaping, Propagation and Revegetation

- Landscaping would utilise native endemic species from locally collected seed or propagation material. An indicative landscape-planting list should source locally endemic species identified in this report and characteristic species of the Shale Gravel Transition Forest and Alluvial Woodland, as provided in NPWS (2002).
- Landscaping, including revegetation within and adjacent to the proposed road corridor, would be carried out where possible.
- All plants to be used for landscaping would be certified weed and pathogen free.
- Where planting of grasses is proposed for soil stabilisation, sterile or native grasses would be used.

5. Conclusions

5.1 Ecological Impact Assessment

Following consideration of the relevant legislation and Environmental Planning Instruments (Appendix B), the following is concluded regarding the study site:

5.1.1 Environment Protection and Biodiversity Conservation Act 1999.

- No threatened flora species listed under the EPBC Act were located in the study area;
- Suitable habitats for several threatened fauna species were located in the study area;
- No endangered ecological communities were located on the subject site;
- It was concluded that the proposal would not be likely to constitute a controlled action concerning species listed under the EPBC Act (refer Appendix B). As such, a referral to Environment Australia is not considered necessary.

5.1.2 Threatened Species Conservation Act 1995.

- No threatened plant species listed under the TSC Act were located in the study area;
- One threatened fauna species, the Large Land Snail, was located in the study area;
- Suitable habitats for several threatened fauna species were located on the subject site;
- Two endangered ecological communities, Shale Gravel Transition Forest and Sydney Coastal River-flat Forest were located on the subject site;
- It was concluded that the proposal is not likely to significantly impact threatened species or ecological communities (refer Appendix B). As such, preparation of a Species Impact Statement is not considered necessary;

5.1.3 Fisheries Management Act 1994.

- No threatened plant species listed under the FM Act have been located, or are considered likely to occur, in the study area;
- It was concluded that the proposal is not likely to significantly impact on species listed under the FM Act. As such, preparation of a Species Impact Statement is not considered necessary.

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Appendix A

In situ Resilience / Anticipated Recovery Capacity Assessment

Table 2. Recovery Potential

Matrix Adapted from Perkins (2002).

<table>
<tr><th>Current condition and land use</th><th>Past land use and disturbance</th><th>Soil Condition</th><th>Vegetation</th><th>Recovery Potential</th><th>Recovery Code</th></tr>
<tr><td rowspan="6">Cleared (no woodland canopy). Includes Bursaria thickets in grassland</td><td rowspan="3">Recently cleared (<2 years)</td><td rowspan="2">Unmodified or largely natural. Uncultivated.</td><td>Native dominated</td><td>High</td><td>C1</td></tr>
<tr><td>Exotic dominated</td><td>Moderate</td><td>C2</td></tr>
<tr><td>Modified. Heavily cultivated and/or pasture improved. Imported material.</td><td>Either</td><td>Low</td><td>C3</td></tr>
<tr><td rowspan="3">Historically cleared (>2 years) and consistently managed as cleared.</td><td rowspan="2">Unmodified or largely natural. Uncultivated.</td><td>Native dominated</td><td>Moderate</td><td>C4</td></tr>
<tr><td>Exotic dominated</td><td>Low</td><td>C5</td></tr>
<tr><td>Modified. Heavily cultivated and/or pasture improved. Imported material.</td><td>Either</td><td>Very Low</td><td>C6</td></tr>
<tr><td rowspan="12">Wooded/Native Canopy present or regenerating</td><td rowspan="6">No recent clearing of understorey</td><td rowspan="3">Unmodified or largely natural. Uncultivated.</td><td>Native understorey relatively intact or in advanced state of regeneration. Native dominated.</td><td>High</td><td>W1</td></tr>
<tr><td>Native understorey significantly structurally modified, absent or largely absent. Includes areas dominated by African Olive.</td><td>Moderate</td><td>W2</td></tr>
<tr><td>Exotic dominated</td><td>Low</td><td>W2.1</td></tr>
<tr><td>Moderately modified by long term grazing or mowing.</td><td>Native dominated</td><td>Low</td><td>W2.2</td></tr>
<tr><td rowspan="2">Modified. Heavily cultivated and/or pasture improved. Imported material.</td><td>Native understorey significantly structurally modified, absent or largely absent. Includes areas dominated by African Olive.</td><td>Very Low</td><td>W3</td></tr>
<tr><td>Native understorey present. Heavily weed invaded.</td><td>Low</td><td>W4</td></tr>
<tr><td rowspan="2">Understorey patchily intact</td><td rowspan="2">Disturbed</td><td>Native dominated</td><td>Moderate</td><td>W4.1</td></tr>
<tr><td>Exotic dominated</td><td>Low</td><td>W4.2</td></tr>
<tr><td rowspan="4">Recent clearing of understorey and or native understorey significantly structurally modified due to existing land use (eg. Mowing, grazing)</td><td rowspan="2">Unmodified or largely natural. Uncultivated.</td><td>Native dominated. If no vegetation present, assume native dominated.</td><td>High</td><td>W5</td></tr>
<tr><td>Exotic dominated</td><td>Moderate</td><td>W6</td></tr>
<tr><td rowspan="2">Modified. Heavily cultivated and/or pasture improved. Imported material.</td><td>Native dominated</td><td>Low</td><td>W7</td></tr>
<tr><td>Exotic dominated</td><td>Very Low</td><td>W8</td></tr>
</table>

Appendix B

Statutory Requirements

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Appendix B

1. Federal Legislation

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) was introduced on 16th July 2000. This Act requires that Commonwealth approval be sought for certain actions. These actions are those that have, may have, or are likely to have, a significant impact on a matter of National Environmental Significance (NES). Matters of NES are declared World Heritage areas, declared Ramsar wetlands, listed nationally threatened species and ecological communities, listed migratory species, nuclear actions, and the environment of Commonwealth marine areas.

Under the EPBC Act, an assessment of the impact of a proposal on any matter of NES and Commonwealth land must be undertaken to demonstrate whether there is likely to be a significant impact. If the assessment concludes that there is likely to be a significant impact then it will become a controlled action under the EPBC Act and the proposal must be referred to the Commonwealth. Environment Australia is the agency that assists the Federal Minister of the Environment to make decisions as to whether an action is likely to have a significant impact and require further assessment.

An assessment of NES Matters is given below.

1.1 World Heritage Properties

The proposal would not affect any World Heritage property. There would not be any effect on this matter of National Environmental Significance.

1.2 Wetlands of International Importance

There are no wetlands of international importance within the study area. There would not be any effect on this matter of National Environmental Significance.

1.3 Commonwealth Listed Threatened Species and Ecological Communities

The administrative guidelines for determining whether an action has, will have, or is likely to have a significant impact on a matter of NES under the EPBC Act list a number of criteria which must be addressed in respect of the following categories of species:

- Extinct in the wild
- Critically endangered
- Endangered
- Vulnerable

Suitable habitat was located on the subject site for several threatened species that are known to occur within 10km of the subject site. As these species have suitable habitats on the subject site, there is some potential for these species to be impacted upon by the proposal. An assessment under the 'administrative guidelines' of the Act has been undertaken for these species in order to determine whether the proposal is likely to constitute a controlled action. The assessment has been prepared below with consideration of the relevant criteria.

1.3.1 Endangered Species

Regent Honeyeater (*Xanthomyza phrygia*) and the Swift Parrot (*Lathamus discolor*)

The Regent Honeyeater is associated with temperate eucalypt woodland and open forest including forest edges, wooded farmland, urban areas with mature eucalypts and riparian forests of River Oak (*Casuarina cunninghamiana*) (SFNSW 1995, Garnett 1993). Reliant on locally abundant nectar sources, especially flowering eucalypts that occur mainly in dry open woodland (SFNSW 1995), on richer soil types with different flowering times to provide reliable supply of nectar (Environment Australia 2000).

The Swift Parrot is associated with dry open eucalypt forests and woodlands with winter flowering eucalypts (Marchant and Higgins 1999). In the Sydney Bioregion, this species has utilised the Forest Red Gum (*Eucalyptus tereticornis*) (NPWS 1997, SFNSW 1995). This species is often located in urban areas and farmlands with remnant eucalypts.

The subject site does not constitute breeding habitat for either of these species (Marchant and Higgins 1999). As such, the site only provides a small amount of foraging habitat for these species. Further, the site is considered to provide limited quality foraging habitat, as it does not contain a variety of eucalypts with different flowering times. In total, these limited values indicate that the site is unlikely to be utilised by these species, and that as such it is likely to be of little significance.

An action has, will have, or is likely to have a significant impact on an endangered species if it does, will, or is likely to:

(a) **Lead to a long-term decrease in the size of a population of the species; or**

Both the Regent Honeyeater and the Swift Parrot forage over wide areas (Marchant and Higgins 1999). As detailed above, the subject site is considered to provide limited values, is unlikely to be utilised by these species and that as such it is likely to be of little significance. As such, it is highly unlikely that the proposal would lead to a long-term decrease in the size of a population of these species.

(b) **Reduce the area of occupancy of a population of the species; or**

It is not known if these threatened species occur on site, and if so what the significance of the population may be. Taking into consideration the precautionary principle, it is assumed that a population may exist. It is considered that the proposal, given the limited value of the site as discussed above, is highly unlikely to affect the area of occupancy of the species in terms of its ecological requirements.

(c) **Fragment an existing population into two or more populations; or**

Considering the mobility of the species and the small size of the proposal, the fragmentation of a population is highly unlikely.

(d) **Adversely affect habitat critical to the survival of a species; or**

The habitats on the subject site consist of a small amount of poor quality foraging habitat, which is considered highly unlikely to be critical to these species survival.

(e) **Disrupt the breeding cycle of a population; or**

The Swift Parrot does not breed on site (Marchant and Higgins 1999). There are no records of a breeding population of the Regent Honeyeater on the site or adjacent lands. Considering this and the small amount of poor quality foraging habitat, it is highly unlikely that the proposal would disrupt a breeding event. As such, the proposal is unlikely to disrupt the breeding cycle of a population.

(f) **Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline; or**

The proposal involves the removal of a small amount of poor quality foraging habitat. Indeed, the quality of habitat indicates that the site is unlikely to be utilised by these species. As such, it is considered highly unlikely that the proposal would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that these species is likely to decline.

(g) **Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat; or**

Invasive species that are harmful to the Regent Honeyeater and the Swift Parrot are likely to be those that impact of the availability of foraging habitat (trees). Considering the land uses on the site and presence of exotic species, the threat posed by invasive species that may suppress tree growth is likely to be present. The proposal will include plans for the management of vegetation affected by the proposal, which will involve the removal of invasive species.

(h) **Interfere with the recovery of the species.**

Considering the factors detailed above the proposal is not considered likely to interfere with the breeding cycles or foraging habitats of these species such that the recovery of current or future populations are compromised.

Conclusion:
The site is considered to be of limited values to these species and is unlikely to be utilised. Considering the factors discussed above, the proposal is not likely to constitute a controlled action with respects to Endangered Species.

1.3.2 Vulnerable Fauna Species

The Spotted-tailed Quoll (*Dasyurus maculatus*), Grey-headed Flying-Fox (*Pteropus poliocephalus*), Common Bent-wing Bat (*Miniopterus schreibersii*) and the Large Pied Bat (*Chalinolobus dwyeri*)

The subject site provides no suitable breeding habitat for any of the threatened species with suitable habitat on the subject site. More specifically:

- The Spotted-tailed Quoll: Maternal den sites are logs with cryptic entrances; rock outcrops; windrows; burrows (Environment Australia 2000). These are not located on the subject site;
- Grey-headed Flying-Fox (*Pteropus poliocephalus*) roosts in distinct campsites, which are located in protected areas (Churchill 1998). These are not located on the subject site; and
- The Large Pied Bat (*Chalinolobus dwyeri*) and Common Bent-wing Bat (*Miniopterus schreibersii*) roost in structures such as drains and caves (Churchill 1998). These species were not observed roosting under the existing bridge.

The small amount of foraging habitat is considered insignificant in relation to the larger areas of bushland habitat in the local area, including Hoxton Park Recreation Reserve, Liverpool Showground, Leacock Regional Park, Western Sydney Regional Park and bushland along Cabramatta and Hinchinbrook Creeks.

(a) An action has, will have, or is likely to have a significant impact on a vulnerable species if it does, will, or is likely to:

Lead to a long-term decrease in the size of an important population of the species.

The 'administrative guidelines' of the EPBC Act (Environment Australia 2000) describe important population as ' one that is necessary for the species' long – term survival and recovery.' This was noted to include populations that are:

- key source populations for either breeding or dispersal;
- populations that are necessary for maintaining genetic diversity; and / or
- populations that are near the limit of the species range.

It is not known if these threatened species occur on site, and if so what the significance of the population may be. Taking into consideration the precautionary principal, it is assumed that an important population may exist that may utilise the subject site. In this case, the small amount of limited quality foraging habitat, the absence of suitable shelter / breeding habitat for threatened species indicates that the proposal is highly unlikely to lead to a long-term decrease in the size of an important population.

(b) Reduce the area of occupancy of an important population of the species.

It is not known if these threatened species occur on site, and if so what the significance of the population may be. Taking into consideration the precautionary principle, it is assumed that an important population may exist. It is considered that the loss of a small amount of poor quality foraging habitat is highly unlikely to affect the area of occupancy of an important population in terms of these species ecological requirements.

(c) Fragment an existing important population into two or more populations.

As Hoxton Park Road bisects the vegetated creek line, there is an existing degree of fragmentation. However, these species are highly mobile, with the width of the road widening being relatively insignificant in relation to the movements of these species (see NPWS 1997 and Environment Australia 2000). As such, the fragmentation of an important population is highly unlikely.

(d) Adversely affect habitat critical to the survival of a species.

The habitats on the subject site are considered highly unlikely to be critical to a species survival due to there being a small amount of limited quality foraging habitat and the absence of suitable shelter / breeding habitat for threatened species;

(e) Disrupt the breeding cycle of an important population.

The subject site provides no suitable shelter / breeding habitat for threatened species, which indicates that the proposal is highly unlikely to disrupt the breeding cycle of an important population.

(f) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The proposal involves the removal a small amount of limited quality foraging habitat. Considering the above, it is considered highly unlikely that the proposal would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that a threatened species is likely to decline.

(g) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.

Invasive species that are harmful to these species are most likely those that affect the suitability of foraging habitats. Suitability may be impacted by invasive species altering the structure of a habitat or by altering the abundance of suitable prey items. The proposal will include plans for the management of vegetation affected by the proposal, which will involve the removal of invasive species, to mitigate this risk.

(h) Interfere with the recovery of the species.

The low level of impact indicates that the proposal is highly unlikely to interfere with the recovery of these species.

<u>Conclusion:</u>
The proposal is not likely to constitute a controlled action with respects to Vulnerable Species.

1.4 Commonwealth Listed Migratory Species

The current list of migratory species includes well over 100 bird and mammal species, including those listed on the Japan-Australian Migratory Birds Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA), and from the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

Several listed migratory species are known to occur in the local area (Environment Australia Online Database Search December 2002). None of these species are considered likely to be significantly impacted by the proposal and it is considered that there is unlikely to be any effect on this matter of NES.

The administrative guidelines for determining whether an action has, will have, or is likely to have a significant impact on a matter of NES under the EPBC Act list a number of criteria which must be addressed in respect of migratory species. These relate to whether a proposal would:

1. substantially modify, destroy or isolate an area of important habitat;
2. seriously disrupt the lifecycle of an ecologically significant proportion of the population of the species; and/or
3. result in invasive species that are harmful to the migratory species becoming established in an area of important habitat of the migratory species.

An area of important habitat is described as:

- habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species;
- habitat utilised by a migratory species which is at the limit of the species range; or
- habitat that is within an area where the species is declining.

For the purposes of assessment, it is assumed that species with suitable habitats occur in a region that supports an ecologically significant proportion of the population of the species. Accordingly, habitats in the suitable study area may constitute ' important habitat'.

Factors 1 and 2 above are addressed for each species in Table A1. With respect to Factor 3 (invasive species), invasive species that are harmful to these species are most likely those that affect the suitability of foraging habitats. Management Plans will be adopted which will involve the removal of invasive species, so as to mitigate this risk.

Table A1: Locally occurring Commonwealth listed migratory species and the anticipated level of impact of the proposal.

Species	Habitat Associations	Anticipated impact
Latham's Snipe *Gallinago hardwickii*	A variety of permanent and ephemeral wetlands, preferring open fresh water wetlands with nearby cover. Occupies a variety of vegetation around wetlands (Marchant and Higgins 1999).	**No impact anticipated** due to lack of suitable habitat (*no permanent and ephemeral wetlands*).
White-bellied Sea-Eagle *Haliaeetus leucogaster*	Forages over large open waterbodies and open terrestrial areas. Breeding habitat consists of tall trees, mangroves, cliffs, rocky outcrops, silts, caves and crevices and is located along the coast or major rivers. Breeding habitat is usually in or close to water, but may occur up to a kilometre away (Marchant and Higgins 1999).	**No impact anticipated** due to lack of suitable habitat (*no large open waterbodies* ***and*** *open terrestrial areas*).
White-throated Needletail *Hirundapus caudacutus*	Forages aerially over a variety of habitats most likely with a preference for wooded areas. Has been observed roosting in dense foliage of canopy trees, and may seek refuge in tree hollows in inclement weather (Marchant and Higgins 1999).	**Low level of impact** anticipated due to the subject site containing a relatively small amount of foraging habitat. As such, the proposal is not likely to substantially modify, destroy or isolate an area of important habitat; or seriously disrupt the lifecycle of an ecologically significant proportion of the population of the species.
Black-faced Monarch *Monarcha melanopsis*	Rainforest and eucalypt forests, feeding in tangled understorey (Blakers *et al.* 1984).	**No impact anticipated** due to lack of suitable habitat (*tangled understorey*).
Spectacled Monarch *Monarcha trivirgatus*	Rainforest and mangroves and occasionally eucalypt forests adjacent to rainforests (Blakers *et al.* 1984).	**No impact anticipated** due to lack of suitable habitat (*rainforest & mangroves*).
Satin Flycatcher *Myiagra cyanoleuca*	Associated with drier eucalypt forests, absent from rainforests (Blakers et al. 1984), open forests, often at height (Simpson and Day 1996).	**Low level of impact** anticipated due to the subject site containing a relatively small amount of foraging habitat. As such, the proposal is not likely to substantially modify, destroy or isolate an area of important habitat; or seriously disrupt the lifecycle of an ecologically significant proportion of the population of the species.
Rufous Fantail *Rhipidura rufifrons*	Associated with eucalypt forests (Blakers et al. 1984), mesic forests and the edges of mangroves (Simpson and Day 1996).	**Low level of impact** anticipated due to the subject site containing a relatively small amount of foraging habitat. As such, the proposal is not likely to substantially modify, destroy or isolate an area of important habitat; or seriously disrupt the lifecycle of an ecologically significant proportion of the population of the species.
Painted Snipe *Rostratula benghalensis*	Shallow fresh water for breeding (Blakers et al. 1984) forages in marshes with moderate cover (Simpson and Day 1996).	**No impact anticipated** due to lack of suitable habitat (*shallow fresh water, marshes*).

No listed migratory species would be significantly impacted by the proposal. As such, it is considered unlikely that the proposal would have an effect on this matter of National Environmental Significance.

1.5 Nuclear Actions

The proposal is not a nuclear action.

1.6 Commonwealth Marine Areas

The proposal would not affect any Commonwealth Marine Areas. There is unlikely to be any effect on this matter of NES.

1.7 Commonwealth Land

The proposal is not located on nor would it affect Commonwealth land. As such, there is unlikely to be any effect on this matter of NES.

Conclusion

Based upon the above findings the proposal would not need to be referred to Environment Australia.

2. State Legislation

Section 5A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) sets out eight factors which must be considered when determining whether there will be a significant effect on species, populations or ecological communities or their habitats listed under the TSC Act and whether a Species Impact Statement is required.

Relevant aspects of the ecology of species potentially affected by the proposal, followed by an assessment of the proposal on these species according to the eight factors of Section 5A of the EP&A Act, are provided below. Species assessed are grouped according to their ecological requirements.

Threatened avifauna
(Swift Parrot, Black-chinned Honeyeater, Speckled Warbler, Regent Honeyeater and the Masked Owl)

The Swift Parrot is associated with dry open eucalypt forests and woodlands with winter flowering eucalypts (Marchant and Higgins 1999). In the Sydney Bioregion, this species has utilised the Forest Red Gum (*Eucalyptus tereticornis*) (NPWS 1997, SFNSW 1995). This species is often located in urban areas and farmlands with remnant eucalypts.

The Masked Owl is associated with forest with sparse, open, understorey, particularly the ecotone between wet and dry forest, and non-forest habitat (Environment Australia 2000). It is known to utilise forest margins and isolated stands of trees within agricultural land (Hyem 1979) and heavily disturbed forest where its prey of small and medium sized mammals can be readily obtained (Kavanagh and Peake 1993). The Masked Owl requires old mature trees with large hollows for breeding and as diurnal roosting sites, being dependent upon hollow bearing trees all year round rather than only during the breeding season (Hyem, 1979).

It is considered that the habitat values of this site are poor for these species for two reasons. First, the absence of suitable hollow bearing trees indicates that there is no suitable roosting habitat. Second, the altered nature of the habitats present are likely to support only a limited range of prey items which in turn indicates that the site provides poor quality foraging habitat for these species.

The Black-chinned Honeyeater is predominantly associated with box-ironbark association woodlands and River Red Gum. Also associated with drier coastal woodlands of the Cumberland Plain and the Hunter, Richmond and Clarence Valleys (NSW Scientific Committee, 2001).

Speckled Warblers occupy eucalypt and cypress woodlands on the slopes west of the Great Dividing Range, with an extension of range into the cypress woodlands of the northern Riverina. Populations also occur in drier coastal areas such as the Cumberland Plain, Western Sydney and the Hunter and Snowy River valleys. Speckled Warblers inhabit woodlands with a grassy understorey, often on ridges or gullies.

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.

A viable local population of these species is not likely to be placed at risk of extinction due to:

- no breeding habitats occur on the subject site; and
- the small amount of habitat to be removed, which is insignificant in relation to these species home ranges and to the similar habitats present in local area, including Hoxton Park Recreation Reserve, Liverpool Showground, Leacock Regional Park, Western Sydney Regional Park and bushland along Cabramatta and Hinchinbrook Creeks.

(b) *In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly disrupted.*

Not relevant

(c) *In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.*

The habitats present on the site are of limited extent, do not contain suitable breeding habitats, and provide limited quality habitat for locally occurring threatened species. As such, the proposal is not considered likely to modify or remove a regionally significant area of habitat.

(d) *Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.*

Considering the proximity of the site to Hoxton Park Road, the mobility of the species and the size of the proposal, the fragmentation of a population is highly unlikely.

(e) *Whether critical habitat will be affected.*

The subject site has not been identified as critical habitat within the provisions of the Threatened Species Conservation Act (1995). Therefore, this matter does not require further consideration at this time.

(f) *Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.*

These species are not considered likely to be adequately represented in conservation reserves (or similar protected areas) in the region. As the subject site contains a relatively small amount of disturbed habitat, it is not considered likely to have any significance in any future formation of a conservation system that is regionally representative of these species habitats.

(g) *Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.*

The clearing of native vegetation is recognised as a Key Threatening Process on Schedule 3 of the Threatened Species Conservation Act (1995) (NSW Scientific Committee 2001) that is relevant to this proposal. However, the small area and limited quality of habitat to be removed is not considered likely to threaten these species.

(h) *Whether any threatened species, populations or ecological community is at the limit of its known distribution.*

Records available on the Atlas of NSW Wildlife (NPWS On-line Database) indicate that these species are not at or approaching the limits of their distribution on the subject site.

<u>Conclusion:</u>
The proposal is not likely to constitute a significant impact with respects to threatened avifauna.

Spotted-tailed Quoll

The Spotted-tailed Quoll inhabits a range of forest communities including wet and dry sclerophyll forests and rainforests (Mansergh 1984), more frequently recorded near the ecotones of closed and open forest (SFNSW 1995). Maternal den sites are logs with cryptic entrances; rock outcrops; windrows; burrows (Environment Australia 2000). No potential maternal den sites were located on site, and none are considered likely to occur.

The altered nature of the habitats present is likely to support only a limited range of prey items, which include species commonly associated with disturbed habitats, such as the Black Rat (*Rattus rattus*) and the House Mouse (*Mus musculus*). Further, the limited size of the site indicates that the amount of prey available is also likely to be limited. This decline in quality of habitat in the Cumberland Plain with reduced size and ongoing disturbance is detailed in NPWS (1997).

While the subject site is likely to provide poor quality foraging habitat for this species, it may form part of a movement corridor for this species.

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.

A viable local population of these species is not likely to be placed at risk of extinction due to:

- no breeding habitats occur on the subject site; and
- the small amount of habitat to be removed, which is insignificant in relation to these species home ranges and to the better quality habitats present in local bushland , including Hoxton Park Recreation Reserve, Liverpool Showground, Leacock Regional Park, Western Sydney Regional Park and bushland along Cabramatta and Hinchinbrook Creeks.

(b) In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly disrupted.

Not relevant

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

The habitats present on the site do not contain suitable breeding habitats, and provide poor quality habitat for this threatened species. As such, the proposal is not considered likely to modify or remove a regionally significant area of habitat.

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

Considering the proximity of the site to Hoxton Park Road, the mobility of the species and the small size of the proposal, the fragmentation of a population is highly unlikely.

(e) Whether critical habitat will be affected.

The subject site has not been identified as critical habitat within the provisions of the Threatened Species Conservation Act (1995). Therefore, this matter does not require further consideration at this time.

(f) Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.

This species are not considered likely to be adequately represented in conservation reserves (or similar protected areas) in the region. As the subject site contains a relatively small amount of disturbed habitat, it is not considered likely to have any significance in any future formation of a conservation system that is regionally representative of this species habitats.

(g) Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.

The clearing of native vegetation is recognised as a Key Threatening Process on Schedule 3 of the Threatened Species Conservation Act (1995) (NSW Scientific Committee 2001) that is relevant to this proposal. However, the small area and poor quality of habitat to be removed is not considered likely to threaten this species.

(h) Whether any threatened species, populations or ecological community is at the limit of its known distribution.

Records available on the Atlas of NSW Wildlife (NPWS On-line Database) indicate that this species are not at or approaching the limits of their distribution on the subject site.

Conclusion:
The proposal is not likely to constitute a significant impact with respects to the Spotted-tailed Quoll.

Insectivorous Bats
(Large Pied Bat, Eastern False Pipistrelle, Common Bent-wing Bat, East Coast Freetail Bat, Southern Myotis, Yellow-bellied Sheathtail-bat and the Greater Broad-nosed Bat)

The Large Pied Bat has been recorded in a variety of habitats, including dry sclerophyll forests, woodland, sub-alpine woodland, edges of rainforests and wet sclerophyll forests. This species roosts in caves (Churchill 1998), which are absent from the site.

Eastern False Pipistrelle is associated with dry sclerophyll, moist eucalypt forest and rainforest (Environment Australia 2000). This species occurs predominantly in forested areas with higher rainfall (Parnaby 1983). Roosts mainly in tree hollows, occasionally utilising caves and abandoned buildings (Environment Australia 2000, AMBS 1995, Klippel 1992, Parnaby 1992 and Phillips et al. 1985). While this species has been observed roosting in built structures, not bats were observed roosting under the bridge crossing. Due to the level of disturbance from traffic, it is not considered likely that this species would roost on site.

The Common Bent-wing Bat is associated with a range of habitats, typically well-timbered areas where it forages above and below the tree canopy on small insects (AMBS, 1995; Dwyer, 1995, 1981). The Common Bent-wing Bat will utilise caves, old mines, and stormwater channels, under bridges and occasionally buildings for shelter (Environment Australia 2000, Dwyer 1988). Their dependence upon relatively few nursery caves suggests that threats to the existence or structural integrity of these may place widespread populations in jeopardy (Dwyer 1995a). While this species has been observed roosting in built structures, not bats were observed roosting under the bridge crossing. Due to the level of disturbance from traffic, it is not considered likely that this species would roost on site.

East Coast Freetail Bat is associated with rainforests, open forests and woodland (AMBS 1995). Colonies have been found roosting under loose bark, in tree hollows, within the roofs of houses and in other modified habitats (Environment Australia 2000, Richards and Hall 1979, SFNSW 1995). While this species has been observed roosting in built structures, not bats were observed roosting under the bridge crossing. Due to the level of disturbance from traffic, it is not considered likely that this species would roost on site.

The Southern Myotis inhabits cool temperate, temperate, sub tropical and tropical rainforests and wet and dry sclerophyll forests (Richards 1988). Southern Myotis is associated with water bodies such as rivers, creeks and pools, also farm dams and estuaries, and feeds on a wide range of insects, including water boatmen, mayflies, beetles, flies, grasshoppers and moths, as well as small fish (Robson 1984; Vestjens and Hall 1977). The Southern Myotis roosts in colonies in caves, mines, tunnels, under bridges and buildings, in dense foliage in tropical areas (Richards 1988) and in tree hollows (Menkhorst 1995, Environment Australia 2000). Colonies usually consist of 10-15 individuals but may include over several hundred animals (Richards 1988). Colonies are always found near water bodies as the species feeds predominantly over water. While this species has been observed roosting in built structures, not bats were observed roosting under the bridge crossing. Due to the level of disturbance from traffic, it is not considered likely that this species would roost on site.

Yellow-bellied Sheathtail-bat is associated with open country, mallee, eucalypt forests, rainforests, heathland and waterbodies (SFNSW 1995). This species roosts in tree hollows and may also use caves (Environment Australia 2000). No suitable roosting habitat was observed on site for this species.

Greater Broad-nosed Bat is associated with moist gullies in mature coastal forest, or rainforest, east of the Great Dividing Range (Churchill, 1998), tending to be more frequently located in more productive forests. Within denser vegetation types, use is made of natural and man-made openings such as roads, creeks and small rivers, where it hawks backwards and forwards for prey (Hoye & Richards 1995). No suitable roosting habitat was observed on site for this species.

The absence of suitable breeding habitat and small area of foraging habitat indicates that the site provides poor habitat values for these species.

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.

A viable local population of these species is not likely to be placed at risk of extinction due to:

- no breeding habitats occur on the subject site; and
- the small amount of habitat to be removed, which is insignificant in relation to these species home ranges and to the similar habitats present in local bushland , including Hoxton Park Recreation Reserve, Liverpool Showground, Leacock Regional Park, Western Sydney Regional Park and bushland along Cabramatta Creek.

(b) In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly disrupted.

Not relevant

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

The habitats present on the site are of limited extent, do not contain suitable breeding habitats, and provide poor quality habitat for these threatened species. As such, the proposal is not considered likely to modify or remove a regionally significant area of habitat.

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

Considering the proximity of the site to Hoxton Park Road, the mobility of the species and the size of the proposal, the fragmentation of a population is highly unlikely.

(e) Whether critical habitat will be affected.

The subject site has not been identified as critical habitat within the provisions of the Threatened Species Conservation Act (1995). Therefore, this matter does not require further consideration at this time.

(f) Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.

These species are not considered likely to be adequately represented in conservation reserves (or similar protected areas) in the region. As the subject site contains a relatively small amount of disturbed habitat, it is not considered likely to have any significance in any future formation of a conservation system that is regionally representative of these species habitats.

(g) Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.

The clearing of native vegetation is recognised as a Key Threatening Process on Schedule 3 of the Threatened Species Conservation Act (1995) (NSW Scientific Committee 2001) that is relevant to this proposal. However, the small area and poor quality of habitat to be removed is not considered likely to threaten these species.

(h) Whether any threatened species, populations or ecological community is at the limit of its known distribution.

These species are not at or approaching the limits of their distribution on the subject site.

Conclusion:
The proposal is not likely to constitute a significant impact with respects to threatened insectivorous bats.

Grey-headed Flying-Fox

The Grey-headed Flying-Fox is known to consume a variety of native and exotic fruits (Eby 1998), in addition to a variety of blossoms, leaves and bark (Parry-Jones and Augee 2001). Winter flowering or fruiting species are considered an important resource for this species (NSW Scientific Committee 2001). Campsites are located in a variety of situations, including rainforests, open forests, woodlands, Melaleuca swamps and Banksia woodlands (NSW Scientific Committee 2001).

The site contains a winter flowering tree, the Forest Red Gum (*Eucalyptus tereticornis*) (Law *et al.* 2000), and such provides a potentially important resource for this species.

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.

A viable local population of these species is not likely to be placed at risk of extinction due to:

- no breeding habitats occur on the subject site; and
- the small amount of habitat to be removed, which is insignificant in relation to these species home ranges and to the better quality habitats present in local bushland , including Hoxton Park Recreation Reserve, Liverpool Showground, Leacock Regional Park, Western Sydney Regional Park and bushland along Cabramatta Creek.

(b) In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly disrupted.

Not relevant

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

The habitats present on the site are of limited extent, do not contain suitable breeding habitats, and provide limited quality habitat for this species. As such, the proposal is not considered likely to modify or remove a regionally significant area of habitat.

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

Considering the proximity of the site to Hoxton Park Road, the mobility of the species and the size of the proposal, the fragmentation of a population is highly unlikely.

(e) Whether critical habitat will be affected.

The subject site has not been identified as critical habitat within the provisions of the Threatened Species Conservation Act (1995). Therefore, this matter does not require further consideration at this time.

(f) Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.

This species is not considered likely to be adequately represented in conservation reserves (or similar protected areas) in the region. As the subject site contains a relatively small amount of disturbed habitat, it is not considered likely to have any significance in any future formation of a conservation system that is regionally representative of these species habitats.

(g) Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.

The clearing of native vegetation is recognised as a Key Threatening Process on Schedule 3 of the Threatened Species Conservation Act (1995) (NSW Scientific Committee 2001) that is relevant to this proposal. However, the small area of habitat to be removed is not considered likely to threaten this species.

(h) Whether any threatened species, populations or ecological community is at the limit of its known distribution.

Records available on the Atlas of NSW Wildlife (NPWS On-line Database) indicate that this species are not at or approaching the limits of their distribution on the subject site.

Conclusion:
The proposal is not likely to constitute a significant impact with respects to the Grey-headed Flying-Fox.

Large Land Snail

The Large Land Snail is associated with open eucalypt forests, particularly Cumberland Plain Woodland described in Benson (1992), Castlereagh Woodland and the fringes of River-flat Forest, especially where this meets Cumberland Plain Woodland (Rudman 1998). The Large Land Snail is found under fallen logs, debris and in bark and leaf litter around the trunk of gum trees or burrowing in loose soil around clumps of grass (NPWS 1997, Rudman 1998). Urban waste may also form suitable habitat (NPWS 1997, Rudman 1998).

Large Land Snail records from the local area made during the studies for the Western Sydney Orbital were typically low, and located in similar habitats to that on the site.

No live Large Land Snails were found, only two empty shells of this species were observed on site, with no live individuals being located. AMBS conducted a targeted survey of the study area south of the existing road for *Meridolum corneovirens* on the 9th January 2004 in order to, if possible, draw a conclusion regarding the likelihood that an extant population of Large Land Snail.

AMBS found no further evidence of the Large Land Snail. AMBS noted that, while the study area contains potential habitat for the Large Land Snail, it is not considered to be optimal habitat and is degraded to some extent by the presence of exotic vegetation. AMBS also found the introduced snail *Bradybaena similaris* throughout the subject site, an indication that the study area has been degraded habitat for the Large Land Snail.

AMBS was not able to draw any conclusion in regard to the shells detected earlier in this study, however, it was noted that these shells may have been evidence the Large Land Snail previously occurred. On the basis of the poor habitat value of the subject site for the Large Land Snail, AMBS concluded that the study area was unlikely to contain an extant population of the Large Land Snail.

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.

AMBS concluded that, due to the poor habitat value of the subject site for the Large Land Snail, the study area was unlikely to contain an extant population of the Large Land Snail. This, combined with the small area of habitat, all of which is, degraded indicates that the proposal is not likely to have a significant impact on a viable local population of this species.

(b) In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly disrupted.

Not relevant

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

This species is restricted to the Sydney Basin Bioregion, and is known from over 100 populations, which are often small and isolated (NPWS 1999). The known habitat on site is considered relatively small in relation to that in the region, as is broadly indicated by the level of Shale Gravel Transition Forest removal to similar habitats remaining in the region (Table A2). This, combined with the degraded nature of the habitat, indicates that the proposal is not likely to modify or remove a regionally significant area of habitat.

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

Connectivity of habitat to the north of the site is considered unlikely due to the presence of Hoxton Park road and the steep concrete walls that support the bridge crossing of Cabramatta Creek. Due to the existing barriers to movement, the fragmentation of a population resulting from the proposal is considered highly unlikely.

(e) Whether critical habitat will be affected.

The subject site has not been identified as critical habitat within the provisions of the Threatened Species Conservation Act (1995). Therefore, this matter does not require further consideration at this time.

(f) Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.

This species has been recorded in Agnes Banks, Windsor Downs, Gulguer and Castlereagh Nature Reserves and Scheyville National Park (NPWS 1999). These reserves are located in the north west of this species range, and are unlikely to represent an adequate representation of this species across its range. As such, this species is not considered to be adequately represented in conservation reserves (or similar protected areas) in the region.

(g) Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.

The clearing of native vegetation is recognised as a Key Threatening Process on Schedule 3 of the Threatened Species Conservation Act (1995) (NSW Scientific Committee 2001) that is relevant to this proposal. As the proposal will remove a small area of degraded habitat, the proposal is not considered to be a class of development that threatens this species.

(h) Whether any threatened species, populations or ecological community is at the limit of its known distribution.

This species approaching the easterly limit of its, however, is not at the easterly limit of its distribution on the subject site.

Conclusion:
The proposal is not considered likely to have a significant impact on a viable local population of this species considering the relatively small loss of degraded habitat. As such, a Species Impact Statement should not be required for the proposal.

Endangered Ecological Communities
(Shale Gravel Transition Forest, Sydney Coastal River Flat Forest and Sydney Coastal River Flat Forest)

Shale - Gravel Transition Forest (SGTF) occurs primarily in areas where shallow deposits of Tertiary alluvium overlie shale soils but may also occur in association with localised concentrations of iron-indurated gravel (NSW Scientific Committee 2002). SGTF has predominantly an open-forest structure, with *Eucalyptus fibrosa*, sometimes with *E. moluccana* and *Eucalyptus tereticornis*. *Melaleuca decora* is frequently present in a small tree stratum (NSW Scientific Committee 2002).

SGTF is or has been known to occur in the Auburn, Bankstown, Baulkham Hills, Blacktown, Fairfield, Hawkesbury, Holroyd, Liverpool, Parramatta and Penrith Local Government Areas, but may occur elsewhere in the Sydney Basin Bioregion. SGTF has been cleared for agriculture and rural development. About 36% of the original distribution of about 7000 ha remain (NPWS 2002) and much of this is in a degraded state (NSW Scientific Committee 2002). SGTF occurs in Agnes Banks Nature Reserve, Castlereagh Nature Reserve, Scheyville National Park and Windsor Downs Nature Reserve. The area in these reserves is about 3% of the original distribution (NSW Scientific Committee 2002).

Table A2 The amount of SGTF to be affected by the proposal

SGTF	Canopy Cover <10%	Canopy Cover >10%
Site	6,383 m^2	287 m^2
% removed of total in Local Government Area	0.08%	<0.01%
% removed of total in Region	0.05%	<0.01%

Sydney Coastal River-flat Forest (SCRFF) is typically associated with rivers and creeks and occurs on the riparian zone and on associated floodplains, terraces and flats on alluvial soils (TSC Act 1995). SCRFF occurs exclusively on or in close proximity to watercourses draining areas where soils are derived from Wianamatta Shales (NPWS 2000).

SCRFF incorporates vegetation that has previously been described by:

- Benson (1992) as 'River Flat Forest' (Map Unit 9f) and 'Camden White Gum Forest' (Map Unit 6d).
- NPWS (1997) as 'Forest Gum – Cabbage Gum Forest' and 'Forest Red Gum – Cabbage Red Gum Forest'.
- NPWS (2002) as Map Unit 11 (Alluvial Woodland) and Map Unit 12 (Riparian Forest).

SCRFF is now reduced to 4176 ha which is 9.7% of its original distribution (NPWS 1999), and is located in Mulgoa and Chain-O-Ponds Nature Reserves, Bents Basin State Recreation Area, Western Sydney Regional Park, Cabramatta Creek Park and Nurragingy Reserve.

Table A3 The amount of SCRFF to be affected by the proposal

SCRFF	Canopy Cover <10%	Canopy Cover >10%
Site	33 m^2	7, 438 m^2
% removed of total in Local Government Area	<0.01%	0.08%
% removed of total in Region	<0.01%	0.01%

(a) In the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.

Not relevant

(b) In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly disrupted.

Not relevant

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

The amount of CPW, SGTF and SCRFF vegetation to be removed, as shown in Tables A2-4 is not considered to be regionally significant. As such, the proposal is not considered likely to impact on a regionally significant area of known habitat for these communities.

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

Considering the location of Hoxton Park Road, the degree of fragmentation of an ecological community is negligible.

(e) Whether critical habitat will be affected.

The subject site has not been identified as critical habitat within the provisions of the Threatened Species Conservation Act (1995). Therefore, this matter does not require further consideration at this time.

(f) Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or similar protected areas) in the region.

These communities are not considered likely to be adequately represented in conservation reserves (or similar protected areas) in the region. As the subject site contains a relatively small amount of disturbed habitat, it is not considered likely to have any significance in any future formation of a conservation system that is regionally representative of these communities' habitats.

(g) Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.

The clearing of native vegetation is recognised as a Key Threatening Process on Schedule 3 of the Threatened Species Conservation Act (1995) (NSW Scientific Committee 2001) that is relevant to this proposal. However, the small area of habitat to be removed is not considered likely to threaten these communities.

(h) Whether any threatened species, populations or ecological community is at the limit of its known distribution.

Records available on NPWS (2002) indicates that these communities are not at or approaching the limits of their distribution on the subject site.

Conclusion:

The proposal is not likely to constitute a significant impact with respects to endangered ecological communities, considering the relatively small loss of habitat and the mitigative measures outlined above. As such, a Species Impact Statement should not be required for the proposal.

Appendix D

Flood Study

FLOOD AND STORMWATER DRAINAGE ASSESSMENT REPORT FOR PROPOSED HOXTON PARK ROAD UPGRADE WEST HOXTON AND HINCHINBROOK

VOLUME 1 OF 2

FEBRUARY 2004

PRELIMINARY DRAFT FOR CLIENT REVIEW

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S1 SUMMARY AND RECOMMENDATIONS

TABLE S1
SUMMARY OF CROSS DRAINAGE REQUIREMENTS

Design Road Chainage	Location	Existing Drainage Infrastructure	Existing Capacity (ARI)	Cross Drainage Requirements	Post-Upgrade Capacity (ARI)	Comments	Refer Figure Number
100	East of Cowpasture Road	3 off 2400 x 900 RCBCs	100	➢ No upgrade of cross drainage culverts required ➢ Provide additional inlet capacity along northern kerbline of HPR to intercept gutter flows discharging from the west.	100	➢	Figure D1
290	Ashford Close	2 off 600 RCPs	>10	➢ Demolish & remove 27 m (approx.) length of existing 2 off 600 RCPs ➢ Extend existing 825 RCP to northern kerbline of HPR. ➢ Trench and lay 37 m (approx.) length of new 825 RCP (minimum diameter) across HPR. ➢ Construct new grated surcharge pit in depressed median and connect new pavement drainage system draining westbound lanes of HPR. ➢ Lower finished footpath levels fronting inlet to cross drainage system to RL 36.6 m AHD (max.).	~10	ALTERNATIVE TO LOWERING PAVEMENT LEVELS ➢ Construct drainage swale along southern footpath of HPR through No. 636 HPR. Invert level of swale to fall from RL 36.6 m AHD to RL 36.4 m AHD. ➢ Construct low block wall along eastern boundary of No. 636 HPR	Figure D1
490	Glen Innes Road	1 off 900 RCP	>20	➢ Demolish and remove 25 m (approx.) length of 900 RCP and 20 m (approx.) length of existing 375 RCP at road intersection. ➢ Trench and lay 25 m (approx.) length of new 900 RCP and construct new sag inlet pits in low point of Glen Innes Road. ➢ Adjust finished pavement levels in south-east corner of road intersection to ensure gutter levels are no higher than RL 34.0 m AHD. ➢ Connect pavement drainage system controlling runoff from HPR west of Glen Innes Road to KIP in western gutter of local road, north of HPR	<20	➢ Pavement drainage system along southern kerbline of HPR to be improved, including that in the sag in Glen Innes Road, to intercept flows approaching from cross drainage system at Design Road Chainage 290.	Figure D2
720	West of Dorrigo Avenue	2 off 600 RCPs	>20	➢ Connect existing 450 RCP draining via easement to HPR road reserve (DRC 580) to new pavement drainage system and pipe via 600 RCP (min.) to new junction pit in depressed median at DRC 725. ➢ Demolish and remove 29 m (approx.) length of existing 2 off 600 RCPs. ➢ Trench and lay 25 m (approx.) length of new 2 off 900 RCPs beneath eastbound lanes of HPR. ➢ Construct new concrete headwall at outlet of 2 off 900 RCPs and connect new pavement drainage system draining eastbound lanes of HPR. ➢ Trench and lay 25 m (approx.) length of new 2 off 750 RCPs beneath westbound lanes of HPR. ➢ Construct new grated surcharge pit in depressed median and connect new pavement drainage system draining westbound lanes of HPR. ➢ Construct new concrete inlet structure along southern side of HPR at inlet to new 2 off 750 RCPs	>100	➢	Figure D2
820	Dorrigo Avenue	1 off 375 RCP	NA	➢ Reconstruct existing sag inlet pits at new low point in local road.	NA	➢ Investigate location of existing pipe drainage system at northern end of Dorrigo Avenue.	Figure D2
1060	First Avenue	1 off 375 RCP	<2	➢ Connect existing pavement drainage system in First Avenue to new pavement drainage system for HPR comprising 675 and 750 RCP's. ➢ Connect new pavement drainage system to right bank of Hinchinbrook Creek at location of new bridge crossing.	~10	➢	Figure D3

TABLE S1 (CONTINUED)
SUMMARY OF CROSS DRAINAGE REQUIREMENTS

Design Road Chainage	Location	Existing Drainage Infrastructure	Existing Capacity (ARI)	Cross Drainage Requirements	Post-Upgrade Capacity (ARI)	Comments	Refer Figure Number
1280	Hinchinbrook Creek	Single Span Bridge	<5	➢ Demolish existing bridge structure and construct two new three span bridges. ➢ Excavate channel and rock armour banks. ➢ Construct rock riffles in invert of creek to create level pool through bridge opening ➢ Revegetate creek banks.	20-100	➢	Figure 6.1 & 6.2
1435	East of Wilson Road	2 off 450 RCPs	<2	➢ Demolish and remove 20 m (approx.) length of existing 2 off 450 RCPs. ➢ Trench and lay 40 m (approx.) length of 2 off 2100 x 300 RCBCs across HPR at 0.5% grade. Upstream invert IL 27.0 m AHD. ➢ Construct new concrete headwall at inlet to culverts and shape natural surface levels along northern side of roadway to promote overland flows towards culvert entrance. ➢ Adjust finished surface levels in depressed central median to RL 27.6 m AHD (min.) ➢ Connect new pavement drainage system to outlet headwall.	2-5	➢ Investigate location of M7 bridge supports in vicinity of cross drainage system due to possible clash.	Figure D4
1700	Whitford Road	1 off 900 RCP	10-20 (Local) <2 (Main River)	➢ Extend existing 1200 x 450 RCBC by a length of 20 m (approx.) and construct new concrete headwall in Hoxton Park Recreation Reserve. ➢ Demolish and remove 80 m (approx.) length of existing 450 and 525 RCP beneath northern kerbline of HPR west of Whitford Road. Concrete encase existing 900 RCP at point of connection. ➢ Construct new concrete inlet headwall in north-west corner of HPR/Whitford Road intersection and connect new 7 m (approx.) length of 1200x 450 RCBC and connect to existing 900 RCP. ➢ Clean out, regrade at 1% min. and returf 150 m (approx.) length of existing open channel draining 2 off 450m RCPs in north-east corner of HPR/Whitford Road intersection.	~20 (Local) 2-5 (Main River)	➢	Figure D4
1720	Illaroo Road	1 off 600 RCP	20-100	➢ Demolish and remove 47 m (approx.) length of existing 450 and 600 RCP beneath HPR. Concrete encase existing 1050 RCP at point of connection. ➢ Incorporate drainage of Illaroo Road into new independent pavement drainage system for HPR.	~5	➢	Figure D5
1840	East of Whitford Road	1 off 1200 RCP	<5	➢ Clean out inlet to existing 1200 RCP ➢ Demolish and remove existing concrete inlet structure and construct new inlet headwall with 1.2 m^2 (min.) opening. ➢ Install pedestrian safety handrail around new headwall structure.	~5	➢	Figure D5
1860	East of Whitford Road	Open Channels	<2	➢ Construct 2 off new surface inlet pits at downstream end of existing open channels. Connect new pits to new independent pavement drainage system for HPR.	~5	➢	
1890	West of Banks Road	1 off 450 RCP	<2	➢ Demolish and remove 13 m (approx.) length of existing 450 RCP. Concrete encase existing 1200 RCP at point of connection.	NA	➢	Figure D5
2000	West of Banks Road	1 off 525 RCP	<2	➢ Demolish and remove 13m (approx.) length of existing 525 RCP. Concrete encase existing 1200 RCP at point of connection.	NA	➢	
2120	Banks Road / Liverpool to Parramatta Transitway	1 off 1200 RCP	<5	➢ Trench and lay new independent pavement drainage system for HPR within depressed median. Construct new concrete outlet headwall on left bank of Cabramatta Creek and provide rock scour protection works in creek invert. ➢ Install gross pollutant trap beneath median of HPR on new independent pavement drainage system.	~5	➢	Figure D6

1 INTRODUCTION

1.1 Study Background

This report deals with the results of an investigation into the characteristics of flooding along an approximate 2 km length of Hoxton Park Road (HPR) which the RTA is presently proposing to upgrade to a multi-lane carriageway. The report also outlines a number of recommendations for the upgrade of existing cross drainage infrastructure along the route of the road upgrade.

The roughly 2 km length of HPR to be upgraded extends from a location immediately east of Cowpasture Road to the intersection of the recently completed Liverpool to Parramatta Bus Transitway (LPT), as shown in Figure 1.1.

HPR is subject to flooding from the adjoining local catchments during events which surcharge the numerous pipes and culverts which cross the roadway along its length. The section of roadway east of Buggys Bridge is also subject to flooding from floodwaters which surcharge the left bank of Hinchinbrook Creek and traverse the wide flat floodplain across which the at-grade road is located.

The road concept currently being prepared by the Authority is a development of the earlier design prepared by Hughes Trueman Consulting Engineers and includes:

- the widening of the existing roadway to 4 lanes, with provision being made in the road design for the possible future construction of two additional lanes.
- the re-alignment of the northern end of Illaroo Road and the installation of a signalised intersection where Illaroo Road and Whitford Road meet HPR.
- the demolition of the existing 20 m long three span concrete bridge over Hinchinbrook Creek (locally known as Buggys Bridge) and the construction of two 45 m long three span concrete bridges. Each new bridge will accommodate the eastbound or westbound lanes separately, with provision being made in the bridge design for the possible future construction of one additional lane to each.

1.2 Study Objectives

The drainage investigation had the following objectives:

- Assess the possible impacts the proposed road construction has on the patterns of flooding across the Cabramatta/Hinchinbrook Creek floodplain as a result of main river flooding. The two-dimensional (in plan) hydrodynamic computer model set up by the designers of the M7 Motorway was used to assess the possible impacts the recent changes in the HPR design could have on flooding.
- Assess the performance of the drainage system crossing HPR under present day conditions. The drainage system comprises the pavement drainage system of HPR, as well as the cross drainage lines and the local catchments which contribute runoff to those lines. This step required the development of a hydrologic model which incorporated all of the relevant sub-catchments.

- The performance of the system was examined for a range of storm frequencies between 2 and 100 year Average Recurrence Interval (ARI).

- Assessment of the performance of the cross drainage system with the upgraded HPR in place. The existing cross drainage systems modelled under present day conditions were reconfigured to reflect changes to the ground topography within the confines of the road corridor, and alternatives assessed for the upgrade of each system. The objectives of the piped upgrades recommended by this study was to improve the level of flood security afforded to the new roadway and to reduce the duration over which the carriageway would be inundated by floodwaters.

- Recommend works within the inbank area of Hinchinbrook Creek, where the construction of the two new bridges will impact upon the environs of the creek.

- Assess opportunities for incorporating on-site detention into the road design.

1.3 Study Methodology and Report Layout

The DRAINS rainfall-runoff catchment modelling software was used to generate flows for the various storm events and undertake hydraulic analysis of the pipe drainage system. The TUFLOW two-dimensional hydrodynamic modelling software was used to describe the nature of flooding along the length of road affected by main river flooding from the Hinchinbrook/Cabramatta Creek systems.

The characteristics of the roughly 2 km length of road corridor along which HPR will be upgraded, including the catchments which drain to the existing cross drainage infrastructure is given in **Section 2** of the report.

Section 3 gives the results of hydrologic and hydraulic modelling and discusses the characteristics of both main river and local catchment flooding under present day conditions.

Section 4 gives a brief description of the proposed road upgrade works.

The results of hydrologic and hydraulic modelling under post-upgrade works for both main river and local catchment flood events are given in **Section 5** of the report. Also given in this section, are the recommended works required to upgrade existing cross drainage infrastructure along the route.

Section 6 describes the inbank works which are recommended at the Hinchinbrook Creek crossing and gives a brief discussion on the effectiveness of incorporating on-site detention into the road design.

A list of references is given in **Section 7**.

Bound in a separate volume of this report are the **Appendices**, which should be referred to when reading this report.

2 PRESENT DAY ROAD AND CATCHMENT CHARACTERISTICS

2.1 General

For discussion purposes, the roughly 2 km length of roadway has been divided into the following two sections:

- the Western Section, which extends west of Buggys Bridge and comprises the works over Design Road Chainage (DRC) 0 to 1280; and
- the Eastern Section, which extends east of Buggys Bridge and comprises the works over DRC 1280 to 2157.

Figures 2.1 and 2.2 show the watershed boundaries of the numerous sub-catchments which contribute stormwater runoff to the cross drainage systems of HPR. Additional figures referred to in this section of the report are contained in **Appendix B** of **Volume 2**.

2.2 Western Section

2.2.1 Design Road Chainage 0 to 400

The Western Section of HPR which is to be upgraded commences at the intersection with Cowpasture Road. Survey plans provided by the RTA show 3 off 2400 x 900 reinforced concrete box culverts (RCBCs) crossing beneath the recently constructed road intersection, with the culverts discharging to an open reach of channel which is located to the north of HPR and Warialda Way (refer **Figure B1**).

The culverts control runoff from a rapidly developing catchment of approximately 130 ha to the west of Cowpasture Road. Limited survey information was available giving details of the culverts, however, data contained within the hydrodynamic model set up by the designers of the M7 Motorway show that the upstream and downstream invert levels of the 175 m long culvert are RL 35.07 m AHD and RL 33.6 m AHD respectively.

Approximately 200 m to the east of the large box culverts, at DRC 290, RTA survey shows the presence of two existing 600 reinforced concrete pipes (RCPs) crossing HPR where it narrows to two lanes. Plans provided by the RTA (refer **Ref. 8 in Appendix A**) show the existing 2 off 600 RCPs discharge to an 825 RCP which drains via an easement through to Ashford Close.

RTA's surveyors did not level the invert of the two pipes, however, based on the contour data supplied by the RTA, the upstream invert level of the existing 600 RCPs along the southern side of the existing two lane carriageway was estimated at RL 35.9 m AHD. Drainage plans relating to the subdivision to the north (refer **Ref. 8**) show the invert level of the twin 600 RCPs at the grated inlet pit on the northern side of HPR drops through the pit from an elevation of RL 35.7 to RL 35.4 m AHD. The cover over the pipe twin pipes as they cross the carriageway based on RTA ground survey levels is less than 0.5 m.

Downstream of the grated inlet pit the twin 600 RCPs continue over a roughly 5 m length and enter a junction pit located along the northern road reserve boundary at an invert level of RL 35.15 m AHD. The invert level of the 825 RCP where it enters the easement from HPR is shown as RL 34.91 m AHD.

The cross drainage system at DRC 290 controls runoff from a catchment of roughly 7.3 ha. The land immediately upstream of the crossing is presently undeveloped, however, aerial photography flown in December 2002 shows that a large subdivision development had commenced in the south-east corner of the Cowpasture Road/HPR intersection. No plans were made available showing the internal drainage system of this subdivision. It was therefore assumed that stormwater generated by the rapidly developing catchment would follow the natural fall in ground levels and discharge to the entrance to the twin 600 RCPs.

An existing dwelling is located to the east of the inlet to the twin 600 RCPs at No. 636 HPR (Lot No. 71 in DP 2475). Ground levels fall along the western boundary of the allotment from RL 37.0 m AHD (at a location immediately adjacent to the dwelling) to RL 36.6 m AHD adjacent to the existing carriageway where a depression falls towards the east along the frontage of the property.

Along the northern frontage to the road reserve, a low earth mound of between 0.5 – 1 m was observed running along the rear of several allotments which gain access via Ashford Close. A continuous line of colorbond type fencing was observed atop the mound along its full length.

2.2.2 Design Road Chainage 400 to 900

At DRC 500, RTA survey shows the presence of an existing 900 RCP crossing HPR from the eastern kerbline of Glen Innes Road (refer **Figure B2**). No details of the pipe, other than its plan location is given by the survey.

However, subdivision plans of the area (refer **Ref. 8**) show the 900 RCP drains from the south in a northerly direction beneath the western kerbline of Glen Innes Road before crossing to the eastern kerbline of the local road at the location of the sag in the roadway (located immediately to the south of its intersection with HPR).

The invert level of the 900 RCP beneath the western and eastern kerblines at the sag in the local road are RL 31.9 m AHD and RL 31.79 m AHD respectively. A 375 RCP is also shown to drain to the sag inlet pit in the western kerbline of Glen Innes Road and controls gutter flows in the southern kerbline of HPR.

The pipe is then shown to cross HPR to a junction pit which is located on the northern side of the carriageway. The invert level of the pipe at this location is RL 31.52 m AHD. The cover over the 900 RCP as it crosses HPR is over 1 m.

Downstream of this pit, the 900 RCP continues for a distance of approximately 12 m where it discharges to a kerb inlet pit located in the western kerbline of Glen Innes Road, north of HPR. The invert of the 900 RCP at this location is RL 33.34 m AHD where it is joined by a 375 RCP which drains the northern verge of HPR and has an invert level at the point of connection of RL 32.54 m AHD.

Downstream of the junction between the two pipes, a 1050 RCP is shown to continue in a northerly direction along Glen Innes Road where it eventually discharges to the open channel which discharges along the northern side of Warialda Way.

Further to the east, at DRC 595, RTA survey shows a 450 RCP discharging to the road reserve from an easement which fronts the southern road reserve boundary. Survey shows the pipe running along the southern side of the carriageway towards the east over a distance of approximately 17 m before crossing to the northern side of the carriageway. The pipe again turns eastward and runs along the northern side of the road reserve over a distance of approximately 110 m before discharging to the western most cell of two 600 RCPs which cross the road at DRC 720.

RTA survey shows the two 600 RCPs at DRC 720 have an upstream invert level of RL 30.65 m AHD and a downstream invert level of RL 29.98 m AHD. The cover over the pipes based on RTA ground survey is less than 200 mm.

The two pipes discharge to an open channel which is heavily overgrown along most of its length. Aerial photography (refer **Figure 2.1**) shows the open channel drains in a north-east direction across a vacant allotment before turning northward and discharging along the western boundary of the Good Samaritan Catholic College.

Dorrigo Avenue meets HPR at a high point in the latter road. Survey information supplied by the RTA does not show the presence of any pavement drainage system at this location, however, two pits draining the sag in the local road near its intersection with HPR were observed during a site inspection. The size and direction of the pipe system draining these two pits is unknown, however, a small diameter pipe was observed leading out of the pit located in the western kerbline of the roadway, possibly draining the system towards the south.

2.2.3 Design Road Chainage 900 to 1280

A minor pipe drainage system is located at the intersection of First Avenue at DRC 1060 (refer **Figure B3**). RTA survey shows the presence of two 375 RCPs draining the southern kerbline of HPR and the western kerbline of First Avenue. Both pipes discharge to a kerb inlet pit located in the eastern kerbline of First Avenue. A 375 RCP drains the kerb inlet pit and discharges to a grated surface inlet pit which is located off the southern kerbline of HPR.

RTA survey shows a 375 RCP draining the pit and discharging via a concrete headwall to an open length of drain which continues along the southern edge of the HPR carriageway. The pipe discharges to the right bank of Hinchinbrook Creek, immediately downstream of Buggys Bridge.

Site inspections carried out during the course of this investigation observed works being undertaken to enclose the open drain via a new length of 375 RCP. It is presumed Liverpool City Council (LCC) is carrying out this work.

2.3 Eastern Section

2.3.1 Design Road Chainage 1280 to 1560

HPR crosses Hinchinbrook Creek between DRC 1290 and 1310 via a narrow three span concrete bridge, locally known as Buggys Bridge. The bridge deck is approximately 20 m in length and has a deck elevation of RL 28.6 m AHD. RTA concept drawings of the new bridge works show the low cord of the existing bridge soffit has an elevation of around RL 27.4 m AHD.

Based on inbank survey of Hinchinbrook Creek carried out by the RTA, the invert of the creek is approximately 2.2 m below the soffit level of the bridge at RL 25.2 m AHD. The waterway area through the bridge opening was estimated at around 26 m^2.

Immediately downstream of the bridge crossing, aerial photography and RTA survey shows Hinchinbrook Creek splits into two arms, with the main arm of the creek discharging in a south-east direction and a smaller high flow channel tracking due south over a distance of approximately 100 m. The secondary high flow channel drains towards existing residential development which fronts the creek corridor from Murwillumbah Avenue, before rejoining the main arm a distance of approximately 150 m downstream of the bridge crossing.

Hinchinbrook Creek is heavily wooded in the vicinity of the road crossing, with inbank survey and site inspections showing that a sequence of pool and riffle zones are present within the invert of the creek.

Immediately to the east of the bridge crossing, Wilson Road has no formal pavement drainage system and stormwater which approaches the sag in the roadway (located immediately north of HPR) runs off to either the western side of the roadway and spills directly into Hinchinbrook Creek or flows overland along the northern side of HPR where it discharges beneath the roadway via twin 450 RCPs which are located at DRC 1435.

The inlet to the 450 RCPs is located within a natural depression, across which HPR crosses. The invert level of the pipes at their inlet is RL 27.18 and outlet is RL 26.84 m AHD. The elevation of the sag in HPR, which is located directly above the twin 450 RCPs, is RL 28.0 m AHD. The resulting cover over the pipes is less than 400 mm.

An open channel drains the outlet to the twin 450 RCPs and appears to have been constructed as part of the works for the M7 Motorway. An access road for construction plant has been constructed alongside the heavily treed section of Hinchinbrook Creek and twin 450 RCPs were observed beneath the roadway. The pipes were observed discharging to an indistinct waterway which drains directly to the creek.

RTA survey shows that a shallow depression is located along the northern side of HPR, between Wilson Road and Whitford Road. A slight rise in ground levels at around DPC 1480 forces stormwater to pond to a depth of around 600 mm at the inlet to the twin 450 RCPs at DRC 1435 (or an elevation of RL 27.8 m AHD before it can flow eastward, towards Whitford Road.

2.3.2 Design Road Chainage 1580 to 1900

RTA survey and plans showing the pipe drainage system between Whitford Road and Banks Road (refer **Ref. 3 and 10**) were used to define the location and elevation of the pipe network which drain beneath this section of roadway.

The system (which discharges to Cabramatta Creek as a 1200 RCP at DRC 2110 commences a distance of approximately 60 m to the west of Whitford Road, where a 450 RCP controls runoff discharging in an easterly direction along the northern side of the HPR carriageway. Plans show the 450 RCP increasing to a 525 RCP before it discharges to a 900 RCP which crosses from the western kerbline of the local road to a junction pit located beneath the pavement of HPR.

Whilst not shown on RTA survey, a short length of 900 RCP was observed draining an open channel which drains the Hoxton Park Recreation Reserve along the western side of the Whitford Road Reserve. Downstream of the short length of 900 RCP, a 1200 x 450 RCBC is joined by a 600 x 300 RCBC which crosses from the eastern kerbline of the local road, with the larger box element discharging to the existing 900 RCP which crosses Whitford Road at its southern end.

The 600 x 300 RCBC which crosses Whitford Road north of the intersection drains a short length of open channel. The channel accepts stormwater which surcharges the pavement drainage system of Whitford Road to the north. Plans show that this system comprises twin 450 RCPs at its outlet where it discharges to an open channel.

RTA survey shows that the open channel (approximately 2.3 m wide at its base) is relatively flat over its roughly 150 m length. The channel was observed to be heavily infested with weed growth, including dense thickets of brambles.

Plans show a 625 RCP drains the southern end of Pegasus Avenue and discharges to the channel midway along its length opposite DRC 1780. At its downstream end, the channel falls steeply towards an inlet headwall located at DRC 1840. A reno mattress was observed in the invert of the steep section of channel, however, thick overgrowth prevented a visual inspection of the opening at the headwall, details of which are not shown on the RTA survey.

On the southern side of HPR, near the Illaroo Road intersection, a 450 RCP drains the western verge of the local road. The pipe is shown to cross the local road where it is drained by a 600 RCP which crosses HPR. The 600 RCP joins the 900 RCP from Whitford Road and a 1050 RCP continues eastward to the location where the open channel, which controls runoff from the residentially developed catchments to the north, drains to the pipe drainage system (DRC 1840).

As mentioned, a 1200 RCP continues downstream of this location. At DRC 1890, the large diameter pipe is joined by a 375 RCP which drains a residential area to the north and a 450 RCP which drains a relatively large catchment located to the south of HPR.

Two open channels were observed draining towards HPR from the south at DRC 1870. No outlet pipe was observed at the downstream confluence of the two channels, and it appears stormwater is forced to surcharge the channels and flow overland towards a grated surface inlet pit which is drained by the 450 RCP.

Stormwater which bypasses the inlet to the 450 RCP follows the prevailing grade alongside the HPR carriageway towards the east.

2.3.3 Design Road Chainage 1900 to 2157

East of DRC 1900, the 1200 RCP located beneath the northern verge of HPR continues in an easterly direction where it is joined by a 525 RCP which drains the southern side of HPR. The 1200 RCP extends eastward to DRC 2108 before crossing to the southern side of HPR and discharging to Cabramatta Creek via a concrete headwall.

No information on the invert level of the 1200 RCP was available from RTA survey, however, plans of the pipe system (refer **Ref. 3**) show the invert to be RL 21.975 m AHD. The standing water level in Cabramatta Creek is noted on the drawings at RL 21.385 m AHD, which is over 0.5 m below the invert level of the 1200 RCP.

Vacant land to the north of HPR between DRC 2000 and 2120 was not surveyed by the RTA for the design of the road upgrade, however, survey models obtained for the LPT design show natural ground levels falling towards the north, where stormwater will be conveyed beneath the recently constructed section of the LPT via a low bank of box culverts.

On the southern side of HPR, the 525 RCP which drains to the 1200 RCP at DRC 2000 controls runoff which sheets off the Integral Energy site or bypasses the inlet to the 450 RCP located further to the west.

Stormwater which cannot enter the 525 RCP will pond in a shallow depression to a depth of around 300 mm before escaping towards the east into Cabramatta Creek or northward across HPR at the location of the sag in the roadway at DRC 1960.

3 CHARACTERISTICS OF FLOODING UNDER PRESENT DAY CONDITIONS

3.1 General

This section of the report describes the characteristics of flooding which originates from both main river and local catchment sources along the roughly 2 km length of HPR which is to be upgraded.

Section 3.2 of the report describes the nature of flooding along the Eastern Section of roadway where floodwaters which surcharge the Hinchinbrook/Cabramatta Creek systems inundate the roadway during relatively frequent flood events. The results of hydrodynamic modelling carried out by the designers of the M7 Motorway have been used to illustrate the expected magnitude, depth and velocity of flood flows traversing the floodplain across which the road is located for a range of design storm events.

Section 3.3 of the report outlines the results of analyses undertaken using the DRAINS rainfall-runoff catchment modelling software to determine the capacity of the existing pipe drainage system which cross the HPR reserve.

The figures referred to in this section of the report are contained in **Appendix C** of **Volume 2**.

3.2 Main River Flooding

3.2.1 Background to TUFLOW Model

Flooding patterns described in this section of the report are based on the results of hydraulic modelling of the Hinchinbrook/Cabramatta Creek systems which was recently undertaken for the design of the M7 Motorway road project by the Maunsell SMEC Design Joint Venture (DJV) on behalf of the Westlink Consortium.

The analysis carried out for the M7 Motorway design used a two-dimensional (in plan) modelling approach based on the TUFLOW software. Flow hydrographs were derived from the RAFTS hydrologic model originally developed by Bewsher Consulting in the Floodplain Management Study for the creek system (BC, 1999).

The topographic data for the hydrodynamic model comprised a digital terrain model (DTM) which was generated from aerial photography flown in December 2001. Ground survey was also carried out by the DJV to provide more detailed information in the heavily wooded inbank areas along the creek reaches.

3.2.2 Results of TUFLOW Modelling

Results of the TUFLOW modelling are available for the 2, 5, 20 and 100 year ARI events, with storm durations of 2 and 9 hours shown to be critical for producing peak flood levels in the vicinity of the road upgrade.

Figure C1 shows the extent of flooding in the vicinity of HPR for the 2 year ARI design storm of 2 hours duration. The pattern of flooding, with arrows representing the direction of flow over the floodplain at the peak of the flood, are also shown on **Figure C1**, with the length of each arrow proportional to the magnitude of flow velocity.

The results of the modelling show that floodwaters will surcharge the left bank of Hinchinbrook Creek upstream of Buggys Bridge during this relatively frequent storm event. Floodwaters can be expected to inundate Wilson Road to depths of around 0.5 m before slipping eastward along the northern side of HPR. The location at which floodwaters escape Hinchinbrook Creek at Wilson Road is commonly referred to by LCC as the *"Wilson Road Breakout"*.

Floodwaters which flow across Wilson Road follow the alignment of HPR towards the east and extend northward into the Hoxton Park Recreation Reserve over a width of approximately 50 m.

At the location where a slight sag in HPR exists (around DRC 1435), floodwaters slip across the roadway to its southern side before spreading out and flowing overland in a southerly direction where they eventually rejoin flows in the main channel of Hinchinbrook Creek. Depths of flow over the roadway at this location are less than 100 mm.

Floodwaters which do not slip across HPR at this location continue towards the east along the northern side of the roadway and spread out in the heavily treed area at the eastern end of the Recreation Reserve. Floodwaters then slip across the southern end of Whitford Road where a sag in the roadway is present. Model results show that the depth of flooding at the location of the sag in the local road is relatively shallow, at less than 100 mm, with floodwaters confined to the north of the centerline of HPR.

Floodwaters which inundate Whitford Road continue in an easterly direction and join stormwater which discharges from the residential catchment to the north into the open section of drain which extends between DRC 1700 and 1840. At the downstream end of the open channel, where it discharges to the existing 1200 RCP, floodwaters are forced to spill onto the road surface by naturally rising ground levels further to the east.

Floodwaters inundate the roadway between DRC 1840 and 2060 to depths of up to 200 mm before eventually finding their way into Cabramatta Creek via a southerly route through the Integral Energy site, or via a northerly route beneath the LPT and through the campus of the South Western Sydney TAFE College.

Figure 3.1 shows the discharge hydrographs for flow crossing Wilson Road and Whitford Road for the 2 hour 2 year ARI event. The results show that floodwaters will inundate Wilson Road for a period of approximately 2 hours.

Also shown on **Figure 3.1** is the discharge hydrograph for flow crossing HPR at the location of the sag in the roadway at around DRC 1435. The figure shows that floodwaters will inundate HPR over a lesser duration of approximately 1 hour.

Table 3.1 gives the peak discharge of flow crossing both Wilson Road and Whitford Road for the four design storm events modelled of 2 hours duration. The results show that the magnitude of flow surcharging the left bank of Hinchinbrook Creek and discharging in an easterly direction toward Whitford Road will increase 20 fold between the 2 and 100 year ARI events, from a discharge of around 7 m^3/s, up to 103 m^3/s for the respective events.

The results presented in **Table 3.1** also show that only around one fifth of the total flow which surcharges the left bank of Hinchinbrook Creek to the north of Buggys Bridge will remain on the northern side of the roadway by the time floodwaters reach Whitford Road, with the balance of flow either crossing to the southern side of the reserve, or re-entering Hinchinbrook Creek immediately upstream of the Buggys Bridge crossing.

TABLE 3.1
PEAK OVERLAND FLOWS
IN VICINITY OF HOXTON PARK RECREATIONAL RESERVE
PRESENT DAY CONDITIONS
2 HOUR DESIGN STORM BURST
(m^3/s)

Location	2 year ARI	5 year ARI	20 year ARI	100 year ARI
Crossing Wilson Road north of HPR	6.7	29	61	103
Crossing Whitford Road north of HPR	1.3	2.4	8.2	22

At the location of the sag in HPR at DRC 1950, the road can be expected to be flooded for a period of time similar to that which is experienced at Whitford Road, as floodwaters which discharge across the local road are forced onto the surface of HPR by naturally rising ground levels to the east of the existing open channel.

As the magnitude of flood flows in Hinchinbrook Creek increases, floodwaters spread out over a wider frontage and inundate the relative flat floodplain in the vicinity of the Hoxton Park Recreational Reserve. **Figures C2 to C4** show the extent and depth to which floodwaters can be expected to inundate the floodplain during the 5, 20 and 100 year ARI events of 2 hours duration.

Similarly, **Figures 3.2 to 3.4** show the discharge hydrographs for flow crossing Wilson Road and Whitford Road for the three larger events.

The results of the modelling show that both HPR and the local road system will be inundated for several hours during a major flood event, with significant flows being experienced across the road surface for periods of up to 6 hours during a 100 year ARI design storm event of 9 hours duration.

It should be noted that HPR could experience longer periods of inundation during events which may last several days, however, details of these events have not been presented in this report.

3.3 Local Pipe Drainage System

3.3.1 DRAINS Model Setup

Hydrologic modelling was carried out using the DRAINS rainfall-runoff catchment modelling software to assess flows in the cross drainage systems under present day conditions for the 2, 5, 10, 20 and 100 year ARI storms.

Adopted DRAINS model parameters comprise initial losses of 1 and 10 mm for paved and grassed areas respectively. An antecedent moisture condition of 3 was adopted, reflecting rather wet conditions prior to the occurrence of the storm and the soil type was set equal to 3, which corresponds with a soil of comparatively high runoff potential.

Catchment characteristics input to the model were based on aerial photography flown in December 2002 for the M7 Motorway design. Pipe invert levels and sizes were based on RTA survey and the plans listed in **Appendix A** of this report. Detailed ground survey of the road corridor undertaken by the RTA was also used to define the depth to which stormwater would pond along the upstream side of the roadway and the path overland flows will take upon surcharging the pipe drainage system.

For the purpose of assessing the capacity of the pipe drainage system east of Buggys Bridge, a tailwater level of RL 23.7 m AHD was adopted at the outlet to the 1200 RCP where it discharges to Cabramatta Creek. This flood level equates to the 2 year 2 hour peak flood level in the creek at this location. The adoption of higher tailwater levels was not considered appropriate due to the large influx of overland flows to the area during less frequent events.

3.3.2 Western Section

Table 3.2 shows peak local catchment flows under present day conditions at the five locations where existing drainage infrastructure was found to either cross or run alongside the existing carriageway. The table also shows the approximate capacity of each system in terms of storm frequency (i.e. ARI).

DRC 290

Model results show that the twin 600 RCPs crossing HPR have a capacity to convey a peak flow of approximately 1.3 m^3/s. In ARI terms, this approximates a peak flow generated by a 1 in 10 year storm event.

During intense rainfall events, stormwater will pond along the upstream (southern) side of HPR to an elevation of RL 36.6 m AHD before slipping towards the east, along the frontages of the residential properties which front the road reserve. During a 100 year ARI event, the width of flow within No. 636 HPR would be around 17 m, with stormwater inundating the westbound lane of the roadway to depths of up to 100 mm.

The prevailing grade in HPR is towards the east and the presence of the earth mound along the northern frontage of the road reserve result in all stormwater which cannot discharge through to Ashford Close via the existing 825 RCP, flowing east towards Glenn Innes Road.

DRC 480

At Glenn Innes Road, modelling shows the 900 RCP has a capacity to convey flows generated by the critical 20 year ARI design storm event, including a peak overland flow rate of 0.39 m^3/s which approaches the sag in the local road due to the surcharging of the cross drainage system at DRC 290.

During larger events, stormwater which ponds in the sag in the local road will slip onto HPR and follow the prevailing grade towards the sag in HPR at DRC 720.

DRC 595

Modelling of the 450 RCP, which RTA survey shows controls runoff from a relatively large residential subdivision to the south, shows that the pipe will be surcharged during events as frequent as 2 year ARI.

During events which result in a surcharging of the pipe, stormwater will follow the prevailing grade in the local road system and discharge to the vacant allotments located to the south of HPR between DRC 620 and 740. Stormwater which enters the vacant allotments will flow overland and discharge to the inlet to the existing twin 600 RCPs at DRC 720.

DRC 720

Stormwater arriving overland at the inlet to the twin 600 RCPs will pond to a depth of around 1 m before slipping across the sag in HPR during events larger than 10 year ARI.

Depths of flooding across the road will be relatively shallow, with stormwater spilling across the sag in the road at a depth of around 100 mm during a 100 year ARI event.

DRC 1060

Modelling of the catchment draining to the 375 RCP which is located at the northern end of First Avenue shows that the pipe is of limited capacity and stormwater can be expected to pond in the sag in the roadway for events as frequent as 2 year ARI.

Stormwater which surcharges the pipe drainage system will quickly enter onto HPR and follows the alignment of the road within the open roadside drainage channel before discharging to Hinchinbrook Creek. With the 375 RCP now being extended by others to Hinchinbrook Creek, it is unclear whether flows would be confined to the road pavement by a kerb and gutter system.

TABLE 3.2
PEAK FLOWS AT OUTLET TO EXISTING CROSS DRAINAGE STRUCTURES
PRESENT DAY CONDITIONS
WESTERN SECTION

Design Road Chainage	Pipe/Culvert Dimensions (mm)	Flow Location	Peak Flows (m^3/s)					Assessed Capacity of Cross Drainage System (ARI)
			2 year ARI[(1)]	5 year ARI[(1)]	10 year ARI[(1)]	20 year ARI[(1)]	100 year ARI[(1)]	
290	1 off 825 RCP	Pipe	0.50	0.91	**1.17**	1.41	1.47	>10
		Surcharge	0 N 0 S	0 N 0 S	**0 N** **0 S**	0 N 0.4 S	0.23 N 1.17 S	
480	1 off 1050 RCP	Pipe	0.38	0.76	0.98	**1.29**	1.45	>20
		Surcharge	0 N 0 S	0 N 0 S	0 N 0 S	**0 N** **0 S**	0 N 1.17 S	
595	1 off 450 RCP	Pipe	**0.26**	0.26	0.26	0.26	0.26	<2
		Surcharge	**0 N** **0.11 S**	0 N 0.34 S	0 N 0.47 S	0 N 0.72 S	0 N 1.54 S	
720	2 off 600 RCPs	Pipe	0.51	0.89	**1.1**	1.29	1.33	>10
		Surcharge	0	0	**0**	0.77	1.76	
1060	1 off 375 RCP	Pipe	**0.22**	0.22	0.22	0.22	0.22	<2
		Surcharge	**0.19**	0.36	0.47	0.58	0.72	

(1) Critical 25 minute design storm burst
N = Overland flow along northern side of HPR carriageway S = Overland flow along southern side of HPR carriageway

3.3.3 Eastern Section

Table 3.3 shows peak local catchment flows under present day conditions at the eight locations where existing drainage infrastructure was found to either approach, cross or run alongside the existing carriageway. The table also shows the approximate capacity of each system in terms of storm frequency (i.e. ARI).

DRC 1435

[to be completed following site inspection]

DRC 1690

The existing 600 x 300 RCBC at DRC 1690 accepts flows which surcharge the pavement drainage system of Whitford Road to the north. Model results show that the system to the north has a capacity of around a 1 in 5 year event.

Modelling shows that the box culvert has sufficient capacity to accept flows discharging along the eastern kerbline of Whitford Road for events up to and including 10 year ARI. During larger events, stormwater will bypass the inlet to the culvert and pond in the sag point in the local road near its intersection with HPR.

DRC 1685

In the absence of main river flooding, the 1200 x 600 RCBC which drains runoff from the Hoxton Park Recreation Reserve, has a capacity to convey flows generated by the local catchment for events with a frequency of up to and including 20 year ARI.

During larger events, stormwater will surcharge the inlet to the culvert and join those ponding in the sag of Whitford Road.

As the rate of stormwater arriving at the sag in Whitford Road increases, flows will commence to slip eastward along the northern side of the carriageway where they will firstly pond across the sag in HPR at DRC 1960 before eventually slipping into; i) the vacant land located to the west of the LPT (between DRC 2000 and 2120), or ii) towards the south-east into Cabramatta Creek.

DRC 1740

The 600 RCP draining the intersection of HPR and Illaroo Road was assessed as having a hydrologic capacity in excess of 20 year ARI. The ability of this pipe to control stormwater runoff during events of this magnitude would however be limited by the unfavourable inlet conditions to the pipe. It is also unclear whether the roof drainage system of the complex to the south discharges to this pipe or to the open channel which drains to the 450 RCP at DRC 1880 (assumed to be the case in this present study).

DRC 1840

The ability of stormwater to enter the existing 1200 RCP from the open channel which is located to the north of HPR would be severely hampered by the dense vegetation present at the concrete inlet headwall. Under ideal conditions, modelling shows that the inlet to the system would be surcharged by flows generated by the local catchment to the north during a 5 year ARI event.

Stormwater which surcharges the inlet headwall will enter onto the road surface and join those discharging eastward towards the sag in the road at DRC 1960.

DRC 1880

A relatively large catchment drains via two open channels to the grated surface inlet pit at DRC 1890. Modelling shows that the 450 RCP draining this pit has a capacity in hydrologic terms of less than 2 year ARI.

Stormwater which bypasses the inlet to the 450 RCP continues in an easterly direction and ponds along the frontage of the Integral Energy site between DRC 1960 and 2040.

DRC 2000

The grated surface inlet to the 525 RCP is located alongside the paved carriageway of HPR. RTA survey shows that stormwater must pond to a depth of around 200 mm in the frontage of the Integral Energy site before it can enter the grated surface inlet pit.

At this depth, stormwater commences to pond across HPR before slipping across the roadway to its northern side or flowing across the Integral Energy site and discharging directly to Cabramatta Creek.

DRC 2110

The capacity of the 1200 RCP at its outlet was assessed at around 2.1 m^3/s, which is less than the peak flow which would be generated by the surrounding local catchments during a 5 year ARI event.

TABLE 3.3
PEAK FLOWS (LOCAL CATCHMENT ONLY)
AT INLET TO EXISTING CROSS DRAINAGE STRUCTURES
PRESENT DAY CONDITIONS
EASTERN SECTION

Design Road Chainage	Pipe/Culvert Dimensions (mm)	Flow Location	Peak Flows (m^3/s)					Assessed Capacity of Cross Drainage System (ARI)
			2 year ARI(1)	5 year ARI(1)	10 year ARI(1)	20 year ARI(1)	100 year ARI(1)	
1435	2 x 450 RCPs	Pipe						
		Surcharge						
1690	600 x 300 RCBC	Pipe	0	0.10	**0.29**	0.31	0.31	~10
		Surcharge	0	0	**0**	0.48	0.74	
1685	1200 x 450 RCBC	Pipe	0.17	0.54	0.91	**1.13**	1.15	~20
		Surcharge	0	0	0	**0**	0.61	
1740	600 RCP	Pipe	0.16	0.28	0.35	0.45	**0.53**	20-100
		Surcharge	0	0	0	0	**0.09**	
1840	1200 RCP	Pipe	1.38	**2.2**	2.36	2.44	2.46	<5
		Surcharge	0	**0.31**	0.83	1.99	3.10	
1880	450 RCP	Pipe	**0.24**	0.24	0.24	0.24	0.24	<2
		Surcharge	**0.42**	0.78	1.00	1.28	1.74	
2000	525 RCP	Pipe	**0.23**	0.23	0.23	0.24	0.24	<2
		Surcharge	**0.19**	0.56	0.77	1.05	1.52	
2110	1200 RCP (Outlet)	Pipe	1.6	**2.1**	2.1	2.1	2.1	<5
		Surcharge	0	**0.6**	1.3	2.3	3.6	

(1) Critical 25 minute design storm burst

4 BRIEF DECRITION OF PROPOSED ROADWORKS

4.1 Western Section

The proposed road upgrade west of Buggys Bridge will comprise a 4-lane carriageway, with two eastbound and two westbound lanes. The road will be constructed largely at-grade along its full length and tie into the already constructed intersection with Cowpasture Road. **Appendix D** shows the layout of the proposed road upgrade works.

A depressed grassed median of approximately 11 m width will be provided along the full length of the western section (other than at local road intersections), and is of sufficient width to allow for the future upgrade of HPR to a 6-lane carriageway.

The northern footpath of HPR will be located along the existing road reserve boundary where it fronts residential development.

Along the southern edge of the roadway, the RTA has compulsorily acquired land within the frontage of several properties to create the required 40 m width of road reserve.

RTA has advised that the existing residential dwelling within No. 636 HPR will be demolished as a result of the roadworks. Further discussion on works required to alleviate the impacts of the roadway on upstream flooding within this allotment is provided in **Section 5** of this report.

4.2 Eastern Section

Road upgrade works along this section of HPR will include the demolition of the existing three span concrete road bridge crossing Hinchinbrook Creek (Buggys Bridge) and the construction of two new three span concrete bridges to service the eastbound and westbound lanes separately.

The bridges, which will be approximately 45 m in length, will be constructed of sufficient width to allow for the future upgrade of HPR to 6 lanes. Further discussion on the bridge upgrade and works required within the inbank areas of Hinchinbrook Creek to facilitate the widening of the bridge opening is given in **Section 6.1** of this report.

East of Buggys Bridge, HPR will continue as a new 4-lane carriageway separated by a depressed grassed median and cross beneath the M7 Motorway overpass, which is presently being constructed between DRC 1390 and 1480.

Immediately to the east of the underpass, a large detention basin has been constructed as part of the M7 Motorway roadworks. The basin forms the most northern compartment of a dual storage system and has been denoted Basin 22 (Upper Compartment) by the road designers.

Along the full length of the eastern section of HPR, the roadway will be constructed no higher than present day road levels to minimise the impacts the roadway has on main river flooding. Further discussion on the impacts the road will have on flooding is given in **Section 5.2** of this report.

5 CHARACTERISTICS OF FLOODING AND CROSS DRAINAGE REQUIREMENTS UNDER POST-UPGRADE CONDITIONS

5.1 General

This section of the report deals with the assessed requirements for cross drainage at locations where stormwater will need to be piped beneath HPR. Also set out in this section of the report is a description of the impact the road works will have on main river flooding patterns in the area.

Table S1 gives a summary of the assessed cross drainage requirements. The requirements given in **Table S1** should be read in conjunction with the following sections of the report.

It should be noted that the location of underground utilities along much of the route have only been mapped spatially by the Authority, with only limited information available on the depth of each utility. Whilst the location of utilities and their impact on the cross drainage systems proposed in this study have been considered, more detailed investigations will need to be carried out during the preparation of the detailed design for the road upgrade.

Appendix D contains plans showing the proposed road and cross drainage network along the route of HPR and should be referred to when reading the following sections of the report.

5.2 Requirements Under the M7 Motorway Deed

Under the conditions of the M7 Deed, the Abigroup Leighton Joint Venture are required to ensure that the design meets the following conditions for the 100 year ARI flood:

"The Motorway and associated drainage works must be designed to take account of the hydraulic performance and modelling requirements of Appendix 64 so that the potential for flooding of any other property is not increased, for a 1 in 100 year ARI storm event, by the presence of the Project Works by any more than:

i) 0.5 m for open space, recreational and rural land without buildings or sensitive structures;

ii) 0.15 m for urban, commercial or industrial land where buildings or sensitive structures are not inundated at the design flood levels including afflux;

iii) 0.05 m for rural or rural residential land where buildings or sensitive structures are inundated;

iv) zero for urban residential, commercial or industrial land where buildings or sensitive structures are inundated."

Under the requirements of Appendix 64 of the Deed, the Abigroup Leighton Joint Venture were required to incorporate the earlier design of HPR prepared by Hughes Trueman Consulting Engineers and address the impacts the proposed works have on flooding conditions in the area. The inclusion of the HPR upgrade in the DJV's modelling for the M7 did not however include the larger bridge waterway opening at Buggys Bridge, which will be discussed in Section 6.1 of this report.

5.3 Impact of Proposed Road Works on Main River Flooding

Figures contained in **Appendix E** show the nature of flooding under post-HPR upgrade conditions and with the M7 Motorway and LPT road works in place (denoted herein as the Three Projects).

Table 5.1 gives the peak flows discharging beneath the new three span concrete bridges crossing Hinchinbrook Creek, with present day values given for comparative purposes.

TABLE 5.1
COMPARATIVE PEAK FLOWS
BENEATH BUGGYS BRIDGE
(m^3s)

Condition	2 year ARI		5 year ARI		20 year ARI		100 year ARI	
	2 hr Event	9 hr Event	2 hr Event	9 hr Event	2 hr Event	9 hr Event	2 hr Event	9 hr Event
Present Day	48.3	NA	56.7	56.1	58.6	57.6	60.4	57.6
Post-Three Projects	49.5	NA	74.5	76.2	102.5	99.2	119.2	114.1

Table 5.2 gives the peak rate of floodwaters crossing both Wilson Road and Whitford Road under post-Three Project conditions, with present day values from **Table 3.1** presented also for comparative purposes.

TABLE 5.2
PEAK OVERLAND FLOWS
IN VICINITY OF HOXTON PARK RECREATIONAL RESERVE
POST THREE PROJECTS
2 HOUR DESIGN STORM BURST
(m^3/s)

Location	2 year ARI	5 year ARI	20 year ARI	100 year ARI
Crossing Wilson Road north of HPR	2.6 (6.7)	18 (29)	47 (61)	85 (103)
Crossing Whitford Road north of HPR	0.5 (1.3)	2.7 (2.4)	10.8 (8.2)	27 (22)

Note: Numbers in ( ) relate to corresponding peak flow under present day conditions. Refer **Table 3.1** of this report.

A summary of the main impacts of the proposed road works on flooding is as follows:

i) The enlargement of the bridge waterway area from approximately 26 m^2 to 70 m^2 results in a greater magnitude of flow discharging beneath the new bridge crossing. Results of the modelling show that flows beneath the bridges will approximately double when compared to present day conditions (refer **Table 5.1**), with the peak flow rate in a 100 year ARI 2 hour event increasing from approximately 60 m^3/s to 120 m^3/s.

   Figure 5.1 shows the impact on peak flood levels which will result from the construction of the Three Projects. An increase in levels when compared to present day conditions can be observed downstream of Buggys Bridge of between 20 and 100 mm, with floodwaters shown to be generally confined to undeveloped land bordering the creek zoned *1(c) Rural – Future Urban*. This impact is acceptable under *classification iii)* of the Deed.

   Figure 5.2 shows the comparison in peak flood levels between the modelling carried out for this present study (which includes the larger bridge waterway at Buggys Bridge) and the latest results presented by the DJV for the 100 year 2 hour event.

   The comparison shows that downstream of Buggys Bridge, the larger waterway area will increase flood levels by over 50 mm when compared to the DJV's results (which showed a general decrease in peak flood levels when compared to present day conditions in the reach of Hinchinbrook Creek immediately downstream of HPR).

ii) As a result of a increased magnitude of flows discharging beneath Buggys Bridge, a reduced rate of flow surcharges the left bank of Hinchinbrook Creek upstream of the bridge crossing and discharges through the Hoxton Park Recreation Reserve, as shown in **Table 5.2** (with the exception of the 20 year ARI event when measured at Whitford Road).

   Figure 5.1 shows that an afflux is still present within the Recreation Reserve and is of the order of between 20 to 100 mm along the frontage of several properties which front Whitford Road at its southern end.

   By comparison with the DJV's results in this area (refer **Figure 5.2**), peak flood levels fronting these properties are over 50 mm lower than those presented by the designers of the M7 Motorway. In their report dated November 2003 (MS, 2003), the DJV closely inspected ground and floor levels in the three properties at the southern end of Whitford Road (i.e. Lots 3, 4 and 5 in DP 863846) and concluded that as the floor levels of the three dwellings were above the 100 year ARI flood event, an afflux of up to 150 mm was acceptable under *classification ii)* of the Deed.

iii) As a result of the reduction in flows traversing the flat floodplain east of Wilson Road, flood levels east of Whitford Road are shown to decrease when compared to present day conditions (refer **Figure 5.1**).

   Whereas the DJV modelling showed an increase in peak flood levels across the northern portion of the Integral Energy site, the present modelling shows that flood levels will be reduced across the site for the 100 year ARI event.

iv) Extents of flooding will be greatly reduced following the completion of the three projects with the southern portion of the Integral Energy site and the building complex to the west rendered flood free for the 100 year ARI event.

v) Depths of flooding along the section of HPR to be upgraded are relatively shallow for events up to and including the 20 year event and reach a maximum of between 400 – 500 mm at the location of the sag in the road profile at DRC 1435 (refer **Figure E3**).

Depths of flooding increase for the 100 year ARI event and reach a maximum of between 600 – 700 mm at DRC 1435.

Further reductions in the magnitude of flows traversing or crossing the new roadway can be achieved by improving the pavement drainage system of HPR (which is not schematised in the TUFLOW model), details of which are given in **Section 5.4.2** of this report.

vi) **Figures 5.3** to **5.6** show the discharge hydrographs for floodwaters crossing Wilson Road and Whitford Road for the 2, 5, 20 and 100 year ARI events respectively.

Model results show that the duration over which the road will be inundated will be reduced following the construction of the Three Projects, with the 100 year ARI 9 hour event inundating Whitford Road for a period of 5 hours, which is 1 hour less than occurs presently.

Further reductions in the time over which the road remains inundated by floodwaters can be achieved by improving the pavement drainage system of the new roadway, details of which are given in **Section 5.4.2** of this report.

5.4 Local Catchment Flooding

5.4.1 Western Section

Table 5.3 shows peak local catchment flows under post upgrade conditions at the five locations where existing cross drainage infrastructure will be impacted upon by the new works. For comparative purposes, present day values have been included in the table and are shown in brackets.

DRC 290

The upgrade of the cross drainage system at this location will require the existing twin 600 RCP to be removed and replaced with a single pipe of minimum 825 mm diameter.

Results of DRAINS modelling of the upgraded system indicate that an 825 RCP laid at 0.5% across the road corridor will convey around 0.2 m^3/s less than the existing system, and stormwater will surcharge the inlet to the new pipe more frequently than occurs under present day conditions.

TABLE 5.3
PEAK FLOWS AT OUTLET TO NEW CROSS DRAINAGE STRUCTURES
POST THREE PROJECTS
WESTERN SECTION

Design Road Chainage	Pipe/Culvert Dimensions (mm)	Flow Location	Peak Flows (m³/s)					Assessed Capacity of Cross Drainage System (ARI)
			2 year ARI(1)	5 year ARI(1)	10 year ARI(1)	20 year ARI(1)	100 year ARI(1)	
290	1 off 825 RCP	Pipe	0.66 (0.50)	1.07 (0.91)	**1.3 (1.17)**	1.2 (1.41)	1.23 (1.47)	~10 (>10)
		Surcharge	0 N 0 S	0 N 0 S	**0 N** **0.05 (0) S**	0 N 0.62 (0.4) S	0 (0.23) N 1.11 (1.17) S	
480	1 off 1050 RCP	Pipe	0.46 (0.38)	0.82 (0.76)	1.02 (0.98)	**1.42 (1.29)**	1.47 (1.45)	<20 (>20)
		Surcharge	0 N 0 S	0 N 0 S	0 N 0 S	**0 N** **0.23 (0) S**	0 N 1.1 (1.17) S	
595	1 off 600 RCP	Pipe	0.32 (0.26)	0.52 (0.26)	**0.52 (0.26)**	0.52 (0.26)	0.52 (0.26)	<10 (<2)
		Surcharge	0 N 0 (0.11) S	0 N 0 (0.34) S	**0 N** **0.11 (0.47) S**	0 N 0.26 (0.72) S	0 N 1.31 (1.54) S	
720	2 off 900 RCPs	Pipe	0.61 (0.51)	1.01 (0.89)	**1.21 (1.1)**	1.47 (1.29)	2.48 (1.33)	>100 (>10)
		Surcharge	0	0	**0**	0 (0.77)	0 (1.76)	
1060	1 off 375 RCP	Pipe	0.68 (0.22)	0.97 (0.22)	**1.05 (0.22)**	1.05 (0.22)	1.05 (0.22)	~10 (<2)
		Surcharge	0 (0.19)	0 (0.36)	**0.09 (0.47)**	0.28 (0.58)	0.52 (0.72)	

(2) Critical 25 minute design storm burst
N = Overland flow along northern side of HPR carriageway S = Overland flow along southern side of HPR carriageway
Values in ( ) represent present day peak flows from **Table 3.2** for comparative purposes.

The additional flow surcharging the cross drainage system will enter onto the eastbound carriageway and be collected by the pavement drainage system which will drain to the existing system at Glen Innes Road.

A review of the road design model shows that if additional measures are not carried out to either lower the new road surface or provide an overland flow route through No. 636 HPR, peak flood levels will be increased in the land to the south by up to 800 mm.

It is recommended that the RTA assess options for regarding the road or preferably, creating a grassed swale through the frontage of No. 636 HPR.

During detail design of the roadway, the Authority may wish to consider over-sizing the cross drainage line at this location to reduce barrel velocities in the pipe and hence losses through the system.

DRC 480

At Glen Innes Road, the existing 900 RCP has over 1 m cover to the new road surface and will therefore not require replacing. It is however recommended that a roughly 25 m length of the 900 RCP be removed beneath Glen Innes Road and the pipe relocated to the eastern kerbline of the local road.

The pavement drainage system controlling runoff from the new road surface to the west should be connected to the kerb inlet pit located in the western kerbline of Glen Innes Road on the northern side of HPR.

A review of the RTA design model shows that stormwater ponding in the newly formed sag in Glen Innes Road on the southern side of HPR will be forced to pond to an elevation of RL 34.2 m AHD, 200 mm higher than occurs presently.

A residential dwelling of slab-on-ground type construction was observed in the south-east corner of the road intersection and there is concern that the increased depth of ponding resulting from the proposed road works could result in adverse flooding conditions being experienced within the property.

RTA is therefore advised to re-grade the intersection so that ponding levels will not exceed the present day level of RL 34.0 m AHD at this location.

DRC 595

As presented in **Section 3.3.2**, the existing 450 RCP has insufficient capacity to convey flows discharging from the residentially developed catchment for events as frequent as 2 year ARI.

It is recommended the RTA incorporate the drainage of this pipe into the new pavement drainage system for HPR and convey flows discharging to the road reserve from the south to the cross drainage system at DRC 720 via a 600 RCP. This will increase its hydrologic capacity to between 5 and 10 year ARI.

DRC 720

Due to the relatively shallow depth of the existing 600 RCPs which presently cross the two lane roadway at the location of the sag in HPR, it is recommended the pipes be removed and replaced with two 900 RCPs beneath the eastbound and two 750 RCPs beneath the westbound lanes of the new roadway.

The new 600 RCP which will convey flows discharging to the road corridor via the existing 450 RCP at DRC 595, should be connected to the upstream end of the new 900 RCPs at a grated inlet pit which should be provided in the depressed grassed median.

A review of the road design model shows that pavement levels at the sag in the road are no higher than present day conditions. Pavement levels should not be altered during the detail design of the road works.

DRAINS model results show that peak flows will be increased in the open channel which drains through the vacant allotment to the north. For example, peak flows will increase from 0.89 m^3/s to 1.01 m^3/s in the event of a 5 year storm and from 1.1 m^3/s to 1.21 m^3/s in the event of a 10 year ARI storm event.

No information is available on the waterway area of the channel where it drains alongside the Good Samaritan Catholic College. Prior to finalizing the detail design for the roadworks, the RTA should carry out further survey of the channel and its overbank area to determine the impacts an increase in peak flows has on the College.

DRC 1060

The widening of the road will result in a relatively large increase in the impervious area draining to the existing 375 RCP near First Avenue. To improve the level of flood security and to prevent excessive widths of gutter flow occurring in the vicinity of First Avenue, it is recommended that the 375 RCP be replaced with a 675 RCP. A 750 RCP is to be provided downstream of the 675 RCP, where the system discharges to Hinchinbrook Creek.

5.4.2 Eastern Section

Table 5.4 shows peak local catchment flows under post-upgrade conditions where existing cross drainage infrastructure will be impacted upon by the new works. For comparative purposes, present day values have been included in the table and are shown in brackets.

DRC 1435

To improve the level of flood security afforded to HPR at the location of the sag in the roadway, it is proposed to replace the existing twin 450 RCPs with 2 off 2100 x 300 RCBCs with an upstream invert level of RL 27.0 m AHD.

Natural ground levels to the north of the roadway are to be re-graded to promote flows approaching through the Recreation Reserve towards the inlet to the new system. Further investigation into the location of the M7 Motorway bridge supports will need to be carried out prior to the preparation of the detailed design.

TABLE 5.4
PEAK FLOWS (LOCAL CATCHMENT ONLY)
AT INLET TO CROSS DRAINAGE STRUCTURES
POST THREE PROJECTS
EASTERN SECTION

Design Road Chainage	Pipe/Culvert Dimensions (mm)	Flow Location	Peak Flows (m^3/s)					Assessed Capacity of Cross Drainage System (ARI)
			2 year ARI[(1)]	5 year ARI[(1)]	10 year ARI[(1)]	20 year ARI[(1)]	100 year ARI[(1)]	
1435	2 x 450 RCPs	Pipe						
		Surcharge						
1690	600 RCP (600 x 300 RCBC)	Pipe	0.1 (0)	0.22 (0.10)	0.33 (0.29)	**0.69 (0.31)**	0.71 (0.31)	>20 (~10)
		Surcharge	0	0	0	**0 (0.48)**	0.37 (0.74)	
1685	1200 x 450 RCBC	Pipe	0.17	0.44 (0.54)	0.61 (0.91)	**0.81 (1.13)**	0.92 (1.15)	~20 (~20)
		Surcharge	0	0	0	**0.05 (0)**	0.91 (0.61)	
1740	675 RCP (600 RCP)	Pipe	0.43 (0.16)	0.61 (0.28)	**0.65 (0.35)**	0.65 (0.45)	0.65 (0.53)	<10 (20-100)
		Surcharge	0	0	**0.21 (0)**	0.35 (0)	0.57 (0.09)	
1840	1200 RCP	Pipe	0.87 (1.38)	**1.76 (2.2)**	2.01 (2.36)	1.75 (2.44)	1.75 (2.46)	~5 (<5)
		Surcharge	0	**0.05 (0.31)**	0.64 (0.83)	1.33 (1.99)	1.91 (3.10)	
1880	750 RCP (450 RCP)	Pipe	0.60 (0.24)	**0.80 (0.24)**	0.79 (0.24)	0.79 (0.24)	0.79 (0.24)	~5 (<2)
		Surcharge	0 (0.42)	**0.09 (0.78)**	0.34 (1.00)	0.53 (1.28)	0.85 (1.74)	
2105	New 1200 RCP (Outlet)	Pipe	1.28	1.78	**2.04**	2.25	2.25	>10
		Surcharge	0	0	**0**	0.35	1.31	
2110	Existing 1200 RCP (Outlet)	Pipe	0.98	2.0	2.1	2.0	2.1	NA
		Surcharge	NA	NA (0.6)	NA (1.3)	NA (2.3)	NA (3.6)	

(1) Critical 25 minute design storm burst   Numbers in ( ) represent present day values from **Table 3.3** for comparative purposes.

The pavement drainage system for the new roadway is not to be connected to the cross drainage system at this location. Rather, it is to be connected to the outlet headwall of the culverts, as shown on **Figure D4**.

A pavement drainage system controlling stormwater ponding in the sag in Wilson Road should also be incorporated into the road design at this location.

DRC 1690 to 2110

The proposed upgrade of the drainage system which is located between DRC 1690 to 2110 will involve the separation of the existing system from that of the new road drainage system. The existing drainage system will cater for flows approaching from the residentially developed catchments to the north in addition to conveying main river flood flows which approach Whitford Road from the west, through the Recreation Reserve.

Key elements of the proposed upgrade are as follows:

- The removal of the 600 x 300 RCBC which crosses Whitford Road and the installation of a 600 RCP which is to be connected to the junction pit located at the upstream end of the existing 900 RCP at the southern end of Whitford Road.
- The extension of the existing 1200 x 450 RCBC a distance of approximately 20 m northward along Whitford Road and the construction of a new concrete inlet structure at the location where the open channel enters the local road reserve.
- The provision of an additional length of 1200 x 450 RCBC in the north-west corner of the Whitford/HPR intersection. The new length of culvert will accept flows discharging through the Recreation Reserve during events which surcharge the left bank of Hinchinbrook Creek upstream of Buggys Bridge.

  DRAINS modelling of the proposed system shows that by piping runoff from HPR directly to Cabramatta Creek, the existing 1200 RCP is capable of accepting flows which approach Whitford Road from Hinchinbrook Creek for events up to and including 2 year ARI.

  Model results also show that whilst the 5 year ARI event will result in a surcharging of the existing system at Whitford Road, the new 1200 RCP proposed beneath the depressed central median of HPR will control a large portion of the flood flows reaching the sag in HPR at DRC 1960, with a peak flow of around 0.8 m^3/s, shown to surcharge the roadway at the location of the sag.

- New grated inlet pits at the location where the two existing channels discharge to the southern footpath of the new roadway (DRC 1850 and 1870). The two pits are to be drained by 600 RCPs which discharge to a kerb inlet pit in the southern kerbline of the roadway. The new pit is to be drained via a 750 RCP to the new 1200 RCP which is to be located beneath the depressed central median of the roadway.
- The construction of a new concrete headwall on the left bank of Cabramatta Creek, at a location immediately upstream of the existing 1200 RCP's outlet.

6 ASSOCIATED FLOOD AND STORMWATER RELATED ISSUES

6.1 Inbank Works at Buggys Bridge

As mentioned, the proposed upgrade of HPR involves the demolition of the existing three span concrete bridge structure and the construction of two new three span concrete bridges of approximately 45 m length. **Appendix F** contains plans showing the concept design for the bridge works prepared by RTA's Bridge Design Section.

The plans provided by the RTA show that the two bridges will be approximately 18 m wide and will each accommodate a maximum of three lanes of traffic in addition to a pedestrian footpath. The bridges will be spaced approximately 2.5 m apart to provide a clear opening between each structure. The bridge piers are shown slightly skewed to the centreline of the road.

To reduce the impact of the road works, works within the inbank area of Hinchinbrook Creek have been recommended. **Figures 6.1** and **6.2** show the recommended works, which are as follows:

i) The excavation of a benched section of channel through the bridge openings. A deep water section is proposed on the outer bend (left bank) of the creek as it passes beneath the two bridges. The invert of the creek is proposed at RL 25.2 m AHD, which approximates the existing level of the creek in this area.

   The deeper section of creek is approximately 20 m wide, with the remainder of the creek invert excavated to a higher level of between RL 25.6 m AHD and RL 25.8 m AHD.

ii) Armouring of the creek banks both upstream, through and downstream of the bridge crossing using sandstone rock rip-rap. Provision of the rock rip-rap will reduce the potential for the banks to scour in the future.

   Also proposed beneath the bridge is a rock gabion cut-off which will prevent the possibility of any future undermining of the creek banks and the resulting exposure of the bridge supports.

iii) The creation of a pool which will extend upstream through the bridge openings by constructing two rock riffles downstream of the bridge crossing.

   The rock riffles have been set at an elevation of RL 26.2 m AHD, which approximates the existing water level in the creek at this location. The riffles will create a maximum depth of ponding beneath the bridge of 1 m.

iv) The excavation of the northern end of the island which is formed by the bifurcation of Hinchinbrook Creek immediately downstream of the existing bridge structure.

   The newly formed creek bank will need to be armoured where it fronts the right (western) abutment of the bridge. The revegetation of the newly formed creek bank, which should be shaped to train flows towards the main arm of the creek as they exit from beneath the bridge structure, will be required.

The scheme shown in **Figure 6.1** includes a shallow benched section of channel along the frontage of the newly formed creek bank, where depths of ponding will be around 400 mm. The reduced depth of ponding will allow macrophytes to be planted which will assist in reducing the velocity of flood flows impacting upon the newly formed creek bank.

v) Connection of the new pavement drainage systems from the Western Section of HPR and Wilson Road.

vi) The outlet to the existing 1500 RCP should also be improved as this pipe will likely become visible from the footpath crossing the northern bridge structure.

6.2 Opportunities for Incorporating On-Site Detention into the Road Design

A review of the road design prepared by the RTA shows there is limited, if any, opportunity to incorporate on-site detention into the road design.

Along the Western Section of the roadway, the fall in road levels along most of its length would prevent the temporary storage of floodwaters in the centrally depressed grassed median of HPR.

Furthermore, on-site detention systems are typically sized to attenuate flows up to and including the 100 year ARI event. Based on the analysis carried out for this present study, all the pipe drainage systems along the Western Section will be surcharged for events larger than 20 year ARI, making the temporary storage of stormwater on the surface of the roadway difficult.

Along the Eastern Section of HPR, the roadway and its pavement drainage system will be impacted upon by main river flooding during events as frequent as 2 year ARI, with the roadway inundated by floodwaters during larger events. On-site detention along the Eastern Section of HPR cannot therefore be achieved.

7 REFERENCES

Bewsher Consulting, 1999. *"Draft Cabramatta Creek Floodplain Management Study"*.

Maunsell Smee JV, 2003. *"Impact of the Western Sydney Orbital on the Flood Regime in Cabramatta Creek Catchment. Milestone 01D001. Volume 2: Post Development Flood Analysis"*. Revision E dated 25 November 2003.

N

0 200 400 m
Scale

Legend

Area of Road to be Upgraded

FLOOD AND STORMWATER DRAINAGE ASSESSMENT FOR PROPOSED UPGRADE OF HOXTON PARK ROAD WEST HOXTON AND HINCHINBROOK

Figure 1.1
LOCATION PLAN

FLOOD AND STORMWATER DRAINAGE ASSESSMENT FOR PROPOSED UPGRADE OF HOXTON PARK ROAD WEST HOXTON AND HINCHINBROOK

Figure 2.1

LOCAL CATCHMENT PLAN - WESTERN SECTION

N

0 200 400 m

Scale

Legend

Design Road Chainage

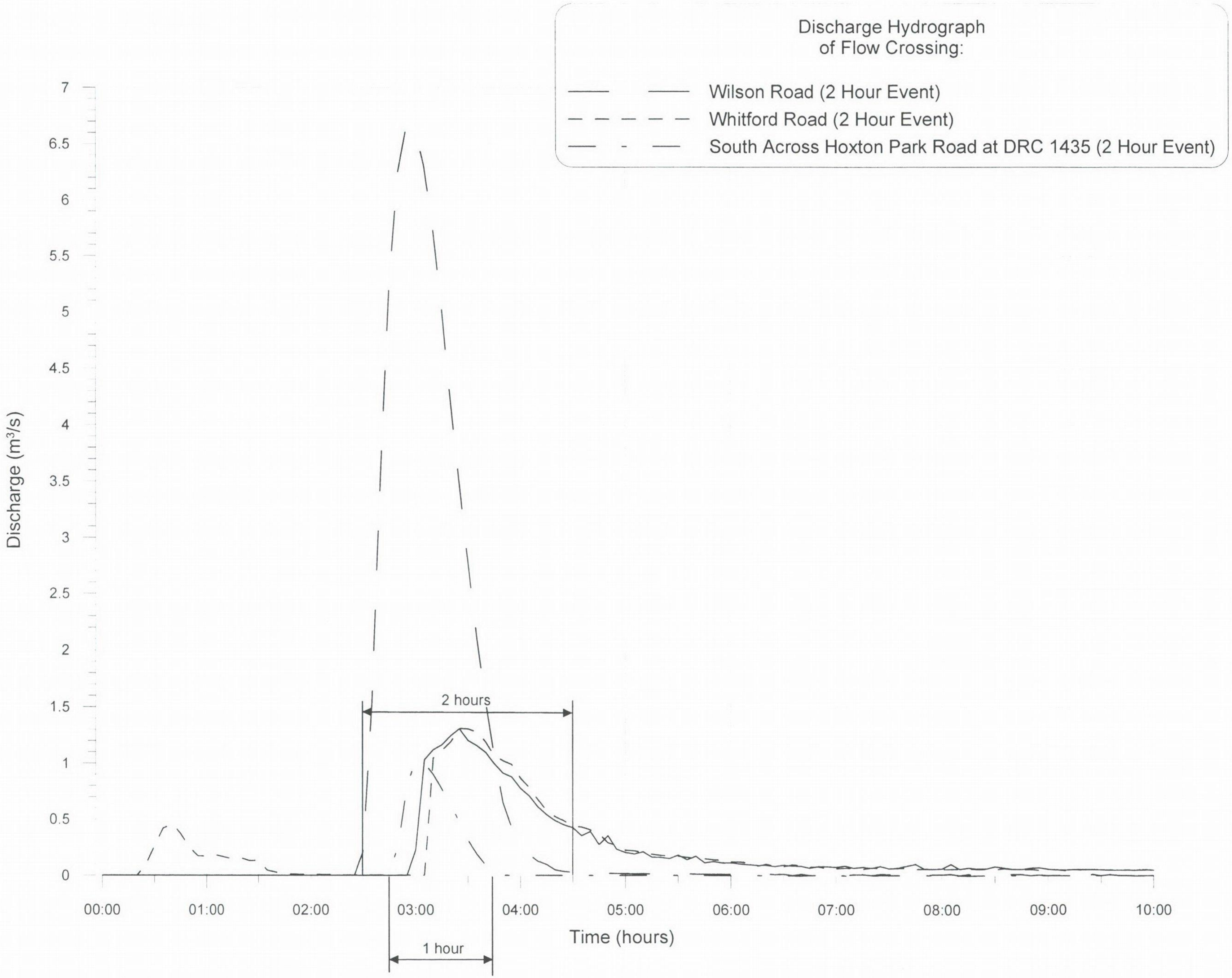
Subcatchment Boundary and Identifier

Approximate location of existing cross drainage system and direction of flow
Refer Corridor Plans for further details
(based on information provided by RTA)

FLOOD AND STORMWATER DRAINAGE ASSESSMENT FOR PROPOSED UPGRADE OF HOXTON PARK ROAD WEST HOXTON AND HINCHINBROOK

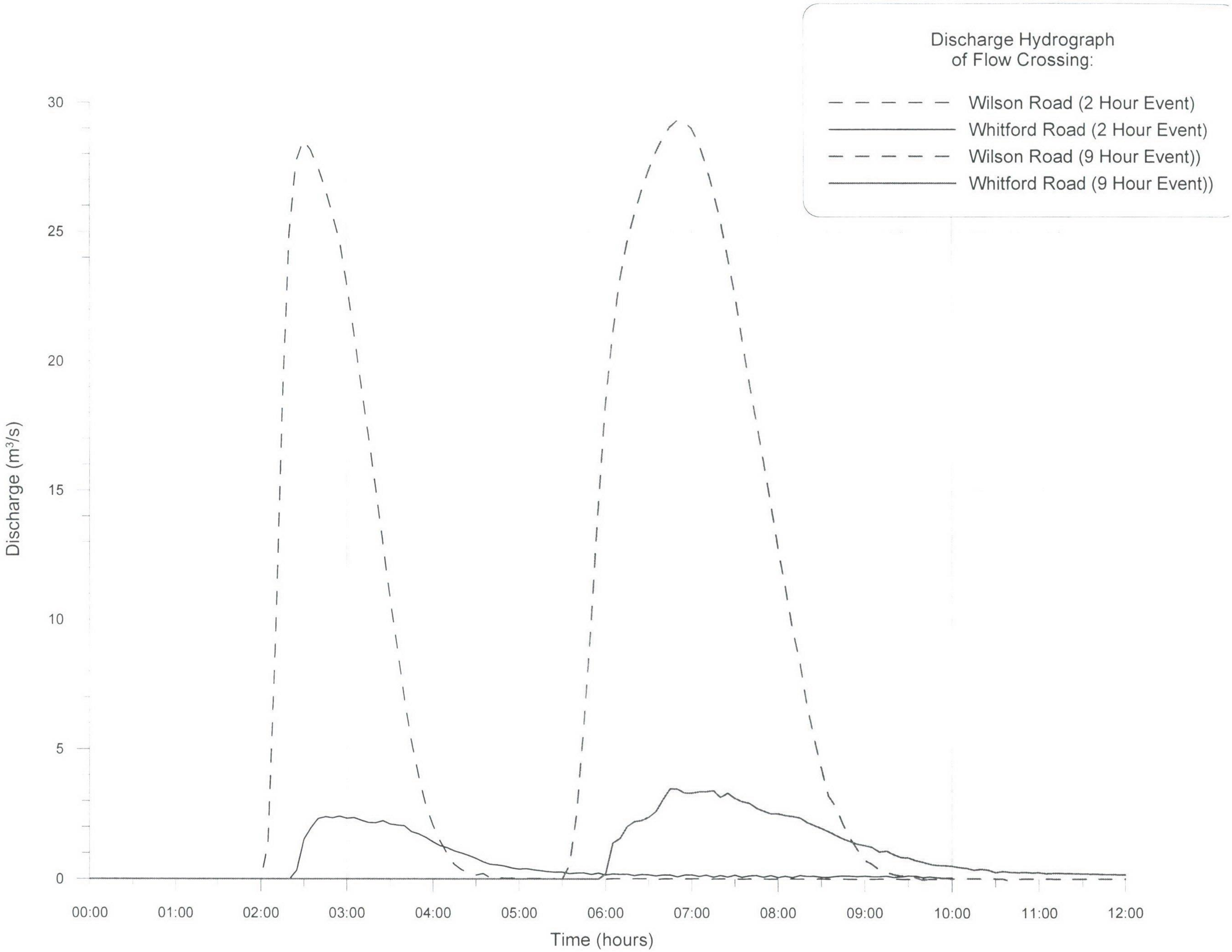
Figure 2.2

LOCAL CATCHMENT PLAN - EASTERN SECTION



FLOOD AND STORMWATER DRAINAGE ASSESSMENT FOR PROPOSED UPGRADE OF HOXTON PARK ROAD WEST HOXTON AND HINCHINBROOK

Figure 3.1
DISCHARGE HYDROGRAPHS
2 year ARI EVENT
PRESENT DAY CONDITIONS

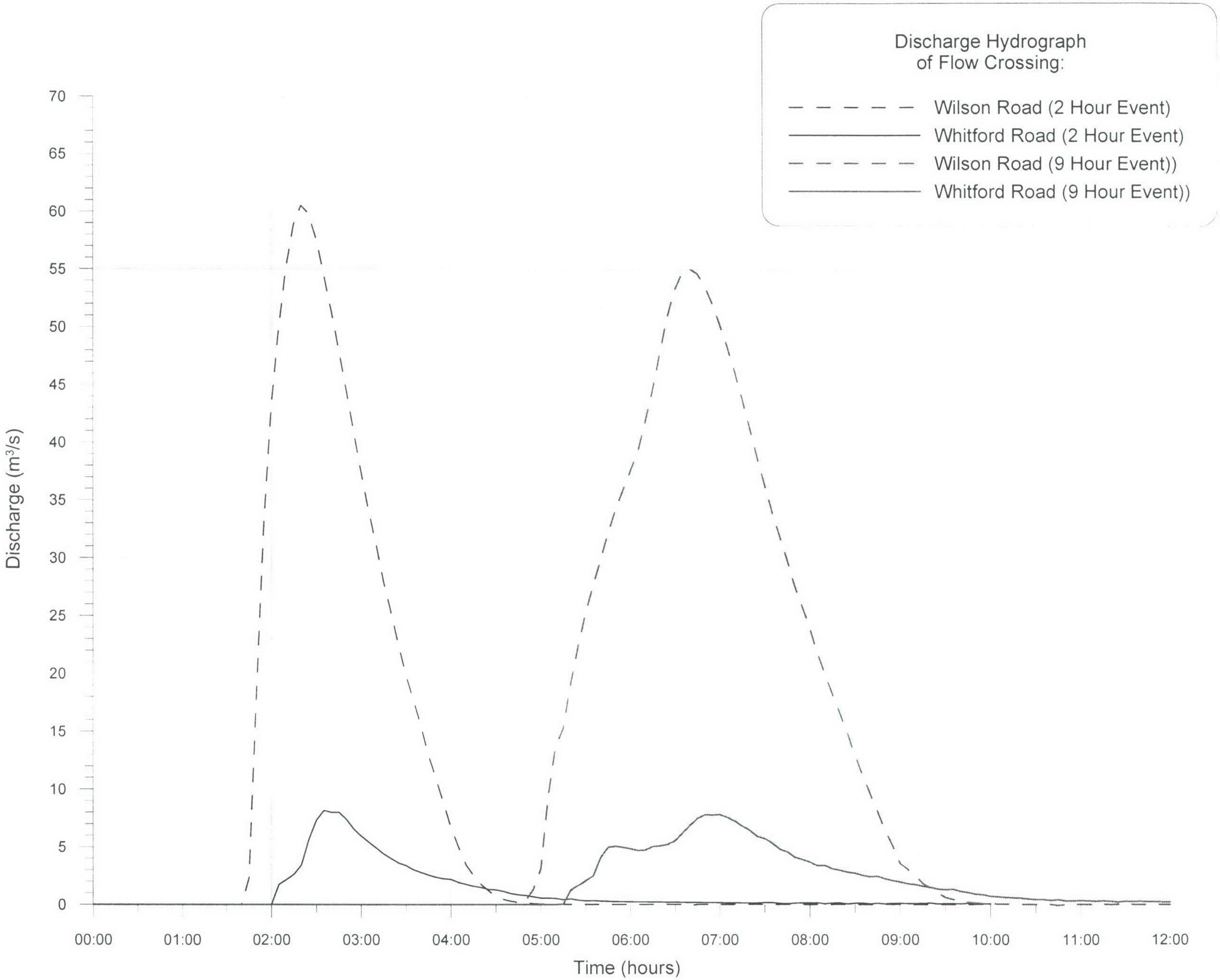


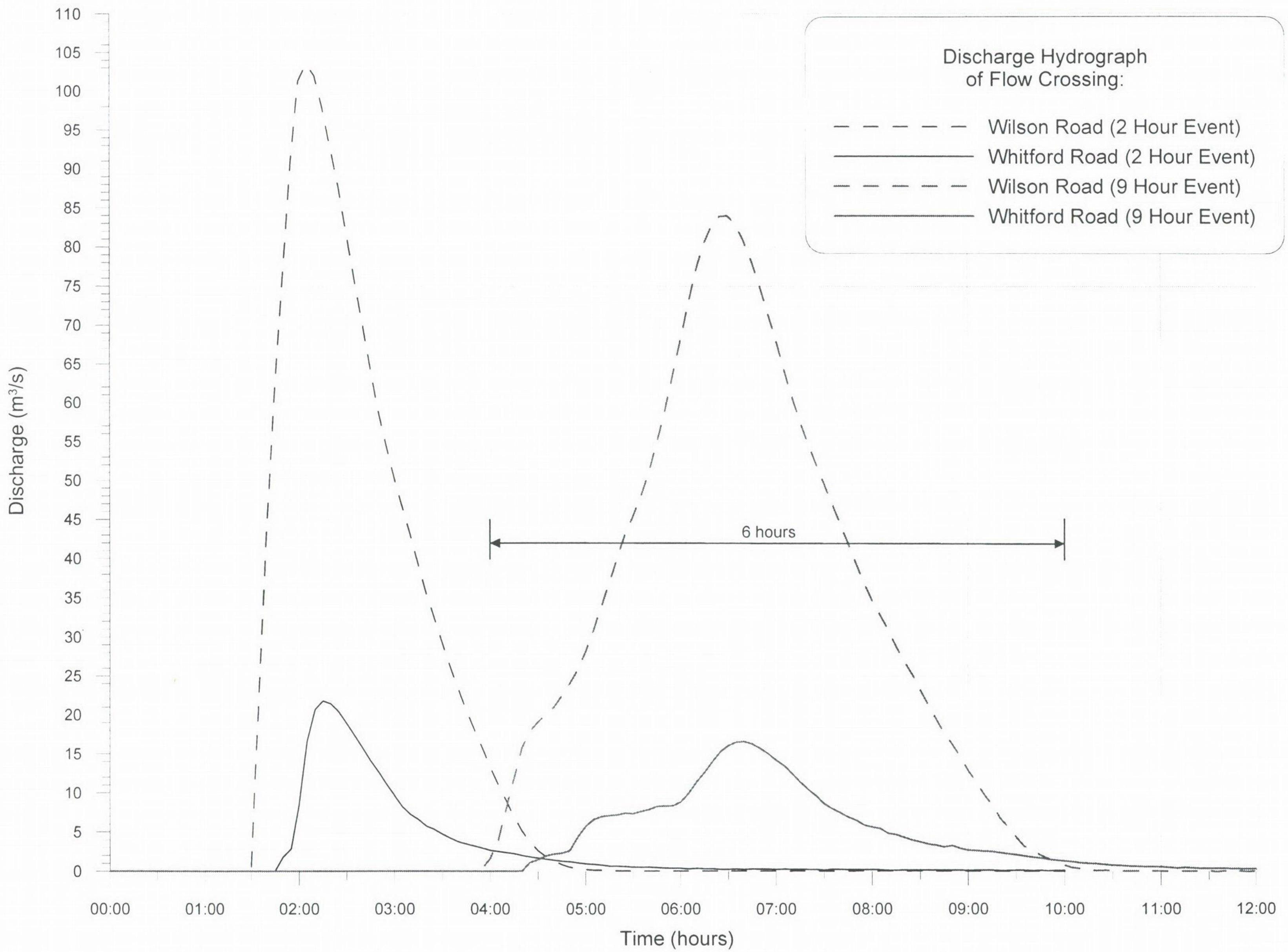
FLOOD AND STORMWATER DRAINAGE ASSESSMENT
FOR PROPOSED UPGRADE OF HOXTON PARK ROAD
WEST HOXTON AND HINCHINBROOK

Figure 3.2
DISCHARGE HYDROGRAPHS
5 year ARI EVENT
PRESENT DAY CONDITIONS

FLOOD AND STORMWATER DRAINAGE ASSESSMENT
FOR PROPOSED UPGRADE OF HOXTON PARK ROAD
WEST HOXTON AND HINCHINBROOK

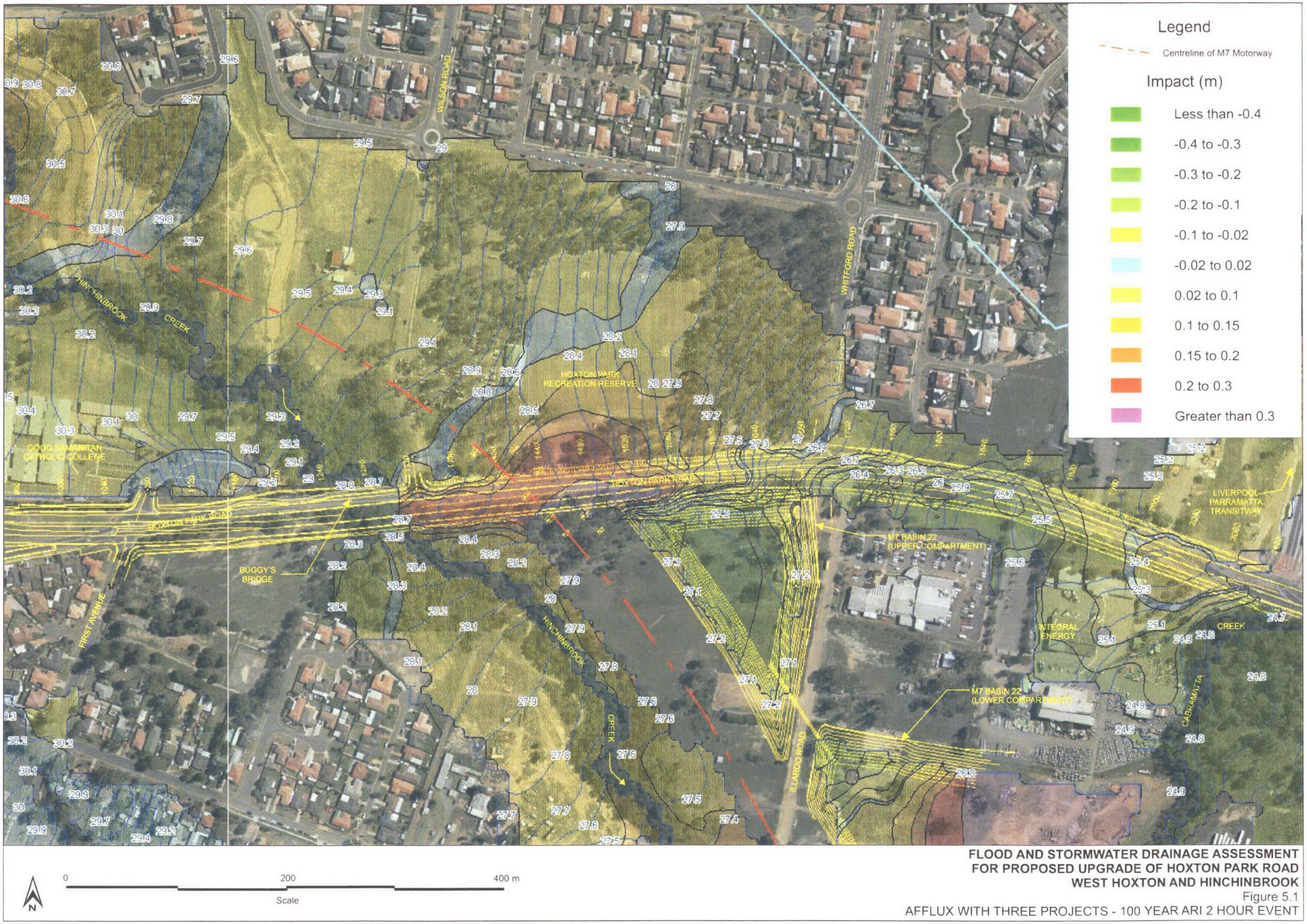
Figure 3.3
DISCHARGE HYDROGRAPHS
20 year ARI EVENT
PRESENT DAY CONDITIONS





FLOOD AND STORMWATER DRAINAGE ASSESSMENT
FOR PROPOSED UPGRADE OF HOXTON PARK ROAD
WEST HOXTON AND HINCHINBROOK

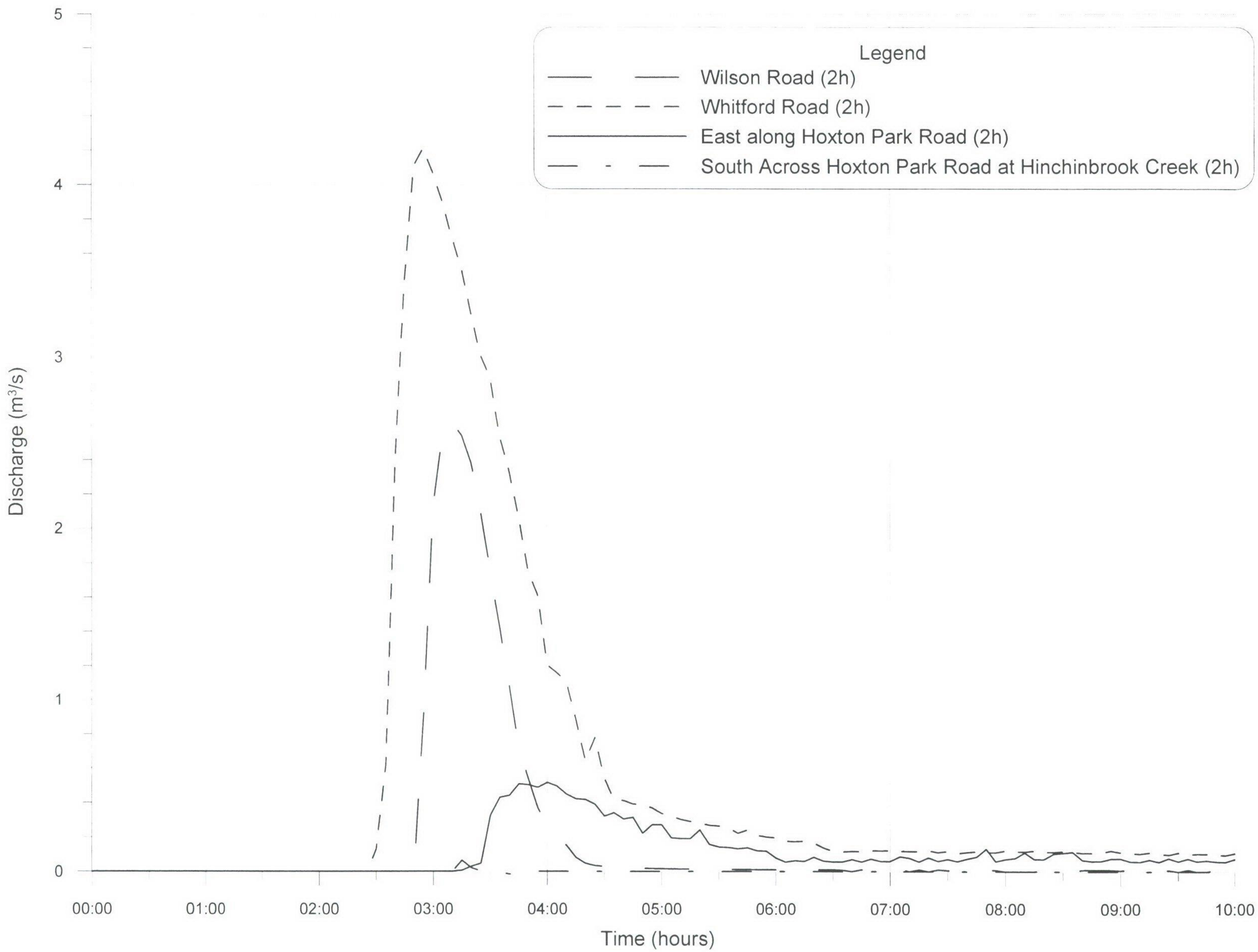
Figure 3.4
DISCHARGE HYDROGRAPHS
100 year ARI EVENT
PRESENT DAY CONDITIONS



FLOOD AND STORMWATER DRAINAGE ASSESSMENT FOR PROPOSED UPGRADE OF HOXTON PARK ROAD WEST HOXTON AND HINCHINBROOK

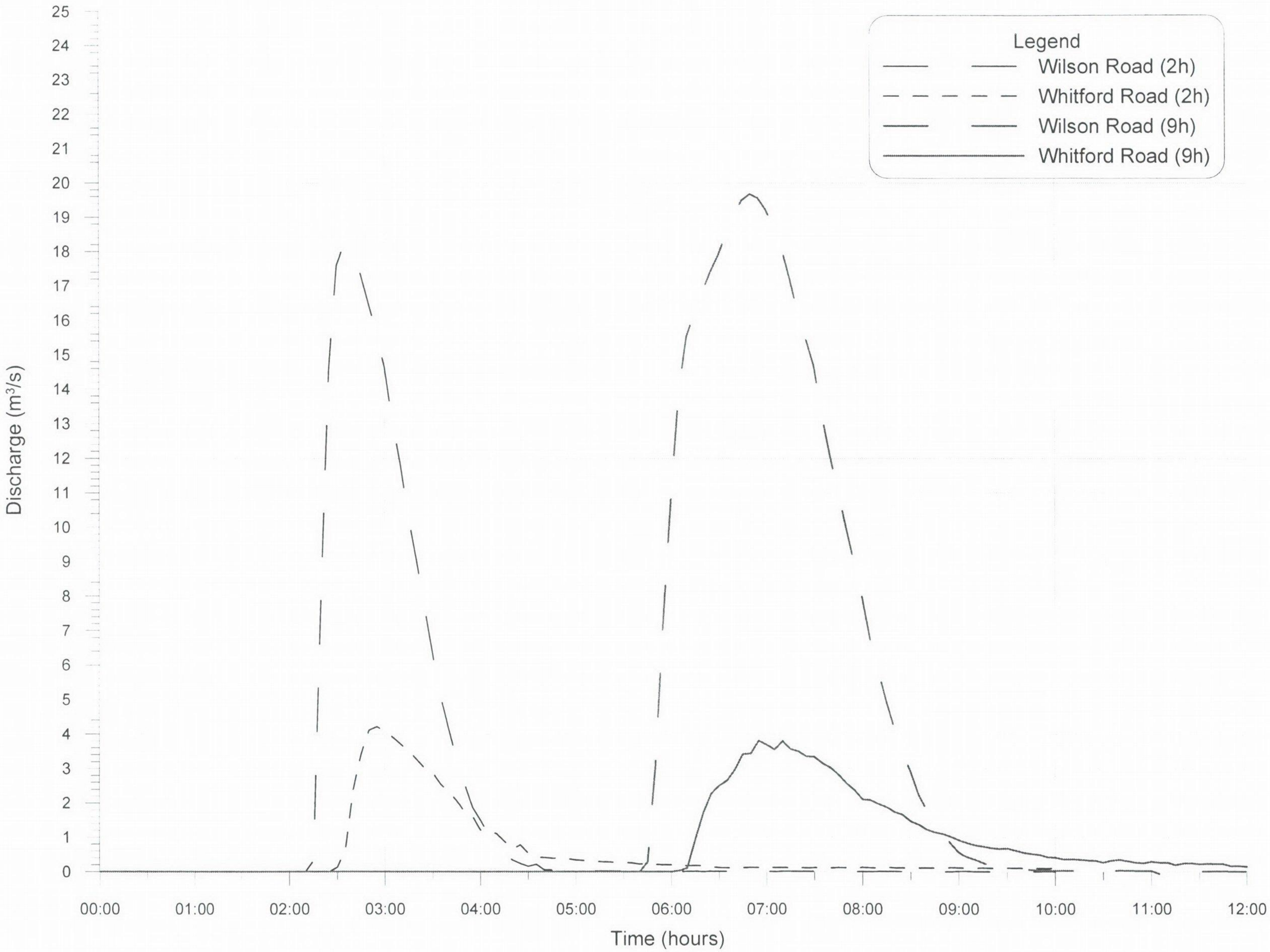
Figure 5.1

AFFLUX WITH THREE PROJECTS - 100 YEAR ARI 2 HOUR EVENT



FLOOD AND STORMWATER DRAINAGE ASSESSMENT
FOR PROPOSED UPGRADE OF HOXTON PARK ROAD
WEST HOXTON AND HINCHINBROOK

Figure 5.3
DISCHARGE HYDROGRAPHS
2 year ARI EVENT
POST THREE PROJECTS

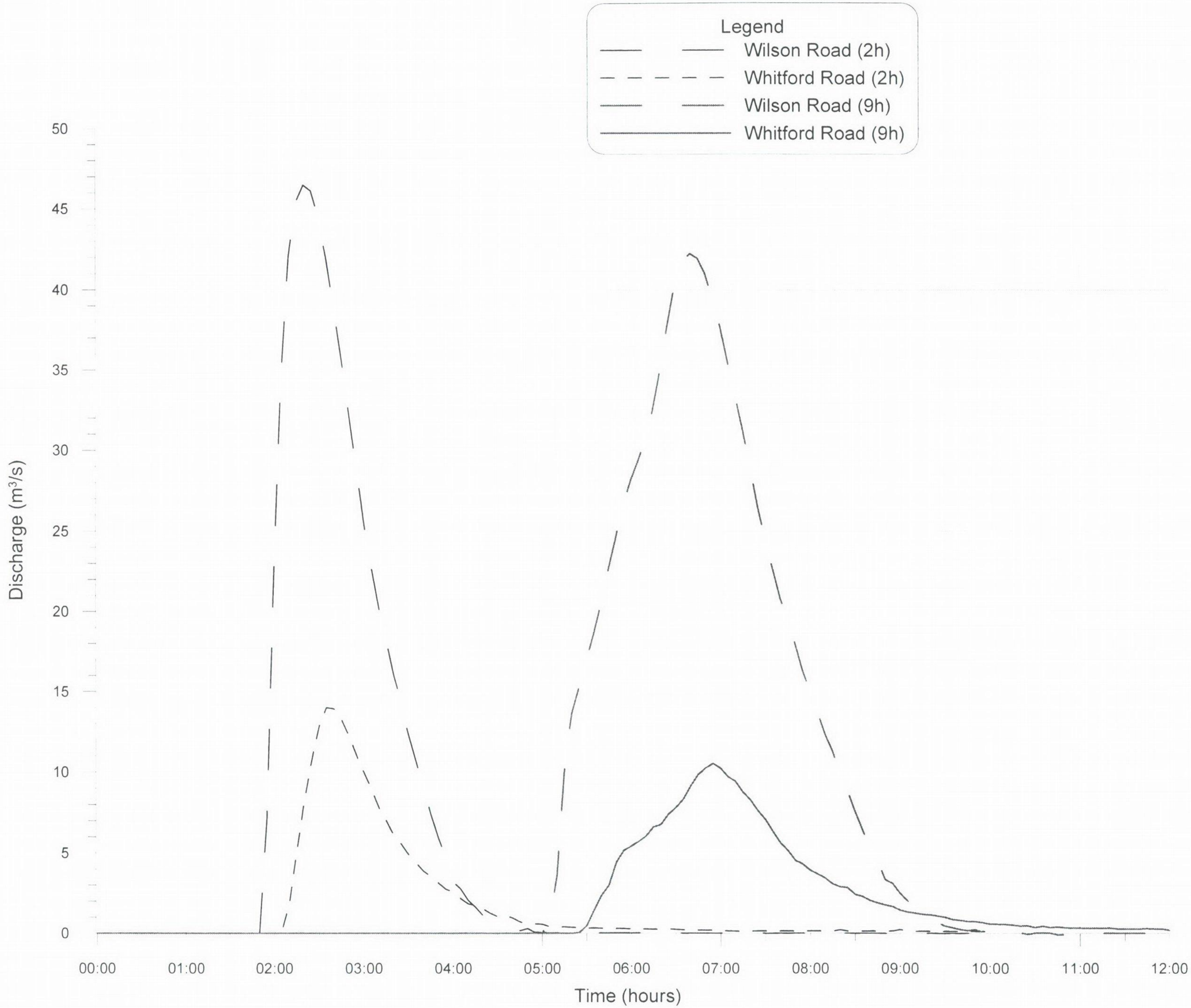


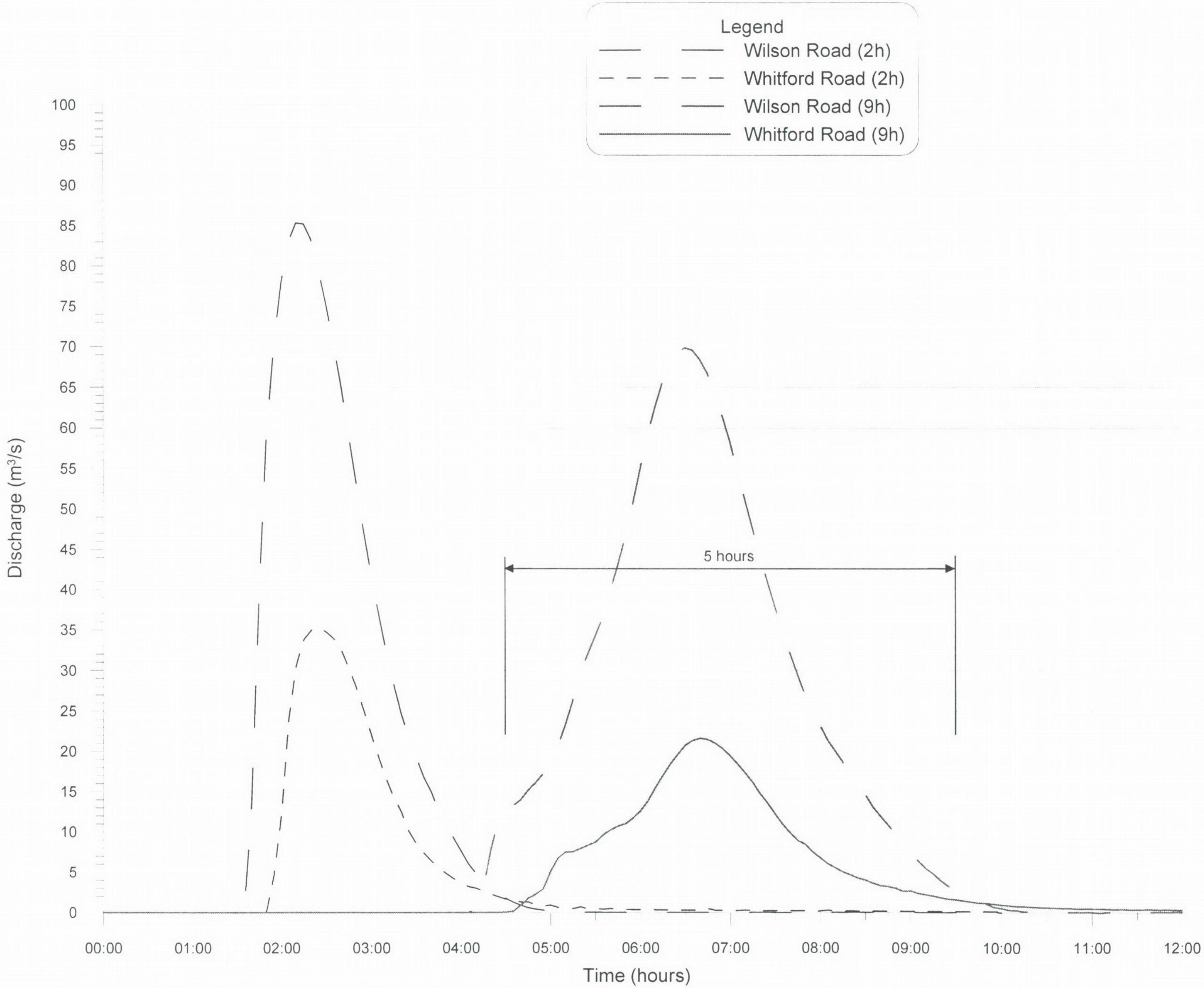
FLOOD AND STORMWATER DRAINAGE ASSESSMENT
FOR PROPOSED UPGRADE OF HOXTON PARK ROAD
WEST HOXTON AND HINCHINBROOK

Figure 5.4
DISCHARGE HYDROGRAPHS
5 year ARI EVENT
POST THREE PROJECTS

FLOOD AND STORMWATER DRAINAGE ASSESSMENT
FOR PROPOSED UPGRADE OF HOXTON PARK ROAD
WEST HOXTON AND HINCHINBROOK

Figure 5.5
DISCHARGE HYDROGRAPHS
20 year ARI EVENT
POST THREE PROJECTS





FLOOD AND STORMWATER DRAINAGE ASSESSMENT
FOR PROPOSED UPGRADE OF HOXTON PARK ROAD
WEST HOXTON AND HINCHINBROOK

Figure 5.6
DISCHARGE HYDROGRAPHS
100 year ARI EVENT
POST THREE PROJECTS

FLOOD AND STORMWATER DRAINAGE ASSESSMENT REPORT FOR PROPOSED HOXTON PARK ROAD UPGRADE WEST HOXTON AND HINCHINBROOK

February 2004

VOLUME 2 of 2

APPENDICES

DRAFT FOR CLIENT REVIEW

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LIST OF APPENDICES

APPENDIX A

AVAILABLE DATA

APPENDIX A

LIST OF AVAILABLE DATA

A1 List of Available Data

1. Benjamin M T Chow and Associates, August 1994. Plan no. HP04/ENG, Sheets 2, 3, 17 & 18 of 21.

2. Gallagher, Odell & Garey, April 1991. ***"PROPOSED CONSTRUCTION OF ROADWORKS AND DRAINAGE FOR SUBDIVISION OF PT LOT 62 DP2475 AT HOXTON PARK"***. Ref 9114, Sheets 1 & 7 of 7.

3. Liverpool City Council, February 1980. ***"Hoxton Park Road Banks Road to Whitford Road Drainage Construction"***. Drawing No. 52/79 Sheets 1 – 5 of 5.

4. The City of Liverpool. ***"Buggy's Bridge, Over Cabramatta Ck at Hoxton Park Road, Superstructure Abutment and Pier Detail"***. Plan No. 1, Single Sheet.

5. Liverpool City Council. Drawing No. 19/81, Sheets 1A, 7 & 8 of 11.

6. Liverpool City Council. ***"Plan of Proposed Roundabout At The Intersection Of Cowpasture & Hoxton Park Rds, Hoxton Park"***. Drawing No. 19A/81, Single Sheet.

7. RN Grinsell & Johns, October 1993. ***"Proposed Drainage Works at Wilson Road Hinchinbrook"***. Plan No. S873A, Single Sheet.

8. Rose Consulting Group, Sera Park Pty Ltd, January 1995. ***"Central Park at Hoxton Park, Stages 5,6 & 10"*** Ref. No. 21/133/5,6 & 10, Sheets 3 & 25 of 30; Ref No. 21/133/1 Sheets 1 & 6 of 9.

9. Rose Consulting Group, November 1997. ***"Tributary 'C' Hoxton Park"***. Ref. No. 21/179, Sheets 23 & 29 of 30.

10. RS Canceri, September 1995. ***"Subdivision of Lot 1 Sect. 2 Dp 2202 7 Lot 1a Dp 3023 Cnr. Whitford Road & Hoxton Park Road, Hoxton Park"*** A Ref 20066. Sheets 1, 9 & 10 of 11

11. Roads and Traffic Authority of NSW ***"Two Bridges Over Hinchinbrook Creek at Hoxton Park Option 1"*** Sketch No. KD623CP1. Sheets 1 & 2 of 2.

APPENDIX B

PRESENT DAY ROAD CORRIDOR PLANS

APPENDIX C

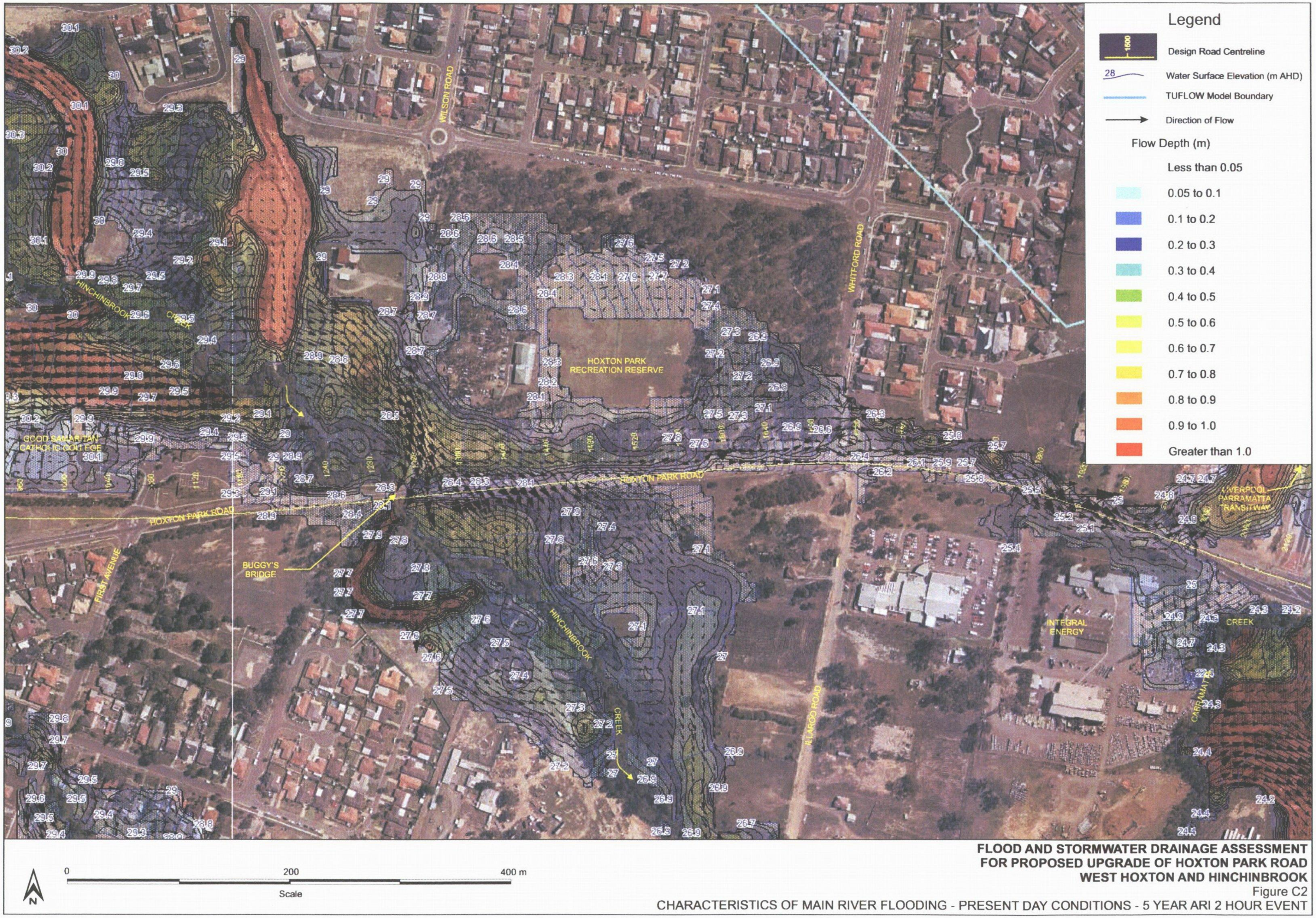
CHARACTERISTICS OF MAIN RIVER FLOODING – PRESENT DAY CONDITIONS

0 200 400 m
Scale

FLOOD AND STORMWATER DRAINAGE ASSESSMENT
FOR PROPOSED UPGRADE OF HOXTON PARK ROAD
WEST HOXTON AND HINCHINBROOK

Figure C1

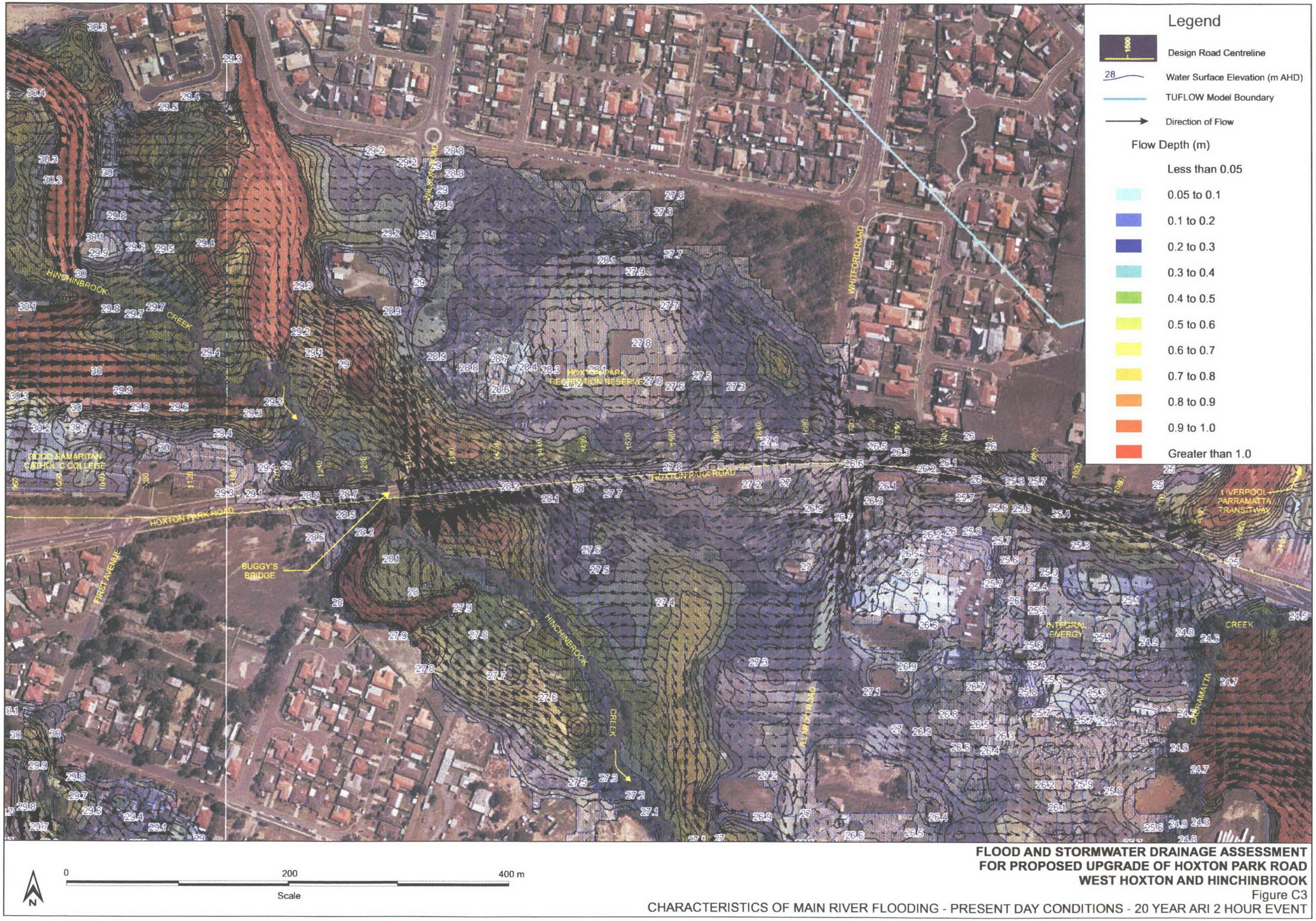
CHARACTERISTICS OF MAIN RIVER FLOODING - PRESENT DAY CONDITIONS - 2 YEAR ARI 2 HOUR EVENT



FLOOD AND STORMWATER DRAINAGE ASSESSMENT FOR PROPOSED UPGRADE OF HOXTON PARK ROAD WEST HOXTON AND HINCHINBROOK

Figure C2

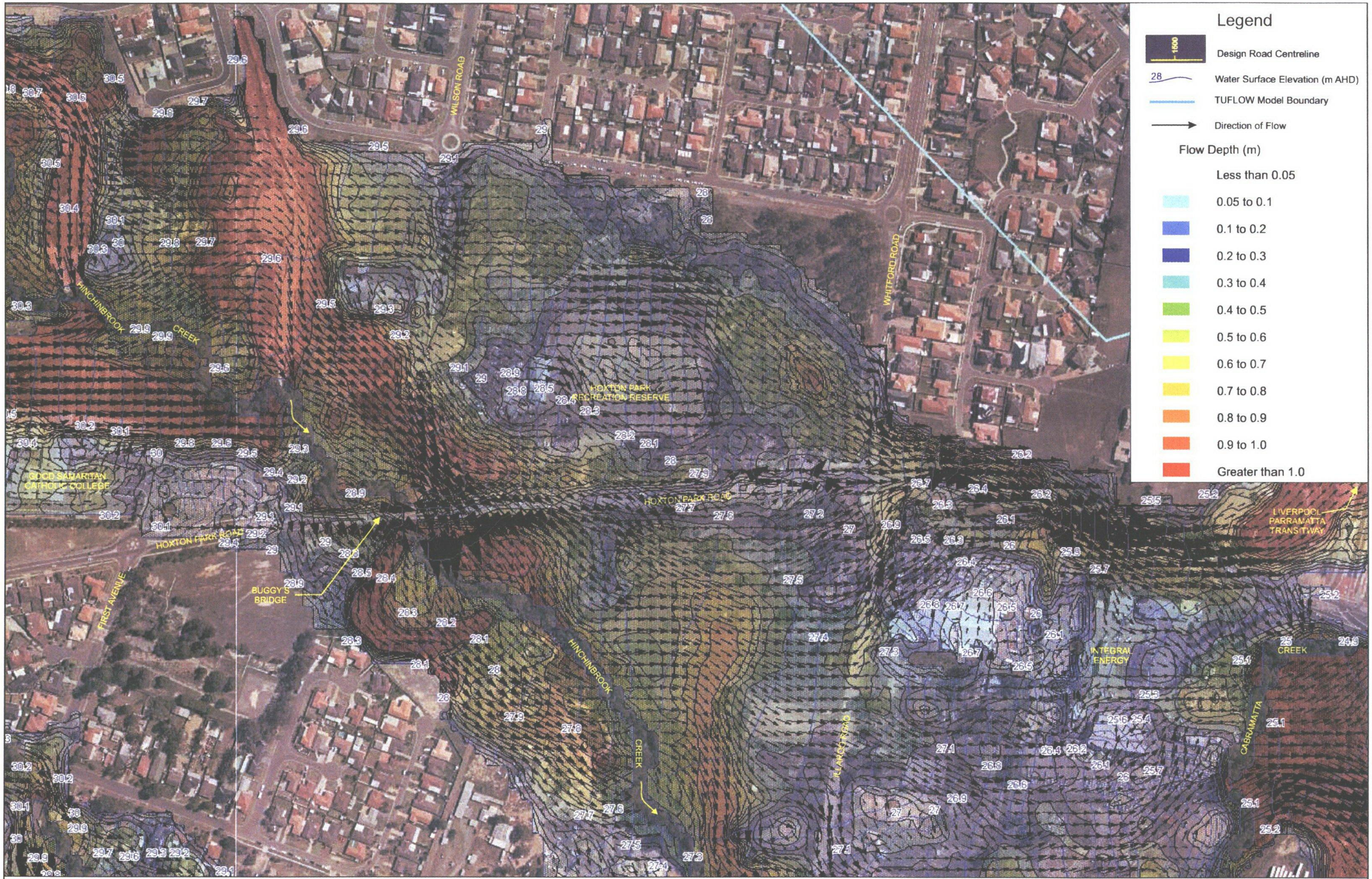
CHARACTERISTICS OF MAIN RIVER FLOODING - PRESENT DAY CONDITIONS - 5 YEAR ARI 2 HOUR EVENT



FLOOD AND STORMWATER DRAINAGE ASSESSMENT
FOR PROPOSED UPGRADE OF HOXTON PARK ROAD
WEST HOXTON AND HINCHINBROOK

Figure C3

CHARACTERISTICS OF MAIN RIVER FLOODING - PRESENT DAY CONDITIONS - 20 YEAR ARI 2 HOUR EVENT



FLOOD AND STORMWATER DRAINAGE ASSESSMENT FOR PROPOSED UPGRADE OF HOXTON PARK ROAD WEST HOXTON AND HINCHINBROOK

Figure C4

CHARACTERISTICS OF MAIN RIVER FLOODING - PRESENT DAY CONDITIONS - 100 YEAR ARI 2 HOUR EVENT

APPENDIX D

POST-HPR UPGRADE ROAD CORRIDOR PLANS

APPENDIX E

CHARACTERISTICS OF MAIN RIVER FLOODING – POST THREE PROJECTS

0 200 400 m

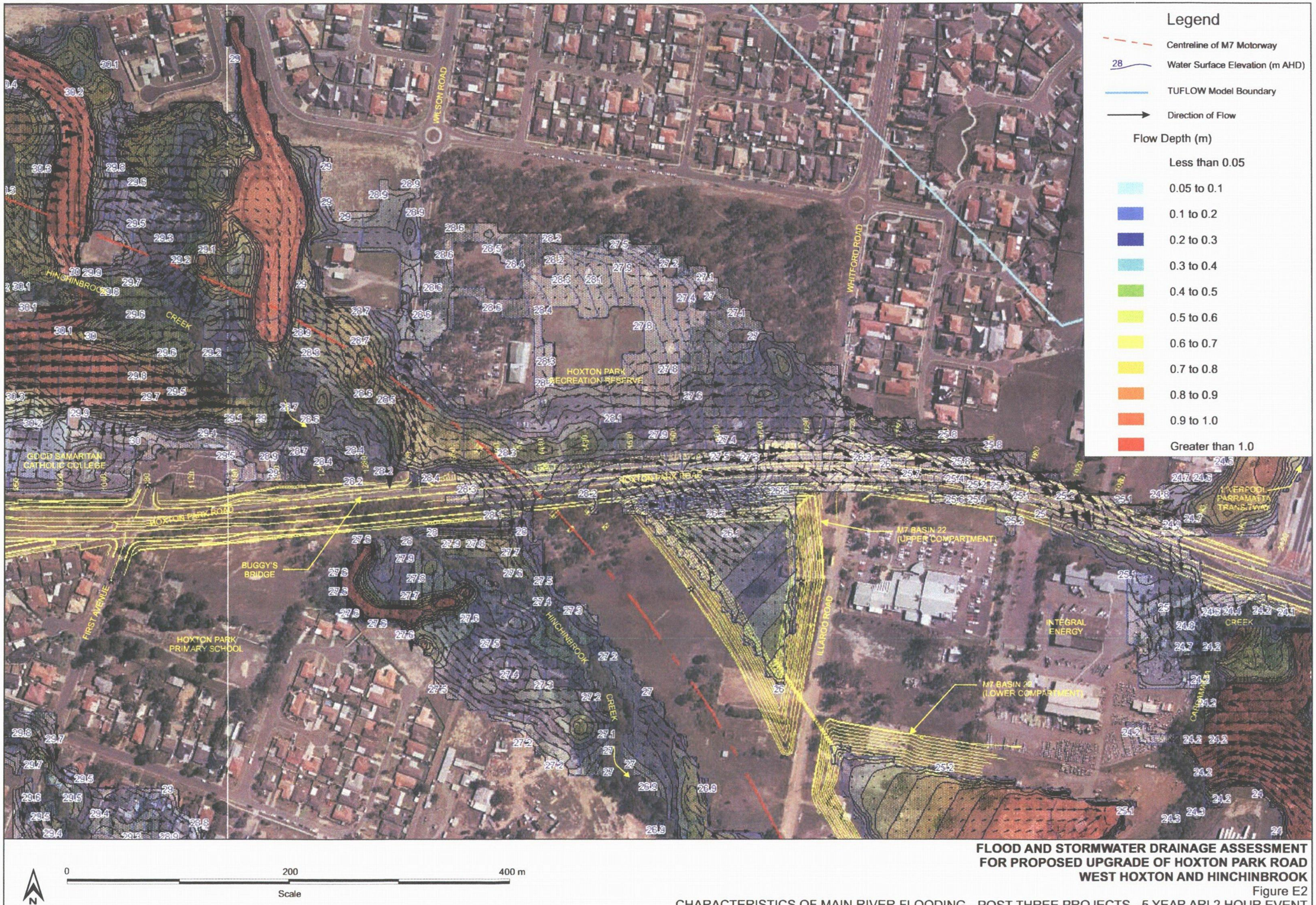
Scale

N

FLOOD AND STORMWATER DRAINAGE ASSESSMENT
FOR PROPOSED UPGRADE OF HOXTON PARK ROAD
WEST HOXTON AND HINCHINBROOK

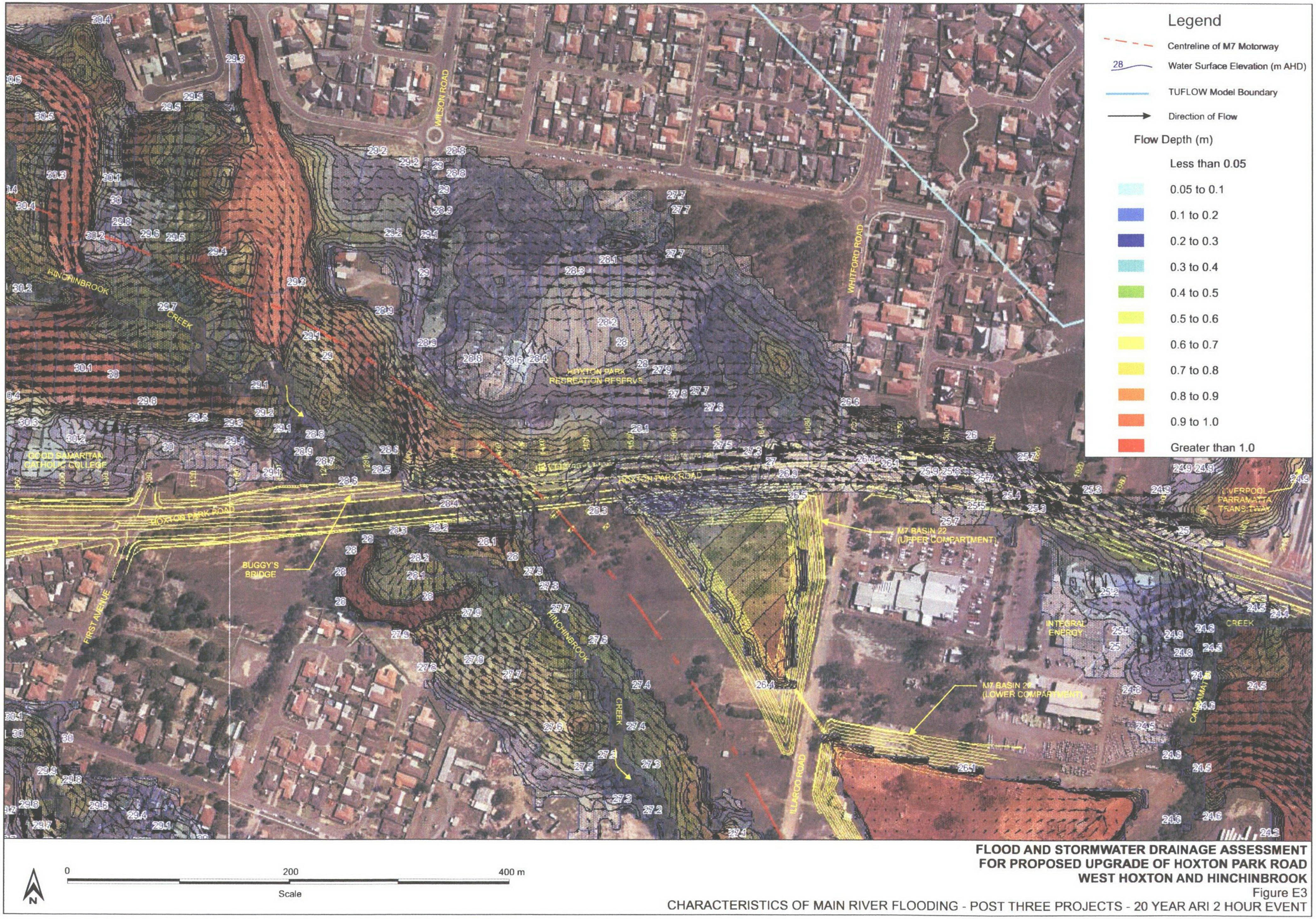
Figure E1

CHARACTERISTICS OF MAIN RIVER FLOODING - POST THREE PROJECTS - 2 YEAR ARI 2 HOUR EVENT



FLOOD AND STORMWATER DRAINAGE ASSESSMENT
FOR PROPOSED UPGRADE OF HOXTON PARK ROAD
WEST HOXTON AND HINCHINBROOK

Figure E2
CHARACTERISTICS OF MAIN RIVER FLOODING - POST THREE PROJECTS - 5 YEAR ARI 2 HOUR EVENT



FLOOD AND STORMWATER DRAINAGE ASSESSMENT FOR PROPOSED UPGRADE OF HOXTON PARK ROAD WEST HOXTON AND HINCHINBROOK

Figure E3

CHARACTERISTICS OF MAIN RIVER FLOODING - POST THREE PROJECTS - 20 YEAR ARI 2 HOUR EVENT

N

0 200 400 m

Scale

FLOOD AND STORMWATER DRAINAGE ASSESSMENT
FOR PROPOSED UPGRADE OF HOXTON PARK ROAD
WEST HOXTON AND HINCHINBROOK

Figure E4

CHARACTERISTICS OF MAIN RIVER FLOODING - POST THREE PROJECTS - 100 YEAR ARI 2 HOUR EVENT

APPENDIX F

RTA CONCEPT DRAWINGS – PROPOSED RECONSTRUCTION OF BUGGYS BRIDGE

Appendix E

Economic Analysis

DETAILED ECONOMIC ANALYSIS

PROJECT NAME: Hoxton Park Road Upgrade (From Banks Road to Cowpasture Road)

PARAMETER VALUES

General	
Base Year (Discounting Purposes)	2003
Discount Rate	7%
Evaluation Period (years from opening)	30
Travel Cost Parameters	
Based on the 2002 Rates of the RTA Economics Analysis Manual	
Accident Costs per MVKT	
Base	$75,000
Option	$54,700

CAPITAL COST ($M)

Option
$40

PRESENT VALUE OF CHANGE IN MAINTENANCE COSTS ($M)

Scenario	30 Year Period	20 Year Period	10 Year Period
Option	$0.22	$0.19	$0.13

RESULTS OF ECONOMIC ANALYSIS

Scenario	PVC* ($M)	30 Year Period			20 Year Period			10 Year Period			FYRR
		PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	
Option	$34	$65	$31	1.91	$44	$10	1.31	$19	-$15	0.57	2.82%

* includes maintenance cost for 30 year period

TRAVEL AND ACCIDENT COSTS ($M)

	Base		Option	
	2006	2016	2006	2016
Annual Travel Cost	$1.98	$7.71	$1.47	$1.95
Annual Accident Cost	$0.83	$0.98	$0.61	$0.72
Annual Travel Costs	$2.81	$8.69	$2.08	$2.67

YEARLY CASH FLOWS ($M) - BENEFITS

Year	Base	Base Discounted	Option	Option Discounted
2006				
2007	3.40	2.59	2.14	1.63
2008	3.99	2.84	2.20	1.57
2009	4.57	3.05	2.26	1.50
2010	5.16	3.21	2.32	1.44
2011	5.75	3.35	2.38	1.38
2012	6.34	3.45	2.43	1.32
2013	6.93	3.52	2.49	1.27
2014	7.51	3.57	2.55	1.21
2015	8.10	3.60	2.61	1.16
2016	8.69	3.61	2.67	1.11
2017	9.28	3.60	2.73	1.06
2018	9.87	3.58	2.79	1.01
2019	10.45	3.54	2.85	0.96
2020	11.04	3.50	2.91	0.92
2021	11.63	3.44	2.97	0.88
2022	12.22	3.38	3.02	0.84
2023	12.81	3.31	3.08	0.80
2024	13.39	3.23	3.14	0.76
2025	13.98	3.16	3.20	0.72
2026	14.57	3.07	3.26	0.69
2027	15.16	2.99	3.32	0.65
2028	15.75	2.90	3.38	0.62
2029	16.33	2.81	3.44	0.59
2030	16.92	2.72	3.50	0.56
2031	17.51	2.63	3.56	0.53
2032	18.10	2.54	3.61	0.51
2033	18.69	2.45	3.67	0.48
2034	19.27	2.37	3.73	0.46
2035	19.86	2.28	3.79	0.43
2036	20.45	2.19	3.85	0.41
Discounted Costs				
10 Year Period		$33		$14
20 Year Period		$67		$22
30 Year Period		$92		$27
Present Value of Benefits				
10 Year Period				$19
20 Year Period				$44
30 Year Period				$65

YEARLY CASH FLOWS ($M) - CAPITAL COSTS

Year	Option A	Option A Discounted
2005	$20.0	$17.5
2006	$20.0	$16.3
Total	**$40**	**$34**

DETAILED ECONOMIC ANALYSIS

PROJECT NAME: Hoxton Park Road Upgrade (From Banks Road to Cowpasture Road)

PARAMETER VALUES

General	
Base Year (Discounting Purposes)	2003
Discount Rate	4%
Evaluation Period (years from opening)	30
Travel Cost Parameters	
Based on the 2002 Rates of the RTA Economics Analysis Manual	
Accident Costs per MVKT	
Base	$75,000
Option	$54,700

CAPITAL COST ($M)

Option
$40

PRESENT VALUE OF CHANGE IN MAINTENANCE COSTS ($M)

Scenario	30 Year Period	20 Year Period	10 Year Period
Option	$0.35	$0.28	$0.17

RESULTS OF ECONOMIC ANALYSIS

Scenario	PVC* ($M)	30 Year Period			20 Year Period			10 Year Period			FYRR
		PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	
Option	$37	$114	$77	3.11	$68	$31	1.85	$25	-$11	0.69	2.94%

* includes maintenance cost for 30 year period

TRAVEL AND ACCIDENT COSTS ($M)

	Base		Option	
	2006	2016	2006	2016
Annual Travel Cost	$1.98	$7.71	$1.47	$1.95
Annual Accident Cost	$0.83	$0.98	$0.61	$0.72
Annual Travel Costs	$2.81	$8.69	$2.08	$2.67

YEARLY CASH FLOWS ($M) - BENEFITS

Year	Base	Base Discounted	Option	Option Discounted
2006				
2007	3.40	2.90	2.14	1.83
2008	3.99	3.28	2.20	1.81
2009	4.57	3.61	2.26	1.78
2010	5.16	3.92	2.32	1.76
2011	5.75	4.20	2.38	1.74
2012	6.34	4.45	2.43	1.71
2013	6.93	4.68	2.49	1.68
2014	7.51	4.88	2.55	1.66
2015	8.10	5.06	2.61	1.63
2016	8.69	5.22	2.67	1.60
2017	9.28	5.36	2.73	1.58
2018	9.87	5.48	2.79	1.55
2019	10.45	5.58	2.85	1.52
2020	11.04	5.67	2.91	1.49
2021	11.63	5.74	2.97	1.46
2022	12.22	5.80	3.02	1.44
2023	12.81	5.84	3.08	1.41
2024	13.39	5.88	3.14	1.38
2025	13.98	5.90	3.20	1.35
2026	14.57	5.91	3.26	1.32
2027	15.16	5.91	3.32	1.29
2028	15.75	5.91	3.38	1.27
2029	16.33	5.89	3.44	1.24
2030	16.92	5.87	3.50	1.21
2031	17.51	5.84	3.56	1.19
2032	18.10	5.80	3.61	1.16
2033	18.69	5.76	3.67	1.13
2034	19.27	5.71	3.73	1.11
2035	19.86	5.66	3.79	1.08
2036	20.45	5.61	3.85	1.06
Discounted Costs				
10 Year Period		$42		$17
20 Year Period		$99		$32
30 Year Period		$157		$43
Present Value of Benefits				
10 Year Period				$25
20 Year Period				$68
30 Year Period				$114

YEARLY CASH FLOWS ($M) - CAPITAL COSTS

Year	Option A	Option A Discounted
2005	$20.0	$18.5
2006	$20.0	$17.8
Total	**$40**	**$36**

DETAILED ECONOMIC ANALYSIS

PROJECT NAME: Hoxton Park Road Upgrade (From Banks Road to Cowpasture Road)

PARAMETER VALUES

General	
Base Year (Discounting Purposes)	2003
Discount Rate	10%
Evaluation Period (years from opening)	30
Travel Cost Parameters	
Based on the 2002 Rates of the RTA Economics Analysis Manual	
Accident Costs per MVKT	
Base	$75,000
Option	$54,700

CAPITAL COST ($M)

Option
$40

PRESENT VALUE OF CHANGE IN MAINTENANCE COSTS ($M)

Scenario	30 Year Period	20 Year Period	10 Year Period
Option	$0.15	$0.13	$0.10

RESULTS OF ECONOMIC ANALYSIS

Scenario	PVC* ($M)	30 Year Period			20 Year Period			10 Year Period			FYRR
		PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	
Option	$32	$40	$8	1.25	$30	-$2	0.95	$15	-$17	0.47	2.71%

* includes maintenance cost for 30 year period

10% Discount Rate

File Name: O:\1168\Economic Analysis - 30 September 2003 - 4% Discount Rate

24-Nov-03

TRAVEL AND ACCIDENT COSTS ($M)

	Base		Option	
	2006	2016	2006	2016
Annual Travel Cost	$1.98	$7.71	$1.47	$1.95
Annual Accident Cost	$0.83	$0.98	$0.61	$0.72
Annual Travel Costs	$2.81	$8.69	$2.08	$2.67

YEARLY CASH FLOWS ($M) - BENEFITS

Year	Base	Base Discounted	Option	Option Discounted
2006				
2007	3.40	2.32	2.14	1.46
2008	3.99	2.47	2.20	1.36
2009	4.57	2.58	2.26	1.27
2010	5.16	2.65	2.32	1.19
2011	5.75	2.68	2.38	1.11
2012	6.34	2.69	2.43	1.03
2013	6.93	2.67	2.49	0.96
2014	7.51	2.63	2.55	0.89
2015	8.10	2.58	2.61	0.83
2016	8.69	2.52	2.67	0.77
2017	9.28	2.44	2.73	0.72
2018	9.87	2.36	2.79	0.67
2019	10.45	2.28	2.85	0.62
2020	11.04	2.18	2.91	0.57
2021	11.63	2.09	2.97	0.53
2022	12.22	2.00	3.02	0.49
2023	12.81	1.90	3.08	0.46
2024	13.39	1.81	3.14	0.42
2025	13.98	1.72	3.20	0.39
2026	14.57	1.63	3.26	0.36
2027	15.16	1.54	3.32	0.34
2028	15.75	1.45	3.38	0.31
2029	16.33	1.37	3.44	0.29
2030	16.92	1.29	3.50	0.27
2031	17.51	1.21	3.56	0.25
2032	18.10	1.14	3.61	0.23
2033	18.69	1.07	3.67	0.21
2034	19.27	1.00	3.73	0.19
2035	19.86	0.94	3.79	0.18
2036	20.45	0.88	3.85	0.17
Discounted Costs				
10 Year Period		$26		$11
20 Year Period		$46		$16
30 Year Period		$58		$19
Present Value of Benefits				
10 Year Period				$15
20 Year Period				$30
30 Year Period				$40

YEARLY CASH FLOWS ($M) - CAPITAL COSTS

Year	Option A	Option A Discounted
2005	$20.0	$16.5
2006	$20.0	$15.0
Total	**$40**	**$32**

DETAILED ECONOMIC ANALYSIS

PROJECT NAME: Hoxton Park Road Upgrade (From Banks Road to Cowpasture Road)

PARAMETER VALUES

General	
Base Year (Discounting Purposes)	2003
Discount Rate	7%
Evaluation Period (years from opening)	30
Travel Cost Parameters	
Based on the 2002 Rates of the RTA Economics Analysis Manual	
Accident Costs per MVKT	
Base	$75,000
Option	$54,700

CAPITAL COST ($M)

Option
$36

PRESENT VALUE OF CHANGE IN MAINTENANCE COSTS ($M)

Scenario	30 Year Period	20 Year Period	10 Year Period
Option	$0.22	$0.19	$0.13

RESULTS OF ECONOMIC ANALYSIS

Scenario	PVC* ($M)	30 Year Period			20 Year Period			10 Year Period			FYRR
		PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	
Option	$31	$65	$34	2.12	$44	$14	1.45	$19	-$11	0.63	3.14%

* includes maintenance cost for 30 year period

10% Reduction in Cost

TRAVEL AND ACCIDENT COSTS ($M)

	Base		Option	
	2006	2016	2006	2016
Annual Travel Cost	$1.98	$7.71	$1.47	$1.95
Annual Accident Cost	$0.83	$0.98	$0.61	$0.72
Annual Travel Costs	$2.81	$8.69	$2.08	$2.67

YEARLY CASH FLOWS ($M) - BENEFITS

Year	Base	Base Discounted	Option	Option Discounted
2006				
2007	3.40	2.59	2.14	1.63
2008	3.99	2.84	2.20	1.57
2009	4.57	3.05	2.26	1.50
2010	5.16	3.21	2.32	1.44
2011	5.75	3.35	2.38	1.38
2012	6.34	3.45	2.43	1.32
2013	6.93	3.52	2.49	1.27
2014	7.51	3.57	2.55	1.21
2015	8.10	3.60	2.61	1.16
2016	8.69	3.61	2.67	1.11
2017	9.28	3.60	2.73	1.06
2018	9.87	3.58	2.79	1.01
2019	10.45	3.54	2.85	0.96
2020	11.04	3.50	2.91	0.92
2021	11.63	3.44	2.97	0.88
2022	12.22	3.38	3.02	0.84
2023	12.81	3.31	3.08	0.80
2024	13.39	3.23	3.14	0.76
2025	13.98	3.16	3.20	0.72
2026	14.57	3.07	3.26	0.69
2027	15.16	2.99	3.32	0.65
2028	15.75	2.90	3.38	0.62
2029	16.33	2.81	3.44	0.59
2030	16.92	2.72	3.50	0.56
2031	17.51	2.63	3.56	0.53
2032	18.10	2.54	3.61	0.51
2033	18.69	2.45	3.67	0.48
2034	19.27	2.37	3.73	0.46
2035	19.86	2.28	3.79	0.43
2036	20.45	2.19	3.85	0.41
Discounted Costs				
10 Year Period		$33		$14
20 Year Period		$67		$22
30 Year Period		$92		$27
Present Value of Benefits				
10 Year Period				$19
20 Year Period				$44
30 Year Period				$65

YEARLY CASH FLOWS ($M) - CAPITAL COSTS

Year	Option A	Option A Discounted
2005	$18.0	$15.7
2006	$18.0	$14.7
Total	**$36**	**$30**

DETAILED ECONOMIC ANALYSIS

PROJECT NAME: Hoxton Park Road Upgrade (From Banks Road to Cowpasture Road)

PARAMETER VALUES

General	
Base Year (Discounting Purposes)	2003
Discount Rate	7%
Evaluation Period (years from opening)	30
Travel Cost Parameters	
Based on the 2002 Rates of the RTA Economics Analysis Manual	
Accident Costs per MVKT	
Base	$75,000
Option	$54,700

CAPITAL COST ($M)

Option
$46

PRESENT VALUE OF CHANGE IN MAINTENANCE COSTS ($M)

Scenario	30 Year Period	20 Year Period	10 Year Period
Option	$0.22	$0.19	$0.13

RESULTS OF ECONOMIC ANALYSIS

Scenario	PVC* ($M)	30 Year Period			20 Year Period			10 Year Period			FYRR
		PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	
Option	$39	$65	$26	1.66	$44	$5	1.14	$19	-$20	0.49	2.46%

* includes maintenance cost for 30 year period

15% Increase in Cost

TRAVEL AND ACCIDENT COSTS ($M)

	Base		Option	
	2006	2016	2006	2016
Annual Travel Cost	$1.98	$7.71	$1.47	$1.95
Annual Accident Cost	$0.83	$0.98	$0.61	$0.72
Annual Travel Costs	$2.81	$8.69	$2.08	$2.67

YEARLY CASH FLOWS ($M) - BENEFITS

Year	Base	Base Discounted	Option	Option Discounted
2006				
2007	3.40	2.59	2.14	1.63
2008	3.99	2.84	2.20	1.57
2009	4.57	3.05	2.26	1.50
2010	5.16	3.21	2.32	1.44
2011	5.75	3.35	2.38	1.38
2012	6.34	3.45	2.43	1.32
2013	6.93	3.52	2.49	1.27
2014	7.51	3.57	2.55	1.21
2015	8.10	3.60	2.61	1.16
2016	8.69	3.61	2.67	1.11
2017	9.28	3.60	2.73	1.06
2018	9.87	3.58	2.79	1.01
2019	10.45	3.54	2.85	0.96
2020	11.04	3.50	2.91	0.92
2021	11.63	3.44	2.97	0.88
2022	12.22	3.38	3.02	0.84
2023	12.81	3.31	3.08	0.80
2024	13.39	3.23	3.14	0.76
2025	13.98	3.16	3.20	0.72
2026	14.57	3.07	3.26	0.69
2027	15.16	2.99	3.32	0.65
2028	15.75	2.90	3.38	0.62
2029	16.33	2.81	3.44	0.59
2030	16.92	2.72	3.50	0.56
2031	17.51	2.63	3.56	0.53
2032	18.10	2.54	3.61	0.51
2033	18.69	2.45	3.67	0.48
2034	19.27	2.37	3.73	0.46
2035	19.86	2.28	3.79	0.43
2036	20.45	2.19	3.85	0.41
Discounted Costs				
10 Year Period		$33		$14
20 Year Period		$67		$22
30 Year Period		$92		$27
Present Value of Benefits				
10 Year Period				$19
20 Year Period				$44
30 Year Period				$65

YEARLY CASH FLOWS ($M) - CAPITAL COSTS

Year	Option A	Option A Discounted
2005	$23.0	$20.1
2006	$23.0	$18.8
Total	**$46**	**$39**

DETAILED ECONOMIC ANALYSIS

PROJECT NAME: Hoxton Park Road Upgrade (From Banks Road to Cowpasture Road)

PARAMETER VALUES

General	
Base Year (Discounting Purposes)	2003
Discount Rate	7%
Evaluation Period (years from opening)	30
Travel Cost Parameters	
Based on the 2002 Rates of the RTA Economics Analysis Manual	
Accident Costs per MVKT	
Base	$75,000
Option	$54,700

CAPITAL COST ($M)

Option
$40

PRESENT VALUE OF CHANGE IN MAINTENANCE COSTS ($M)

Scenario	30 Year Period	20 Year Period	10 Year Period
Option	$0.22	$0.19	$0.13

RESULTS OF ECONOMIC ANALYSIS

Scenario	PVC* ($M)	30 Year Period			20 Year Period			10 Year Period			FYRR
		PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	PVB ($M)	NPV ($M)	BCR	
Option	$34	$55	$21	1.63	$41	$7	1.19	$19	-$15	0.57	2.82%

* includes maintenance cost for 30 year period

50% Traffic Growth after 2016

File Name: O:\1168\Economic Analysis - 30 September 2003

24-Nov-03

TRAVEL AND ACCIDENT COSTS ($M)

	Base		Option	
	2006	2016	2006	2016
Annual Travel Cost	$1.98	$7.71	$1.47	$1.95
Annual Accident Cost	$0.83	$0.98	$0.61	$0.72
Annual Travel Costs	$2.81	$8.69	$2.08	$2.67

YEARLY CASH FLOWS ($M) - BENEFITS

Year	Base	Base Discounted	Option	Option Discounted
2006				
2007	3.40	2.59	2.14	1.63
2008	3.99	2.84	2.20	1.57
2009	4.57	3.05	2.26	1.50
2010	5.16	3.21	2.32	1.44
2011	5.75	3.35	2.38	1.38
2012	6.34	3.45	2.43	1.32
2013	6.93	3.52	2.49	1.27
2014	7.51	3.57	2.55	1.21
2015	8.10	3.60	2.61	1.16
2016	8.69	3.61	2.67	1.11
2017	8.98	3.48	2.70	1.05
2018	9.28	3.36	2.73	0.99
2019	9.57	3.24	2.76	0.93
2020	9.87	3.12	2.79	0.88
2021	10.16	3.01	2.82	0.83
2022	10.45	2.89	2.85	0.79
2023	10.75	2.78	2.88	0.74
2024	11.04	2.67	2.91	0.70
2025	11.34	2.56	2.94	0.66
2026	11.63	2.45	2.97	0.63
2027	11.92	2.35	2.99	0.59
2028	12.22	2.25	3.02	0.56
2029	12.51	2.15	3.05	0.53
2030	12.81	2.06	3.08	0.50
2031	13.10	1.97	3.11	0.47
2032	13.39	1.88	3.14	0.44
2033	13.69	1.80	3.17	0.42
2034	13.98	1.72	3.20	0.39
2035	14.28	1.64	3.23	0.37
2036	14.57	1.56	3.26	0.35
Discounted Costs				
10 Year Period		$33		$14
20 Year Period		$62		$22
30 Year Period		$82		$26
Present Value of Benefits				
10 Year Period				$19
20 Year Period				$41
30 Year Period				$55

YEARLY CASH FLOWS ($M) - CAPITAL COSTS

Year	Option A	Option A Discounted
2005	$20.0	$17.5
2006	$20.0	$16.3
Total	**$40**	**$34**

Appendix F

Heritage Study

HOXTON PARK ROAD UPGRADE

Heritage Assessment
and
Statement of Heritage Impact
for
Indigenous and Non-Indigenous Cultural Heritage Values

FINAL REPORT

Prepared by
Austral Archaeology Pty Ltd
Archaeological and Cultural Heritage Consultants

For

Connell Wagner Pty Ltd

on behalf of

NSW Roads and Traffic Authority

2004

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EXECUTIVE SUMMARY

Austral Archaeology Pty Ltd was commissioned by Connell Wagner Pty Ltd to undertake an Indigenous and non-Indigenous Heritage Assessment (HA) and Statement of Heritage Impact (SoHI) for the proposed upgrade to Hoxton Park Road, between Cowpasture Road and Banks Road, Hoxton Park.

The NSW Roads and Traffic Authority (RTA) is proposing to upgrade Hoxton Park Road, between Cowpasture and Banks Roads. The proposed upgrade will result in 2 lanes of eastbound and 2 lanes of westbound traffic separated by median strips and a 2 lane transitway. Footways will be constructed on each side of the completed road and utilities such as lighting and stormwater drainage will be connected. Plans provided by the RTA indicate that the upgrade will consist of an asphalt surface applied to a bituminous seal. These will be placed on a graded base of concrete and sandstone select fill.

A search of all the relevant registers identified that there were no items of non-Indigenous heritage significance registered within the proposed corridor. A search of the NSW National Parks and Wildlife Service Aboriginal Heritage Information Management System identified several registered Indigenous sites in the vicinity of the study corridor and one registered site (45-5-2320) which is in the impact area of the proposal.

Background research undertaken was used to develop a predictive model for Indigenous relics within the study area. Based on the pre-contact resource base of the region and site types, frequencies and distribution across the landscape there is the potential for Indigenous sites to occur in the study area. These are most likely to be open campsites and isolated artefacts, which are the predominant site type within the general vicinity of the study area. These tend to be located on gently sloping land situated within an easy distance of water. Sites may contain few or many artefacts and, depending on the extent of subsurface disturbance, potential archaeological deposits. Scarred trees are likely to be identified in areas where there has been minimal impact on native vegetation.

The landform component of previous studies indicates that areas adjacent to swamps and/or fresh water are more likely to have been used by Indigenous groups. In addition, flat or undulating topography was utilised more often than steep slopes. This includes both creek banks and flats as well as the crests of small rises and spurs. Previous studies also indicate that access to resources such as water and food were important factors in the selection of sites characterised by larger deposits. Given the resource base within the region, there is potential for isolated finds to occur anywhere within the study area, not withstanding more recent disturbance events. The potential for intact surface and subsurface Indigenous cultural remains was predicted to be higher in undisturbed areas possessing gentle topography with easy access to fresh water.

Historical research into the European settlement of the Hoxton Park locale flagged several items of interest in the study area. Hoxton Park Road appears to have been built some time between 1843 and 1865 and was originally known as the Benera Road, presumably after the Benera Estate owned by Donald McLeod. Initially granted as agricultural holdings, the Hoxton Park area remained largely agricultural until the subdivision of the Hoxton Park estate, in 1887, allowed for smaller agricultural lots and denser settlement of the Plain. The development of Hoxton Park should be seen in the context of a number of historic themes, including pastoral expansion, trade, communications and transport.

Settlement of the region promoted the establishment of services, these included roads to the settlement at Liverpool where markets were located and mail could be collected, churches and schools. Two school grounds have been identified within the study corridor. Although educational facilities within the Hoxton Park area are thought to have been established as early as the 1840s, no records have survived detailing these early schools. The first school in the region to be documented was a Roman Catholic school, "Cabramatta", located on the site of the present Post Office and Scout Hall on the southern side of Hoxton Park Road west of First Avenue. Its earliest records date to 1873. This school closed in 1881 due to poor attendance, but in the following year seemed to have re-opened as a provisional school for the surrounding area. Similar attendance problems also plagued this school, despite the opening of a new saw mill and the building of the Housing Estate nearby. However, by 1891 pupil numbers stabilised and slowly increased, as did the school buildings and grounds to accommodate the children. By the early 1950s it had become clear that Hoxton Park School would have to be enlarged to accommodate increasing pupil numbers. Between 1955 and 2002 a much larger Hoxton Park Public School was situated east of First Avenue, on a site neighbouring the original school site. Both these school grounds are within the boundaries of the current corridor and there is potential for archaeological remains associated with the schools to be present within the study area.

Two surveys of the study area were undertaken to further elucidate the background research and refine predictions on the likelihood of Indigenous and non-Indigenous archaeological sites within the study area. The first survey was conducted on the 9th April 2003 by Sam Moody and Fiona Kidd (Archaeologists, Austral Archaeology), accompanied by Gil Saunders (representative of Gandangara Local Aboriginal Land Council, GLALC). A second field survey was undertaken on 15th May 2003 by Sam Moody and Fiona Kidd, this time accompanied by Peter Gale (Darug Tribal Aboriginal Corporation, DTAC).

The survey area was divided up into 12 survey units based on current landuse and levels of disturbance. The registered Indigenous site (45-5-2320, HPR1 in unit 7) within the direct impact area could not be relocated during the survey due to high vegetation cover within it's designated location. A further five sites were identified within, or on the boundary of, the proposed corridor. Two additional Indigenous sites were identified, a 'scarred' tree (HPR2 in unit 9), which is to be directly impacted by the current proposal, and a 'scarred' tree (HPR3 in unit 10), which is on the boundary of the impact area.

Three potential historic sites were identified, these being the remains associated with a 20th C. structure (HPR4 in unit 7), and those associated with the 1870s Hoxton Park Primary School (HPR5 in unit 8) and the 1958 Hoxton Park Primary School (HPR6 in unit 8). These six areas are those which have been flagged by the background research and the results of the survey. Additional to these six sites, are several areas which possess the potential for intact soil profiles that may contain archaeological remains. The market garden paddocks (units 2, 4 and 6) and riparian areas (units 9 and 12) retain potential for intact soil profiles and, consequently, *in situ* Indigenous relics.

The following table provides a summary of the results of the field survey.

Survey Unit	Summary of Survey Results
Unit 1	No Constraints.
Unit 2	Area of Indigenous archaeological potential identified, no historical items of cultural heritage significance identified.
Unit 3	No Constraints
Unit 4	Area of Indigenous archaeological potential identified, no historical items of cultural heritage significance identified.
Unit 5	No Constraints
Unit 6	Area of Indigenous archaeological potential identified, no historical items of cultural heritage significance identified.
Unit 7	Registered indigenous site (HPR1) within unit, potential historic archaeological feature associated with 20th C. structure (HPR4)
Unit 8	No Indigenous items of cultural heritage significance identified, potential historic archaeological features associated with an 1870s school (HPR5) and a 20th C school (HPR6).

Unit 9	'Scarred' tree (HPR2) identified, area retains potential for Indigenous archaeological sites. No historic items of cultural heritage significance identified.
Unit 10	'Scarred' tree (HPR3) identified. No historic items of cultural heritage significance identified.
Unit 11	No Constraints
Unit 12	No Constraints within development impact area.

The sites recorded were assessed under the guidelines and criteria developed by the NSW National Parks and Wildlife Service and the NSW Heritage Office. These sites were assessed as follows:

Survey Unit	Summary of Survey Results	Assessed level of significance
Unit 1	No identified items / potential	N/A
Unit 2	Indigenous archaeological potential	Low research
Unit 4	Indigenous archaeological potential	Low research
Unit 5	No identified items / potential	N/A
Unit 6	Indigenous archaeological potential	Low research
Unit 7	Registered indigenous site (HPR1)	Low research, awaiting input from Indigenous stakeholders re. social significance
Unit 7	Historic archaeological feature associated with 20th C. structure (HPR4)	Limited local
Unit 8	Potential historic archaeological feature associated with an 1870s school (HPR5)	Limited local
Unit 8	Potential historic archaeological feature associated with a 20th C school (HPR6).	Limited local
Unit 9	'Scarred' tree (HPR2) identified	Low research, awaiting input from Indigenous stakeholders re. social significance
Unit 9	Potential for Indigenous archaeological sites.	Low research
Unit 10	'Scarred' tree (HPR3) identified	Low research, awaiting input from Indigenous stakeholders re. social significance
Unit 11	No identified items / potential	N/A
Unit 12	No identified items / potential in impact area.	N/A

Based on the results of the survey and the statutory controls which apply to the sites, the following management strategies and recommendations are made:

Recommendation 1 – Indigenous archaeological test excavation – HPR1 and PADs

Test excavation by a qualified archaeologist is recommended in the vicinity of HPR1 (registered site 45-5-2320). As the artefacts were identified on the ground surface, manual excavation is required in this area. This testing program should aim to identify the extent and integrity of site HPR1 and the significance of the site to the local Indigenous custodians. The excavation procedure should be determined in consultation with NSW NPWS, GLALC, DTAC and the RTA. Gandangara LALC and Darug TAC members should be invited to participate in the testing program.

Archaeological test excavation to determine the extent, nature and significance of Indigenous cultural heritage resources should be undertaken by a qualified archaeologist in Units 2, 4, 6, 7, and 9. A suitable testing regime should be established in consultation with NSW NPWS, GLALC, DTAC and the RTA. Gandangara LALC and Darug TAC members should be invited to participate in the testing program.

Recommendation 2 – Removal and relocation of HPR2 – scarred tree

HPR2 (scarred tree) should be removed prior to the widening of Hoxton Park Road. The tree should be removed by a qualified abourist to a secure location which allows interpretation of the relic. Gandangara LALC have suggested that the tree be relocated to their cultural centre in Menai where it will be used for educational purposes, for both LALC members and members of the wider community who can access the centre. The consultant recommends that this is an appropriate location for the tree. The tree should be removed from its current location by a qualified abourist in the presence of a qualified archaeologist and GLALC representatives.

Recommendation 3 – Site HPR3 – scarred tree

A heavy machinery exclusion zone is to be established around site HPR3. This zone will be a circle with a radius of 5m which will be flagged out prior to the introduction of heavy machinery to the area. If the RTA cannot construct the road with this exclusion zone, the tree is to be removed by a qualified arbourist to a secure location which allows for interpretation of the relic. The GLALC cultural centre in Menai is an appropriate repository for the relic. If required, the tree should be removed from its current location by a qualified arbourist in the presence of a qualified archaeologist and GLALC representatives. Removal of the tree (if necessary) may only take place once the archaeological testing program is completed in the vicinity of HPR3.

Recommendation 4 – Application for Consent to Destroy and accompanying documentation submitted to NSW NPWS

Consent to destroy must be received from NSW NPWS prior to any impacts on the identified sites and PADs. An application and accompanying research design must be submitted to NSW NPWS in order to undertake recommendations 1 – 3. Documentation will need to be written by a qualified archaeologist and outline the proposed works. In addition, an application for Care and Control of Cultural Items must be made to allow for GLALC custodianship of the scarred trees HPR2 and HPR3 (should it be removed).

- It is recommended that this archaeological assessment report be submitted to the Cultural Heritage Branch of NSW National Parks and Wildlife Service.
- It is recommended that a qualified archaeologist be engaged to complete a research design to accompany the consent to destroy applications required for the proposed works to proceed.
- Applications should also be made on behalf of GLALC for care and control of the scarred trees HPR2 and HPR3.

Recommendation 5 – Historical archaeological monitoring not required

Sites HPR4 and HPR5, although protected under the auspices of the *NSW Heritage Act 1977 (amended)*, have been assessed to be of limited archaeological potential and of little local significance. Works may proceed in the vicinity of sites HPR4 and HPR5 without a requirement for archaeological monitoring or testing. Site HPR 6 does not fall under the auspices of the relics provisions of the *NSW Heritage Act 1977 (amended)*, and has been assessed as of limited archaeological potential and of little local significance. Works may also proceed in the vicinity of site HPR6 without a requirement for archaeological monitoring or testing.

It should be noted that recommendation 5 does not absolve the client from a responsibility to adhere to the relics provisions of the *NSW Heritage Act 1977 (amended)* if historic archaeological features and cultural deposits further to those identified in this report are encountered.

Recommendation 6 – Works in Land Unit 10

The archaeological potential of Land Unit 12 is restricted to those parts which may retain intact soil profiles. In general, these areas are located at the furthest points of the Land Unit from the proposed development works.

The proposed creek & drainage works anticipated at the Banks Street end of Land Unit 12 will only impact upon the existing creek bed and banks. Due to the nature of the creek and its propensity for flooding, as well as significant pre-existing modifications to the landform, there is no potential for *in situ* Aboriginal sites in this area. Therefore, the creek & drainage works can proceed without the need for further cultural heritage works.

Recommendation 7 – Overall project timing

The timing of these recommendations is open to the RTA, however, it is imperative that all Indigenous archaeological testing be conducted prior to any bulk earth works in survey units 2, 4, 6, 7 & 9.

Recommendation 8 – Stop work provision

As required by the *NSW National Parks and Wildlife Service Act, 1974* in the event that Indigenous cultural fabric or deposits are encountered, works must cease immediately to allow the archaeologist to make an assessment of the find. The archaeologist may need to consult with the NSW National Parks and Wildlife Service regarding Indigenous relics.

As required by the *NSW Heritage Act 1977 (amended)*, in the event that historic cultural fabric or deposits not described in this report are encountered, works must cease immediately to allow the archaeologist to make an assessment of the finds. The archaeologist may need to consult with the NSW Heritage Office concerning the significance of historic cultural material unearthed.

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Background

Connell Wagner Pty Ltd commissioned Austral Archaeology Pty Ltd to undertake an Indigenous and non-Indigenous Heritage Assessment (HA) and Statement of Heritage Impact (SoHI) for the proposed upgrade to Hoxton Park Road, between Cowpasture Road and Banks Road, Hoxton Park. Refer to Figure 1.1.

1.2 Objectives

The objectives of this report are as follows;

1. To clearly document the history of Indigenous and historic occupation in the study area and the locations of all known Indigenous and historic heritage sites, items, areas, landscapes, etc (including surface and underground items);
2. Identify any Native Title implications for project design, construction and operation, including a formal Native Title search;
3. Identify locations of and map Indigenous sites as recorded on the NSW National Parks and Wildlife Aboriginal Heritage Information Management System;
4. Map and describe any sites nominated on the National Estate;
5. Map and describe any sites nominated on the State Heritage Register;
6. Document, including mapping and description, any natural, heritage or archaeological features within the Local Government Planning instruments of Liverpool City Council;
7. Conduct a field study to produce comprehensive knowledge of heritage issues and to identify and map all items within the corridor; and
8. Provide recommendations regarding the preservation, recording, excavation or destruction of any sites and any further investigations required to fulfil legislative requirements.

1.3 Proposed Development

The NSW Roads and Traffic Authority (RTA) is proposing to upgrade Hoxton Park Road, between Cowpasture and Banks Roads (refer to Plate 1.1). The proposed upgrade will result in 2 lanes of eastbound and 2 lanes of westbound traffic separated by median strips and a 2 lane transitway. Footways will be constructed on each side of the completed road. Plans provided by the RTA indicate that the upgrade will consist of an asphalt surface applied to a bituminous seal. These will be placed on a graded base of concrete and sandstone select fill. Utilities such as lighting and stormwater drainage will be connected. Refer to Figure 1.2 for a schematic outline of the RTA concept plan

Plate 1.1 Hoxton Park Road at Banks Road

Figure 1.1 Location of Hoxton Park Road (Basemap UBD 2003 Sydney and Blue Mountains Street Directory)

Figure 1.2 Schematic outline of the RTA concept plan for the widening of Hoxton Park Road, the blue line represents the side of the existing road to be widened.

1.4 Author Identification

The project was managed and reviewed by Charles Parkinson (NSW Manager, Austral Archaeology). Sam Moody and Fiona Kidd researched the history of the area and conducted two site inspections, the first with Gil Suanders (Gandangara Local Aboriginal Land Council) on 9th April 2003 and the second on 15th May 2003 with Peter Gale (Darug Tribal Aboriginal Corporation). Sam Moody and Fiona Kidd were jointly responsible for writing the report. Charles Parkinson provided input to the management recommendations.

1.5 Statutory Controls

1.5.1 Indigenous Statutory Controls

Indigenous cultural heritage in Australia is protected and managed under the following Commonwealth and State Legislation.

- *Australian Heritage Commission Act, 1975*

The *Australian Heritage Commission Act 1975*, established the Australian Heritage Commission (AHC), to identify places of importance to the National Estate. The AHC maintains a register (the Register of the National Estate) of places which are significant in terms of their association with a particular community or social groups for social, cultural or spiritual reasons.

A search of the RNE to identify listed indigenous items in the vicinity of the study area was undertaken on 22/7/02. No items of Indigenous cultural heritage significance were listed on the RNE within the study area nor within the immediate surrounding area.

- *Aboriginal and Torres Strait Islander Heritage Protection Amendment Act 1987*

The *Aboriginal and Torres Strait Islander Heritage Protection Amendment Act of 1987* is a federal act administered by the Aboriginal and Torres Strait Islander Commission, and provides blanket protection for Aboriginal heritage in circumstances where such protection is not available at a state level. This Act comes under Commonwealth jurisdiction which means that it can override state and territory provisions (Pearson & Sullivan 1999: 52-53).

- *New South Wales National Parks and Wildlife Act 1974*

All Indigenous relics are protected under Section 90 of the *National Parks and Wildlife Act 1974*. Sites of traditional significance that do not necessarily contain archaeological materials may be gazetted as Aboriginal places and are protected under Section 84 of the Act. This protection applies to all sites regardless of their significance or land tenure. Under Section 90 of the Act it is an offence to knowingly disturb, damage or destroy relics or Aboriginal places without prior written consent of the Director-General of the NSW National Parks and Wildlife Service (NPWS).

Under the Act, a relic is defined as:

> *any deposit, object or material evidence (not being a handicraft for sale) relating to Aboriginal habitation of the area that comprises New South Wales, being habitation both prior to and concurrent with the occupation of that area by persons of European extraction, and includes Aboriginal remains.*

A search of the NSW National Parks and Wildlife Service Aboriginal Heritage Information Management System (AHIMS) identified a number of Aboriginal sites within the local region. There is one registered site (45-5-2320) which is directly impacted by the proposal. Refer to Section 3.3.1 for a full description.

- *Environmental Planning and Assessment Act 1979*

The *Environmental Planning and Assessment Act 1979 (EP&A Act)* requires that environmental impacts are considered prior to land development. This includes impacts to items of Indigenous cultural heritage. Local Environment Plans (LEPs) prepared in accordance with the *EP&A Act* provide guidance on the level of environmental assessment required. LEPs often include heritage schedules of significant items.

A search was made of the heritage schedule of Liverpool LEP 1997 (Liverpool City Council) prepared under the *EP&A Act 1979*. No items of Indigenous cultural heritage significance within the study area, were listed on this schedule.

1.5.2 *Non-Indigenous Statutory Controls*

Non-Indigenous cultural heritage in Australia is protected and managed under the following legislation.

- *Australian Heritage Commission Act 1975*

Commonwealth heritage is protected under the *ACH Act 1975*. The AHC identifies and advises the Commonwealth Government on the protection of Australia's National Estate, which is defined as:

> *4. (1) those places, being components of the natural environment of Australia or the cultural environment of Australia, that have aesthetic, historic, scientific of social significance or other special value for future generations, as well as for the present community.*

The powers of the Commission and Act do not extend to State authorities/owners or private individuals.

The ACH maintains the Register of the National Estate (RNE), which lists all sites and places of significance to the nation (note that items of local level significance may be included on the RNE). Within the visual catchment of the proposal there are several items listed on the RNE. Refer to Section 2.3.7 for details on items identified within the broader impact area.

- *NSW Heritage Act 1977 (amended 1999)*

The *Heritage Act 1977 (amended)* affords protection to items of heritage significance which are defined as a *place, building, work, relic, movable object, or precinct*. **Place** is defined as an area *of land, with or without improvements*, and **relic** is defined as *any deposit, object or material evidence:*

> *a) which relates to the settlement of the area that comprises NSW , not being Aboriginal settlement; and*
> *b) which is more than 50 years old.*

The concept of cultural heritage significance helps estimate the value of places or items at the local, state, national or world level, and is defined by specific criteria. New criteria were gazetted following amendments to the Heritage Act 1977, which came into force in April 1999. Seven significance assessment criteria have now replaced those derived from the ICOMOS Burra Charter, the new criteria being more consistent with the criteria developed by the AHC for the determination of heritage significance at a national level.

Section 139 defines the need for an excavation permit in certain cases, it being illegal to knowingly excavate in an area where there is a strong likelihood that the excavation will result *in a relic being discovered, exposed, moved, damaged or destroyed.*

Items of State significance are protected through inclusion on the State Heritage Register (SHR). A search was made of the SHR to identify items of State heritage significance within the study area. No items within the study area are listed on the SHR.

- *Environmental Planning and Assessment Act 1979*

The *Environmental Planning and Assessment Act 1979 (EP&A Act)* requires that environmental impacts are considered prior to land development. This includes impacts to items of Non-Indigenous cultural heritage. Local Environment Plans (LEPs) prepared in accordance with the *EP&A Act* provide guidance on the level of environmental assessment required. LEPs often include heritage schedules of significant items.

A search was made of the heritage schedule of Liverpool LEP 1997 (Liverpool City Council) prepared under the *EP&A Act 1979*. Numerous items of cultural heritage were listed on the heritage schedule of Liverpool LEP, however, none were identified within the immediate area of the proposal. Consultation with Suzanna Webb (Heritage Planner, Liverpool City Council) confirmed that Council does not consider there to be any items of historic heritage significance within the corridor.

1.5.3 Non-Statutory Controls

The National Trust maintains a register of items which it considers significant (significance is determined by criteria similar to the AHC and State Heritage Register criteria). Classification by the National Trust, although lacking legal force, is recognised by the public as an indication of heritage significance. For this reason a search has been undertaken of the registers maintained by the National Trust. No items within the study corridor, nor the immediate environs are listed on the National Trust register of historic places, the industrial register nor the cemetery register.

1.6 Acknowledgements

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Peter Gale - Darug Tribal Aboriginal Corporation
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Gil Saunders – Gandangara LALC
Rebecca Simon – NSW National Parks and Wildlife Service
Suzanna Webb – Liverpool City Council
Dallas Wellington - National Native Title Tribunal

1.7 Abbreviations

The following abbreviations are used within this report:

AHC	Australian Heritage Commission
DTAC	Darug Tribal Aboriginal Corporation
GLALC	Gandangara Local Aboriginal Land Council
LEP	Local Environmental Plan
LGA	Local Government Area
NPWS	National Parks and Wildlife Service
NT	National Trust
RNE	Register of the National Estate
SHI	State Heritage Inventory
SHR	State Heritage Register

2.0 CONTEXTUAL BACKGROUND

2.1 General Environmental Context

The study area is located on the southern portion of the Cumberland Plains/Lowlands, which are gently undulating plains and low lying hills overlying Wianamatta Group shales and sandstones. The Cumberland Plains are drained by a dense system of predominately north flowing channels.

Vegetation cover in the region has been modified greatly in the last 200 years with the result that the original Cumberland Plains Woodlands exist only as remnant pockets in the current semi-rural/urban environment.

The study area can be generally described as level with a height differential of approximately 10m over the 2.2km of the proposed route. The area slopes down gently to the east, towards Hinchinbrook Creek. Hoxton Park Road crosses Hinchinbrook Creek twice; one crossing of the creek being that of Buggys Bridge over the larger Hinchinbrook Creek channel, and the other being that of a smaller tributary of the Creek which is located opposite Banks Road. The area is characterised by a number of small tributaries feeding into both Hinchinbrook Creek and Cabramatta Creek (located southeast of the study area). Two smaller drainage channels / tributaries are located east of Cowpasture Road, however, these appear to be ephemeral water courses.

2.1.1 Geological Context and Soil Landscapes

The Middle Triassic Wianamatta Group is found within the Cumberland Lowlands. It lies over the Mittagong formation and the Hawkesbury Sandstone and is divided into two formations, the Bringelly Shale and underlying Ashfield Shale. These two formations are separated by the Minchinbury Sandstone.

> *The Ashfield Shale caps many ridges on the Hawkesbury Sandstone plateaux. It consists of black to dark grey siltstone and laminate. Extensive areas of Bringelly Shale occur throughout the Cumberland Lowlands. It consists of shale (claystone and siltstone), carbonaceous claystone, laminate and fine to medium-grained lithic sandstone.*
>
> *The igneous rocks consist mainly of volcanic breccia and basalt. These are sparsely distributed through the Penrith map area as diatremes....They also occur throughout the lower Blue Mountains as a system of small intrusive dykes that are basaltic and are seldom more than three meters wide.*
>
> Bannerman and Hazelton, 1990:3

Soil landscapes are areas of land with 'recognisable and specifiable topographies, that are capable of presentation on maps, and can be described by concise statements' (Northcote, 1978, cited in Bannerman and Hazelton 1990:6). Soil landscapes differ from soil associations and land systems in that more emphasis is placed on the topography as similar causal factors are involved in the formation of both soils and landscapes. Within the study area there are three identified recurring soil landscapes. These are Blacktown (bt), South Creek (sc) and Berkshire Park (bp).

- Blacktown (bt)

The Blacktown soil landscape is a residual formation composed of gently undulating rises on Wianamatta Group shales. Ashfield Shale, consisting of laminate and dark grey siltstone; Bringelly Shale, consisting of shale with occasional outcrops of calcareous claystone and laminate and infrequent coal outcrops; and Minchinbury Sandstone, consisting of fine to medium grained quartz lithic sandstone are present within this landscape. The topography is characterised by gently undulating rises with a local relief 10-30 m and slopes generally less than 5% but up to 10%. Crests and ridges are broad (200-600 m) and rounded with concave lower slopes grading into convex upper slopes (Bannerman and Hazelton, 1990:28). Shales are not naturally occurring on the surface. The original vegetation associated with this landscape was open-forest and open-woodland (for further detail refer to Section 2.1.2). There are four dominant soil types in this landscape consisting of: bt1, a friable brownish black loam which occurs as topsoil (Horizon A); bt2, a hardsetting brown clay loam which occurs as an A2 horizon; bt3, a strongly pedal, mottled brown light clay which occurs as a subsoil (B horizon); and bt4, a light grey plastic mottled clay occurring as a B3 of C horizon (Bannerman and Hazelton, 1990:29-30). Soils in this landscape tend to be strongly to slightly acid, although neutral soils also occur in bt1.

- South Creek (sc)

South Creek is a fluvial landform overlying Quaternary alluvium derived from Wianamatta Group shales and Hawkesbury Sandstone. The topography of the landscape is a flat to gently sloping alluvial plain 'with occasional terraces of levees providing low relief' (Bannerman and Hazelton, 1990:68). Slopes are less than 5% with a local relief of less than 10 m. The vegetation of this landscape reflects its frequent inundation (refer to Section 2.1.2 below). Dominant soils of the landscape consist of sc1, a brown, apedal, single grained loam which occurs as an A horizon; sc2, a dull brown clay loam which occurs as a topsoil (A horizon); and sc3 which is a bright brown clay occurring as a subsoil (B horizon). Soil pH is this landscape varies from extremely acid to neutral, sc1 being consistently acidic whilst sc2 and sc3 range from moderately acid to neutral and extremely acid to neutral respectively (Bannerman and Hazelton, 1990:69). These soils are highly susceptible to erosion which is reflected in a very high to extreme erosion hazard for this landscape as evident in the visible stream bank and gully erosion (Bannerman and Hazelton, 1990:70).

- Berkshire Park (Bp)

The Berkshire Park soil landscape is derived from three depositional phases of Tertiary alluvial/colluvial origin. All three formations are derived from sandstone and clay, with surface erosion exposing the three formations in different areas. The topography of the Berkshire Parks group is generally characterised by flat terrace tops dissected by small drainage channels and narrow drainage lines. Soils in this group comprise bp1, a dark brown sandy loam with an apedal single-grained structure and porous structure, which occurs as a topsoil (A horizon). Bp1 is generally acidic with a pH range from neutral (pH7.0) to moderately acidic (pH 5.0). Also occurring as a topsoil is bp2, a brown apedal sandy clay loam, which has a similar acidity to bp1 (Bannerman and Hazelton, 1990:82). Bp3 is a subsoil of brown sandy clay with up to 20% ironstone nodules. The pH is slightly acid, averaging pH 6.0, although but can range from pH 5.0 – pH 7.0. Bp is a high chroma (bright coloured) clay with up to 90% stones. This material has a wide pH range, from moderately acid (pH 5.0) to moderately alkaline (pH 8.5). As a general rule, soils in this landscape have an increasing clay content with depth, although erosion and deposition cycles can reverse this trend (Bannerman and Hazelton, 1990:83).

2.1.2 Flora Resources

The Cumberland Plain vegetation communities have been extensively modified in the wake of European settlement. There are pockets of traditional vegetation communities across the plain, but these tend to be fringe remnants of the native vegetation. Vegetation communities within an area are determined by the available conditions such as soil type and drainage characteristics, factors generally related to the underlying geology. Within the study area there are three identified vegetation communities. These are Shale Communities, represented within the study area by Shale Plains Woodland, Riparian Communities represented by Alluvial Woodland and Tertiary Alluvium Communities represented by Shale Gravel Transition Forest (NSW National Parks and Wildlife Service, 2000:map 7).

- Shale Communities

Shale Plains Woodland is found in areas with parent geologies including Wianamatta Shale (68%), Holocene Alluvium (21%), Mittagong Formation (4%), Tertiary Alluvium (3%), Hawkesbury Sandstone (3%) and Aeolian Deposits (1%). Shale Plains Woodland is dominated by grey box *Eucalyptus moluccana* and forest red gum *E. tereticornis,* with narrow leaved ironbark *E. crebra*, thin leaved stringy bark *E. eugenioides* and bloodwood *Corymbia maculata* occurring less frequently. These species often form a small tree stratum generally including other species such as native cherry *Exocarpos cupressiformis,* Parramatta wattle *Acacia parramattensis subsp. parramattensis* and black wattle *Acacia decurrens* (NSW NPWS 2000:77). If a shrub stratum is present it is usually dominated by boxthorn *Bursaria spinosa*, whilst common ground stratum species include kidney weed *Dichondra repens*, speargrass *Aristida vagans*, weeping meadow grass *Microlaena stipoides var. stipoides,* kangaroo grass *Themeda australis*, glycine *glycine tabacina,* jersey cudweed *Gnaphalium sphaericum,* blue trumpet *Brunoniella australis* and *Desmosium variens*.

- Riparian Communities

The Alluvial Woodland subset tends to occur in areas with parent geology including Holocene Alluvium (59%), Wianamatta Shale (22%), Mittagong Formation (8%), Hawkesbury Alluvium (8%) and Tertiary Alluvium (3%). Within Alluvial Woodland there are a number of identified tree species, although the dominant species include cabbage gum *Eucalyptus amplifolia* and forest red gum *E. tereticornis* with rough-barked apple *Angophora floribunda* occurring slightly less frequently. A shrub stratum is usually evident in this community, although it is invariably dominated by boxthorn *Bursaria spinosa* (NSW NPWS, 2000:67). Alluvial Woodland often has a dense ground cover of grasses and herbs including weeping meadow grass *Microlaena stipoides var. stipoides*, many-flowered mat rush *Lomandra multiflora,* wiry panic *Entolasia marginata*, tufted grass *Echinopogon ovatus*, forest nightshade *Solanum prinophyllum* and white root *Pratia purpurascens*.

- Tertiary Alluvium Communities

Shale Gravel Transition Forest is generally present in areas of shallow tertiary alluvium overlying shale soils, but also in areas of iron-indurated gravel. Shale Gravel Transition Forest grades into Shale Plains Woodland as alluvial and ironstone influences decline (NSW NPWS, 2000:29). The tree stratum in the community is dominated by ironbark *Eucalyptus fibrosa,* with grey box *E moluccana* and forest red gum *E. tereticornis* occurring less frequently, although both grey box and forest red gum will dominate in areas where ironbark is not present. A shrub stratum often occurs, and this is characterised by species such as boxthorn *Bursaria spinosa* and native cranberry *Lissanthe strigosa*. Ground cover is provided by species such as weeping meadow grass *Microlaena stipoides var. stipoides*, speargrass *Aristida vagans*, kangaroo grass *Themeda australis*, many-flowered mat rush *Lomandra multiflora,* and white root *Pratia purpurascens* (NSW NPWS, 2000:29).

Plants within vegetation communities such as these would have been utilised by Indigenous peoples as sources of wood, bark, sap and food (refer to 3.7 for further details)

2.1.3 Faunal Resources

Vegetation communities such as those described above would have supported an array of faunal resources.

Mammals within the area would have included Eastern grey kangaroo, ringtail and brushtail possums, sugar and squirrel gliders and flying foxes. 'The mammal fauna of western Sydney, especially on the Cumberland Plain, is noticeably depauperate. This area is similar to other areas in the extent of mammalian decline, due to prolonged and extensive ecosystem degradation' (Dixson 1999:3). It is worth remembering that faunal diversity, like vegetal diversity, has been severely reduced since European occupation of the region, and that the current environment, may not accurately reflect the resources previously available to Indigenous communities.

Avian resources available in the Cumberland Plain area include numerous species of birds, some of which are no longer present within the region. Birds which may still be seen in the area include various species of cockatoo, rosella, lorikeet, parrot, owl, cuckoo, galah, currawong, butcherbird, thornbill, greygone, treecreeper, kingfisher, kookaburra, honeyeater, whistler, robin, swallow, martin, cisticola, eagle, falcon and kite (refer to Dixson, 1999 for a comprehensive listing). 'At least 38 species have declined or disappeared since European arrival. Most are those that typified the Cumberland Plains Woodland, with the greatest decline in the past 50 years' (Dixson 1999:5).

In addition to birds and mammals numerous amphibians and retiles would have been found in the area. Frog species would have included the eastern banjo, brown-striped, spotted grass, bleating tree, and broad-palmed tree frogs as well as brown toadlets. The river systems along the Plain, although probably supporting mullet, would have provided eels as a major resource. Reptiles found within the area include stone gecko, lace monitor, striped, grass and garden skin, blue-tongued lizard, death adder and red-naped, eastern brown and red-bellied black snake (Dixson, 1999:2-3). Native bees would also have been present within the area.

Faunal resources such as these provided many items utilised by Indigenous communities, Refer to Section 2.2.7 for a detailed description of use patterns.

2.1.4 Climatic Conditions

The study area lies in a rain shadow created by the 'higher coastal plateaux capturing winds from the prevailing south-east' (Bannerman and Hazelton, 1990:3). The Cumberland Plain contains the driest area of the Sydney zone, as is reflected in its average annual rainfall. Annual rainfall in the study area is between 800-860 mm per year, with slightly more rain falling towards the east. Rainfall is summer dominant, falling on approximately 100 days per year and ranging from 10-11 days per month through spring and summer and dropping to 6 days per month during winter. The general area is characterised by considerable diurnal and seasonal range in temperatures with the average temperature range at Penrith ranging from 29.6 – 17.4°c during January to 17.2 – 3.6°c in July. The average monthly humidity of the area hovers around 49.5% in summer and 48.5% in winter (Bannerman and Hazelton, 1990:3-4).

3.0 INDIGENOUS BACKGROUND

3.1 Regional Prehistory

Aboriginal people are believed to have inhabited the Sydney region for at least 20,000 years, and possibly longer (see Nanson et al 1987). Archaeological sites investigated in the Blue Mountains and along Hawkesbury/Nepean River System have to-date, produced evidence for the earliest occupation. The Kings Table Cave site in the Blue Mountains produced a radiocarbon date of c22,000 years BP (Stockton & Holland 1974), although Kohen notes that there is a 'marked disconformity in the deposition of sediments within this site immediately above the flakes, and the early dating of this site is not secure (1995:29). Excavation of the Greaves Creek rock shelter site of Walls Cave near Medlow Bath has produced a date of c.12,000 years BP (ibid). At Shaws Creek KII, a rockshelter on the west bank of the Nepean River, north of Penrith, is dated to c13,000 BP (Kohen et al 1984).

Sites located on the south coast, such as Burrill Lake (c20,000) and Bass Point (c17,000), provide complimentary dates (Lampert 1971, Bowdler 1970). At the time of these periods of occupation, both sites would have been located within hinterland areas some distance away from the sea. In the case of Burrill Lake, the sea would have been at least 16 km further east than the present coastline (McDonald 1992). There are no other Pleistocene sites recorded on the Sydney coast. There are however two sites dated to around 7,000 years ago, and these are located at Curracurrang and the Prince of Wales Hospital, Randwick.

It is likely that an unquantifiable number of coastal sites of a similar antiquity within the Sydney region have been submerged and/or destroyed by sea-level changes that have occurred in eastern Australia during the last 20,000 years. It appears on the basis of the available evidence that the occupation of the Sydney region was sporadic, and that the population was fairly low during the earliest periods. It has been estimated that from approximately 5,000 years ago, there appears to have been an increase as well as a continuation of the use of many sites subject to recent archaeological investigation. Evidence for the use and occupation of the Sydney region from this period appears to be more visible in the archaeological record than for the previous periods.

In support of the likelihood that occupation of the region intensified around this time, the majority of rockshelter and open camp sites which have been investigated to-date contain archaeological deposits, features and artefacts which generally date to c.2,500 BP or less. Kohen (1986) suggests that there was a more intensive use of open sites in the region during the last 1,500 years. This researcher suggests that the majority of campsites can therefore be associated with this time frame.

Over the 20,000 years of occupation in the region, and in particular the last 5,000 to 8,000 years, changes in excavated stone tool assemblages have been observed. Various temporal markers have subsequently been established by archaeologists in an attempt to distinguish what are considered to be the more significant changes in tool types and tool kit composition (eg. McCarthy 1948, Megaw 1965, Lampert 1971 and Wright 1977).

Within the Sydney region, the most widely used terminology for the phases within what is currently known as the *Eastern Regional Sequence* are the *Capertian*, followed by the *Early, Middle* and *Late Bondaian*. This sequence continues to be refined by ongoing archaeological work in the region. A summary description of the various characteristics of each of these phases or cultural markers is outlined below.

The *Capertian* comprises of large, heavy stone artefacts. Tool types include uniface pebble tools, core tools, denticulate saws, scrapers, hammerstones, some bipolars and burins. The change from the *Capertian* to the *Bondaian* took place some time after 5,000 years BP, and is largely characterised by a shift in raw material use (and the proportions of raw materials), in addition to a developing predominance of smaller implements.

The three phases, which are generally recognised within the Bondaian sequence are based upon first the introduction, and then the subsequent decline of backed implements and the use of the bipolar flaking technique. Other technological innovations evident during the

Bondaian include the introduction of ground edge implements around 4,000 years BP, and shell fishhooks during the last 1,000 years.

During the *Early Bondaian*, which is dated to between approximately 5,000 years BP and 2,800 years BP, the predominant raw materials for artefact manufacture appear to have been fine grained siliceous cherts and silcretes. Features of the *Capertian* appear to have continued in many sites, but backed and edge ground implements were also introduced.

The *Middle Bondaian* which dates between approximately 2,800 years BP and 1,600 years BP, displays a greater percentage of *bondi points* (which are backed and pointed artefacts generally characteristic of *Bondaian* assemblages) to bipolar pieces. The proportion of quart artefacts (a raw material which is frequently 'reduced' by employing bipolar techniques) appears to increase within assemblages of this time frame. Some sites have also produced edge ground implements.

Artefacts of quartz dominate the Late Bondaian, which dates from approximately 1,600 years to the present, although other raw materials are present. *Bondi points* are absent. *Eloueras* and bipolar pieces are predominant within assemblages of this period. Edge ground implements are also more common. Bone and shell implements occur in some sites.

3.2 Contact

At contact, European observations of Aboriginal life around the Sydney region suggest that toolkits were fashioned largely of organic materials, such as wood, bark, palm leaves, shell and bone. The use of stone does not figure prominently in many of the early European descriptions, and is more likely to reflect the focus and bias of these early observers, rather than being a reflection of the material culture of Aboriginal people.

Population estimations at the time of contact are notoriously problematic, as Aboriginal groups avoided the early settlers. Early population estimates range wildly depending on a number of factors and it is important to note that the Indigenous populations were decimated by European disease such as influenza and small pox. Kohen estimates that an accurate population of the Sydney region, including the Hawkesbury River and lower Blue Mountains was probably between 4,000 and 8,000 individuals, whilst the western Cumberland Plain (area 600km) supported 5 – 8 clans each with approximately 50 people.

Today, the Gandangara Local Aboriginal Land Council is the statutory body that represents the Aboriginal people of the Hoxton Park area, and acts as custodian of Aboriginal archaeological and cultural sites in this locality. Darug Tribal Aboriginal Corporation are registered Native Title claimants in the area and as such are also Indigenous stakeholders requiring consultation.

3.3 Archaeological Context

3.3.1 Aboriginal Heritage Information Management System Search Results

A search of the NSW NPWS Aboriginal Heritage Information Management System (AHIMS) was conducted on 10/03/03, searching between 6264000n, 6246000n, 300000e and 305000e. The results identified 35 sites within the bounds of the search (search results identified 37 sites in the search area, however 2 of these sites were duplicated entries). These sites include 1 scarred tree, 9 isolated finds, 21 open camp sites and 1 shelter with art. A number of these sites are located in the vicinity of Hoxton Park Road, especially between Cowpasture Road and Wilson Road (refer to Figure 2.1). One registered site was identified within the direct impact area associated with the proposal. Site 45-5-2320 is an open campsite, consisting of three artefacts: a yellow silcrete broken flake, a red silcrete broken backed blade and a pink silcrete broken flake. These artefacts were found in along Hoxton Park Road, in front of the newly completed Catholic High School.

Number	Site ID	Site Type	Landform Units
1 (23)	**45-2-2298**	**Open Camp site**	**Flat**
2 (22)	*45-2-2299*	*Isolated find*	*Flat*
3	45-2-2303	Shelter with art	Hillslope associated with creek gully.
4	45-5-0424	Open camp site	Ridge top
5	45-5-0425	Open camp site	Originally floodplain, now a dam embankment.
6	45-5-0426	Open camp site	Floodplain.
7	45-5-0769	Open camp site	Creek bank
8	45-5-0770	Open camp site	Creek flats
9	45-5-0771	Open camp site	Creek flats
10	45-5-0774	Open camp site	Creek flats
11	45-5-0775	Open camp site	Creek terrace
12	45-5-0776	Scarred tree	Creek bank
13	45-5-0778	Open camp site	Low rise above paperbark swamp
14	45-5-0779	Open camp site	Low rise above swampy creek flat
15	45-5-0833	Open camp site	Floodplain
16	45-5-0844	Open camp site	Modified creek flat
17	45-5-0964	Open camp site	Hillslope and creek
18	45-5-0965	Open camp site	Hillslope and knoll
19	45-5-2303	Open camp site	Footslope
20	45-5-2304	Open camp site	Floodplain
21	45-5-2305	Open camp site	Hillslope
22 (2)	*45-5-2319*	*Isolated find*	*Flat*
23 (1)	**45-5-2320**	**Open camp site**	**Flat**
24	*45-5-2377*	*Open camp site*	*Creek bank*
25	45-5-2470	Isolated find	Creek flat
26	45-5-2471	Isolated find	Creek flat
27	45-5-2472	Isolated find	Creek flat
28	45-5-2473	Isolated find	Creek flat
29	45-5-2474	Isolated find	Hillslope
30	45-5-2475	Isolated find	Floodplain
31	45-5-2434	Isolated find	Carpark
32	45-5-2437	Open camp site	Road easement
33	45-5-2566	Isolated find	Creek flat
34	45-5-2588	Open camp site	Flood plain and creek bank
35	45-5-2609		Spur
36	45-5-2730		Hillslope
37	45-5-2749		Disturbed road verge

- Numbers in brackets refer to duplicate entries in the AHIMS Database
- Sites in bold are directly impacted by the proposal
- Sites in italics are along the boundary of the proposed impact area

Table 2.1 Summary of results of NSW NPWS AHIMS search.

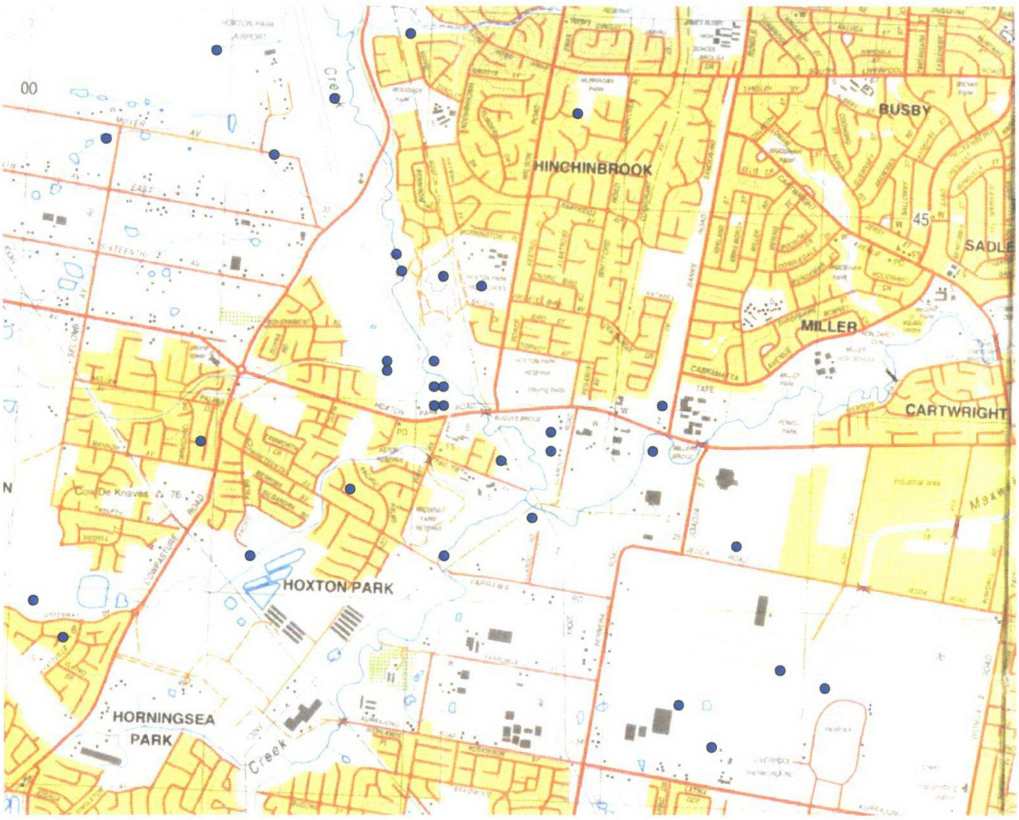

Figure 2.1 Map showing the location of Hoxton Park Road and the locations of Registered Indigenous Sites – Each blue dot represents an individual site (Basemap 1:100k Penrith Sheet 9030 LPI NSW)

3.3.2 Recent archaeological works in the immediate area

Several heritage investigations have been undertaken in the area immediately surrounding the study corridor. These works are summarised below and provide an insight into the types of projects carried out, the methods used to examine heritage and the results of these investigations

- Haglund, L. 1983. Archaeological Survey for Aboriginal Relics at Hoxton Park, NSW.

A survey of an area bordered on the west by Cowpasture Road, to the southwest by Hinchinbrook Creek, to the south by Hoxton Park Road, to the east by Banks Road, to the northeast by South Liverpool Road and to the northwest by Green Valley Road was undertaken in July by Conyers of Haglund and Associates for Wellings, Smith and Byrnes, Planning and Development Consultants. Surface visibility was described as poor, and the study area is described as disturbed, comprising a heavily grassed low lying flood plain.

The survey identified eight isolated finds (5 pieces of red silcrete, flakes or flaked, 1 flake of cream coloured chert, 1 flaked piece of fine-grained pink silcrete and an undefined "flaked piece") in an area described as "severely disturbed and/or actively eroding" (p. 10). Three open sites were also found: CP1 is defined by three artefacts found in a gully; CP2 is defined by 10 artefacts located on the top and side of a dam embankment in a highly disturbed context. The third site, WR1 is located on a low ridge top in the northern section of the survey area.

- Brayshaw and Associates. 1986. Preliminary Archaeological Reconnaissance of the Proposed Schofields regional Depot Plumpton, N S W.

Preliminary archaeological reconnaissance of the proposed regional waster disposal depot at Schofields was commissioned by the Metropolitan Waste Disposal Authority (MWDS) and undertaken by Josephine McDonald for Brayshaw and Associates in October 1985. It was commissioned in order to clarify the extent of the overlap between the area selected by NPWS for Conservation and the site proposed by the MWDA for development. The area comprised approximately 92 ha and is located between Thomson Road, Eastern Creek and the Plumpton Ridge.

Both surface survey and subsurface investigation was undertaken. Artefact scatters were found, together with stratified archaeological material. Surface visibility was defined as poor. Twelve sample areas (meaning artefact concentrations) and eight isolated finds (all comprising silcrete) were documented.

The details of these are as follows:

Sample Area 1 – located on an access track in the northernmost paddock, about 100 metres west of the large dam (p. 29). Average density of artefacts was 1.2/m², comprising predominantly red silcrete.

Sample Area 2 – located on the western boundary of the study area, crossing the access track and focussed on the northern side of the hill. Artefact density was 10/ m² and typically comprised silcrete.

Sample Area 3 – located west of the access track. Average artefact density was 30/ m², comprising predominantly silcrete.

Sample Area 4 – located in a gully on one of the major drainage channels. Artefact scatters were observed here, but importantly, *in situ* artefacts were also noted.

Sample Area 5 – located along a drainage channel had no surface scatters, but *in situ* artefacts were noted below the surface.

Sample Area 6 – located on the northern side of the gully, 120 metres west of the second tributary dam. Average artefact density was 25/ m², comprising predominantly red and yellow silcrete, several large cores and unmodified cobbles.

Sample Area 7 – located at the western end of the southernmost spur (??). Average artefact density was 1/ m², comprising predominantly silcrete, together with mudstone, chert and petrified wood.

Sample Area 8 – located on the easement for the Natural Gas pipeline and consequently highly disturbed. Average artefact density was 1/ m² comprising silcrete, with some quartz, mudstone, and volcanic and petrified wood. Two backed implements and several cores were also found.

Sample Area 9 – located at the edge of the knoll at the northernmost spur. Average artefact density was 1/3m² and comprising predominantly silcrete.

Sample Area 10 - located on the easement for the Natural Gas pipeline and consequently highly disturbed. Average artefact density was 4/ m² comprising predominantly silcrete, with rare quartz and fine grained silicious.

Sample Area 11 - located on the easement for the Natural Gas pipeline and consequently highly disturbed. Average artefact density was 2/ m² comprising predominantly silcrete, but with rare FGS, quartz and possibly tuff.

Sample Area 12 – located at the access track on the northern boundary. Artefact density was 1/7 m², comprising only silcrete.

- Smilth, L. 1989. Liverpool Release Areas: Archaeological Site Survey and Planning Study.

The survey was commissioned by the Liverpool City Council and was undertaken by Laurajane Smith and Alice Gorman in August 1989 over a five day period. The study area is bounded on the north by Elizabeth Drive, Cecil Park and by Cowpasture and Hoxton Park Roads, Hoxton Park. Campbelltown Road forms the southern border and Ash, Wonga and Box Roads in Casula form the western boundary. In the east it is limited by Second Avenue and Bringelly Road at West Hoxton (p. 5). Several different land usages were defined in this area, including housing and industrial areas.

Surface visibility was low, and only a minimal area was surveyed on foot, rendering tentative any conclusions (p. 28).

The area was divided into 20 survey areas. Surface visibility was said to be generally low throughout the study area (p. 40). 21 new sites were located and recorded during the survey, comprising 19 artefact scatters and two scarred trees (p. 29). Another 5 isolated artefacts were also documented. Artefact scatters and isolated finds were generally found in areas characterised by some disturbance, and with the highest site clustering along creek beds. The artefact scatters comprised predominantly debitage (p. 49) characterised by flaked pieces. Silcrete was the most common raw material although quartz, indurated mudstone and chert were also found. Quartzite and basalt were rare.

- Brayshaw McDonald Pty Ltd. 1991. Archaeological Survey of Proposed Church at Hoxton Park, NSW.

In 1991 a field survey was undertaken by Josephine McDonald in the area at the corner of Illaroo and Hoxton Park roads. The study area comprised a 2ha site on a low hillslope. The area had been cleared of original vegetation although in the north west corner there are some Eucalyptus spp. trees and immediately south of this there is some sapling regrowth. One open scatter was found adjacent to the western boundary of the study area and is known as Hoxton Park 2. Visibility in the scour area was estimated to be 90%, although in the surrounding area it is only 20%. 35 artefacts were recorded at an estimated density of 5 artefacts/m sq (p. 9).

- Navin Officer. 1991. Archaeological Survey of the Prestons Industrial Release Area, Liverpool, NSW.

The survey was conducted by Kerry Navin of Navin Officer Archaeological Resource Management and Paul Newman from the Gandangara Local Aboriginal Land Council over an area comprising 30 ha limited on the north by Hoxton Park Road and to the south by Jedda

Road, to the east by the western boundary defined in a previous survey undertaken by Smith in 1989 and the west by a flood line (p. 5).

One site, Prestons 1, was located during the survey. This site located in a large, cleared space in the southern part of the study area, and is defined by two artefacts (a pink/red mottled silcrete flake and a very fine grained yellow banded flaked chert). Surface visibility in this area was good.

- Brayshaw McDonald Pty Ltd. 1992. Archaeological Investigation of Project 12603 Cowpasture Road, Hoxton Park, NSW.

The survey was undertaken in March by Josephine MacDonald, Paul Tarasanko of the Department of Housing and Warren Carroll from the Gandangara Local Aboriginal Land Council for the Department of Housing, Liverpool. The study area is situated in an area of low hills, just over a kilometre north west of Cabramatta Creek. It is midway along a tributary approximately 2 kilometres upstream of the confluence with Cabramatta Creek. It has been modified and is "quite unlike that which would have existed prior to white contact" (p. 5).

The survey identified three surface sites (WH2, WH3 and WH4) previously identified by Smith (1989) and located on established tracks. Another pre-existing site, WH1 could not be re-located. A further artefact scatter site was identified in a previous report by Smith (1989) and confirmed during the present survey.

WH2 is identified by a scatter of 24 artefacts, predominantly silcrete debitage, and an artefact density of 4 artefacts/m². The area comprising WH2 has been completely cleared and replanted and is currently covered with thick grass. It is located on the lower side of a graded trotting track about 50m from the creek (p. 13). There is 80 – 100% visibility at the track, while off the track it was described as nil. Subsurface investigation revealed a further 16 artefacts from this area (p. 24).

WH3 comprises a relatively undisturbed area and is located around a knoll surrounded on three sides by the creek or drainage lines. It is identified by 6 artefacts, 5 silcrete and 1 indurated mudstone, in an area of 90 - 100% visibility at the track, compared with nil visibility off the track. The average artefact density was 1 artefact/m². Subsurface investigation revealed a further 61 artefacts from this area (p. 24)

WH4 is located 80 upslope of the site WH1 identified by Smith in 1989. 6 artefacts were found out of context in a disturbed area at an average density of 1 artefact/m² along a graded track running from Cowpasture Road to across the creek, "near the corner post for Woodlands" (p. 16).

- Australian Museum Business Services. 1995. Archaeological Survey of Proposed Catholic High School, Hoxton Park.

In 1995 a field survey commissioned by Denton Corker Marshall Pty Ltd (architects) was undertaken by Neville Baker of Australian Museum Business Services (AMBS) and Jamie Thomas from the Gandangarra Local Aboriginal Land Council to find Aboriginal sites in the area between Hinchinbrook Creek and Hoxton Park Road. The land comprises 6.4 ha of flat to gently sloping, predominantly cleared, grass paddocks. Three of these paddocks form the focus of the report. Visibility of the topsoil surface was estimated at 0 – 5%.

The report defined two areas in which stone artefacts were found, HPC1 and HPC2, and noted the potential for further material to be found. HPC1, an open camp site, is located in an area currently destined to become a walkway within the school. One red silcrete flake (with no diagnostic attributes) was found here, "23 metres from the middle of the creek and 8m from the barbed wire fence" (p. 10).

HPC2 is defined by the presence of three silcrete artefacts spread over 10m, including one diagnostic piece. HPC2 is in the area "to be passed over to Liverpool City Council as road reserve for the widening of Hoxton Park Road", that is, within the study area covered by the current report. The AMBS report suggests that the surrounding area is "considered highly likely to contain artefacts within the topsoil" (p. 11).

- Australian Museum Business Services. 1996. Archaeological Test Excavation of Site HPC1, Proposed Catholic High School, Hoxton Park.

Test excavations commissioned by Denton Corker Marshall Pty Ltd (architects) were undertaken by Neville Baker, Stephanie Garling and Dominic Steele in December 1995 and February 1996 with Jamie Thomas and John Clegg from the Gandangara Local Aboriginal Land Council at the site of HPC1 identified in the 1995 AMBS report. The excavations were designed to "clarify the extent and character of probably subsurface archaeological deposit" (p. 1) at the site. HPC1 is located between Hoxton Park Road and a minor channel beside the Hinchinbrook Creek. It is a cleared grass paddock but would originally have been open eucalypt woodland (p. 2).

Aboriginal stone artefacts were found at an average density of 7/m². Many European artefacts were also found, including a significant amount of glass and ceramics.

- Helen Brayshaw Heritage Consultants, 1999, Western Sydney Orbital EIS, Prestons to Cecil Park – Aboriginal Archaeology.

The field inspection of the Western Sydney Orbital route identified several Indigenous sites, including nineteen open campsites, eleven isolated finds and six PADs within the Prestons to Cecil Park section of the route. Brayshaw and White surveyed part of the current study area (equivalent to survey unit 9 in this project) as part of the Western Sydney Orbital project, and identified no Indigenous sites within the overlapping area. Two sites identified by Brayshaw and White are close to the current study area. PAD2 (NPWS # 45-5-2588), located on the eastern side on Hinchinbrook Creek, 200m north of Hoxton Park Road, was identified as an area of potential as it was near a creek junction, did not appear overly disturbed and was geographically likely to have been used as an Aboriginal camp site. IF3 (NPWS # 45-5-2471),was a silcrete artefact with retouch/usewear located in a highly disturbed area 50m west of Illaroo Rd and 100m northeast of Hinchinbrook Creek.

- Central West Archaeological and Heritage Services Pty Ltd. 2002a. Western Sydney Orbital Motorway: An Aboriginal Archaeological Investigation, Illaroo Road Detention Basin Site # 22, Hoxton Park: A Supplementary Report.

The field survey of the proposed detention basin sites was undertaken by Jim Kelton of Central West Archaeological and Heritage Services Pty Ltd and Nigel Robinson, the RTA Aboriginal Liaison Officer in October 2002. This report focuses on detention basin site 22. Lance Syme from the Gandangarra local Aboriginal Land Council attended a subsequent on-site inspection in November 2002. The survey was conducted over an area bounded by the Hinchinbrook Creek and the Cabramatta Creek floodplain near the junction of the two creeks. The land is defined as an alluvial floodplain which the report describes as "highly disturbed" (p. 2). The surface is heavily grassed, and surface visibility was put at low (p. 14). No Aboriginal relics or objects were found during the survey, despite the presence of a previously recorded site (NPSW # 45-5-2471).

- Central West Archaeological and Heritage Services Pty Ltd. 2002b. Western Sydney Orbital Motorway: An Aboriginal Archaeological Investigation, Ash Road Detention Basin Site 18, Prestons: A Supplementary Report.

The field survey of the proposed detention basin sites was undertaken by Jim Kelton of Central West Archaeological and Heritage Services Pty Ltd and Nigel Robinson, the RTA Aboriginal Liaison Officer in October 2002. This report focuses on detention basin site 18. Lance Syme from the Gandangara Local Aboriginal Land Council attended a subsequent on-site inspection in November 2002. The survey was conducted over an area comprising 21.5 ha, defined by "Maxwells Creek and the orbital to the east, Ash Road to the west, a small housing subdivision and Camden Valley Way in the south and privately owned market garden land to the north" (p. 1). The land is defined as an alluvial floodplain which has been highly disturbed. The area is heavily grassed and surface visibility was put at low. No new PAD's were defined, and no Aboriginal relics or objects were found due to poor exposure. Two open campsites had been previously identified (NPWS site # 45-5-2482 and site # 45-5-2376) however, these were unable to be re-located at the time of this survey.

3.4 National Native Title Tribunal

A native title search request was lodged with the National Native Title Tribunal (02/04/03) in order to identify stakeholders pertinent to the consultation process. Native Title claimants are considered Aboriginal stakeholders within the area and should be consulted as part of the project The results of search 618/03DW – 99711 are summarised below.

A search of the Liverpool Local Government Area was requested. The results of the search indicate that Native Title claims have been registered in the Liverpool LGA by Gundungurra Tribal Council Aboriginal Corporation (NC97/7), **and** by Daraug Tribal Aboriginal Corporation (NC/97/8). Gundungurra Tribal Council Aboriginal Corporation is an unregistered claimant group whose claim extends west of the Liverpool LGA boundary, and as such are not an Indigenous stakeholder group requiring consultation. Daraug Tribal Aboriginal Corporation is a registered claimant group and as such is a recognised Indigenous stakeholder in the study area. Although no lands affected by claim NC97/8 lie within the study area, NPWS and RTA policies require consultation with registered Native Title claimant groups.

3.5 Summary of Common Site Types in the Region

On the basis of archaeological sites registered in the region and the results of past archaeological studies, a number of site types may occur in the study area. These include:

- Isolated Finds

These sites consist of a single artefact which has been exposed. Isolated finds may be the result of either opportunistic resource use or discard.

- Campsites

Also described as Open Campsites or Open Artefact Scatters, these deposits include archaeological remains such as stone artefacts and sometimes hearths. Such sites are usually identified as surface scatters of artefacts in areas where ground surface visibility is increased due to lack of vegetation. Erosion, agricultural events (such as ploughing) and access ways may also expose surface campsites.

- Scarred Trees

Scarred trees are the result of the removal of a section of bark for the production of shields, water containers, canoes or shelter roofing. Scars may also be in the form of toe holds, which were used by Aboriginal people foraging for native honey and possums.

- Shelter with art

Rock shelters form a potentially important archaeological deposit. Artworks are sometimes found drawn, painted or stencilled on the walls of rock shelters and rock outcrops in white, red, yellow or back ochre. The images found at these sites may include humans and animals, animal tracks, tools, hand motifs, grid and other patterns.

3.6 Past Land Use Practices

Information concerning past land use practices has been based on general historical information. Extensive vegetation clearance has occurred, with the study area having been cleared of most large trees and understorey/scrub. This clearance may have resulted in the loss of many of the scarred trees in the area. Vegetation clearance will have resulted in subsurface disturbance, especially in regards to the removal of stumps. Once cleared, the area was used as rural holdings. Rural land also results in subsurface disturbance, although not to the same extent as de-stumping. Regular ploughing will churn the top layers of soil to the depth of the ploughshare and this is a factor which needs to be considered in a determination of possible site integrity. Although the area is still semi-rural, it is undergoing a transition to residential as the western suburbs of Sydney expand. The study area passes through a residential precinct and it should be noted that residential development impacts upon archaeological features. This occurs as either the disturbance of subsurface remains during the excavation of foundations, or as the obscuring of surface remains through the placement of fill. Detailed information regarding the level of disturbance of individual lots through which the corridor passes was beyond the scope of the brief; consequently for the purposes of this study general observations have been made regarding the level of site disturbance along different sections of the route. In general, these are that remnant stands of bushland may be the least disturbed, that rural lands have the potential to range from moderate to extensive levels of subsurface disturbance and that residential areas may be considered highly disturbed. These generalisations may be refined or modified through field observation.

3.7 Predictive Statement

The flora and fauna of the region would have supported a rich and diverse resource base. Tench (1793) noted that the inland Aborigines, such as the Cumberland Plain tribes 'depend but little on fish, as the river yields only mullets,...their principal support is derived from small animals which they kill, and some roots (of a species of wild yam chiefly) which they dig out of the earth' (1996:193). Kohen reiterates that the Aboriginal tribes along the Hawkesbury and Nepean Rivers had a diet consisting largely of roots and tubers (1985:9, 1992:3, 1993:25). In the open woodlands these were derived from the edible tubers of orchids and lilies.

Vegetation provided food, utilitarian items, decorative items and medicines with many species providing more than one resource. Within the region, resources provided by particular species are known. Parramatta wattle provided fishgigs, gum, edible grubs and wood for woomeras (Dixson, 1999:5). Grasses provided a variety of resources, with dianella having edible roots and fruits, whilst the grass stalks were used for baskets. Many-flowered mat rush (*Lomandra sp*) was woven into dilly bags, and the flowers and leaf bases were edible (Dixson, 1999:5; Kohen and Downing 1992:7). Glycine had an edible root. Flowering plants such as the waratah, and Banksia, Grevillia and Melaleuca species provided nectar for birds and insects, as well as people. The flowers were either sucked directly or placed in water to make a sweet drink (Kohen 1993:24). For a comprehensive list of edible fruits found in the Sydney basin reference should be made to Kohen and Downing (1992).

The medicinal uses of plants by Aboriginal people of the Cumberland Plain is not well documented. Particular uses have been hazarded through extrapolation as plants with medicinal uses which are used in parts of south-eastern Australia are also found on the Cumberland Plain. Of the plants identified by Kohen and Downing as being used for medicinal purposes (1992:7), only jersey cudweed is located within the vegetation communities found within the study area. Another important use of plants was in the transport of embers, Kohen and Downing noting that Leptospermum species were used for this purpose (1992:7).

In general, large trees were available for bark and fibres which were used for tools and containers, whilst resinous saps would have been used in the hafting process. Grasses would have been twisted into twine which would then be woven into baskets, containers or traps whilst many also had edible leaf bases. The variety of wooden tools used by Aboriginals of the Cumberland Plain was extensive. These included 'hunting, fishing, and fighting spears, throwing sticks and non-returning boomerangs, clubs, shields, and spearthrowers. The women used digging sticks, wooden and bark containers and nets made of the inner bark of the kurrajong tree' (Kohen, 1985:11). Eucalypt wood was used for the production of shields, coolamons, whilst the bark of some species could be twisted into fishing lines (Dixson, 1999:5; Kohen and Downing, 1992:7).

Vegetation communities supported extensive faunal resources. These included kangaroo, possums, snakes, lizards, insects and birds (including eggs), all of which would have been used as sources of food. In addition to providing food, these animals would also have provided skins and furs for clothing, sinews for hafting tools, twisted fur fibres as twines for traps and in the hafting process and feathers as decorative items. Resources gathered within the area may have been traded with neighbouring tribes for items not readily available.

The numerous small creeks which dissect the plain would have been primarily used as water sources. Creeks were also home to eels which were captured in traps made of hollow wood, and to numerous small amphibians. Although amphibians may not have been used as food, predators which fed upon them (such as snakes), would have been.

Insects were used as a food source, with edible grubs being found in the bark of the paperbark tree as well as Parramatta wattle. Bees provided honey and also beeswax which was used as an adhesive. Resin and 'wax was used to attach the handle to the hatchet head and to hold in place the barbs on fishing and hunting spears' (Kohen, 1993:26).

The geology of the region supports few outcrops of lithic material suitable for working into stone tools. The nearest lithic outcrops with material suitable for working into tools are the silcrete outcrops adjacent to South and Eastern Creeks and the gravel beds of the Nepean River (Kohen 1985:8). These gravel beds also provided basalt pebbles which were ground down into hatchet heads. Stone tools used within the study area were probably made from stone sourced in adjacent areas and include raw materials such as silcrete (red, yellow, grey and pink), quartzite, indurated mudstone (yellow, red and grey) and chert (red and grey).

Based on site types, frequencies and distribution across the landscape, open campsites and isolated artefacts are the predominant site type within the general vicinity of the study area. These tend to be located on gently sloping land situated within an easy distance of water. Sites may contain few or many artefacts and, depending on the extent of subsurface disturbance, potential archaeological deposits.

Scarred trees are likely to be identified in areas where there has been minimal impact on native vegetation. The sustained and comprehensive clearing of vegetation within the study area reduces the likelihood of scarred trees remaining, however, one scarred tree has been identified within the vicinity of the study area. Consequently, there is potential for scarred trees to be present within any stand of mature trees in the study area.

The landform component of previous studies indicates that areas adjacent to swamps and/or fresh water are more likely to have been used by Indigenous groups. In addition, flat or undulating topography was utilised more often than steep slopes. This includes both creek banks and flats as well as the crests of small rises and spurs. Previous studies also indicate that access to resources such as water and food were important factors in the selection of sites characterised by larger deposits. Within the study area creek lines would have provided water and a suitable environment for yams and tubers. As demonstrated above, the woodlands of the Cumberland Plain supported an extensive resource base, and within the scale of the study area do not allow for specific prediction or exclusion of site occurrence.

Given the resource base within the region, there is potential for isolated finds to occur anywhere within the study area, not withstanding more recent disturbance events. The potential for intact surface and subsurface Indigenous cultural remains is predicted to be higher in undisturbed areas possessing gentle topography with easy access to fresh water.

4.0 HISTORIC BACKGROUND

4.1 Early settlement of the Cumberland Plain

The geology of the Cumberland Plain was one of the prime factors in its early settlement. The poor sandstone soils of the Sydney Cove area were unsuited for farming, and resulted in early surveys to identify better agricultural land. The heavy clay and loam soils of the Cumberland Plain, derived from the Wianamatta Shale formations, in association with the rich alluvial soils along the Nepean River at Camden, on the Nepean–Hawkesbury between Penrith and Windsor, on the Georges River at Liverpool and along South Creek resulted in early agricultural settlement of the area. The earliest major road in the Colony was between the settlements at Sydney Cove and Parramatta, although this road remained quite small until the crossing of the Blue Mountains in 1813. From Parramatta smaller roads led into surrounding areas, such as Windsor, Richmond and Castlereagh.

Under Governor Phillip farms were granted at Parramatta, Prospect Hill, Kissing Point and the Field of Mars, although these tended to be smaller holdings of 25-30 acres. Extra allowances were made (each man receiving 30 acres and an extra 20 for a wife and 10 for each child) and most families took advantage of these to secure larger, more viable, holdings (Karskens, 1991:22). By 1794 farms were established at Toongabbie and on the alluvial soils of the Hawkesbury and a track linking these holdings to Parramatta and Sydney was in place. In the following years the settlement patterns reflect the value of alluvial soil as an agricultural base, areas around the Hawkesbury and Georges Rivers being settled first, along with the basalt derived soils of the Prospect Hill area where 1,920 acres had been alienated (Karskens, 1991:26). Many of the smaller holdings on poorer soils were abandoned as continual cultivation resulted in the loss of fertility and productivity. The farms based on the alluvial soils of the Hawkesbury-Nepean were the major source of grain in the colony, with Governor King noting in 1801 that these farms were producing 25, and in some cases up to 35, bushels of wheat per acre, whilst other areas in the colony only produced between 12 and 14 bushels per acre (cited in Perry, 1963:23).

Settlement continued in the area with land grants issued at Castlereagh, many of these given to retired officers of the NSW corps. These grants were larger than those before them, possibly reflecting the recipients status as soldiers and their familial dependants. These grants appear to have been surveyed prior to settlement as they have a strong axial orientation. Previously, in this area occupation was characterised by the settlement of a farm and then a survey and grant formalising the existing arrangement (Morris and Britton, 2000:12). The axial patterning of the granted lands surveyed before occupation is still a dominant feature of the landscape around Castlereagh.

In the boarder Cumberland district, large tracts of land were also reserved by the government. Governor King set these areas aside in 1804, as the potential of the land had not been fully assessed. These areas were set aside as commons and ranged in size from 5,000 to 10,000 acres. Government reserved commons were located at Field of Mars, Nelson (Pitt Town Common), the Castlereagh district (as distinct from Castlereagh town), Wilberforce, Greenhills, Richmond [Ham Common which is now RAAF Richmond] and Prospect (Karskens, 1991:28). The commons were set aside in addition to areas reserved by the Government for its own use as stock land. Such land was reserved at Rooty Hill, Blacktown and Castle Hill, with a large Government Orphan School Farm being granted south of Prospect Hill in 1803. Many of these lands were not established as farms, although Government farms were established on land at Toongabbie, Castle Hill and Emu Plains these were not permanent ventures and were eventually phased out (Morris and Britton, 2000:12). In the south-western section of the Cumberland Plain, was the Cowpastures. In 1788, four cows and two bulls had escaped, and when discovered seven years later, numbered 61, prompting Governor Hunter to name the area (Mountford, 1999:12). This land was subsequently reserved for the wild cattle of the colony with no settlement allowed in or near the Cowpastures nor on the western bank of the Nepean River. By 1811 there were estimated at between 4,000-5,000 head of cattle in the Cowpastures.

Larger grants to individuals were also occurring at this time, although some, such as those to Lawson at Prospect, had been made earlier. Governor King granted 3,300 acres in the

Fairfield area to Major George Johnston and Captain Abbot in 1806. Abbot's portion was known as Abbotsbury, and Johnston's grant, which remained relatively unimproved until it passed to his daughter, was developed as Horsley. These grants, in association with grants to Thomas Wylde (Cecil Park) and Barron Field (Hinchinbrook), formed a vast tract of large holdings along the Cowpasture Rd to present Hoxton Park. Other large grants included an 1805 order by Lord Camden that 5,000 acres near Mt Taurus be granted to John Macarthur. This grant was later increased by another 5,000 acres as the land was thought to be particularly suited to sheep. Although large, Macarthur's grant was in two portions, separated by a 2,000 acre grant to Walter Davidson. When Davidson returned to England in 1809, this land effectively became Macarthur's.

> *Macarthur's land grant coup came at a time when George Caley, Sir Joseph Bank's botanist, had undertaken two journeys into The Cowpastures area and cautioned that the land of the Cumberland Plain and its Immediate environs were not as fit for cultivation and grazing as it appeared and [that] care should be taken with allocating the remaining land. His advice came when the south west was viewed with increasing interest due to flooding on the upper Hawkesbury and depleted soils giving lower crop yields.*
>
> *Morris and Britton, 2000:13*

4.1.1 Expansion into the Cumberland Plain

In 1809, two floods destroyed the grain crops of the colony leading to chronic shortages. Lieutenant-Governor Patterson saw no alternative, and began the settlement of the forest lands of the Cumberland Plain. The first grants under Paterson were issued in the districts of Minto, Bringelly, Evan and Cook, and in Airds and Appin to the south. In 1809 Paterson also issued the first grants in the Campbelltown area, including grants of 500 acres to Richard Atkins (Denham Court) and 110 acres to James Meehan (Macquarie Fields). Paterson's grants were all recalled and re-issued by Macquarie (Perry, 1963:24). Macquarie filled those areas not already granted, starting in 1811 with a grant of 400 acres to Rowland Hassall which was known as Macquarie Grove. 'Another thirteen small grants were given out around Elderslie, between 1811 an 1815. A decade later only two of the original owners remained, Henrietta Fletcher and Thomas Galvin on their grants of 40 acres' (Mountford 1999:12).

In general, the grants issued on the Wianamatta shale soils away from the creeks remained uncultivated, although on the larger holdings, such as Kirkham (owned by John Oxley) and Glenfield (owned by Charles Throsby) substantial areas were under cultivation. In part this was helped by the fact that the larger holding carried enough stock to manure the cultivation paddocks (Jeans, 1972:90).

Governor Macquarie thought highly of the Minto district, noting that Mr Thompson's farm, St Andrews, and Dr Townson's farm, Varroville, were 'by far the finest soil and best pasturage I have yet seen in the Colony' (Macquarie, 1956:16). Macquarie also noted that the area between the Georges River and Bunbury Curran Creek was suited to the establishment of smaller farm holdings as the land was fine and rich. Topographical features of the land influenced grant sizes with smaller grants tending to cluster on the rich alluvial soils along creeks and rivers, whilst larger grants were on the Wianamatta shale soils. The underlying geology, original grant size and the establishment of roads were all factors in the later consolidation and subdivision which occurred later in the century (Morris and Britton, 2000:14).

Although many small grants were issued in the area, only those which were on the richest and most fertile lands were viable as small holdings and many were consolidated into larger holdings. At the other end of the spectrum, many of the large grants were made even bigger by the amalgamation of large grants within the family. It was in this way that some families began to dominate particular areas, such as the Cox family in the Mulgoa area. In 1812, Macquarie had prevented the spread of settlement west of the Nepean River at Camden beyond the holdings of Macarthur. This area became a government reserve for the raising of stock and included a convict settlement.

4.1.2 Changing Use Patterns

The early decades of the 19^{th} century were characterised by appalling agricultural conditions. In 1806 a massive flood devastated the region, causing extensive stock and crop losses.

Between 1813-15 the region was under drought conditions, and these had only been broken for a year when a series of floods in 1816-17 again hit the region. These were followed by further floods in 1820, after which many farmers left the area. The crossing of the Blue Mountains in 1813 and subsequent settlement at Bathurst opened up a new agricultural basin in the Colony, and by 1820, younger colonists were heading south to the Goulburn and Braidwood districts and west to Mudgee.

Cultivation of the Cumberland Plain still continued, however many of the landowners with large holdings on the plain held larger and more productive properties to the west. Many of the large farms on the Cumberland Plain became stock or holding stations for produce from the Bathurst, Goulburn and Braidwood districts, with the result that in places the land clearance of the Cumberland Plain remained incomplete. 'Molle's Main, named for the original grantee George Molle, is representative of the trend where the grantees pushed westward taking up more land and either selling or leasing out their grants in the Cumberland Plain or using them as holding places before their stock was sent to the Sydney markets. Granted to Molle in 1816, by 1820 it was occupied by William Howe who was preparing to build is house at "Glenlee"' (Morris and Britton, 2000:15).

Amalgamation of the Cumberland Plain grants resulted and farming continued. Wheat still remained the prime agricultural product of the area and influenced the development of secondary processing ports in the urban areas. An 1827 map of the township of Liverpool shows a windmill on Crown Land and although no longer marked on 1830s maps, other mills had replaced it. Horse mills were operating in the area at this time and a steam powered mill was operating at Collingwood in 1841 (Kass, 1992:3.18).

By this time the larger farms of the Cumberland Plain were becoming well established, with Raby, on the Cowpasture Road, described by Dr John Lhotsky in 1834 as 'one of the most famous farms in the colony' (cited in Andrews: 1979:24). Other large estates included Glenfield, Macquarie Fields, Campbellfield and Varroville (ML Map County Cumberland, Parish Minto), all of which had absentee owners from the late 1820s. Expenditure on upkeep of the leased properties or properties held in trust for juveniles was minimal. As a result, rates of land clearance slowed and this was further enhanced by the large tracts of unimproved government land.

The economic depression of the 1840s would have seen a decline in the profitability of farming and a loss of appeal in the area; although this may have been alleviated by the completion of the rail ink in the 1850s, as it offered a more efficient and comfortable service for goods and passengers.

Waves of settlement took place, and as the interior of NSW was settled and farmed, Queensland became the new frontier. By the 1860s a second generation of families moved out of the County of Cumberland. These moves further entrenched the settlement and farming practices of the Cumberland Plain that were established in the first half of the 19th century. The establishment of town centres, the transition to larger landholdings as stock stops, changes in ownership and management patterns and the establishment of a road network determined the way the land was 'bounded, cultivated and traversed' (Morris and Britton, 2000:16).

4.1.3 Landscape Design Principles in the Early Estates

The large houses of the prominent land grants were designed to reflect their owners status within the colony. During the early settlement years, these houses tended to be small, but were usually extended or replaced, often with the profits of pastoral stations to the west. The principles of the 18th century English Landscape Schools were often employed in the siting of a house, although some properties, such as Bungarribee at Doonside, ascribed to the picturesque ideal. Regardless of which ideal a property eschewed, the larger houses were also designed to display the wealth and status of the occupants and convey the sense that the holding was a 'gentleman's seat'. The house may have been sited according to principles governing preferred views, but it was also built to be seen.

The areas surrounding the house were also important to display and convey the aesthetics of the occupants, with many properties boasting orchards. Fruiting varieties which dominated early orchards included the citrus varieties of orange, lemon, lime, loquat and cumquat, and apple, pear, fig, mulberry, peach, cherry, and quince. These orchards were popular on the smaller holdings as well as the large, with produce transported to the Sydney Markets for sale. In addition to the cultivation of citrus for fruit, lemon trees and occasionally orange, were trimmed and used as border hedges. Vineyards were also established on many of the properties including Regentville, Camden Park and Wimbourne. Grapevines appear to have gone through a phase of popularity during which it was *de rigeour* for each property of worth to claim a vineyard.

4.1.4 Later Development

As noted above, the early decades of the 19th century were characterised by appalling agricultural conditions. In 1806 a massive flood devastated the region, causing extensive stock and crop losses. Between 1813-15 the region was under drought conditions, and these had only been broken for a year when a series of floods in 1816-17 again hit the region. These were followed by further floods in 1820, after which many farmers left the area to try their luck in the Appin District to the south (Mountford, 1999:14). Amalgamation of the Cumberland Plain grants resulted and farming continued. Wheat still remained the prime agricultural product of the area and influenced the development of secondary processing ports in the urban areas. An 1827 map of the township of Liverpool shows a windmill on Crown Land and although no longer marked on 1830s maps, other mills had replaced it. Horse mills were operating in the area at this time and a steam powered mill was operating at Collingwood in 1841 (Kass, 1992:3.18). The economic depression of the 1840s would have seen a decline in the profitability of farming and a loss of appeal in the area; although this may have been alleviated by the completion of the rail ink in the 1850s, as it offered a more efficient and comfortable service for goods and passengers.

Orcharding, which began as a small scale enterprise in the 1830s, assumed more importance in following decades as the 1860s saw a reduction in the viability of grain farming on the Cumberland Plain. During the 1860s a series of floods were followed by an outbreak of stem rust in wheat, effectively destroying crops in the region. The increasing importance of the Hunter Valley as a source of agricultural products also reduced the value of produce from the Cumberland Plain. With the decline of wheat and the transition to larger holdings linked to pastoral runs further inland, the Cumberland Plain began a period of agricultural stagnation. Districts embraced new ventures and opportunities. Some farmers maintained wheat crops and harvested before the rust began to show. As a result the hay industry (that was to dominate the Penrith and Camden area) commenced (Jack and Jeans, 1996:24). Orcharding became more important with citrus varieties experiencing a boom phase in the 1860s. The 1880s and 1890s saw the high point of the Windsor area citrus industry, before it was replaced with produce from the large irrigation schemes of the Murray River (HLA 2001:9). After this date intensive orcharding gave way to mixed orcharding and grazing farms. Many farmers, disheartened by the continual loss of stock and crops, left to farm better, drier lands inland. This opened up the Cumberland Plain for the larger dairy farms which were to dominate the area in the following years. The dairy industry was particularly viable following the introduction of refrigeration in the 1880s, however dairying did not dominate the area until the 1920s. Poultry farms were also established in the areas during this time (HLA 2001:9).

The early division of the larger estates was often into smaller estates, although these were still large by today's standards. Harrington Park underwent a number of boundary changes which saw it consolidate a neighbouring property and divide and sell parts of the original estate. The Harrington Park estate to the north of Cobbitty road was sold off in two portions in 1829. One of these became Oran Park which was an impressive estate in it's own right, although much smaller than Harrington Park. In 1863, Harrington Park absorbed part of the neighbouring Orielton estate. A 1905 sale notice for the subdivision and auctioning of the Raby estate (originally 3,000 acres) notes that the homestead and farm areas ranged in size from 1,200 to 500 acres.

From the 1870s speculative subdivision occurred with many of the larger holdings subdivided and sold off as smaller farming allotments (Kass, 1992:3.18). Not all of these smaller lots were purchased, however, for those who wanted to buy land it was available as freehold. This pattern resulted in the transition from large estates with tenant farmers to smaller freehold farms. 'Crops cultivated on these allotments varied from those previously grown. Grains had largely disappeared. Dairying had taken over on many farms, often amalgamating a number into a single holding. Vine growing and orcharding occupied many small-holders' (Kass, 1992:3.19). Hoxton Park Estate was established in 1887 as part of a more localised trend towards small scale agricultural holdings, that in actuality were viewed as residential sites.

Service centres were established to provide the increased population with their immediate needs and these were often based around community facilities such as a post office, church or school. This pattern of subdivision and urban consolidation continues today, with the result that the rural character of the area is slowly being replaced as the Cumberland Plain becomes incorporated into the urban sprawl of greater Sydney.

The opening of the rail line in the 1850s also consolidated urban growth as it provided a direct service with Sydney. Although urban growth was initially slow, it is the current level of urban consolidation which is impacting on the remaining examples of early colonial agricultural landscapes.

4.2 History of Hoxton Park

Hoxton Park Road is located on the eastern side of the Cowpasture Road, in the parish of St Luke. The study corridor comprises the section of the road between Cowpasture Road and Banks Road. The earliest map which details the area is from 1843. In this map Hoxton Park Road is not marked (refer to Figure 4.1). An 1865 map is the earliest in which Hoxton Park Road appears to be marked, though not labelled. This suggests that the road was put in place and / or formalised some time between 1843 and 1865. There is little documentation on the road itself, and it can only be presumed that it was built as a communication route to Liverpool. In addition, the 1865 map shows the initial property boundaries of the area, however, Donald McLeod is the only landholder identified (refer to Figure 4.2). McLeod owned the Bernera Estate, located south of Hoxton Park Road.

An 1885 County Cumberland map identifies landholdings in greater detail, Donald McLeod is identified with the Bernera Estate, whilst land on the north of Hoxton Park Road, between Cowpasture Road and Banks Road was owned by William Reily and Peter Miller. It was also during this stage that land on the northern side of the Cabramatta River, on the western side of Cowpastures Road, began to be divided for the Hoxton Park Estate. The 1903 Parish Map shows similar land holding divisions and names Hoxton Park Road as Bernera Road, probably after the Bernera Estate of Donald McLeod (refer to Figure 4.4). The development of Hoxton Park should be seen in the context of a number of historic themes, including pastoral expansion, trade, communications and transport.

Educational facilities within the Hoxton Park area are thought to have been established as early as the 1840s, however, no records have survived detailing early educational facilities. The first school in the region to be documented was a Roman Catholic school, "Cabramatta", located on the site of the present Post Office and Scout Hall on the southern side of Hoxton Park Road west of First Avenue. Its earliest records date to 1873. This school closed in 1881 due to poor attendance, but in the following year seemed to have re-opened as a provisional school for the surrounding area. Similar attendance problems also plagued this school, despite the opening of a new saw mill and the building of the Housing Estate nearby. However, by 1891 pupil numbers stabilised and slowly increased, as did the school buildings and grounds to accommodate the children.

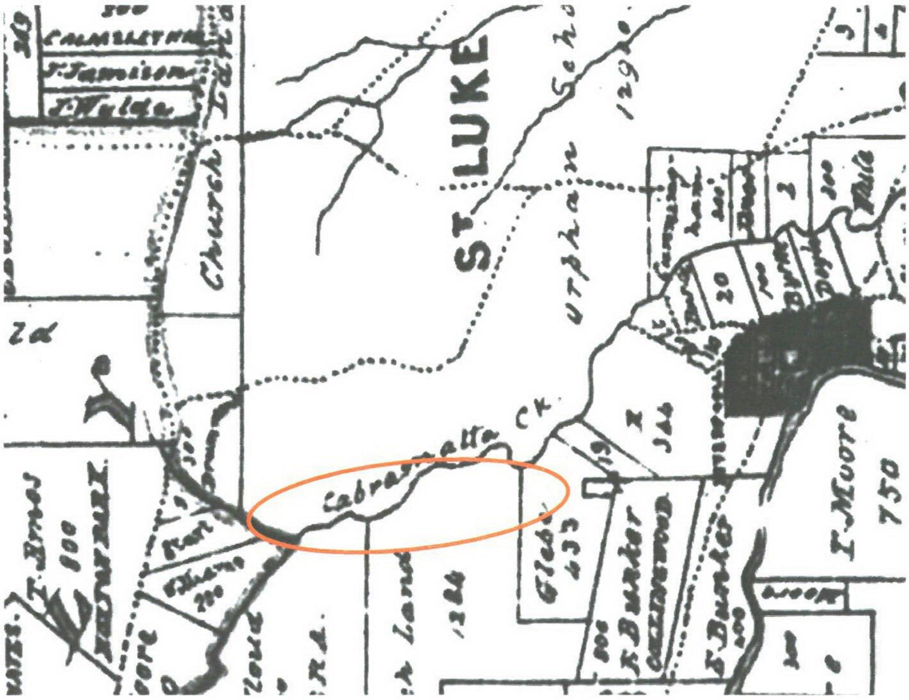

Figure 4.1 Detail of 1843 map of the County of Cumberland (source: ML ZM4 811.1 1843 1)

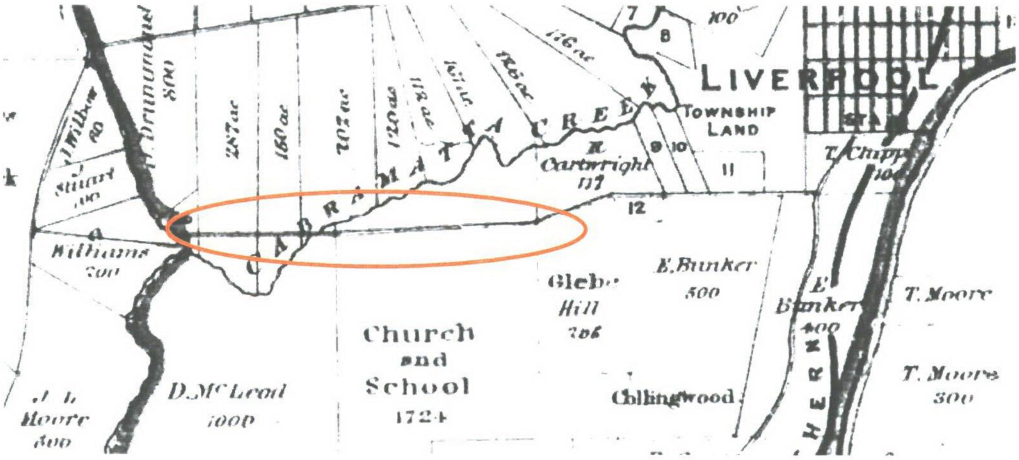

Figure 4.2 Detail of 1865 map of the County of Cumberland (source: 1865 ML ZM4 811.1 1865 1)

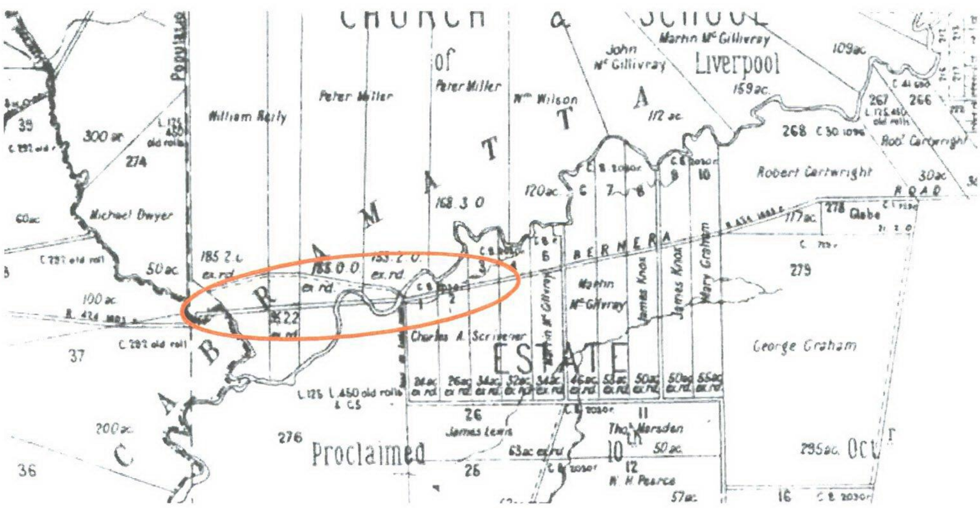

Figure 4.3 Detail of 1903 map of County Cumberland, Parish St Luke (source: ML Z1903)

Hoxton Park Road must have become one of the main feeder routes to Liverpool from the west and the Cowpastures districts by the 1860s. Early maps show that Bringelly Road, along the southern boundary of McLeod's property, was probably the primary road from this region, a status which it maintained throughout the 19th and 20th centuries. However, an 1865 map clearly shows Hoxton Park Road as an unnamed road, and a sizeable increase in land ownership on either side of the road from the preceding map. An 1885 map shows another huge development in the expansion of blocks and residents. NSW Public Works documentation shows that around 1900 it, together with a number of other roads in the area, was repaired at the expense of Council funds (Keating 1996:132). The repairs may also have been instituted as a result of a vocal campaign about the horrendous condition of roads in the area generally, as evidenced by Hutton in the NSW Legislative Assembly Parliamentary Papers (NSWLA PP 69). Nevertheless the importance of the road is manifest in upgrade funding it received during this period, underlying the impending move to urbanism in the districts surrounding Liverpool. In testimonies given in 1904 by local residents to the NSW Parliament for the building of the railway from Liverpool to Mulgoa, the Hoxton Park Road is not mentioned, and Bringelly Road appears as the main transport route from the Hoxton Park Estate (NSWLA PP: 69). Brown mentions a "lower road" which was used to transport goods, including farm goods and wood, however, it is unclear exactly which road he is referring to.

The 5000 acre Hoxton Park Estate was created in 1887 on the original land of Thomas Amos with small residential owners in mind, and was named after the London suburb, Hoxton. The Liverpool City Council website provides a different explanation for the name suggesting that the land of Thomas Amos may have originally borne this name. A stained glass window in St Luke's church reads "In memory of Heneage Finch Esq [d.1850] of HOXTON PARK in this Parish ...' (www.liverpool.nsw.gov.au/info/outersub/hxtnprk.htm).

Despite the grandiose marketing campaign run by Phillips and Co., the Estate ultimately failed to take off. Economic factors were partly responsible; the depression of the 1890s and early 20th century did not entice many to settle in an area with few communications. Three acre blocks originally sold for between £15 and £25, however, by 1904, lots were selling for approximately £7 (NSWLA PP: 15). Another contributing factor in the failure of the Estate was the lack of transport. William Hutton was the caretaker of Hoxton Park Estate in 1904. Some of his comments underline the problem of untenanted land holdings on the Estate (although the bias of his position of caretaker must be borne in mind), an issue which was characteristic of the Estate from its creation in 1887. He comments that although many of the lots on the Hoxton Park Estate had been sold, many remained empty because of the absence of reliable transport, specifically a railway (NSWLA PP: 11 & 14). Petitions dated to 1889 and 1890 reflect the need for the development of more infrastructure. Regarding the condition of the roads in the area, one reads that their condition was "so frightful...so bad, in fact, that at time we cannot go to Liverpool for our letters for a whole fortnight" (Keating 1996:106). A railway line extending from Liverpool to Mulgoa, and passing through Hoxton Park was first proposed in the 1880s, however, the line was never built because of the perceived lack of funding potential and local agitation by Liverpool heavyweights who saw their provincial power being undermined through connection to a larger trade network and the process of urbanisation (Keating 1996:112 & 127), although the real reason can probably be attributed to the Depression during the 1890s. The testimony of Hutton however, highlights the petty rivalries that were being played out on the local scene, and whose impact had far reaching implications.[1] Regarding the import of chaff from Sydney he claims "they would do so if there were ten times as much grown here, because the people of Liverpool will not buy from the people round about. I have offered my own for sale in Liverpool, and they will not accept it" (NSWLA PP: 15).

Although the Estate was created as a residential area, small farms were nevertheless established, and according to residents some farming did take place. The market for this produce was often local or regional, although William Hutton transported his produce as far as Queensland because he received better prices there (NSWLA PP: 14). However, he was an exception to the rule, and most of the residents either worked as splitters or fencers in other local areas, such as Granville, or commuted to Sydney. Catching the train from Liverpool to

[1] Hutton's testimony highlights the complicated relationship between the districts of Liverpool and Liverpool itself. See for example NSWLA PP: 14 – 15.

Sydney remained problematic, as Hoxton Park residents still needed to make their way to Liverpool station

> And for those, like the men of Hoxton Park who worked at Granville, who still had to traverse the appalling roads from Liverpool Station to home every morning and evening, the working day was even longer
>
> (Keating 1996:112)

By the 1880s it is conjectured that Liverpool had become a "suburb" of Sydney, despite retaining it's rural character. At Hoxton Park, despite the initially residential intentions of the planners, residents were occupied predominantly with small agricultural holdings or were commuting city workers, who often worked during the week in Sydney or Liverpool, returning home only on weekends (NSWLA PP: 71). Nevertheless the statements made by Hutton in his testimony make clear that the land was good agricultural land, suitable to dairy farming, orcharding and other crops, and that it was due to poor transport means that produce trade was so difficult, although it is equally clear that this was doubted by the Chairman. By the turn of the century, Liverpool had largely dropped out of state and national trade networks, and produce was more often locally sold, and also bought in from Sydney (eg. NSWLA PP: 15).

During the 1920s and 1930s Hoxton Park underwent great change, culminating in the development of the Hoxton Park Aerodrome during World War II, built as part of the coastal defence system. This period ultimately saw the loss of its rural character with widespread tree clearing in order to support the people living in Sydney, although it was still seen as "country" by some Liverpool residents in the 1940s and 1950s (Robyn Jessiman personal history http://www.wsg.net.au/wagga/earlyyears.htm). Today some of Hoxton Park is zoned as suburban, however, much of the area remains light industrial.

By the early 1950s it had become clear that Hoxton Park School would have to be enlarged to accommodate increasing pupil numbers. Between 1955 and 2002 a much larger Hoxton Park Public School was situated east of First Avenue, on a site neighbouring the original school site. The school history identifies that this land previously belonged to the Buggy family, who planted two Bunya Pines along their driveway to First Avenue. 7.6 acres of the Buggy's land was resumed by the Department of Education in 1955 for £1,300. The Bunya Pines were within the resumed portion and became an intrinsic symbol for the school, underlining personal achievement and growth. The initial school buildings comprised four weatherboard schoolrooms and were officially opened in 1958 by the Minister for Education, the Hon. H. S. Heffron. Enrolments increased, forcing the construction of further buildings, and by the end of the 1960's there were 181 pupils enrolled. The school closed in 2002[?] to make way for a new housing estate.

A search of historic maps does not identify any land belonging to the Buggy family on the southern side of Hoxton Park Road between Banks and Cowpastures Roads. Two early maps (1843 and 1865) show that this land was reserved as Church and School Land, whilst by 1888 the area appears to have been subdivided. Contradictorily, the 1903 parish map erroneously identifies the land as Church and School Land.

5.0 INDIGENOUS AND NON-INDIGENOUS ARCHAEOLOGICAL SURVEY RESULTS

5.1 Introduction

An Indigenous and historical archaeological survey of the Hoxton Park Road Upgrade corridor was carried out on 9th April 2003. Sam Moody and Fiona Kidd (Archaeologists, Austral Archaeology) conducted the field survey and were accompanied by Gil Saunders (representative of Gandangara Local Aboriginal Land Council). A second field survey was undertaken on 15th May 2003. Sam Moody and Fiona Kidd (Archaeologists, Austral Archaeology) were accompanied by Peter Gale (Darug Tribal Aboriginal Corporation). Weather conditions during the first survey were ideal, it being a sunny day with little cloud cover. The second survey was conducted in rainy conditions after an extended period of rainfall in the area.

The survey involved the ground surface inspection for the remains or evidence of both Aboriginal occupation (such as stone artefacts, burials, scarred trees and engravings), and historic remains. A ground surface inspection of the site was conducted on foot, with areas of erosion and/or high ground surface visibility especially targeted.

Photocopies of the RTA Concept plans and the Liverpool 1:25k Topographic Map were used as field maps; notes and photographs were taken in the field.

5.2 Survey Area Description

5.2.1 General Project Description

The study area is a road corridor along Hoxton Park Road between Cowpasture Road in the west and Banks Road in the east. Under the current proposal, Hoxton Park Road is to be widened by approximately four lanes of traffic. For most of the corridor, these works are proposed to be undertaken south of the existing Hoxton Park Road alignment. In one section, however, the proposed route traverses Hoxton Park Road and lies to the north, with the result that the widened road will be somewhat straighter than the current two lane road.

5.2.2 Ground Surface Visibility

Surface surveys for archaeological remains requires that transects (or areas designated for survey) are judged on surface visibility. Ground surface visibility (gsv) refers to the amount of ground surface which can be observed during the survey. Visibility can be influenced by natural processes such as erosion or the character of native vegetation (such as seasonal die back). Visibility can also be influenced by land use practices such as ploughing or grading. Visibility is expressed in terms of percentage of the ground surface that is visible to the observer on foot. An assessment of the surface visibility is useful in describing the general conditions of the area surveyed.

Obtrusiveness is used to describe to how conspicuous a site is within a particular landscape, and thus the chances of finding a particular site. For example, an artefact scatter is generally not obtrusive, especially in areas of high vegetation or scrub cover, yet a scar tree or chimney generally is obtrusive.

The following table provides a guide to the assessment of ground surface visibility based on a percentage rating. It is by no means an objective method of assessment, and it is open to the assessment and interpretation of the field observer. However, it can be regarded as simply a guide to describing the ground surface visibility in a standard format.

Ground Surface Visibility	Percentage Rating
Very Poor – heavy vegetation, scrub, foliage or debris cover, dense tree or scrub cover. Soil surface of the ground difficult to see.	0-9% ground surface visible
Poor – moderate level of vegetation, scrub, and/or tree cover. Some small patches of soil surface visible in the form of animal tracks, erosion, scalds, blowouts etc, in isolated patches. Soil surface visible in random patches	10-29% ground surface visible
Fair – moderate levels of vegetation, scrub and/or tree cover. Moderate sized patches of soil surface visible, possibly associated with animal /stock tracks, unsealed walking tracks, erosion, blowouts etc. Soil surface visible as moderate to small patches, across a larger section of the study area.	30-49% ground surface visible
Good – moderate to low level of vegetation, tree or scrub cover. Greater amount of areas of soil surface visible in the form of erosion, scalds, blowouts, recent ploughing, grading or clearing.	50-69% ground surface visible
Very Good – low levels of vegetation/scrub cover. Higher incidence of soil surface visible due to past or recent land-use practices such as ploughing, grading, mining etc.	70-89% ground surface visible
Excellent – very low to non-existent levels of vegetation/scrub cover. High incidence of soil surface visible due to past or recent land use practices, such as ploughing, grading, mining etc.	90-100% ground surface visible

Table 5.1 Ground Surface Visibility

5.2.3 Survey Unit Description

The study corridor can be divided into several discrete survey units based on landform type and vegetation cover. For the purposes of this survey, the study area has been divided into 12 survey units which are described below. It should be noted that only areas which were publicly accessible were surveyed, all private property remains unsurveyed.

Figure 3.1 illustrates the location of survey units 1 – 12.

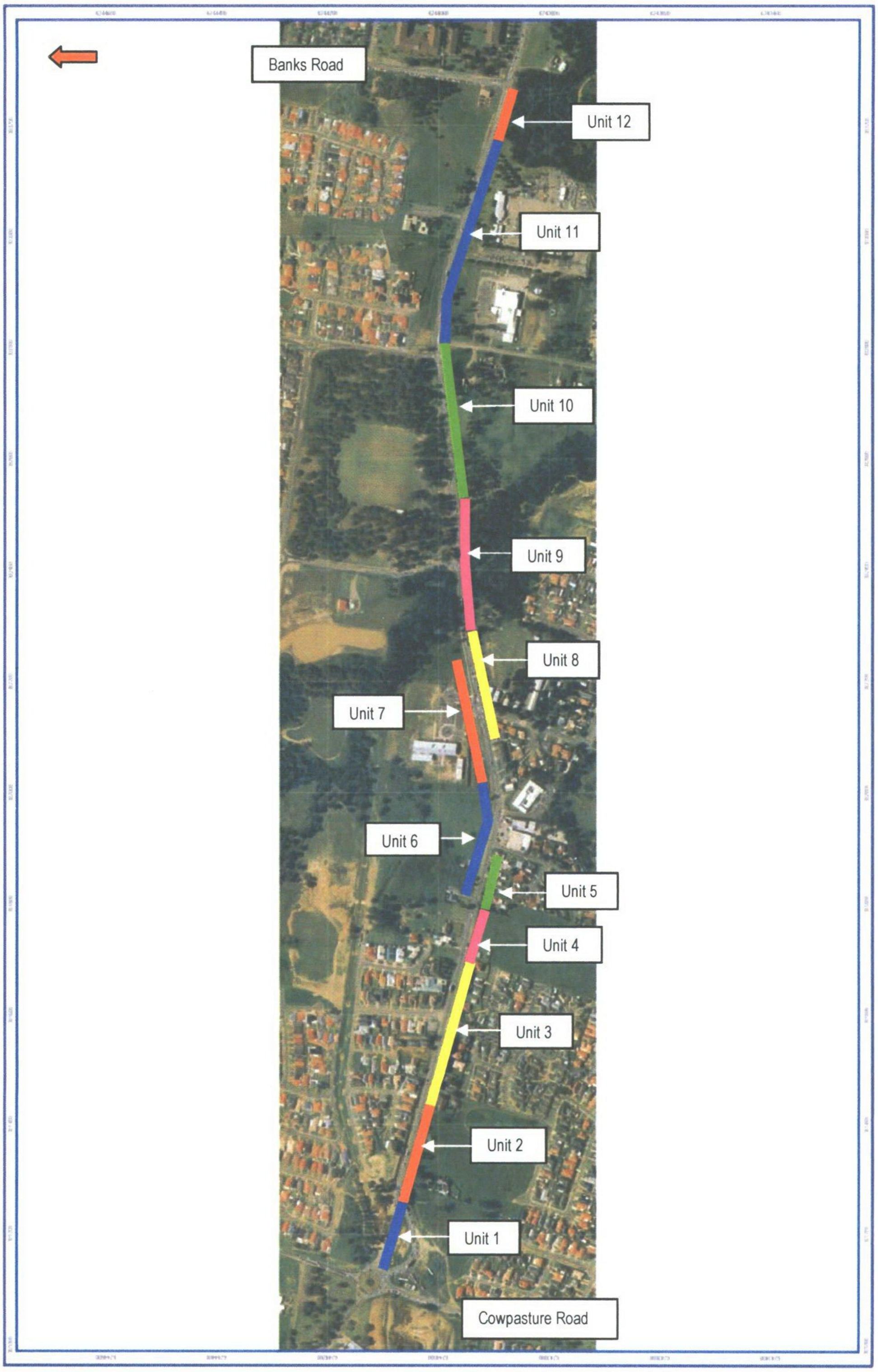

Figure 5.1 Survey Units within the study corridor

- Survey Unit 1 – Cowpasture Road commercial area

Survey unit 1 consists of a commercial / industrial area running from Cowpasture Rd in the west and extending for approximately 200m. The area is characterised by excellent gsv, however recent construction of a fast food franchise and obtrusive stockpiles in the vicinity of the corridor indicate that this unit is highly disturbed. The area appears to have been quite heavily filled, Gil Saunders (GLALC) indicating that much of the ground surface was excavated during construction and fill brought into the area. Peter Gale (DTAC) noted that the area used to be swamp and that extensive fill has been placed to raise the ground to it's current level. There is a small stand of Eucalypt *sp.* regrowth, however, there are no mature trees in this unit. No Indigenous or historic relics were identified in survey unit 1.

GSV	excellent – 95%
Disturbance	very high

Plate 5.1 Survey Unit 1

- Survey Unit 2 – Paddock with drainage line

The verge and public footpath area was surveyed to the boundary of the paddock, however the area south of the fence was not surveyed. The verge area was grassed, possessing poor ground surface visibility. There were two fencelines evident within the unit, one a wooden post and barbed wire fence, the other a more recent star picket and wire fence on the same alignment, indicating some level of historical continuity of landuse as a paddock. The area within the paddock contained knee high grass and appeared to have very poor gsv. The paddock appears to be moderately disturbed (attributable to European land clearance practices) and contains a stand of Eucalypt sp. regrowth and a drainage line. There is moderate potential for intact soil profiles below the depth of the ploughshare in survey unit 2. Historic archaeological remains within survey unit 2 are considered unlikely. No Indigenous or historic relics were identified in survey unit 2.

GSV	very poor - <5%
Disturbance	moderate

Plate 5.2 Survey Unit 2

- Survey Unit 3 – Residential yards

This survey unit consisted mainly of private residential properties. As in survey unit 2, the verge was surveyed and private property was not entered. In general the unit appears to be highly disturbed with poor gsv associated with landscaped lawns, however, particular attention was given to areas of high gsv associated with driveways. No Indigenous or historic relics were identified in survey unit 3.

GSV	poor – 20%
Disturbance	high

- Survey Unit 4 – Paddock west of 612 Hoxton Park Road

Similar to survey unit 2, the verge to the paddock fenceline was surveyed, whilst the paddock was not entered. The paddock is currently used for grazing and at the time of survey supported luxuriant pasture grasses. GSV within the paddock was estimated to be very poor. The only apparent disturbance within survey unit 4 is that associated with land clearance. It is thought that there is moderate potential for the survival of intact soil profiles below the depth of the ploughshare within survey unit 4, Gil Saunders (GLALC) noting that it is the sort of area where he would expect relics to occur (pers comm 9/4/03). There would appear to be little potential for the survival of historic archaeological remains associated with more recent use of the area. No Indigenous or historic relics were identified in survey unit 4.

GSV	very poor – <5%
Disturbance	moderate

Plate 5.3 Survey Unit 4

- Survey Unit 5 – Residential yards

This survey unit was similar to survey unit 3, being composed of private residential properties. As in survey unit 3, the verge was surveyed and private property was not entered. The unit appears to be highly disturbed with poor gsv associated with landscaped lawns. Areas of higher gsv associated with driveways were targeted. No Indigenous or historic relics were identified in survey unit 5.

GSV	poor – 20%
Disturbance	high

- Survey Unit 6 – Vacant land north of Hoxton Park Road

This survey unit consisted of vacant land (previously a market garden), a drainage line and an abandoned house, west of the newly built Good Samaritan Catholic High School. This unit was characterised by some areas of low, dense plant cover, with other areas of good exposure. There was evidence of the drainage line having recently been recut, with dirt stockpiled along the banks. These areas were especially targeted, although no indigenous nor historic artefacts were identified in the area. A nodule of coarse grained grey basalt was identified, however, this had no evidence of working. Given the historic use of the land as a market garden, there is moderate potential for intact soil profiles to exist in survey unit 6, although these would only be expected below the depth of the ploughshare.

An abandoned fibrous cement cottage was also located within this survey unit. The front of the house is sitting on piers, with a rear addition and garage on a concrete slab. The house has been severely vandalised, with walls and windows smashed, and will be demolished under the current proposal. A post and wire fence will also be removed as part of the widening program.

GSV	good – 60%
Disturbance	moderate

Plate 5.4 Survey Unit 6

- Survey Unit 7 – Vacant land in front of Catholic High School

A registered Indigenous site (45-5-2320) is located within this survey unit (referred to as HPR1). The area is currently thickly grassed, with the western section supporting knee high grass. This area appears to have once had a fibro house similar to that in survey unit 6, although this has been demolished. A post and wire fenceline is also extant in this area and remnant garden plantings (pepper tree, oleander and crepe myrtle) would suggest a *c.* 1940s house (HPR4). There is no evidence to indicate when the house was removed. Site 45-5-2320 was located "within [an] old artificial rectangular depression amidst blue metal and red brick debris" suggesting that the campsite is located in the vicinity of the demolished house. Dense knee high grass cover greatly reduced gsv, resulting in an inability to relocate this site.

The area at the gates to the high school is landscaped with mown lawns and mulch, and a concrete gravel driveway. This area is immediately west of the riparian zone of Hinchinbrook Creek. A piece of pink silcrete was identified in this area, however, there was no evidence that the piece had been worked. No Indigenous or historic relics were identified in survey unit 7, although it is known that one registered Indigenous site is located within this survey unit (no collection permit or consent to destroy has been issued by NSW NPWS for this site, so it is assumed that the site is intact under the grass cover).

GSV	very poor – 5%
Disturbance	high

Plate 5.5 Survey Unit 7

- Survey Unit 8 – Commercial yards and school, south of Hoxton Park Road

Similar to survey unit 3, this unit comprised many built structures and also a large vacant block associated with the recently demolished Hoxton Park Primary School. The built structures appear to be mostly of 1960s construction and include the Hoxton Park Scout Hall. These structures have no significance in themselves, but are located on the site of the 1880's Hoxton Park School (HPR5). The site of the 1958 school and yard (HPR6) was fenced off, consequently the school grounds were not entered. A visual reconnaissance of the area indicated that the school has been demolished and the area has been pegged out into smaller residential sized blocks. Two mature pine trees along First Avenue, associated with the driveway of the historic Buggy homestead are outside the impact area of the proposal. East of the school is Hinchinbrook Creek and a narrow riparian zone.

GSV	poor – 20%
Disturbance	high

Plate 5.6 Survey Unit 8, site of demolished 1950s school

- Survey Unit 9 – Riparian zone of Hinchinbrook Creek at Buggy's Bridge

There are some remnant mature trees within this survey unit, however, vegetation is predominately regrowth of Casuarina and Eucalypt *sp* stands with a *Bursaria spinosa* boxthorn understorey and groundcover of native grasses, introduced weed species and leaf litter. There were two erosion gullies identified with excellent gsv, no artefacts were identified in these gullies. Peter Gale (DTAC) indicated that the gullies were deliberately cut to induce water runoff from a flat area further south of the study area which had previously been used as a horse stud/farm (pers comm 15/5/03). There is good potential for the survival of intact soil profiles in this area as ground disturbance appears to have been limited. The proximity of this area to Hinchinbrook Creek would also support the identification of this area as one of good potential for Indigenous relics.

Gil Saunders (GLALC), directed the consultants to a 'scarred' tree (HPR2) which he identified as having been used for a land sled. The scar faces north and is located on a burnt out stump and is 210 cm high, 56 cm wide with 12 cm thick overgrowth. The stump is located approximately 5m from Hoxton Park Road, in line with an existing bus shelter. The scar extends all the way to the ground, is asymmetrical and there is only scar regrowth on one side, the other being shattered. Peter Gale (DTAC) suggested that the tree had been struck by lightning, which had arced in the location of the present scar (pers comm 15/5/03). The consultant is unfamiliar with the effect a lightening strike produces in a tree, however, considers this a feasible explanation for the scar. A search of NPWS AHIMS register shows no record of this tree. This site should have been recorded with NPWS if it had been identified in previous survey works. The 'scarred' tree is in the direct impact zone of the current proposal.

GSV	poor – 10%
Disturbance	low

Plate 5.7 Survey Unit 9

Plate 5.8 Site HPR2, Survey Unit 9

Plate 5.9 Detail of site HPR2, Survey unit 9: note 'scar' extending into ground, exploded edge and smooth edge.

- Survey Unit 10 – Reserve area west of Illaroo Road

Landform in this area was similar to that of survey unit 9, although the understorey was not as thick. In general the area had very poor gsv associated with fallen branches, leaf litter and groundcover plants, however there was one area of excellent gsv associated with a dirt track which cuts the corner between Hoxton Park Road and Illaroo Road. The area of exposure was characterised by fine silty soil which does not appear to be a natural soil profile. There are few mature trees in this area, and those present appear to be stands of regrowth rather than remnant vegetation.

Gil Saunders (GLALC) directed the consultants to a second 'scarred' tree which is on the boundary of the impact area of the current proposal (HPR3). The tree is a mature Eucalypt *sp* with a small scar facing north, located approximately 1.3 m from the base of the tree. The scar is an irregular shape with maximum dimensions of 59 cm high, 31 cm wide and 3 cm thick overgrowth. The overgrowth is dark in colour and sap is 'leaking' from the scar. For these reasons the consultant does not concur that this scar is a result of human action, or that it is particularly old. Peter Gale (DTAC) did not consider the scar to be the result of Indigenous use of the area, suggesting that the scar is the result of cows or horses grazing in the area having stripped the bark for food. The scar is located on the lowest part of the tree trunk which is not encased in wire and may have been the most easily available section for fodder (pers comm 15/5/03).

Peter informed the consultants that an artefact was identified behind an abandoned house on Illaroo Road, which had areas of natural land surface in it's rear yard (this house is outside the impact area of the project). This isolated find is registered on the NPWS AHIMS database as site # 45-5-2471. Both Indigenous stakeholder groups consulted during the course of this project have independently identified the area as containing relics.

The consultant remains unconvinced of the veracity of the identification of the scarred tree as a result of human action, however is certain that Mr Saunders believes it to be a scarred tree and significant to GLALC, whose interests he represents.

GSV	poor – 15%
Disturbance	moderate

Plate 5.10 Survey Unit 10

Plate 5.11 Site HPR3, note the asymmetrical scar and the wire around the trunk.

- Survey Unit 11 – East of Illaroo Road

This area is highly landscaped with mown lawns forming the verge of the road. There is evidence for large scale subsurface disturbance in this area, with services such as electricity, water and telephone service access ports located in this area. This area is immediately in front of the Integral Energy substation and repairs and maintenance depot, which would also suggest active ground disturbance in the recent past.

GSV	fair – 45%
Disturbance	high

Plate 5.12 Survey Unit 11

- Survey Unit 12 – Creek area opposite Banks Road

This area is a low lying creek line and riparian zone associated with Cabramatta Creek. The water surface is approximately 3 m below the current road level with the ground surface stepping down to this level. There is evidence of erosion associated with run off from Hoxton Park Road and both Gil Saunders (GLALC) and Peter Gale (DTAC) informed the consultants that this area is quite flood prone. The creek line meanders in this area, suggesting a generally low flow velocity, however a flood gauge along the road indicates depth up to 2 m; flows increasing dramatically during flood events. Increased water levels were encountered during the second survey, effectively reducing the area surveyed.

The area is vegetated with Eucalypt and Casuarina *sp* stands and there is a thick groundcover of Wandering Jew and Casuarina needles. The tree cover is dense and suggests that the area is not highly disturbed, although the area immediately surrounding a modern culvert under Hoxton Park Road is likely to be quite highly disturbed. In general the unit had very poor gsv, however areas of high visibility associated with erosion scars were targeted. No Indigenous nor historic relics were identified in this area.

GSV	poor – 10%
Disturbance	low

Plate 5.13 Survey Unit 12

5.2.4 *Effective Survey Coverage*

The effective survey coverage represents an estimate of the ground visually examined during the field survey. It can be estimated by dividing the amount of area actually surveyed by the estimated ground surface visibility rating. It does not reflect the amount of the area that was surveyed, but represents an estimate of the area in which the ground was examined. The effective survey coverage for the current study is presented in Table 4.2 below.

Survey Unit	Ground Surface Visibility Rating	Size of Survey Unit	Effective Survey Coverage	Summary of Survey Results
Unit 1	95%	200 m x 50 m 10000 m²	9500 m²	No Indigenous or historical items of cultural heritage significance identified
Unit 2	5%	200 m x 7 m 1400 m²	70 m²	Area of Indigenous archaeological potential identified, no historical items of cultural heritage significance identified,
Unit 3	20%	300 m x 7 m 2100 m²	420 m²	No Indigenous or historical items of cultural heritage significance identified
Unit 4	5%	100 m x 7 m 700 m²	35 m²	Area of Indigenous archaeological potential identified, no historical items of cultural heritage significance identified,
Unit 5	20%	100 m x 7 m 700 m²	140 m²	No Indigenous or historical items of cultural heritage significance identified
Unit 6	60%	150 m x 50 m 7500 m²	4500 m²	Area of Indigenous archaeological potential identified, no historical items of cultural heritage significance identified
Unit 7	5%	300 m x 50 m 15000 m²	750 m²	Registered indigenous site (HPR1) within unit, potential historic archaeological feature associated with 20th C. archaeological feature (HPR4)
Unit 8	20%	300 m x 7 m 2100 m²	420 m²	No Indigenous items of cultural heritage significance identified, potential historic archaeological features associated with an 1870s school (HPR5) and a 20th C school (HPR6)
Unit 9	10%	200 m x 50 m 10000 m²	1000 m²	'Scarred' tree (HPR2) identified, area retains potential for Indigenous archaeological sites. No historic items of cultural heritage significance identified

Unit 10	15%	300 m x 50 m 15000 m²	2250 m²	'Scarred' tree (HPR3) identified. No historic items of cultural heritage significance identified
Unit 11	45%	400 m x 50 m 20000 m²	9000 m²	No Indigenous or historical items of cultural heritage significance identified
Unit 12	10%	200 m x 50 m 10000 m²	1000 m²	No Indigenous or historical items of cultural heritage significance identified in immediate development area.

Table 5.2 Summary of Effective Survey Coverage

5.3 Archaeological Survey Results

Background research identified one registered Indigenous site (45-5-2320, HPR1) within the direct impact area associated with the project. This site was not relocated during the survey due to vegetation cover within it's designated location. The two surveys undertaken resulted in the identification of a further five sites within, or on the boundary of, the proposed corridor. Two further Indigenous sites were located, a 'scarred' tree (HPR2) is to be directly impacted by the current proposal, and a 'scarred' tree (HPR3) on the boundary of the impact area. Three potential historic sites were identified, these being the remains associated with a 20th C. structure (HPR4), and those associated with the 1870s Hoxton Park Primary School (HPR5) and the 1958 Hoxton Park Primary School (HPR6). These six areas are those which have been flagged by the background research and the results of the survey. Additional to these six sites, there are several areas which possess the potential for intact soil profiles which may contain archaeological remains, be they Indigenous and/or historic. These areas of archaeological potential are discussed in detail below.

5.4 Archaeological Potential

The landscape of Hoxton Park is rich in heritage values, both Indigenous and non-Indigenous. The Hoxton Park Road corridor is located in an area where the underlying geology and soils supported an ecosystem and resource base utilised by the Indigenous inhabitants. The same geology and soils were attractive to the colony's first settlers, resulting in early European farming of the area. It is realistic to expect that the study area reflects the intensive and continuous use of this landscape as described in Sections 2, 3 and 4.

During survey it was apparent that a number of factors should be considered in an assessment of archaeological potential. The survey corridor is located on an alluvial floodplain with an extensive network of drainage lines. Flood events have the potential to impact on the archaeological record in a number of ways. Depending on the frequency and ferocity of flooding, floodwaters may sweep away archaeological deposits removing them from their depositional context; alternatively, they may deposit a layer of sediment which effectively caps and protects archaeological sites. Although recent efforts to regulate water flow has resulted in less frequent, less severe floods, the history of flooding in the area is bound to have impacted on site integrity within the survey corridor.

Land in the corridor is zoned as either commercial, light industrial, residential or open space. These zonings have contributed to differing levels of ground disturbance within the study area and should be considered when estimating the potential for intact archaeological deposits within the study area. Those portions of the study area which are open space or riparian corridors retain much higher potential for intact soil profiles than those which may have experienced heavy earthmoving events in the construction of residential or commercial premises.

The historical research completed, aerial photography and survey results have been used to identify the varying levels of disturbance along the Hoxton Park Road corridor. Areas of the route have been described as being of either low, moderate or high disturbance; however, it is worth noting that the level of disturbance does not preclude the existence of Indigenous relics or historic archaeological sites. In some cases, soil disturbance results in the identification of relics. This is particularly true in cases where subsurface deposits are disturbed, eg in excavating for a pipeline, resulting in visible relics on the surface. The differentiation of levels of disturbance provides an indication of the likely integrity of a site identified within that area.

1) Low disturbance: - Areas of remnant native vegetation and riparian zones.
2) Moderate disturbance: - Areas of broad acre grazing and small acre farming, which may have a highly disturbed surface layer (to the depth of the ploughshare), whilst still retaining the potential for significantly intact soil profiles at a greater depth
3) High disturbance: - areas immediately adjacent to major infrastructure projects such as roads, building developments and residential areas.

Within this framework there is a correlation between high disturbance and low potential for intact deposits, and low disturbance and higher potential for intact deposits etc.

5.4.1 Indigenous Areas of Sensitivity and/or Archaeological Potential

The background research undertaken has identified one registered Indigenous site (45-5-2320, HPR1) within unit 7 of the study corridor and several other sites within the immediate area of the corridor. Field survey identified two further Indigenous site and areas of archaeological potential within the corridor. A 'scarred' tree was identified to the consultants within unit 9 (HPR2), this tree lying within the impact area of the current proposal. A second 'scarred' tree (HPR3) was identified in unit 10 and is on the boundary of the impact area. The market garden paddocks (units 2, 4 and 6) and riparian areas (units 9 and 12) retain potential for intact soil profiles and, consequently, *in situ* Indigenous relics.

5.4.2 Historic Areas of Sensitivity and/or Archaeological Potential

Two areas of historic archaeological potential were identified during the surveys of the corridor. Unit 7 may contain the foundations of an early to mid 20th Century dwelling (HPR4). Indigenous site 45-5-2320 (HPR1) was noted to be situated in a rectangular depression and it is plausible that this depression correlates to the foundation area of HPR4. There is potential for archaeological remains associated with the recent historical use of this area to survive in unit 7.

The historic research completed identified the locations of two primary school grounds within the survey corridor. The earliest of these, the 1870s school (HPR5), is located in the vicinity of the present day scout hall. This area appears to be highly disturbed, with the construction of several buildings and the installation of associated services having taken place. These are predicted to have impacted on any archaeological remains associated with the 1870s school. It should also be noted that the HPR5 is located where the corridors tapers in preparation to cross north of the present alignment of Hoxton Park Road. Although there is a narrower corridor in this vicinity, there is potential that archaeological features associated with the 1870s school buildings may be disturbed. Any archaeological features associated with HPR5 are likely to have been severely disturbed by subsequent construction in the area and are assessed as of limited potential.

The 1958 school grounds (HPR6) are also within the study area. The 1950s school site was not accessed during the field survey, and a visual inspection of the area did not provide any insights into the level of post demolition disturbance which may have occurred in the vicinity of the school, nor any clear indication of location of the buildings. There is some potential for the survival of archaeological remains of the 1958 school. These may include the foundations of the numerous buildings on site and/or material culture deposits associated with the use of the site. The school area has consequently been flagged as an area of limited archaeological potential, although this has not been refined under the current level of attainable survey.

There is limited potential that relics associated with the occupation of the area by the Buggy family may survive in this area, however, the use of the site as a school for 45 years is certain to have impacted on any remains associated with earlier occupation of the site. Resulting in an assessment of limited potential that relics associated with the Buggy family remain *in situ*.

It should be noted that the 2 historic Bunya Pines which marked the entrance to the Buggy property on First Avenue are not within the impact area of the current proposal.

5.5 Summary

Of the 12 survey units investigated, several contained items of identified or potential Indigenous or historic heritage significance. The riparian area along the creek lines (unit 9) retains potential for intact Indigenous deposits, whilst units 2, 4 and 6 retain potential for intact soil profiles given the moderate levels of disturbance encountered in these areas. Unit 10 contains a 'scarred' tree which was identified during the survey (HPR2). Unit 7 contains a registered Indigenous site (HPR1), which is protected under the NSW NPWS Act 1974, and potentially the foundations of an early to mid 20^{th} Century structure (HPR4). Depending on the level of post demolition disturbance, unit 8 may contain foundations and / or material culture associated with both the 1870s primary school (HPR5) and the 1958 primary school (HPR6).

Survey Unit	Summary of Survey Results
Unit 2	Area of Indigenous archaeological potential identified, no historical items of cultural heritage significance identified.
Unit 4	Area of Indigenous archaeological potential identified, no historical items of cultural heritage significance identified.
Unit 6	Area of Indigenous archaeological potential identified, no historical items of cultural heritage significance identified.
Unit 7	Registered indigenous site (HPR1) within unit, potential historic archaeological feature associated with 20^{th} C. structure (HPR4)
Unit 8	No Indigenous items of cultural heritage significance identified, potential historic archaeological features associated with an 1870s school (HPR5) and a 20^{th} C school (HPR6).
Unit 9	'Scarred' tree (HPR2) identified, area retains potential for Indigenous archaeological sites. No historic items of cultural heritage significance identified.
Unit 10	'Scarred' tree (HPR3) identified.

Pink = Identified Indigenous sites and/or area of archaeological potential
Blue = Identified historic sites and/or area of archaeological potential
Purple = Identified indigenous and historic sites and/or area of archaeological potential

Table 5.3 Summary of positive results in survey units.

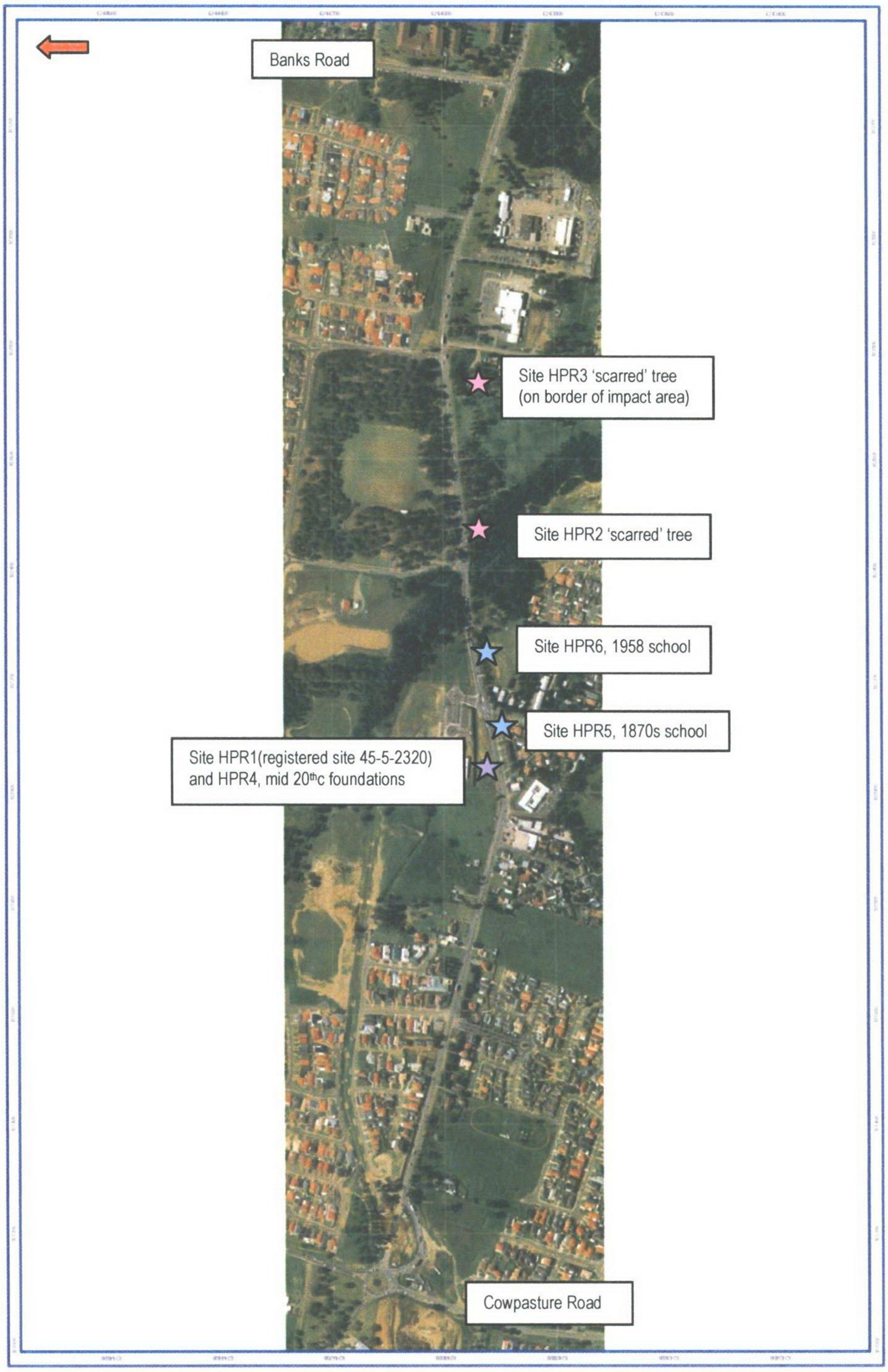

Figure 5.2 Sites identified within the survey area

Key:
Pink Star = Identified Indigenous sites
Blue Star = Identified historic sites
Purple Star = Identified indigenous and historic sites

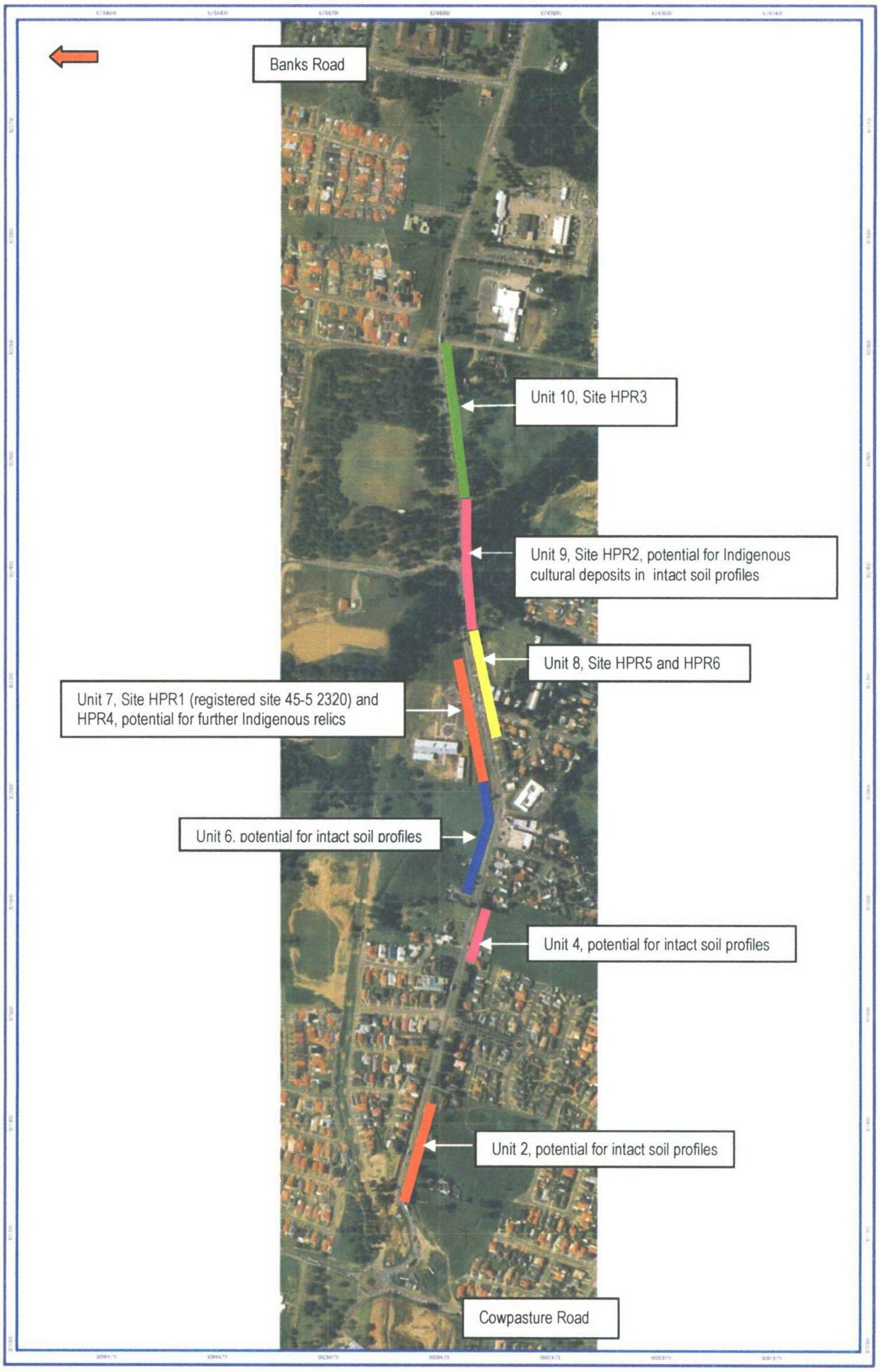

Figure 5.3 Areas of potential identified within the survey area

6.0 ASSESSMENT OF CULTURAL SIGNIFICANCE

6.1 Introduction to the Heritage Assessment Process

An assessment of significance seeks to determine and establish the importance or value that a place, site or item may have to the community at large. The concept of cultural significance is intrinsically connected to the physical fabric of the item or place, its location, setting and relationship with other items in its surrounds. The assessment of cultural significance is ideally a holistic approach that draws upon the response these factors evoke from the community. These standardised aspects of significance assessments are generally applied to sites, places or items that have tangible historic structures or relics visible at the site, and where there is a general understanding of the extent of the historic resources.

Archaeological sites require a different approach to significance assessment because the extent of the heritage resource and the degree to which it can contribute to our understanding of history is not fully known at the outset. It is the significance of the potential of the site to reveal information about the past that needs to be assessed when establishing the cultural significance of archaeological deposits. Similarly, it is the significance of the type of information that can be revealed by the archaeological deposits, especially where the information is not available through any other source and the contribution it can make to our understanding of a place, which may also be of cultural heritage significance.

Despite these differences the same general set of criteria are used to assess cultural significance of different types of heritage resources.

6.2 Basis for Assessment of Indigenous Sites

The NSW National Parks and Wildlife Service assessment criteria for archaeological significance are based on the criteria established by the AHC for assessment of items for inclusion on the RNE. The AHC criteria have been developed to deal specifically with archaeological resources and have been refined to:

A) Research Potential. This criterion is designed to qualify the significance of potential research which may be carried out at a site. Significance is apportioned according to the amount of new information which might be contained in the deposit, rather than the potential to yield a large number of artefacts. A site may have high significance under this criterion if it has an intact stratigraphic sequence and good integrity, the potential to provide a chronology extending into the past, or if it is connected to other sites within the region. Within this criterion are the subsets of representativeness and rarity. Representativeness is the ability of the site to demonstrate a representative type of site or deposit. This is important to maintain a contingency sample of all site types. Rarity is often described within the framework of representativeness as it relates to the distinctive features of a site which set it apart from similar sites.

B) Educational Potential. This criterion allows the educational value of a site to be considered as a component of significance. Under this criterion, an archaeologist may assess the potential of a site to educate the general public. NPWS has acknowledged that this criterion is open to misinterpretation by archaeologists who have the ability to convey the value of a site to other archaeologists. NPWS recommends that, in cases where significance is determined on educational potential, the onus is on the archaeologist go to the public for an assessment of this value.

C) Aesthetic Significance. Aesthetic significance is not inherent in a place, but arises from the response that people have to it. It is pertinent to remember that this response can vary dramatically between cultures and social groups, therefore an assessment of significance based on aesthetic value should incorporate the views of different cultures.

For a full description of assessment procedures refer to the Aboriginal Cultural Heritage: Standards and Guidelines Kit (NPWS 1997). These criteria have been designed to deal specifically with the archaeological resource, however they do not provide a framework for the assessment of social significance to the Indigenous community. For this reason, the criteria for assessment provided in the *Australia ICOMOS charter for the conservation of places of* *cultural significance* (the Burra Charter) are sometimes also used to assess significance as they provide a framework for a more holistic assessment of significance.

6.2.1 Indigenous Landscape Values

Gil Saunders (GLALC) and Peter Gale (DTAC) both discussed the importance of the landscape to Aboriginal people during field surveys. Gil identified two trees which he felt were significant to the GLALC and although these trees are not 'scar' trees in a strict archaeological sense, it is evident that the trees are significant to Gil and the LALC which he represents. This significance is valid in the identification of an important place to Aboriginal peoples. Gil also noted that the area was part of the initiation trail and was significant as a landscape which was travelled during initiation for young boys (pers comm 9/4/03). Peter Gale (DTAC) stated that the area was used as a camping area, but that as the area was flood prone, it was an opportunistic use of the landscape (pers comm 15/5/03).

6.2.2 Assessment of Indigenous Sites and Potential Archaeological Deposits

- HPR1 – Registered site 45-5-2320

As site 45-5-2320 was not relocated during this survey, the assessment of the site provided by AMBS has been applied to this survey

> ...if the site consists of little more than the few artefacts that are presently visible, the site is of little scientific significance. The question of whether further material is present needs to be clarified through test excavation before a final assessment can be made. The significance of the site to the local Aboriginal community has not yet been clarified by the Gandangara LALC.
>
> (AMBS 1995:11)

- HPR2 – significant tree

Site HPR2, although not a scarred tree in the strict archaeological sense, is significant to GLALC. The consultant is hesitant to have the tree registered as a scarred tree, however, Gil Saunders has expressed the initial view that the tree is of significance to the Gandangara people (pers comm 9/4/03), a view which should be endorsed by the LALC at their next meeting. HPR2 has been assessed as of social significance as represented by it's value to GLALC (this assessment can only identify that the tree has social significance, a level of significance will be determined for the tree once further advice has been received from GLALC), and of low research potential as it has been severely damaged by fire or lightening and as such can contribute limited information concerning Aboriginal occupation and use of the area.

- HPR3 – 'scarred' tree

Site HPR3 is on the border of the impact area associated with the proposal, and until the corridor is pegged it is uncertain if the tree will need to be removed. As with site HPR2, the tree is not a scarred tree in the archaeological sense, but it has been indicated to the consultants by Gil Saunders that the tree and surrounding area are significant to GLALC. HPR3 has been assessed as having social value as represented by it's significance to GLALC (this assessment can only identify that the tree has social significance, a level of significance will be determined for the tree once further advice has been received from GLALC), and of low research potential as it does not appear to have been the result of human actions and as such can contribute limited information concerning Aboriginal occupation and use of the area. The area surrounding the tree was identified by both Indigenous stakeholder representatives as containing relics, and as such is considered a PAD of low research potential until the extent, nature and significance of the relics contained in the area are further clarified (this also will be dependent on the input of Indigenous stakeholder groups in the form of comments on the draft report).

- Potential Archaeological Deposits

It is difficult to provide an assessment of areas of Potential Archaeological Deposit (PADs), however, within the context of the study area, units identified as having potential for survival of Indigenous relics may require test excavation to clarify the extent, integrity and level of significance of cultural resources. Until this is undertaken an initial assessment of low research potential has been applied to units 2, 4, 6, 7 and 9. Any archaeological testing programs undertaken should be done so in consultation with GLALC and DTAC to incorporate local Aboriginal stakeholder views of significance into assessments of potential sites within these units.

It should be noted that all Indigenous sites are protected under the provisions of the *NSW National Parks and Wildlife Act 1974*.

6.3 Basis for Assessment of Historic Sites

The *Australia ICOMOS charter for the conservation of places of cultural significance* (the Burra Charter) was formulated in 1979 and most recently revised in 1999, and is the standard adopted by most heritage practitioners in Australia. The Charter divides significance into various groups or categories for the purpose of assessment. They are: Aesthetic, Historical, Scientific/Technical, Social and Other.

In addition, the State Heritage Register, which was established by the amendments to the NSW Heritage Act in 1998, has a separate set of significance assessment criteria. To be assessed for listing on the State Heritage Register an item will need to meet one or more of the following criteria:

A) an item is important in the course, or pattern, of NSW's cultural or natural history;
B) an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history;
C) an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW;
D) an item has strong or special association with a particular community or cultural group in NSW for social, cultural or spiritual reasons;
E) an item has the potential to yield information that will contribute to an understanding of NSW's cultural and natural history;
F) an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history;
G) an item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places; or cultural or natural environments.

A central feature of the amendments to the Act, is the clarification and strengthening of responsibility for the management of heritage items at the Local and State level. Subsequently, items can be assessed as having Local or State Significance.

An item cannot be excluded from the Register on the grounds that items with similar characteristics have already been listed. These criteria can also be applied to items that do not qualify for a state significance ranking.

These categories are useful in considering a wide range of heritage items, and can be applied to sites with items of standing heritage as well as areas with the potential to contain archaeological deposits.

Currently there are no set criteria for the assessment of National levels of significance beyond an extension of the principles and criteria of the Burra Charter. Therefore levels of National significance cannot be established in a formalised framework for wider comparison. However, some points about national levels of significance are made below where relevant criteria from the Burra Charter provide a viable framework and where a national corpus of comparative site information exists.

6.3.1 Grading of Heritage Significance

The following table provides a guide to the grading of significance of items, or places of heritage value and is directly derived from the NSW Heritage Office Heritage Manual (revised 2001). Items of State or local significance can be graded based on the criterion outlined in Table 4.1 below.

Grading	Justification	Status
Exceptional	Rare or outstanding element directly contributing to an item's local or State significance.	Fulfils criteria for local or State listing.
High	High degree of original fabric. Demonstrates a key element of the item's significance. Alterations do not detract from significance.	Fulfils criteria for local or State listing.
Moderate	Altered or modified elements. Elements with little heritage value, but which contribute to the overall significance of the item.	Fulfils criteria for local or State listing.
Little	Alterations detract from significance. Difficult to interpret.	Does not fulfil criteria for local or State listing.
Intrusive	Damaging to the item's heritage significance.	Does not fulfil criteria for local or State listing.

Table 6.1. NSW Heritage Office Grading of Significance Criteria

6.3.2 Assessment of Historic Sites

- HPR4 - early – mid 20th Century archaeological feature, Hoxton Park Road

While it is clear that there is potential for historic archaeological remains at HPR4, the significance of these remains is assessed as limited. Garden plantings suggest that the site is dated to the early to middle 20th century, and there are several houses from this time period remaining within the locality of Hoxton Park; structures which provide a much better understanding of this time period than that which HPR4 could provide. It is assessed that site HPR4 will contribute little, if anything, to our understanding of historical settlement patterns, lifestyle and landuse of the area.

HPR4 has been assessed as of limited local significance.

- HPR5 – 1870s Hoxton Park Public School

The level of disturbance characterising the location of site HPR5, is such that site has been assessed as of limited potential for intact archaeological remains. This high level of disturbance detracts from the significance of the site. HPR5 is significant as the earliest public education institution in Hoxton Park, and for it's association with the early families of the area and it's evening adult education program. However, the archaeological remains expected at HPR5 are not expected to convey any great amount of information concerning early educational practices given the level of disturbance.

HPR5 has been assessed as of limited local significance.

- HPR6 – 1958 Hoxton Park Public School

While it is clear that there is potential for historic archaeological remains at HPR6, the significance of these remains is assessed as limited. The potential for foundations and / or material culture to survive within the study area is not clear, however, those associated with a 1958 educational institution, are assessed as of limited significance.

HPR6 has been assessed as of limited local significance.

7.0 STATEMENT OF HERITAGE IMPACT

7.1 The Proposed Work

The current proposal for the widening of Hoxton Park Road allows for the addition of four extra lanes of traffic; two additional lanes to complement the existing two lanes, which would be separated by a new two lane transit way. Footpaths would be formally installed to the north and south of the finished road and provision would be made for services such as street lighting and storm water runoff. Refer to the RTA concept plan, Figure 1.2.

The actual construction technique will vary according to the types of services provided in each area, but will generally correspond to the following outline: once the current surface has been removed a general fill base will be placed, a geotextile reinforcement will be placed in soft areas where it is required. Over this will be a 300mm upper zone formation, and above this another 300mm of crushed sandstone select fill. A 7mm bituminous primer seal will be sprayed to separate a 150mm concrete sub base from the sandstone fill. Another bituminous seal will be sprayed before the placing of a 230mm concrete base. On top of this will be the usual bituminous layers and asphalt which form the road surface to a thickness of 65mm. Construction materials are required to a minimum depth of 1052mm, necessitating the removal of existing subsoils in the impact area to a corresponding depth.

Although there are indications from the RTA that the content of the project may change, the selected corridor is fixed. This means that, although, for example, there may be a reduction in the number of lanes used as a transit way, the width of the finished road and services is committed to that outlined in the current proposal. This width is set at approximately 30m and is in part determined by the land available for use in the project. During the current investigation, the consultants have allowed for an additional 10 m buffer (room providing) for the movement of heavy machinery and stockpiling of materials etc.

7.2 Predicted Heritage Impacts

The proposal to widen Hoxton Park Road will result in ground disturbance and construction activity within the zone of works. Four sites have been identified within this area and further areas of archaeological potential have also been identified.

- HPR1 – Registered site 45-5-2320
  in association with
- HPR4 - early – mid 20th Century archaeological feature, Hoxton Park Road

These sites are adjacent to each other and will be impacted in a similar manner. The widening of the road will require that a suitable road base is first in place. This road base will necessitate excavation and removal of the upper levels of the current ground surface, and consequently any artefacts within that material, from the sites. This will result in the removal of sites HPR1 and HPR4.

The significance of HPR1 to the Gandangara people is still unclear, however, Gil Saunders has expressed concern that all sites are important to Gandangara people. HPR1 is protected under the auspices of the *NSW NPWS Act 1974* which requires that statutory procedures are completed to before consent is given to allow impacts to an Indigenous site.

Site HPR4 is protected under the auspices of the relics provisions of the *NSW Heritage Act (amended)* which requires that statutory procedures are followed.

- HPR2 – 'scarred' tree

The proposed road widening will result in the removal of HPR2, a 'scarred' tree as identified by Gil Saunders (GLALC). The tree is dead, and discussions with Gil have identified that removal is feasible. Statutory procedures must be followed in order to allow impacts to the site.

- HPR3 – 'scarred' tree and PAD

HPR3 is on the boundary of the impact area and it is unclear if the tree will need to be removed. There will be ground disturbance in the vicinity of the tree and this is predicted to impact on potential Indigenous archaeological deposits which may exist in the area. Any Indigenous relics will be removed during bulk earthworks prior to the construction of the road. These relics are protected under the auspices of the *NSW NPWS Act 1974* which requires that statutory procedures are completed to before consent is given to allow impacts to Indigenous sites.

- HPR5 – 1870s Hoxton Park Public School

Potential remains of the 1870s school building may be impacted by the bulk earthworks required prior to the construction of the widened road. Although the corridor is narrower in the vicinity of the school, there is still potential that foundations may be impacted. These foundations and any associated historic relics will be removed under the current proposal. The relics provisions of the NSW Heritage Act (amended) apply to this site, and as such, statutory procedures must be followed prior to impacting on HPR5.

- HPR6 – 1958 Hoxton Park Public School

It seems unlikely that the current project will impact on any structural remains, unless the school buildings were along the Hoxton Park Road boundary of the school grounds. The plantings which survive suggest that the widening of Hoxton Park Road in the vicinity of the School will impact mainly on playground area. The age of the school is 45 years, which means the relics provisions of the *NSW Heritage Act 1977 (amended)* do not apply to the site.

- Areas of archaeological potential

Units 2, 4, 6, 7 and 9 have been flagged as being of low to moderate disturbance which may have allowed for the survival of intact soil profiles containing Indigenous relics within these units. The proposal to widen Hoxton Park Road will require ground surface clearance and disturbance with the result that any Indigenous relics in these units will be severely disturbed and removed. These impacts are unavoidable given the nature of the proposed works.

8.0 RECOMMENDATIONS

The following recommendations and management strategies are recommended for the proposed works associated with widening Hoxton Park Road:

Recommendation 1 – Indigenous archaeological test excavation – HPR1 and PADs

Test excavation by a qualified archaeologist is recommended in the vicinity of HPR1 (registered site 45-5-2320). As the artefacts were identified on the ground surface, manual excavation is required in this area. This testing program should aim to identify the extent and integrity of site HPR1 and the significance of the site to the local Indigenous custodians. The excavation procedure should be determined in consultation with NSW NPWS, GLALC, DTAC and the RTA. Gandangara LALC and Darug TAC members should be invited to participate in the testing program.

Archaeological test excavation to determine the extent, nature and significance of Indigenous cultural heritage resources should be undertaken by a qualified archaeologist in Units 2, 4, 6, 7, and 9. A suitable testing regime should be established in consultation with NSW NPWS, GLALC, DTAC and the RTA. Gandangara LALC and Darug TAC members should be invited to participate in the testing program.

Recommendation 2 – Removal and relocation of HPR2 – scarred tree

HPR2 (scarred tree) should be removed prior to the widening of Hoxton Park Road. The tree should be removed by a qualified abourist to a secure location which allows interpretation of the relic. Gandangara LALC have suggested that the tree be relocated to their cultural centre in Menai where it will be used for educational purposes, for both LALC members and members of the wider community who can access the centre. The consultant recommends that this is an appropriate location for the tree. The tree should be removed from its current location by a qualified abourist in the presence of a qualified archaeologist and GLALC representatives.

Recommendation 3 – Site HPR3 – scarred tree

A heavy machinery exclusion zone is to be established around site HPR3. This zone will be a circle with a radius of 5m which will be flagged out prior to the introduction of heavy machinery to the area. If the RTA cannot construct the road with this exclusion zone, the tree is to be removed by a qualified arbourist to a secure location which allows for interpretation of the relic. The GLALC cultural centre in Menai is an appropriate repository for the relic. If required, the tree should be removed from its current location by a qualified arbourist in the presence of a qualified archaeologist and GLALC representatives. Removal of the tree (if necessary) may only take place once the archaeological testing program is completed in the vicinity of HPR3.

Recommendation 4 – Application for Consent to Destroy and accompanying documentation submitted to NSW NPWS

Consent to destroy must be received from NSW NPWS prior to any impacts on the identified sites and PADs. An application and accompanying research design must be submitted to NSW NPWS in order to undertake recommendations 1 – 3. Documentation will need to be written by a qualified archaeologist and outline the proposed works. In addition, an application for Care and Control of Cultural Items must be made to allow for GLALC custodianship of the scarred trees HPR2 and HPR3 (should it be removed).

- It is recommended that this archaeological assessment report be submitted to the Cultural Heritage Branch of NSW National Parks and Wildlife Service.
- It is recommended that a qualified archaeologist be engaged to complete a research design to accompany the consent to destroy applications required for the proposed works to proceed.

- Applications should also be made on behalf of GLALC for care and control of the scarred trees HPR2 and HPR3.

Recommendation 5 – Historical archaeological monitoring not required

Sites HPR4 and HPR5, although protected under the auspices of the *NSW Heritage Act 1977 (amended)*, have been assessed to be of limited archaeological potential and of little local significance. Works may proceed in the vicinity of sites HPR4 and HPR5 without a requirement for archaeological monitoring or testing. Site HPR 6 does not fall under the auspices of the relics provisions of the *NSW Heritage Act 1977 (amended)*, and has been assessed as of limited archaeological potential and of little local significance. Works may also proceed in the vicinity of site HPR6 without a requirement for archaeological monitoring or testing.

It should be noted that recommendation 5 does not absolve the client from a responsibility to adhere to the relics provisions of the *NSW Heritage Act 1977 (amended)* if historic archaeological features and cultural deposits further to those identified in this report are encountered.

Recommendation 6 – Works in Land Unit 10

The archaeological potential of Land Unit 12 is restricted to those parts which may retain intact soil profiles. In general, these areas are located at the furthest points of the Land Unit from the proposed development works.

The proposed creek & drainage works anticipated at the Banks Street end of Land Unit 12 will only impact upon the existing creek bed and banks. Due to the nature of the creek and its propensity for flooding, as well as significant pre-existing modifications to the landform, there is no potential for *in situ* Aboriginal sites in this area. Therefore, the creek & drainage works can proceed without the need for further cultural heritage works.

Recommendation 7 – Overall project timing

The timing of these recommendations is open to the RTA, however, it is imperative that all Indigenous archaeological testing be conducted prior to any bulk earth works in survey units 2, 4, 6, 7 & 9.

Recommendation 8 – Stop work provision

As required by the *NSW National Parks and Wildlife Service Act, 1974* in the event that Indigenous cultural fabric or deposits are encountered, works must cease immediately to allow the archaeologist to make an assessment of the find. The archaeologist may need to consult with the NSW National Parks and Wildlife Service regarding Indigenous relics.

As required by the *NSW Heritage Act 1977 (amended)*, in the event that historic cultural fabric or deposits not described in this report are encountered, works must cease immediately to allow the archaeologist to make an assessment of the finds. The archaeologist may need to consult with the NSW Heritage Office concerning the significance of historic cultural material unearthed.

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APPENDIX A

Correspondence received from Gandangara Local Aboriginal Land Council

APPENDIX B

Correspondence received from Darug Tribal Aboriginal Coporation

Appendix G

Visual and Landscape Design

HOXTON PARK ROAD UPGRADE

BETWEEN BANKS ROAD AND COWPASTURE ROAD

Working Paper

Urban and Landscape Design Concept, June 2004

HOXTON PARK ROAD UPGRADE

BETWEEN BANKS ROAD AND COWPASTURE ROAD

Working Paper

Urban and Landscape Design Concept, June 2004

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CONTENTS

1 INTRODUCTION

This Urban and Landscape Concept Design Working paper has been prepared by Tract Consultants with Connell Wagner Pty Ltd and the Roads and Traffic Authority (RTA) to accompany the Review of Environmental Factors for the upgrade of Hoxton Park Road from Banks Road to Cowpasture Road, Hoxton Park, in Sydney's south west. This project is called Hoxton Park Road Upgrade, Stage 2. The report should be read in conjunction with the REF prepared by Connell Wagner for this project.

The proposed upgrade of Hoxton Park Road forms a link in the web of a series of road and public infrastructure upgrades proposed and occurring in Sydney's south west. Other projects that adjoin Hoxton Park Road Stage 2 and tie into the proposal are:

- The Western Sydney Orbital (M7)
- Cowpasture Road upgrade
- Liverpool to Parramatta Transitway (LPT)
- Hoxton Park Road Stage 1 composed of two portions - Banks Road to Hill Road (complete) and Hill Road to Brickmakers Creek (under construction).

Hoxton Park Road forms one of the main arterial roads, along with Elizabeth Drive, leading to Liverpool and the Hume Highway from this rapidly developing sector of Sydney. The release of a number of new estates plus the potential for further land releases including Bringelly and Hoxton Park Aerodrome makes this an important link to address the expanding transport needs of the community. The planning for Hoxton Park Road includes it's potential as a future public transport link to access the future release areas.

The proposed road upgrade involves widening of the present two-lane road to a four lane divided road, over a length of approximately 2.3 kilometres between Banks Road and Cowpasture Road, Hoxton Park. The corridor and road alignment have sought to provide for future demand by allowing space to enable the future expansion of the road to six lanes.

As part of this developing infrastructure corridor the design of the road needs to respond to the designs to its east and its connection to the Cowpasture Road upgrade.

Figure 1.1 - Hoxton Park Road at intersection with Whitford Road looking west

2 LOCATION

2.1 Regional Context

Hoxton Park Road is located in Sydney's south west and is a major road leading into and from the Regional Centre of Liverpool.

Liverpool Local Government area is one of the fastest growing populations in Australia and requires investment in infrastructure works, including roads, to meet the growing demands of this expanding population.

Hoxton Park Road forms one of these critical links, and services a wide section of this expanding community that extends from Rossmore and Austral to Hoxton Park and Prestons.

2.2 Local Context

The proposal is for the upgrading of Hoxton Park Road from Banks Road to Cowpasture Road. This project is Stage 2 of the Hoxton Park Road upgrade. Stage 1 is the upgrade works presently under construction as part of the Liverpool to Parramatta Transit Way, between Banks Road and Brickmakers Creek.

The proposed Stage 2 road upgrade adjoins the following suburbs:

- Hoxton Park - located immediately to the south of the road
- Hinchinbrook - located immediately to the north of the road
- West Hoxton - located to the west of the road
- Miller – located to the north east of the road and
- Prestons – located to the south east of the road

The M7 is a significant infrastructure element which will cross the Hoxton Park Road corridor and will strongly influence its character. The M7 will be grade separated from Hoxton Park Road. Access to and from the M7 will be from Cowpasture Road. The intersection of Hoxton Park Road and Cowpasture Road will be upgraded as part of the M7 upgrade works.

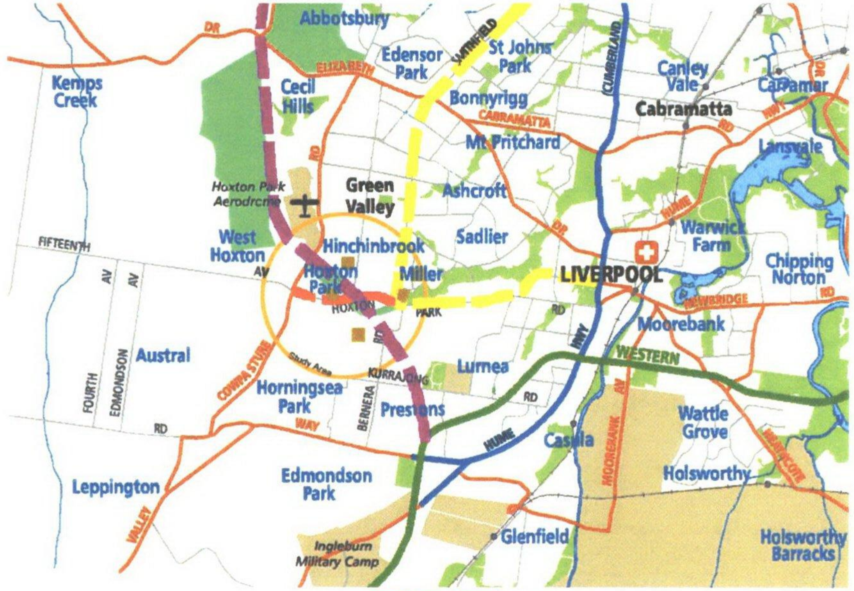


Figure 2.2 - Regional Context Map

Figure 2.1 - Site Aerial Photograph (existing conditions April 2000)

3 NATURAL SETTING

3.1 Geology and Landform

The study area is located on the south western portion of the Cumberland Plains within the Sydney Basin. The Cumberland Plains are characterised by gently undulating plains and low lying hills overlying the Wiannamatta Group of shales and sandstones.

The route of the proposed road is generally flat to gently undulating with a height differential of 10m over its length. The high point of the road is at its western end at its intersection with Cowpasture Road and from here the terrain slopes down to the east. A ridge located west of the site and Cowpasture Road defines the catchment.

Hoxton Park Road crosses two creek lines along its length. The main creek line crossing is at Buggys' Bridge where Hinchinbrook Creek crosses under Hoxton Park Road before connecting with Cabramatta Creek, located to the south east of the study area. The second is a tributary to Hinchinbrook Creek, which crosses the road at its eastern end near Banks Road.

The area is subject to flooding, including Hoxton Park Road. During flood events water from Hinchinbrook Creek leaves the channel near Wilson St and Hoxton Park Road intersection and travels east parallel to Hoxton Park Road before connecting once more just west of Banks Road.

The creek line valley has influenced the soil landscapes. A soil landscape is determined by the soil type and landscape character of the area. The three soil landscapes within the study area are Blacktown, South Creek and Berkshire Park Soil Landscapes as defined in Soil Landscapes of Western Sydney.

- Blacktown - Brown- black loam to clay of moderate to low fertility. Soils are of moderate erodibility
- Berkshire Park - Heavy clays to clayey sands. They are susceptible to erosion, of poor permeability, and of low fertility.
- South Creek - Occurs on the active floodplains of the Cumberland Plain and are alluvial deposits derived from the Wiannamatta Group. This soil is sandy loam, which is friable. Its erodibility is high.

The challenge is to design the Hoxton Park Road Upgrade so that it is integrated into the existing topography and to provide a flood free road that does not exacerbate local flood or erosion issues.

Figure 3.1 - View overlooking Hinchinbrook Creek Valley and Hoxton Park Road from Hinchinbrook looking south west

3.2 Vegetation

The original vegetation communities of the study area are a result of the physical characteristics of differing landform and underlying geology of the site.

The original vegetation pattern of the Cumberland Plain community within the study area has been heavily modified by previous land use, in particular the agricultural heritage of the region. Despite this, pockets of the original plant communities are evident along and adjoining the road corridor. Many creek lines within the area retain part of the original community along their banks. Approximately 1.4 ha of native vegetation occurs within the corridor of the proposed road widening. The main area of remnant vegetation is between Banks Road and First Avenue where native vegetation dominates the character of the road.

The flora assessment identifies three vegetation communities within or adjacent to the study corridor. (Refer Flora and Fauna study). The distribution of the communities is indicated in Figure 3.3. All are listed under the Threatened Species Conservation Act 1995. These communities are:

- Shale Plains Woodland – This is the most widely distributed form of Cumberland Plain Woodland. The canopy trees are the dominant elements of this plant community. These include Eucalyptus molucanna (grey box), Eucalyptus tereticornis (forest red gum) and lesser density of Eucalyptus crebra (narrow leaved iron bark), Eucalyptus eugenoides (thin leaved stringy bark) and Corymbia maculata (spotted gum).
- Alluvial Woodland- Forms part of the Sydney Coastal River Flat Forest . Alluvial Woodlands occur along minor watercourses and terraces adjacent to riparian forest. The canopy is characterised by Casuarina glauca (river she-oak), Eucalyptus amplifolia (cabbage gum), Eucalyptus tereticornis (forest red gum), and Angophora floribunda (roughbark apple). This plant community plays an important role in maintaining aquatic ecosystems and riverbank stability.
- Shale- Gravel Transitional Forest – This is a transitional plant community comprised of species from both clay and alluvial soil communities. It is an open forest plant community with a canopy dominated

Figure 3.2a - Shale gravel transitional forest community at Hoxton Park Recreation Reserve

Figure 3.2b - Alluvial woodland plant community along Hinchinbrook Creek Channel

by Eucalyptus fibrosa (broadleaved ironbark) , Eucalyptus molucanna (grey box), and Eucalyptus tereticornis (forest red gum). Melaleuca decora is common in the small tree layer.

All plant communities occur either within the drainage corridor of Hinchinbrook Creek and its associated floodplain or within public reserves within the existing road corridor or as dedicated open spaces. A detailed list of these communities is listed in the Appendices. The plant communities along the creek line have been heavily infested by weeds primarily privet which has degraded the vegetation community directly adjacent Buggys' Bridge. Refer figure 3.4.

The native plant communities influence the character of the section of road between Banks Road and First Avenue.

The character of the remainder of the road is predominantly that of a cultural landscape. The appearance of that landscape has been influenced by both its previous pastoral use and the more recent residential subdivisions. The existing landscape character is a grassland setting for a series of subdivisions. More recent cultural plantings associated with the residential precincts are yet to establish a common or single identity to the subdivisions, and so it is the built form that currently dominates the character of this section of the road. Refer figure 3.5.

The challenge for this project is on defining these existing vegetation characters and their transitions, and then reinforcing them within the corridor of the road upgrade. The landscape design for the project will seek to highlight and promote existing landscape characters while enhancing the existing natural landscape.

Figure 3.4 - Natives and weeds mix adjacent to Buggys' Bridge, east of First Avenue

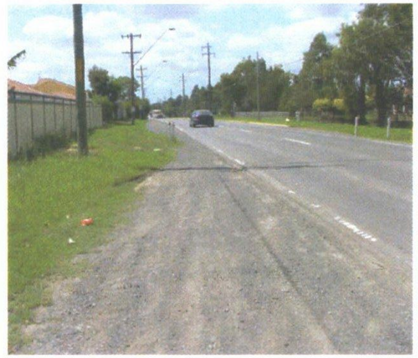


Figure 3.5 -Western section of Hoxton Park Road illustrating built form and cultural planting

Figure 3.3 - Vegetation Communities

4 URBAN SETTING

4.1 Landuse and Visual Setting

The urban design objectives for the Hoxton Park Road Upgrade Stage 2 derive from the key components and characteristics of the place. The urban design objectives are simple:

- The achieve a distinctive shopping centre precinct
- To emphasise the differing landscape characters of the road precincts
- To integrate the road upgrade with the adjoining infrastructure including Cowpasture Road uprade, M7, LPT and Hoxton Park Road Stage 1
- To provide a safe and accessible corridor for all users, with regard to interactions along and across the roadway

The primary land uses of the study area are the residential subdivisions, Hoxton Park village shops, the new driveway service outlets, community uses such as schools, halls, churches etc., and remnant pastoral or farm holdings. The diversity of the uses and the character of the developments associated with these uses reflect the changing nature of the road environment and the region.

Residential

The dominant land use along the road corridor is residential. The development of this land use type reflects the development of the area. While there has been a relatively long history of European occupation in the district it was not until the 1950's that the area appears to have seen a significant scale of residential subdivision. Development has accelerated in recent years and includes developments west of Glenn Innes Road, south of Hoxton Park, Hinchinbrook, and West Hoxton Park.

The post war housing stock within Hoxton Park is generally located along the southern edge of the road with only a couple of dwellings to the north. The method and age of construction varies and includes weatherboard farm cottages located amongst modern brick veneered homes. The post war style homes all front Hoxton Park Road.

The newer subdivisions have been developed in the knowledge of the Hoxton Park Road upgrade proposal and the newer developments turn their back on the road. It is this new housing stock that now dominates the northern boundary of the corridor. High fence lines have been constructed along the road boundary as part of these developments, contributing to the image of a walled corridor. Refer Figure 4.2. This is one of the road characteristics that the road upgrade design needs to address to enliven the street and to make it more usable to pedestrians and motorists alike.

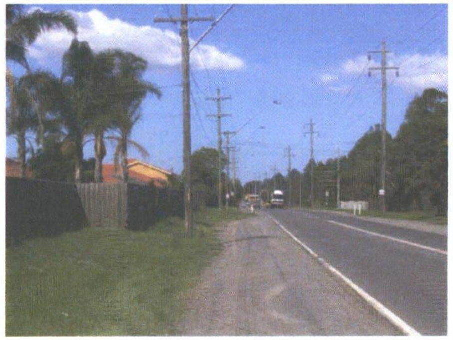


Figure 4.2 - View of fencelines lining northern edge of Hoxton Park Road.

Figure 4.3 - Older style home fronting Hoxton Park Road

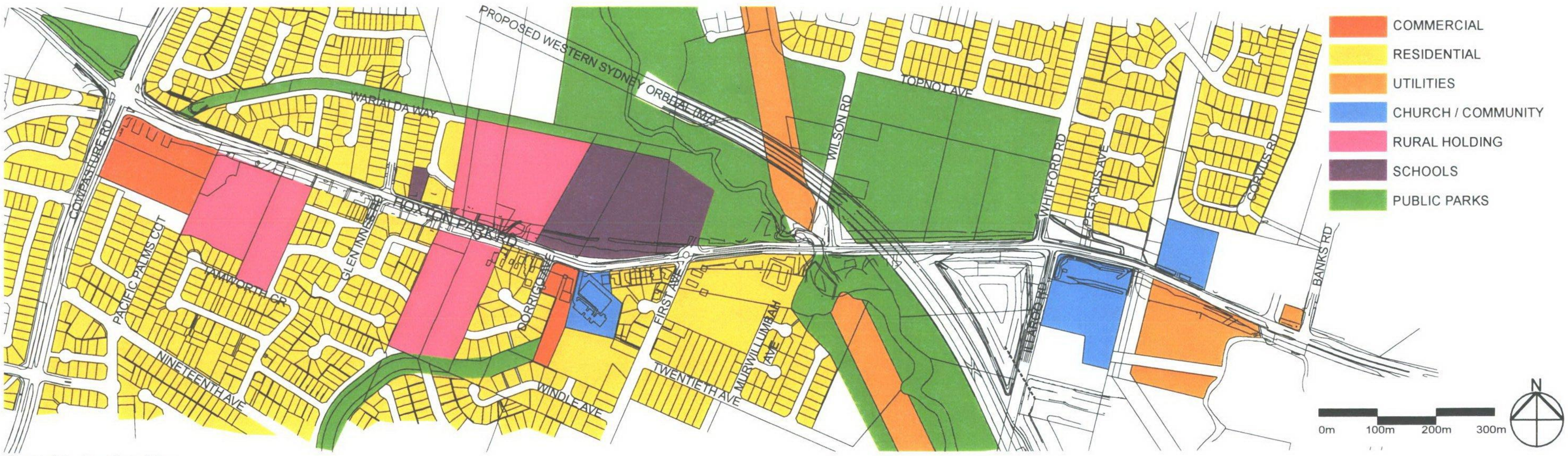


Figure 4.1 - Landuse Map

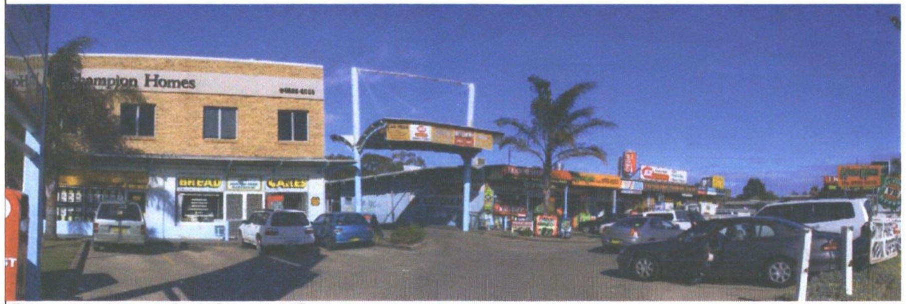


Figure 4.4a Hoxton Park Shopping Centre

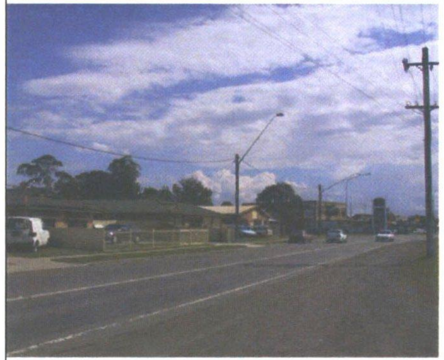


Figure 4.4b Approaching Hoxton Park Shopping Centre from the east


Figure 4.4c Soundwall and landscape in front of the Good Samaritan Catholic School


Figure 4.4d Hoxton Park Recreation Reserve

Commercial

There are two locations with commercial development.

The first occurs between First Avenue and Dorrigo Street. This is a traditional shopping precinct that developed in the 1970's to serve the developing community. It is a convenience shopping precinct with a range of general services such as newsagent, post office, bottle shop, milk bar, independent supermarket, petrol station etc. A range of office space is also integrated into the development. Access is presently directly off Hoxton Park Road with forecourt parking and a small car park located to the rear of the property.

The second location is at the intersection of Cowpasture Road and Hoxton Park Road. This is a new commercial centre that houses a mix of fast food outlets and convenience services. The final mix of this development is not yet clear although its modus operandi appears to be car based shopping.

Community Uses

A number of schools front the road corridor, including the Good Samaritan Catholic School and a preschool.

The Good Samaritan Catholic School is comparatively new and has been designed and developed to allow for the provision of an upgraded Hoxton Park Road. It has adopted the gazetted road boundary as its boundary and has set all buildings well back from that boundary. It has also provided its own bus set down and turning facility within the school grounds to reduce potential risks and conflicts that might occur at a school with the main bus stop on an arterial road.

The Hoxton Park Primary school site, located on the corner of First Avenue and Hoxton Park Road has been closed and cleared of all former school buildings. The site has been developed as a mix of townhouse and freestanding residential buildings.

A small scale preschool development is located within Hinchinbrook Estate with access off Tenterfield Avenue.

A Community Health Centre, managed by the Department of Health, is located adjacent the Hoxton Park Shops and services a wide range of medical functions within the community. The centre while presently accessed off Hoxton Park Road does not directly address the road as it is situated on a battle-axe block.

A small Scout Hall is directly in front of the Community Centre on the front half of a battle-axe block.

Parks and Open space

The main open space fronting the Hoxton Park Road Upgrade Stage 2 is the Hoxton Park Recreation Reserve. This reserve incorporates an oval, change rooms, and play equipment within a setting of remnant Eucalypts and native grasses. The landscape character of this reserve has a strong influence over the character of the eastern half of the study area.

The land adjoining Hinchinbrook Creek and Wilson Road is gazetted as a drainage reserve, and forms a green corridor of remnant and introduced vegetation that extends the parkland setting further to the west of the Recreation Reserve and to either side of the corridor.

There is an open paddock with native vegetation cover south of Hoxton Park Recreation Reserve which presently reinforces the natural woodland feel of the road corridor. Construction of the M7 will alter this significantly as two large detention basins are to be constructed in this area, removing the bulk of the existing vegetation cover.

4.2 Local Access

Hoxton Park Road forms one of the main east west arterial roads in the area. It is located between the main north south arterial roads of Cowpasture Road at its western end and the Hume Highway in the east.

A number of sub arterial and collector roads feed onto Hoxton Park Road. These include Wilson and Banks Roads and to a lesser extent Whitford and Glenn Innes Roads and First Avenue. Dorrigo Avenue and Illaroo Road are the only other streets that intersect Hoxton Park Road in the project area. Presently all turning movements are allowed from all streets connecting with Hoxton Park Road.

The M7 (under construction) is a significant infrastructure element that crosses Hoxton Park Road. No vehicular connection will be possible directly from Hoxton Park Road to the M7. The provision of pedestrian and cycle access will be provided. These facilities will provide another layer of access to those proposed as part of the Hoxton Park Road upgrade and those already existing.

A network of cycleways are beginning to be formed in or adjacent to the Hoxton Park Road corridor.

- Shared pathway east of Banks Road extending to Brickmakers Creek along the northern edge as part of Stage 1
- Connection at Banks Road enables access to the LPT shared cycleway
- A bike path connection exists within the new subdivision of Hitchinbrook to the north of the road corridor between Hoxton Park Road and Warialda Way.

Hoxton Park Road between Banks Road and Cowpasture Road generally has no kerb and gutter, consisting of a single sealed lane and a gravel shoulder in either direction. For a small section of the road between First Avenue and just west of Dorrigo Avenue, kerb and guttering coincides with the main concentration of activity on the street i.e. the shopping centre and adjoining school.

There is a footpath between First Avenue and Glenn Innes Road on the southern side of the road corridor linking the new subdivision with the shopping centre. The upgrade project provides the opportunity to significantly improve the pedestrian and cycle facilities in this area.

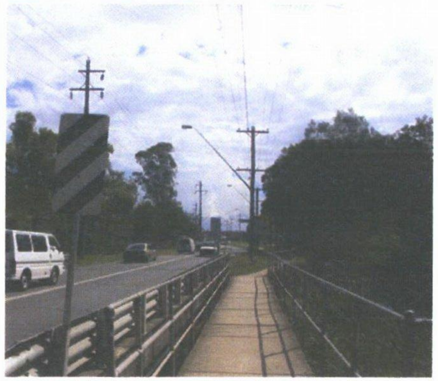



Figure 4.5 - Views of Buggys' Bridge over Hitchinbrook Creek

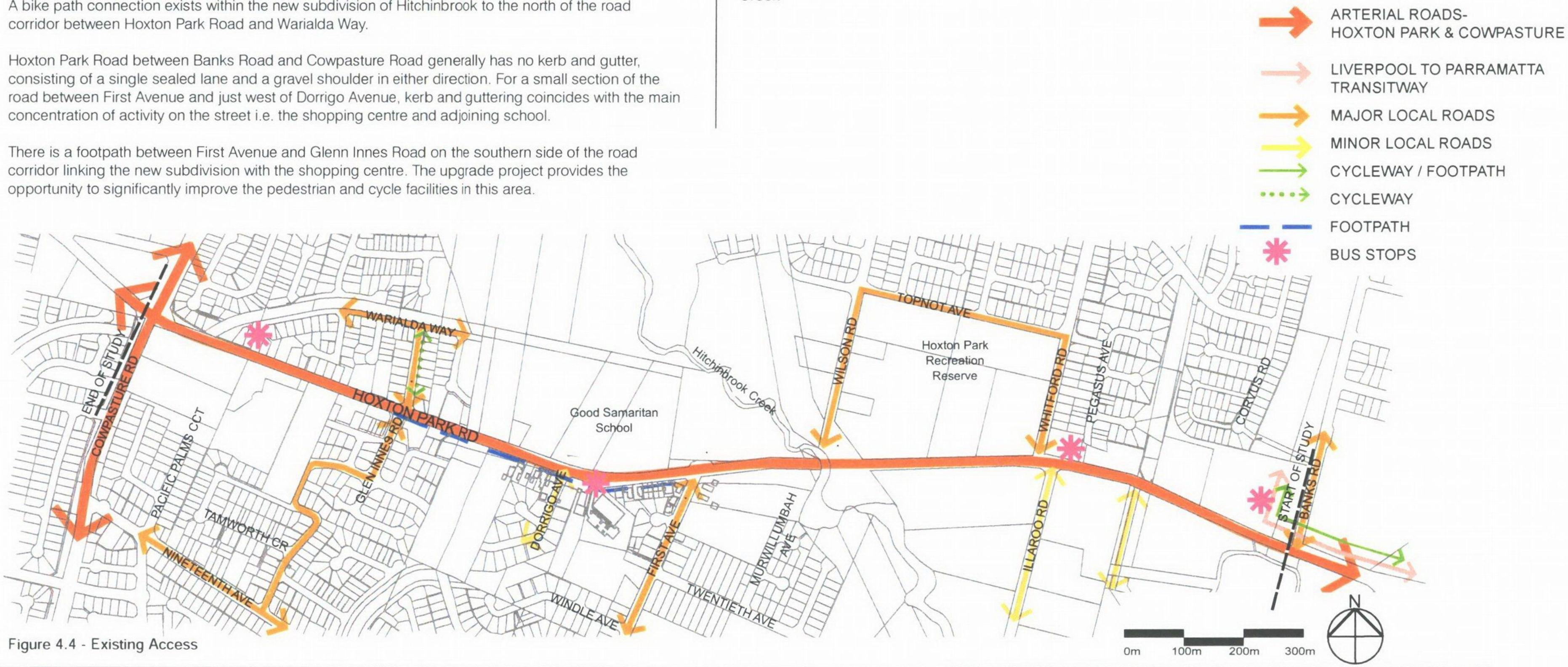


Figure 4.4 - Existing Access

5 THE PROPOSAL

5.1 The Proposal

The upgrade proposal is for a four lane divided road, with sufficient space for future expansion to six lanes. The alignment has been determined by the existing road alignment, and the adjoining recent residential developments that have been implemented in accordance with the gazetted road corridor defined in the Local Environment Plan.

Key features of the proposed road upgrade are:

- Provision of a four lane divided road including kerb and gutter between Cowpasture Road and Banks Road. Lane width is to be 3.5m
- Provision of new double bridge structure across Hinchinbrook Creek
- Provision of controlled intersections including turning lanes at Glenn Innes Road, First Avenue and Whitford/Illaroo Road intersections
- Provision of a seagull intersection at Dorrigo Avenue to provide access to and from Hoxton Park Shops
- Provision of a 3.0m shared cycle/pedestrian pathway to the northern side of Hoxton Park Road with connection to the pathway provided by M7, the preceding stage of Hoxton Park Road (east) and LPT
- Provision of a 1.5m pedestrian pathway to the southern side of Hoxton Park Road
- Provision of bus stops at Glenn Innes Road and Whitford Road (both east and west bound); at the Hoxton Park Shops west bound and the Good Samaritan School east bound
- Removal of direct access from individual properties directly onto Hoxton Park Road
- Acquisition or partial acquisition of a number of properties along the southern side of the corridor, to accommodate the widened road
- Landscape improvements including extensive street tree planting
- Installation of noise walls as required to achieve environmental objectives

5.2 Efficiency and Capacity

The proposal seeks to separate through traffic users of the road from local traffic users through the use of separate turning lanes and the limiting of access points.

Traffic lights are proposed at Glenn Innes Road, First Avenue and Whitford Road. In the case of Glenn Innes Road and First Avenue, the upgrade will not affect street usage but will improve safety.

The upgrading of the Whitford Road/Hoxton Park Road intersection and the provision of traffic lights will introduce changes in traffic movements on Wilson Road. Wilson Road presently serves as the main access road from the south to the Valley Plaza shopping centre. The control of any additional traffic using Whitford Road beyond Topnot Avenue will to be addressed as part of Council's Local Area Traffic Management.

The provision of a seagull intersection at Dorrigo Avenue retains access to and from Hoxton Park Road from Hoxton Park Shopping Centre. This arrangement minimises interruption to the present trading conditions. A one-way west bound service road is proposed between First Avenue and the shopping centre to maintain access to houses fronting Hoxton Park Road. The second (west) half of this link is two way to maintain access to and from the Community centre. The provision of this service road provides a level of safety that is absent in the present road configuration.

5.3 Pedestrian Access and Circulation

The pedestrian and cycle access along the road will be upgraded as part of the proposal. The following provisions are included within the proposal.

- A wide shared pedestrian and cyclist path along the northern side of the road
- A path along the southern side of the road
- Controlled pedestrian crossings at the intersection of Glenn Innes Road, First Avenue and Whitford Road to facilitate the movement of pedestrians and cyclists across the corridor
- Bus bays at Glenn Innes Road and Whitford Road (both east and west bound), at Hoxton Park Shops west bound, and the Good Samaritan School east bound
- Connections to existing and proposed cycleways and paths along Cowpasture Road, Hoxton Park Road east of the site, LPT, and the path network of the M7

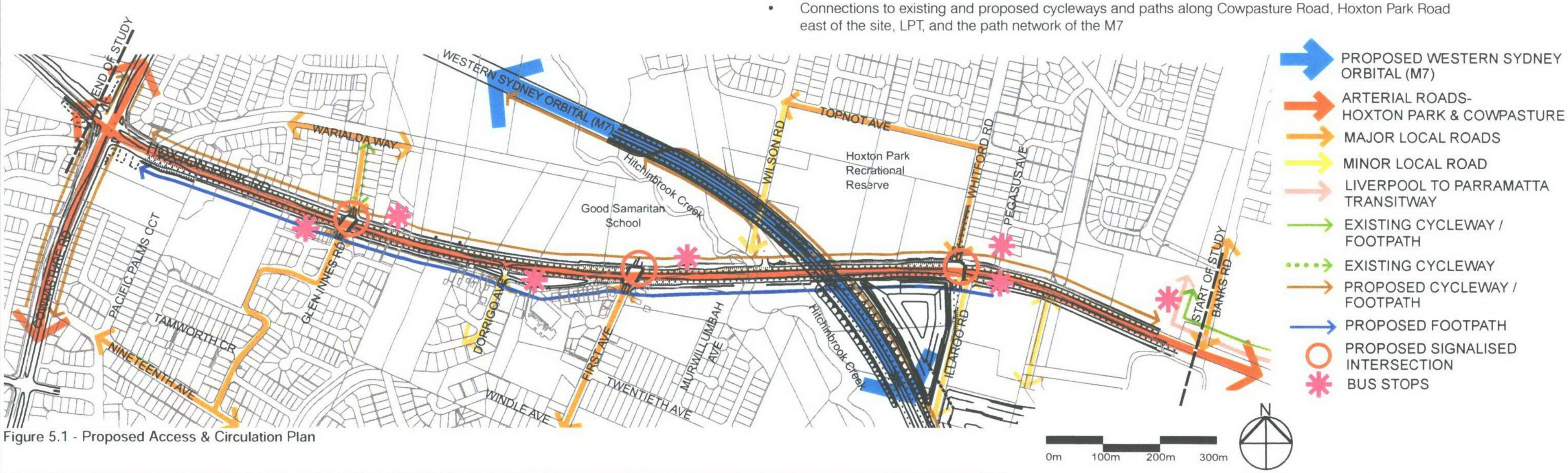


Figure 5.1 - Proposed Access & Circulation Plan

6.1 Landscape and Visual Assessment

The local character and key components of the Hoxton Park Upgrade Stage 2 are identified and described in Section 4, as are the project's urban design objectives. The detailed consideration of the local landscape and visual issues assists the formulation of designs and details that support the urban design objectives. The process of analysis of the existing landscape and visual character, and a consideration of the likely impacts and opportunities of the proposed project gives rise to design outcomes that can ensure the protection and enhancement of the key landscape and visual qualities of the place.

In usual planning processes, the visual impact of a proposal is determined by the degree of change that is proposed between the existing and proposed conditions. The visual sensitivity of a site is a measure of how critical the change would be to the viewer. At Hoxton Park, this study has identified the key urban design characteristics of the place, and identified urban design objectives to guide the detailed design of the project. The overall concept design for the road upgrade has been informed by the urban design and landscape analysis.

In the relatively urban setting of Hoxton Park, the function, arrangement and composition of the existing and new public domain elements such as pedestrian footpaths, bus stops and introduced landscape are a critical component of the visual character of the place, and are considered in the assessment

In order to assess these impacts the road has been divided into three precincts of distinct landscape and visual character.

- Riverine / Parkland Precinct
- Shopping Centre Precinct
- Residential precinct

6.2 Riverine / Parkland Precinct

Located between Banks Road and First Avenue, it is characterised by the remnant landscape setting of Eucalypts within grassland. To the south of the corridor a number of large land holdings address the road. These include the Assemblies of God Christian Life Centre, Integral Energy and an area to be occupied by the M7's detention basins.

Both the Assemblies of God Christian Life Centre and Integral Energy are set well back from the road and incorporate remnant eucalypts and earth mounding in a grassland setting. The scale of the setback will be reduced by the road proposal and will see the loss of a number of trees.

The very large M7 detention basins and the large road overpass structure will strongly influence the future character and image of Hoxton Park Road. The future detailed design of the Hoxton Park Road upgrade needs effective coordination with the M7 design. The quality of the Hoxton Park Road upgrade streetscape is dependant upon sensitive integration of the M7 infrastructure including fencing and landscape earthworks.

To the north of the road the housing is setback 50m to allow for an overland flow path. Between Whitford Road and Wilson Road this appears as a wide grassed verge with little or no tree cover. Between Whitford Road and Wilson Road a large open space, Hoxton Park Recreation Reserve, fronts the road and forms the strongest visual element within the corridor.

Hinchinbrook Creek is located just west of Wilson Road and it is a designated drainage corridor. This area also functions as open space. The vegetation along this creek is a mix of remnant native and weed species. The thick weed growth blocks views further to the west.

The road design needs to address the following issues:

- The proposed increased scale (footprint) of the road width within the limited road reserve
- The small reduction in available park space due to the proposed increase in road width
- Reconstruction of Hinchinbrook Creek to accommodate a new double bridge
- Setback to Integral Energy, the Church and proposed M7 detention basin
- Changes to intersection and road hierarchy at Whitford Road

Visual Effect

The visual impact is the increase in scale of the road and the impacts of the proposed M7. In terms of impacts on the immediate environs, the edge conditions of the road will appear substantially unaltered with limited loss in vegetation cover as a result of the Hoxton Park Road upgrade construction. There is significant impact along the southern edge where the road alignment shifts some 15m to the south, removing part of the existing vegetated separation buffer to adjoining land uses.

The other main impact will be changes to Hinchinbrook Creek. The channel modifications will affect the flow patterns of the creek. The channel will be realigned and revegetated, removing the present weed infestation. These works would improve the landscape and ecology of the creek and its bushland surrounds.

The proposed M7 will make a major change in the character of the road corridor. Hoxton Park Road will pass under the viaduct of the M7. This element will form a gateway and threshold, which marks the transition from the Riverine Precinct to the Shopping Centre precinct of Hoxton Park.

Figure 6.1 - Assemblies of God Christian Life Centre, set well back for existing road, looking west

Figure 6.2 - Hoxton Park Road, at Hoxton Park Recreation Reserve, lined with canopy trees

Sensitivity.

The increase in the road width will bring moderate visual change to those sections of the road that are currently tree lined. There will be tree losses, however the project would include re-vegetation of the road corridor. Those sections of the road where housing backs onto the road reserve currently have a low visual sensitivity to change and the project would include the establishment of a new and visually coherent streetscape. There are only limited external vantage points from which to view the road and it is not considered to be visually sensitive to change.

Recommendations

Measures to mitigate the perceived negative impacts of the increased scale of the road on both drivers and observers needs to be explored. Planting of the median and verge offers the potential to assist in reducing the visual scale of the road and hence integrating the road with its surrounding environment. Critical in this regard is the maintenance of views both into and out of the Hoxton Park Recreation Reserve on the north side and the landscape setting of the properties on the south side. These views should be preserved as much as possible.

6.3 Shopping Centre Precinct

This precinct contains the school to the north and a mix of residential, community and commercial uses on the south side.

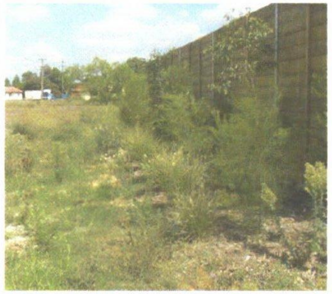


Figure 6.3a - Sound wall adjacent to school

Figure 6.3b - Approach to shopping centre (east)

Figure 6.3c - Approach to shopping centre (west)

The Good Samaritan School defines the northern edge of the road. This is a relatively new development with integrated landscape and acoustic barriers. The timber noise wall is well screened by landscape. Refer Figure 6.3a. The school buildings are set well back from the road and are not visible from the road.

The residential precinct between First Avenue and the Shopping Centre comprises relatively new housing stock of townhouses and freestanding residences. These front directly onto the existing Hoxton Park Road and have minimal landscaping within the front yards. The absence of trees combined with the close proximity of the road make the pedestrian experience uninviting.

The residential precinct terminates at the Scout Hall and transitions into a community and commercial focused shopping centre. Refer Figure 6.3b. The dominant element of this precinct is the shopping centre itself. This is a two storey building, split by an internal road which accesses a car park to the rear of the centre. The shops are setback from the street boundary providing for forecourt parking. The shop frontage is dominated by an awning and shop front advertising. Within the shopping centre there is a full range of services including a supermarket, post office, newsagent, and service station along with a number of specialist stores. Refer Figure 6.3c.

The road design needs to address the following issues:

- Retention of access from residential properties onto the adjoining upgraded road
- Expansion of the road width within the corridor
- Realignment of the road moving it to the north away from shopping centre to retain convenience parking
- Treatment of the Dorrigo Avenue intersection to retain access to the shopping centre
- Maintenance of visual links between the road and shopping centre

Visual Effect

The road geometry limits vantage points within this section of the road. The main vantage points are from the houses that front the road, and from vehicles travelling along the road. The proposed upgrade does not change this situation.

The visual impact is the increase in the width of the road, and the realignment of the road to the north of its present alignment. The road corridor has already been defined by the alignment of the school development and acoustic barrier, and the adjacent residential properties. The spatial nature of the proposed road corridor is already partially evident and the road upgrade will not substantially change it.

The road upgrade offsets the main carriageway from the shops and requires drivers to turn off the road to access the shopping centre. The detailed design of this area will need to preserve the views between the through road and the shops. The proposed road upgrade includes the construction of a median between the road and the service road that accesses the shops.

Sensitivity

This area has a high visual sensitivity due to the road's proximity to the school and Hoxton Park shopping centre. All housing fronting onto the road is susceptible to any change. This change is unavoidable and needs to be managed. The treatment of the road environment and its margins needs to create a quality setting for these properties.

Recommendations

Planting of the median would assist in reducing the visual scale of the road, while integrating it with its surrounding environment.

The design of the new space between the road and the shops will play an important role in creating a memorable setting, a sense of space and character. The design of this space needs to address the requirements of the shopping centre. The retention and enhancement of views between the road and shops is most important.

The presence of individual residences here is part of the road's character. The residences provide a sense of activity, human presence, and community structure to the roadside. It is important that these houses continue to have a street address. The treatment of acoustic issues needs to consider this in the resolution of the design. Architectural treatments to the buildings, if required, would be preferable to noise walls. Solar access needs to be maintained also.

6.4 Residential Precinct

This precinct extends from just west of Dorrigo Avenue to Cowpasture Road. The northern edge consists primarily of housing which addresses the internal estate roads to the north of Hoxton Park Road. Houses along this edge back on to the road. Housing within this section is typically brick veneer construction of one and two storeys in height. Rear boundary fences are either Colorbond, or lapped and capped timber fences of approximately 2.0m in height. Refer figure 6.4.

On the south side, housing stock is more varied. Housing along this edge varies in age and setback. Refer Figure 6.5. Some pockets of remnant rural holdings also exist along this edge retaining part of the character that would have once dominated the area. Approximately half of houses within this section presently address and have access off Hoxton Park Road. The newer subdivision design adjoining these residences has been undertaken so that properties address an internal road and turn their backs on Hoxton Park Road.

Vegetation associated with the housing stock along this edge is presently remnant or regrowth Eucalypts,

Figure 6.4 - Rear boundary lapped fence

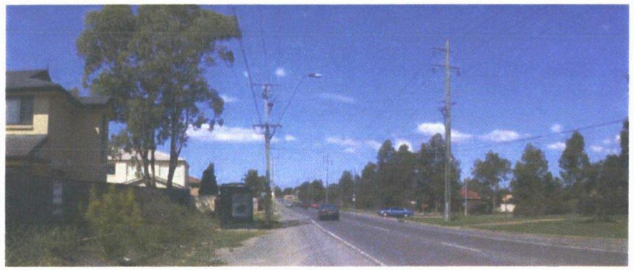


Figure 6.5 - Example of house setbacks from Hoxton Park Road

Casuarinas and screen planting. The character of this southern edge contrasts with the treeless edge along the northern side of the road.

The road design needs to address the following issues:

- The increased scale (footprint) of the road within the limited road reserve
- The formality of the new kerb and guttering
- Significant reduction in the setback of existing houses on the south side due to increased road footprint
- The construction of the pavement closer to the southern houses including property acquisition
- Loss of existing vegetated front yards of houses on the south side of the road
- Treatment of acoustic/noise issues
- Access from adjoining properties to the new Hoxton Park Road

Visual Effect

The greatest visual impact is the increase in scale of the road, and the subsequent loss in vegetation cover and building setback on the south side of Hoxton Park Road. The dominant visual vantage points are that of the road user and the adjoining residences on the south side of the road. The northern properties address the internal estate roads and do not front onto Hoxton Park Road.

The south side properties currently address Hoxton Park Road and are typically set well back from the existing alignment. The proposed changes substantially reduce the setback of properties along the southern edge of the corridor, changing the character and function of the front yards and in some instances requires full acquisition of the property.

Sensitivity

This section of the road has a high sensitivity to change due to its proximity and exposure to residential properties. Almost all housing south of the road fronts onto the road, making these properties susceptible to any change. This change is unavoidable and needs to be managed. This includes the proposed partial or full acquisition of properties along this edge. The key issues of property access and acoustic conditions determine whether partial or full property acquisition is required. The addition of noise barriers along the south edge of the road upgrade would compromise the properties northerly aspect. The re-orientation of the houses to address and access rear streets could necessitate revision to the internal layouts of the houses.

Recommendations

The visual design of the road upgrade can assist in achieving a sense of streetscape and landscape setting for the existing residences. Planting of the median can assist in reducing the visual scale of the road and integrate the road with its surrounding environment.

The treatment of the verges plays an important role in addressing the interface between the existing houses and the road. The design should ensure a treed edge to further define and enclose the corridor and to provide an element of human scale, reducing the impact of the wall of housing on the south side and to soften the strong lineal edge created by the presence of noise walls on the north side.

Verge width should be maintained at a minimum of 5.0m along the southern boundary. This will ensure sufficient space for pedestrians and landscape. The treatment of the southern boundary and the extent of land acquisition are primary concerns. Half of the properties within this section are affected by acquisition. Any future redevelopment of the site should explore construction methods and forms that provide both an effective barrier to noise and address the street. The provision of noise wall housing could provide an extra dimension to the experience of the road by integrating the architecture with the road rather than turning its back on the road. Any such development would need to be undertaken in consultation with Liverpool City Council and is not part of this road upgrade proposal.

7 LANDSCAPE AND URBAN DESIGN

The landscape and urban design concepts for the proposal are depicted in the accompanying plan and cross sections. These concept designs reflect the findings and recommendations of the preceding sections of this working paper.

7.1 Objectives of the Design

The design has sought to provide a safe, efficient four lane divided road which meets the needs of the community by:

- Building on the character of the existing remnant vegetation between Banks Road and First Avenue to create a Riverine landscape setting
- Developing a character that is consistent with the suburban context between First Avenue and Cowpasture Road and links with the developing character of Cowpasture Road.
- Rationalising services within the corridor with potential for under grounding of overhead wires
- Maintaining full access to the shopping/community precinct to minimise impact on the viability of the centre so that it may continue to function as a local node
- Exploring the use of resumption of land to provide an improved residential and road interface. Housing could be developed as part of the noise abatement measures to address the street in a better manner than has occurred to date. Such housing could occur along the southern edge of the upgrade where development along the Hoxton Park Road is incomplete and the need for resumption of land is greatest
- Integrating all transport systems including bus/transit way stops and pedestrian/cycle ways to provide an attractive alternative to the car
- Assisting in the reinforcement and enhancement of the road environs and its relationship to adjoining uses. The road design has adopted a number of principles and a palette of materials, which both define the urban design and integrate the road with its surrounding context

Principles

- Landscape character should be varied and respond to reflect the changing character of the corridor through which it passes, i.e. Riverine/ Parkland, Shopping Centre, and Residential Precincts
- Median to be depressed to assist with drainage and storage volumes during heavy flows
- Integrate landscape and urban design strategies adopted for adjoining works, including Cowpasture Road, M7 and Hoxton Park Road Stage 1.

Figure 7.1 - Example of noise attenuation treatment along Cowpasture Road

7.2 Materials Palette

7.2.1 Hard Landscape Elements

This includes all built structures within the corridor including lighting, bridges, noise walls and paving.

Lighting

Lighting for the road is to use standard road lighting, consisting of tapered steel galvanised pole with outreach. Lighting is to be designed to meet the requirements of an arterial road within an urban setting and should meet the requirements of AS 1158 code of practice for public lighting, category P2 and V3. Lighting should be selected to minimise light spill beyond the corridor and be consistent with that used in Hoxton Park Road Stage 1.

Bridges

Two bridges are to be built as part of the proposal. These are of a standard concrete plank construction, and are located at the present location of Buggy's Bridge. Two bridges are required to enable staged construction and demolition of the existing bridge.

Due to the increased scale of this creek crossing a relatively large area of the creek will be in shade. Opportunities to limit the extent of overshadowing could be explored in the treatment of the pedestrian path. In particular the treatment of the pedestrian path as a continuation of the road deck should be reviewed. This will enable opportunities to reduce the side profile of the bridge, reducing the visual scale.

Services crossing the creek should be integrated with the substructure of the bridge so that they are concealed and do not appear as an afterthought. The design of bridges is to be undertaken in accordance with RTA Aesthetic Guidelines for Bridges.

Bus Shelters

Bus shelters form part of the local bus service network. Shelters should therefore be consistent with those used elsewhere within the system and are to be selected in consultation with Liverpool City Council. Shelters occur within a paved plaza where adjacent to the cycleway. This facilitates uninterrupted access for the users of the shared path and minimises conflicts with bus patrons. The opportunity to use a different paving colour or finish should be explored to delineate this zone.

Noise walls

There are only a limited number of existing noise wall structures along Hoxton Park Road, east of Stage 2. This is primarily due to the age of the road in those sections. Recent upgrade works have included the construction of blockwork noise walls, such as at Liverpool West Primary School. Refer figure 7.2d.

The noise assessment report for the road upgrade has identified a number of locations that require noise attenuation measures. The locations that can be adequately addressed by noise walls are as follows:

- The new residential development, on south side, east of First Avenue
- The Good Samaritan School, on north side, west of First Avenue. The existing timber noise walls can be retained.
- The residential area, on south side, for 150m east to 150m west of Glen Innes Road
- The residential area, on north side, from Glen Innes Road to Cowpasture Road

Architectural treatment of buildings or groups of buildings will be investigated and implemented in locations where other noise attenuation measures are necessary.

The location and height of proposed noise walls is identified in the noise assessment report. The visual design of the walls will be undertaken in accordance with RTA noise wall design guidelines. The visual design will also consider the type of noise walls that have been used in adjacent areas. Where space permits, soft landscape treatments are the prefered means of screening or integrating noise walls with the streetscape. Noise walls have been used extensively along Cowpasture Road. Refer figures 7.2a and 7.2b. Due to the close proximity and neighbourhood relationship of the western end of Hoxton Park Road upgrade, Stage 2 to Cowpasture Road and the existing noise walls, the new walls in Hoxton Park Road should be a complementary design to those existing walls. In areas of visual prominence such as intersections or 'gateways' to adjacent neighbourhoods highlight stone patterned walls should be used. In less prominant locations and where screen planting can be installed the simpler wall panel design should be used.

Figure 7.2a - Feature Wall

Figure 7.2b - Timber Wall as used at the Good Samaritan School

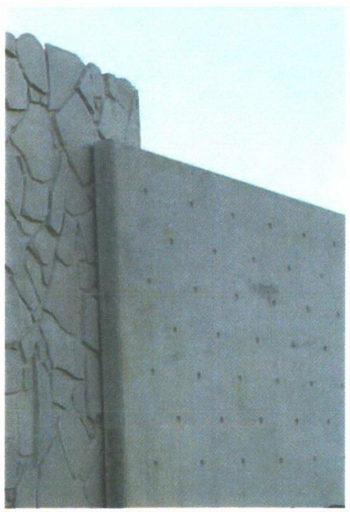


Figure 7.2c - Feature Wall Adjoining Plain Wall

Figure 7.2d - Block work wall

The new noise wall located east of First Avenue should reflect the existing noise wall at the Good Samaritan School. This is a low-key timber wall, which would integrate well with the Riverine Landscape that leads into this precinct. Refer figure 7.2c

7.3 Planting Design

The proposed planting design reflects the three landscape character zones of the area. The landscape character is native throughout, but is locally differentiated by planting mix and structure.

Riverine/Parkland Precinct

Hoxton Park Recreation Reserve and Hinchinbrook Creek strongly influence the character of the road. The planting palette reflects the natural communities present within this zone, ie Shale Plains Woodland and the Alluvial Woodland.

Planting Palette

Canopy Trees	
Angophora Floribunda	- Rough-barked apple
Eucalyptus amplifolia	-
Eucalyptus molucanna	- Grey box
Eucalyptus tereticornis	- Forest red gum
Casuarina glauca	- Swamp Oak
Median/Understorey Planting	
Dianella longifolia	-
Danthonia tenuior	- Wallaby Grass
Isolepsis nodosa	- Club-rush
Isolepsis inudata	- Spikey Club Rush
Lomandra longifolia	- Mat-rush
Micorlena stipoides	- Weeping Rice Grass
Themeda australis	- Kangaroo Grass
Creekline	
Canopy Trees	
Eucalyptus molucanna	- Grey box
Eucalyptus tereticornis	- Forest red gum
Casuarina glauca	- Swamp Oak

Creek and Understorey Planting

Bursaria spinosa	- Blackthorn
Bulbaschoenus caldwellii	-
Carex appressa	- Tall Sedge
Cyperus polystchyos	-
Indigophora australis	-
Isolepsis nodosa	- Club Rush
Isolepsis inudata	- Spikey Club Rush
Juncus continuous	-
Lomandra longifolia	- Mat-rush

The design of the reworked creek line channel needs to consider the ecological parameters of the creek line function. The creek line should not be treated in a hard fashion but should use soft engineering solutions such as jute logs and matting where flow velocities permit. The design should seek to create a series of ponds linked by a wet channel, which would facilitate the movement of aquatic fauna. Planting densities and treatments need to consider the developed nature of the catchment and the presently weed infested condition of the site.

Shopping Centre Precinct

This precinct has a suburban strip development strip residential character. The landscape design provides a formal and structured streetscape planting with lawns and low planting to distinguish this place from the adjoining natural parkland precinct. The landscape design provides avenues and rows of tall canopy trees (Corymbia maculata) that delineate the road. The median design is grass edges with central feature planting of ornamental native shrubs. This landscape design relates to the intersection treatments of Hoxton Park Road Stage 1.

Planting Palette

Canopy Trees

Corymbia maculata	- Spotted Gum

Median/Understorey Planting

Dianella longifolia	
Dinaella revoluta	
Grevillea Superb	
Lomandra longifolia	- Mat-rush

Residential Precinct

The residential precinct is presently a mix of residential buildings, the majority of which back onto the road. This presents a fragmented and awkward frontage to the road. The landscape design aims to unify this section of streetscape by providing a strong lineal landscape of native plants. The median has a row of tall canopy trees (Eucalyptus tereticornis) in the centre, and the surface is planted with low growing native grasses and sedges,

The verge landscape is informal with mixed eucalyptus, native shrubs, and groundcovers defining the edge of the corridor. At intersections, the planting design is more formal, with tall canopy trees flanking the approaches, and with feature shrub planting in the medians.

Planting Palette

Canopy Trees

Corymbia maculata	
Eucalyptus molucanna	- Grey box
Eucalyptus tereticornis	- Forest red gum

Median/Understorey Planting

Dianella longifolia	
Dinaella revoluta	
Grevillea Superb	
Isolepsis nodosa	- Club Rush
Isolepsis inudata	- Club Rush
Lomandra longifolia	- Matt-rush
Poa labillideria	- Large Tussock Grass

RESIDENTIAL PRECINCT	SHOPPING CENTRE PRECINCT	RIVERINE / PARKLAND PRECINCT
BETWEEN COWPASTURE ROAD AND DORRIGO AVENUE	BETWEEN DORRIGO AVENUE AND FIRST AVENUE	BETWEEN FIRST AVENUE AND BANKS ROAD

0m 100m 200m 300m

N

AVENUE / ROW PLANTING
MEDIAN - Eucalyptus tereticornis
VERGE - Eucalyptus maculata

RESIDENTIAL PRECINCT PLANTING

RIVERINE / PARKLAND PRECINCT PLANTING

EXISTING NATIVE VEGETATION RETAINED

MEDIAN AND VERGE PLANTING

SHAREWAY / FOOTPATH

ROADWAY

Figure 7.3 - Landscape and Urban Design Concept Plan

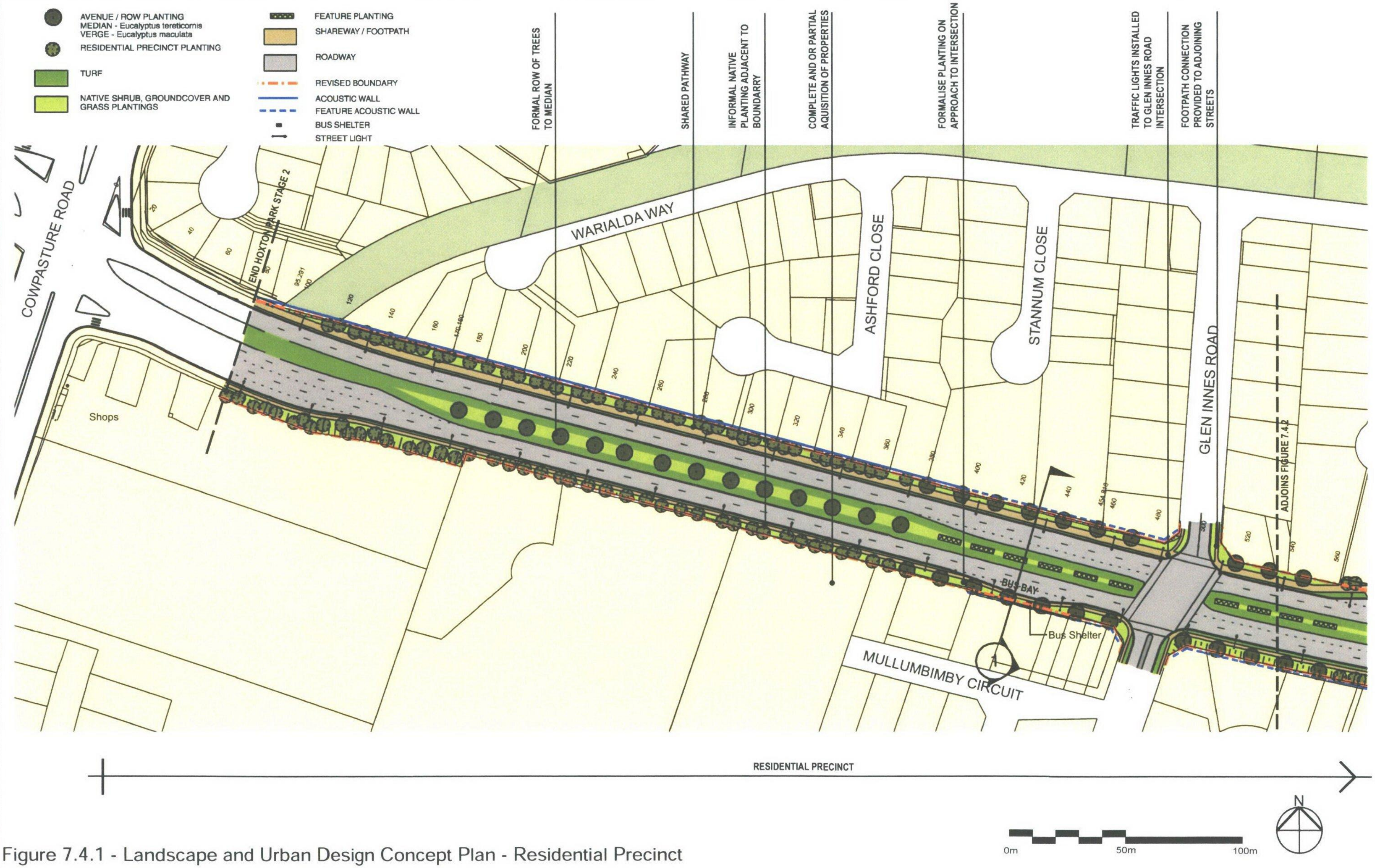


Figure 7.4.1 - Landscape and Urban Design Concept Plan - Residential Precinct

Figure 7.4.2 - Landscape and Urban Design Concept Plan - Residential and Shopping Centre Precinct

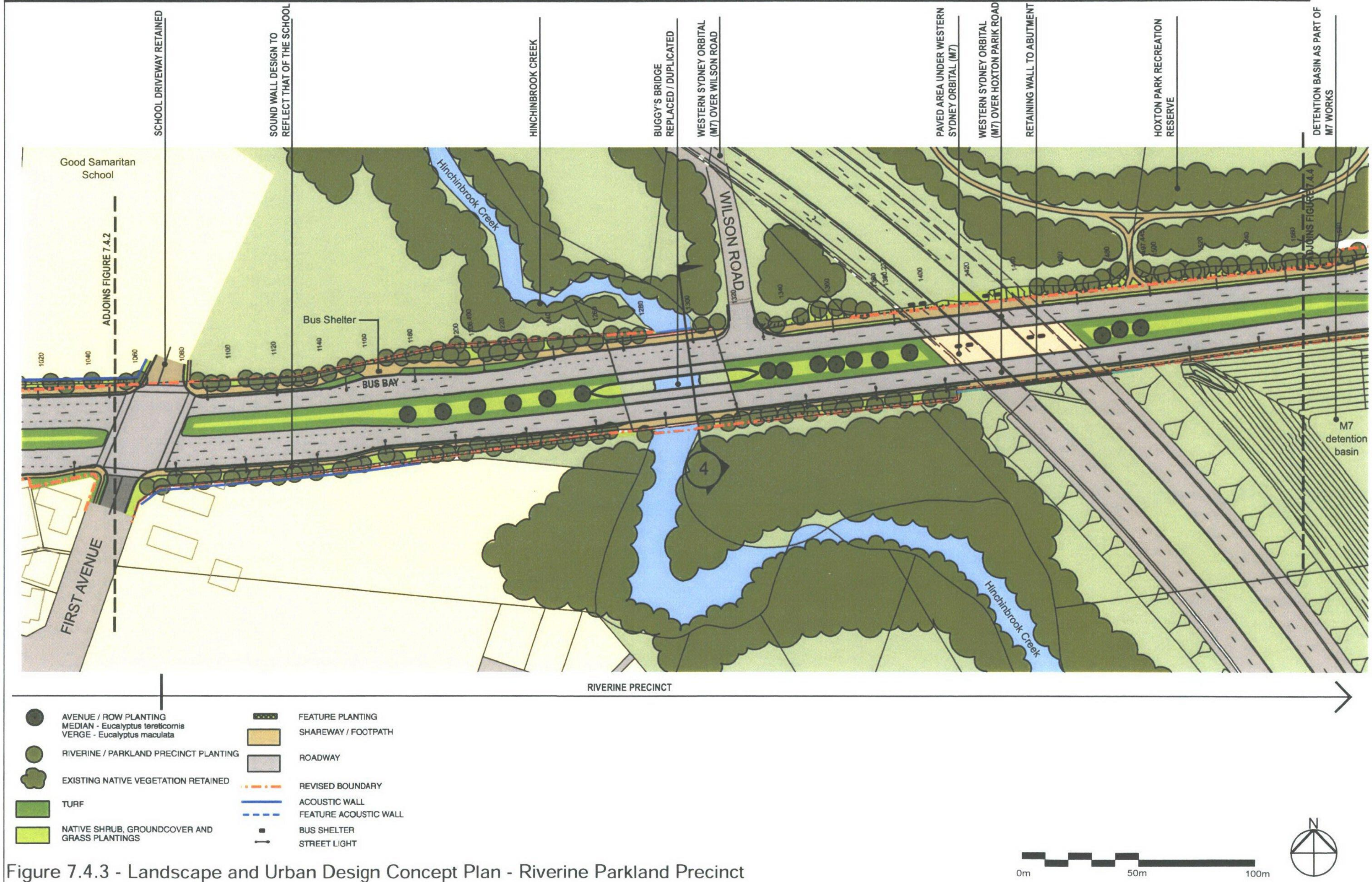
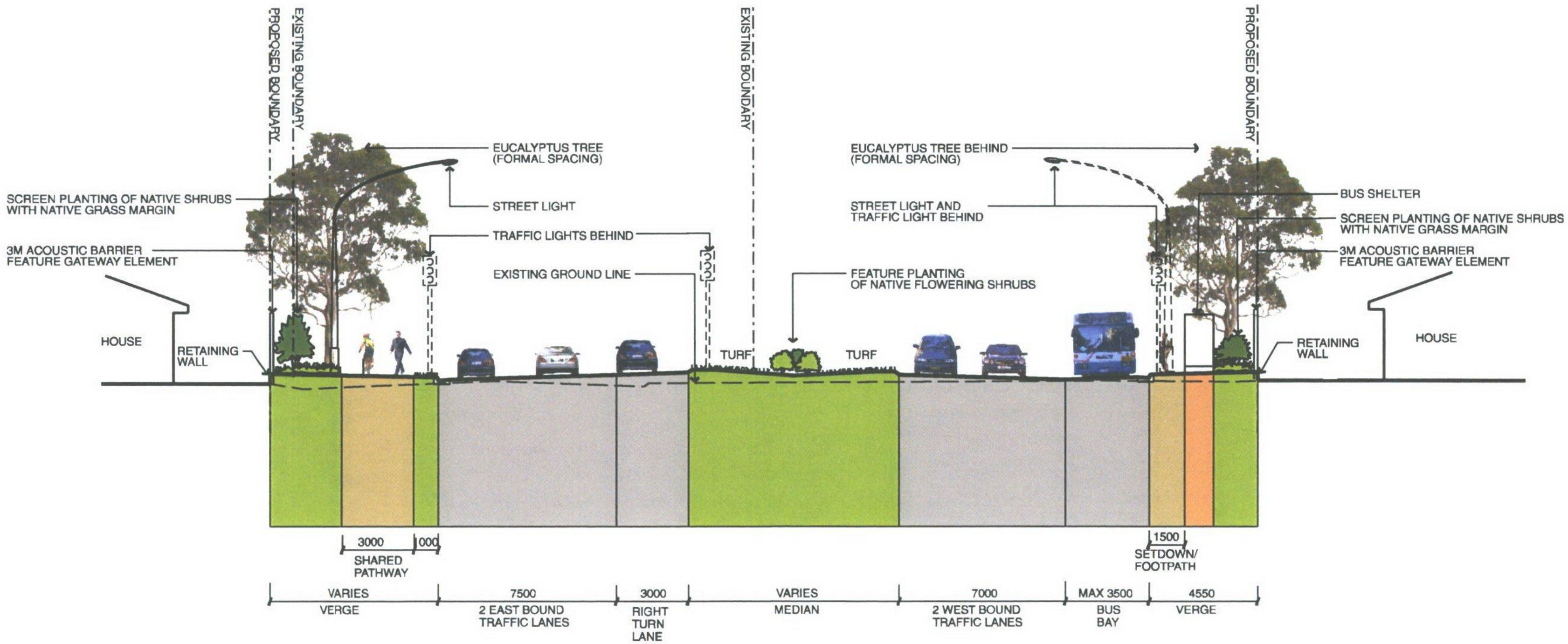


Figure 7.4.3 - Landscape and Urban Design Concept Plan - Riverine Parkland Precinct

Figure 7.4.4 - Landscape and Urban Design Concept Plan - Riverine Parkland Precinct



1 GLEN INNES ROAD INTERSECTION / BUS STOP
SECTION
CH 440

Figure 7.4.5

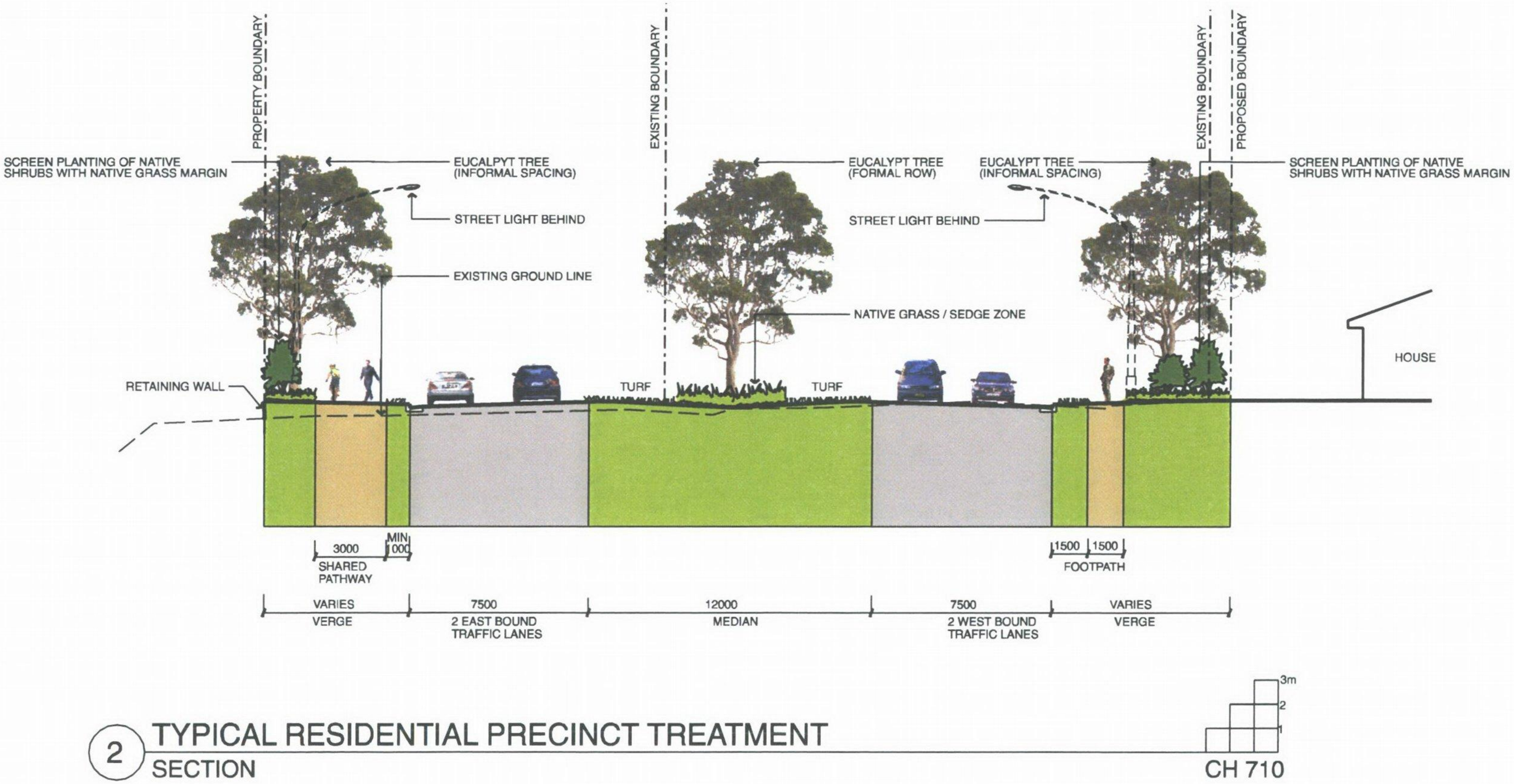
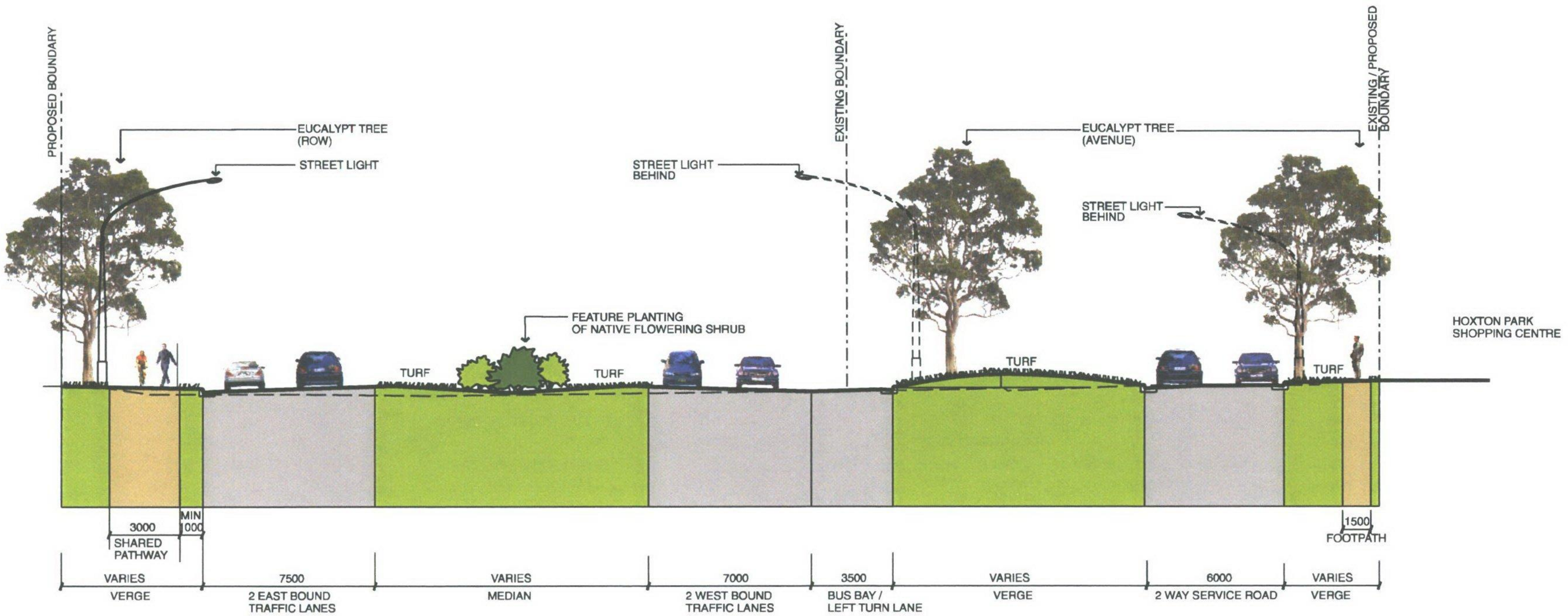

PROPERTY BOUNDARY
EXISTING BOUNDARY
EXISTING BOUNDARY
PROPOSED BOUNDARY
SCREEN PLANTING OF NATIVE SHRUBS WITH NATIVE GRASS MARGIN
EUCALYPT TREE (INFORMAL SPACING)
STREET LIGHT BEHIND
EXISTING GROUND LINE
EUCALYPT TREE (FORMAL ROW)
EUCALYPT TREE (INFORMAL SPACING)
STREET LIGHT BEHIND
SCREEN PLANTING OF NATIVE SHRUBS WITH NATIVE GRASS MARGIN
NATIVE GRASS / SEDGE ZONE
HOUSE
RETAINING WALL
TURF
TURF
3000
SHARED PATHWAY
MIN 1000
1500
1500
FOOTPATH
VARIES
VERGE
7500
2 EAST BOUND TRAFFIC LANES
12000
MEDIAN
7500
2 WEST BOUND TRAFFIC LANES
VARIES
VERGE
3m
2
1
2 TYPICAL RESIDENTIAL PRECINCT TREATMENT
SECTION
CH 710

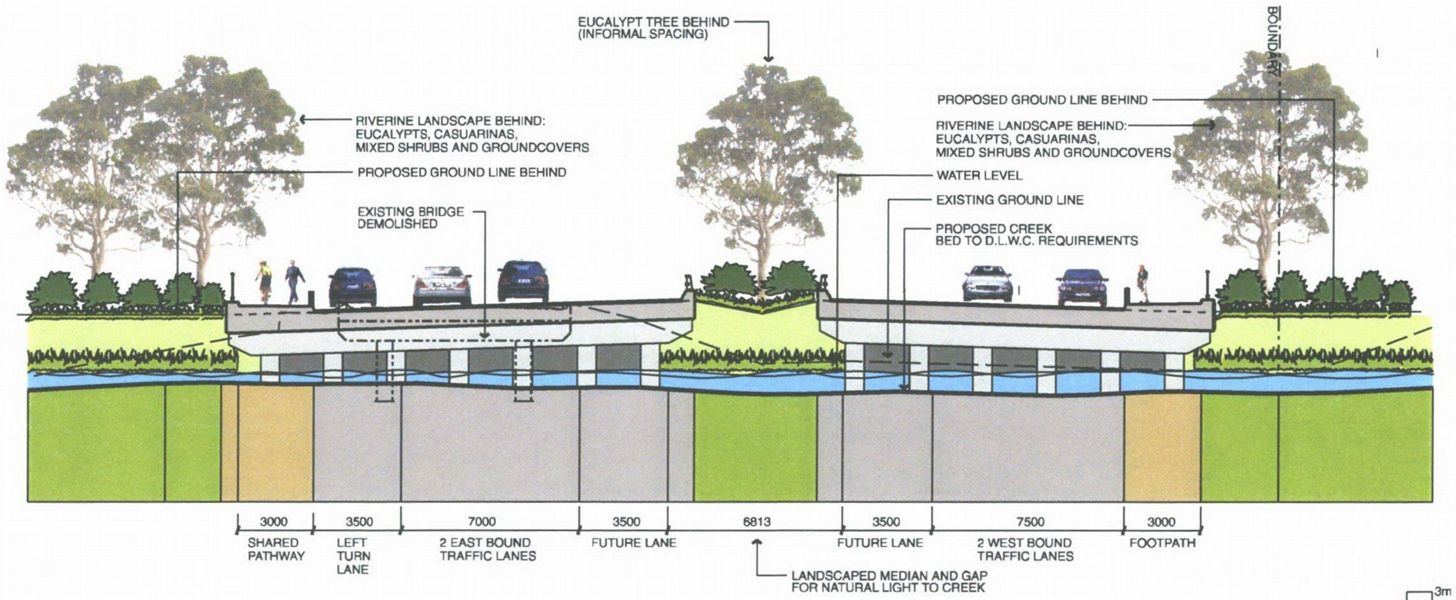
Figure 7.4.6



3 HOXTON PARK SHOPPING CENTRE
SECTION

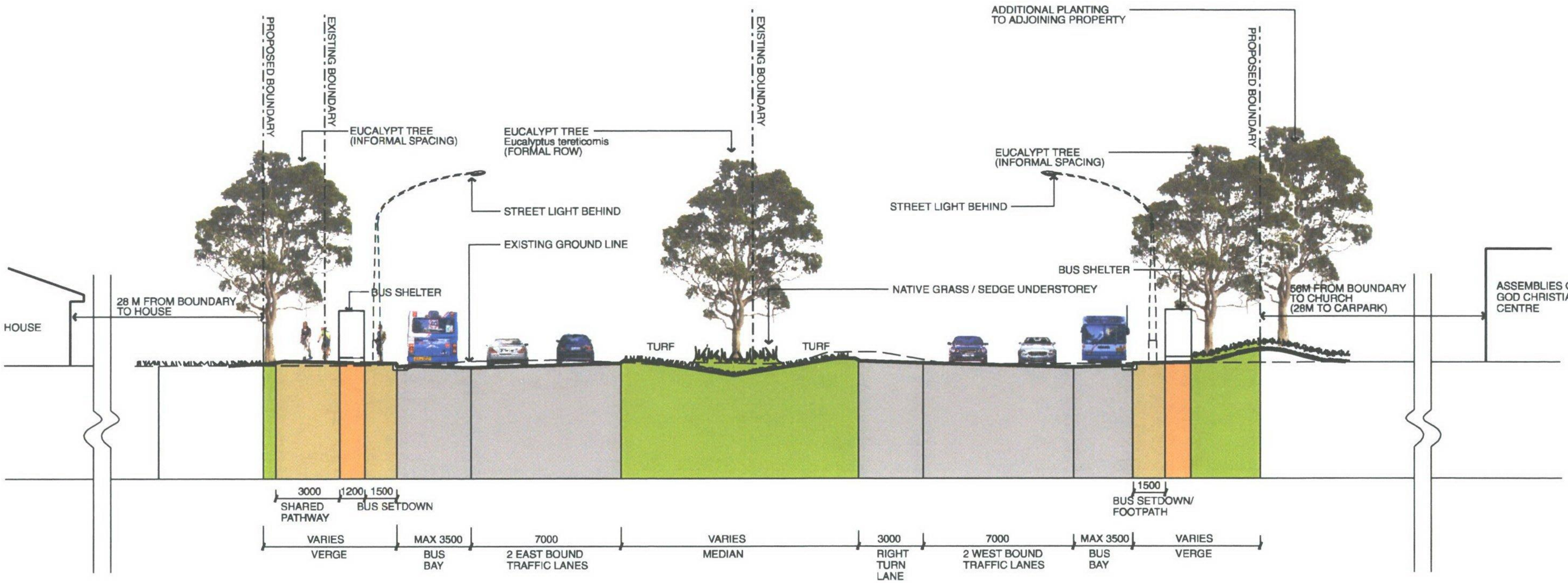
CH 850

Figure 7.4.7



4 BUGGY'S BRIDGE
SECTION
CH 1300

Figure 7.4.8



5 TYPICAL RIVERINE PRECINCT
SECTION

CH 1750

Figure 7.4.9

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Appendix H

Noise and Vibration Assessment

ROAD TRAFFIC AND CONSTRUCTION NOISE AND VIBRATION ASSESSMENT HOXTON PARK ROAD UPGRADE COWPASTURE ROAD TO BANKS ROAD HOXTON PARK

34.5373.R1:DD53
Rev 01

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March 2004

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APPENDICES

1.0 INTRODUCTION

The NSW Roads and Traffic Authority (RTA) proposes to widen Hoxton Park Road between Cowpasture Road and Banks Road from two (2) to four (4) lanes. Appendix 1 shows the location of the proposed road works.

Atkins Acoustics was commissioned by Connell Wagner on behalf of the RTA to conduct an assessment of traffic noise from the proposal and construction noise and vibration during construction of the road.

This report provides a summary of the findings from the noise and vibration assessments and advice on possible control measures to reduce operational and construction noise and vibration impacts.

The findings and recommendations from the study have been prepared for the particular investigation described and no part should be used in any other context or for any other purpose.

2.0 METHODOLOGY

The findings and recommendations presented in this report are based on the identification of potentially affected residences from aerial photographs and site inspections together with traffic data and road alignments provided by Connell Wagner. The methodology adopted for the noise and vibration assessment is as follows:

- site inspection to identify the study area and properties potentially affected by noise and vibration from the proposed road works;
- measurement of existing background and road traffic noise levels at representative receiver locations potentially affected by the proposal;
- establishment of road traffic noise assessment goals in accordance with the Department of Environment and Conservation (DEC) (formerly EPA) Environmental Criteria for Road Traffic Noise (ECRTN, May 1999);
- establishment of construction noise assessment goals in accordance with the DEC Environmental Noise Control Manual (ENCM, 1994);
- establishment of vibration assessment goals in accordance with the ENCM guidelines and other relevant guidelines;
- development of a noise prediction model based on the road alignment provided by Connell Wagner;
- validation of the noise prediction model by comparison of the predicted and measured noise levels;
- prediction and assessment of existing and future operational road traffic noise levels;

- prediction and assessment of noise and vibration levels from envisaged construction activities; and

- recommendation of possible mitigation measures to reduce traffic noise and construction noise and vibration impacts.

3.0 DESCRIPTION OF PROPOSAL

The proposed widening of Hoxton Park Road from two (2) to four (4) lanes is approximately 2km long, commencing from Cowpasture Road to Banks Road (Appendix 1). The widening allows a median reserve of approximately 10m between the east-bound and west-bound lanes for possible future development.

There will be no widening of the road on the east-bound lanes (northern side of Hoxton Park Road), except for a section from chainages 640m to 1100m where straightening of the existing road results in a shift towards the north by approximately 15m – 40m. The west-bound lanes (southern side of Hoxton Park Road) is re-aligned approximately 15m to the south of the existing road, except for the section from chainages 640m to 1100m which will be shifted towards the north.

Existing properties along Hoxton Park Road within the study area include single and two-storey residential dwellings, the First Steps Childcare Centre, Good Samaritan Catholic College, Seventh Day Adventist Church, Liverpool Christian Life Centre and commercial premises.

The nearest residences and childcare centre on the northern side of Hoxton Park Road are approximately 13m from the proposed road alignment. The properties at present are approximately 10m from the existing road alignment.

The nearest classroom of the Good Samaritan Catholic College is approximately 30m from the proposed road alignment, compared to 55m from the existing alignment. The college has a 1m high retaining wall and a 2.5m high acoustic barrier on top of the retaining wall facing the road. Preliminary site inspections revealed that the exposed classrooms are provided with acoustics treatment accept for the de-mountable classrooms near the school entrance. The playgrounds are located behind classroom and administration buildings and are shielded from Hoxton Park Road traffic noise.

The Seventh Day Adventist Church is approximately 55m from both the existing and proposal road alignments. From our inquiries, it is understood that the church is provided with mechanical ventilation and that windows fronting Hoxton Park Road are normally closed.

The Liverpool Christian Life Centre is approximately 75m and 95m from the proposed and existing road alignments respectively. From our inquiries, it is understood that the offices of the Liverpool Christian Life Centre are air-conditioned. The canteen and gymnasium are used for church activities on Sundays and Fridays and the windows and doors are normally open.

On the southern side of Hoxton Park Road, the closest existing single and two-storey residential dwellings are approximately 12m from the proposed alignment compared to 30m for the existing road alignment, except for the residences between chainages 640m and 1100m. These residences are further from the proposed road alignment (25m compared to 8m from the existing alignment).

4.0 EXISTING AMBIENT NOISE LEVELS

The existing noise environment at representative receiver locations was measured at three (3) residential receivers and the Good Samaritan Catholic College (*Appendix 1*) over a period of seven (7) days from Monday 21-28 July 2003.

Instrumentation used for the measurements consisted of four (4) environmental noise data loggers. The loggers were set to A-weighting, fast response and programmed to calculated and record statistical noise levels at every 15-minute interval. The calibration of each logger was checked before and after the measurements with a Bruel & Kjaer sound level calibrator Type 4230. The drift in calibration was within ±1dB(A).

Detailed results of the noise measurements showing common statistical noise levels at every 15-minute interval are provided in *Appendix 2*. *Tables 1* to *3* present a summary of the existing background and road traffic noise levels at the measurement locations.

The measurement was conducted in free field conditions at locations 1 and 3, hence a correction of +2.5dB(A) was added to the traffic noise levels to account for façade reflection.

Results of the measurements (*Table 2*) show that the $L_{Aeq,15hr}$ (daytime) road traffic noise levels are 5dB(A) higher than the $L_{Aeq,9hr}$ (night-time) levels. The morning peak-hour noise levels are 2dB(A) higher the afternoon peak-hour noise levels during school hours from 8:30am to 3:30pm (*Table 3*).

Table 1 ***Existing L_{A90} Rating Background Noise Levels***
dB(A) re 20 × 10^-6 Pa

Measurement Location (*Ref. Figure 1*)	**L_{A90} Rating Background Noise Level**		
	Day	**Evening**	**Night**
Location 1. 7 Whitford Road	53	52	40
Location 2. Good Samaritan Catholic College	48	46	38
Location 3. 620 Hoxton Park Road	55	48	35
Location 4. 2 Glenn Innes Road	57	50	37

Notes: 1. Day (7:00am – 6:00pm)
2. Evening (6:00pm – 10:00pm)
3. Night (10:00pm – 7:00am)

Table 2 ***Existing Road Traffic Noise Levels***
dB(A) re 20 × 10^-6 Pa

Measurement Location (*Ref. Figure 1*)	**Existing L_{Aeq} Road Traffic Noise Level**	
	$L_{Aeq,15hr}$ (Day)	**$L_{Aeq,9hr}$ (Night)**
Location 1. 7 Whitford Road	63	58
Location 3. 620 Hoxton Park Road	67	62
Location 4. 2 Glenn Innes Road	72	67

Notes: 1. Day (7:00am – 10:00pm)
2. Night (10:00pm – 7:00am)

Table 3 ***Existing $L_{Aeq,peak\text{-}hour}$ Road Traffic Noise Levels***
dB(A) re 20 × 10^-6 Pa

Measurement Location (*Ref. Figure 1*)	**Existing $L_{Aeq,1hr}$ Road Traffic Noise Level**	
	Morning Peak Hour	**Afternoon Peak Hour**
Location 2. Good Samaritan Catholic College	56	54

5.0 TRAFFIC NOISE ASSESSMENT GOALS

5.1 Continuous Traffic Noise

Goals for the assessment of road traffic noise are nominated in the ECRTN. The assessment goals depend on the existing noise environment, types of road development and land uses. The widening of Hoxton Park Road would be categorised as a re-development of an existing arterial road and in accordance with the ECRTN the following objectives apply to traffic volumes projected 10 years post opening:

5.1.1 Baseline Noise Assessment Goals

A. Residential Receivers

The baseline traffic noise assessment goals for residential dwellings are:

- daytime ($L_{Aeq,15hr}$) traffic noise levels should be limited to 60dB(A) at 1m from the most exposed external façade of any residential premises; and
- night-time ($L_{Aeq,9hr}$) traffic noise levels should be limited to 55dB(A) at 1m from the most exposed external façade of any residential premises.

B. Places of Worship

The ECRTN traffic noise assessment goal is 40dB(A) $L_{Aeq,peak\text{-}hour}$ inside places of worship.

C. Educational Facility

For existing school, the ECRTN traffic noise assessment goal is 45dB(A) $L_{Aeq,peak\text{-}hour}$ inside classrooms during school hours.

For school playgrounds, the ECRTN road traffic noise assessment goal is 55dB(A) $L_{Aeq,15hr}$.

D. Recreational Area

For the Hoxton Park Recreational Reserve, the daytime road traffic noise level between the hours from 7:00am and 10:00pm should be limited to 60dB(A) $L_{Aeq,15hr}$.

5.1.2 Allowance Noise Assessment Goals

Where the existing road traffic noise already exceed the baseline objectives in Section 5.1.1, the ECRTN requires that the redevelopment be designed so as not to increase existing noise levels by more than 2dB(A).

Additionally, the ECRTN recommends that where feasible and reasonable, control measures should be considered and applied to reduce road traffic noise to satisfy the baseline objectives.

Additionally, the RTA Environmental Noise Management Manual (ENMM) defines noise levels of 65dB(A) $L_{Aeq,15hr}$ (daytime) and 60dB(A) $L_{Aeq,9hr}$ (night-time) as an 'acute' noise exposure. When predicted future noise levels (10 years after road opening) exceed the 'acute' noise exposure levels, the ENMM recommends greater consideration be given to reduce the external noise levels where feasible and reasonable.

5.2 Intermittent Traffic Noise

Maximum noise levels from vehicle pass-bys during night-time hours have the potential to cause sleep disturbance to occupants of buildings. For the assessment of L_{Amax} noise level impact, the ECRTN requires the L_{Amax} noise levels from vehicle pass-bys to be predicted and assessed at potentially affected residences.

For the assessment of intermittent noise sources during night-time, the ECRTN concludes that for the current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to acceptable level of sleep disturbance. Therefore, the assessment procedure considered for this assessment has followed the procedures documented in the "*Practice Note III – protocol for assessing maximum noise levels*" of the RTA ENMM.

Reference to ENMM:

- maximum internal noise levels below 50-55dB(A) are unlikely to cause awakening reactions. These levels equate to external façade levels of 60-65dB(A) L_{Amax} with bedroom windows open to normal extent for natural ventilation.

- one (1) or two (2) noise events per night with maximum internal noise levels of 65-70dB(A) are unlikely to affect health and well-being significantly. These equate to external façade noise levels of 75-80dB(A) L_{Amax} with bedroom windows open to provide natural ventilation; and

- for continuous traffic flow, the $L_{Aeq,9hr}$ noise goal sufficiently accounts for sleep disturbance impacts. However, where the L_{Amax} exceed the $L_{Aeq,9hr}$ noise level by 15dB(A) or higher for intermittent traffic flow, sleep disturbance may occur.

The ENMM considers that the maximum noise level assessment should not be applied as a decisive criterion. However, the maximum noise levels may be used to rank and prioritise design options and noise mitigation strategies where mitigation measures are considered to be feasible reasonable in accordance with the ECRTN.

6.0 TRAFFIC NOISE PREDICTION MODELLING

Factors considered for the traffic noise modelling include traffic volumes, proportion of heavy vehicles, average traffic speed, vertical and horizontal road alignment, road surface texture, distances to noise receivers, noise receivers and source heights, local ground topography, building façade reflection and shielding from front-row dwellings. Details considered for establishing the traffic noise prediction model for Hoxton Park Road included:

6.1 Prediction Methodology

Road traffic noise levels at reference distances were calculated using the UK Department of Transport "The Calculation of Road Traffic Noise (CoRTN)) traffic noise model. Reference sound power levels developed from CoRTN were incorporated in the Environmental Noise Model (ENM) to calculate and generate noise contours for the study area. The ENM model takes account of noise attenuation from distance, shielding from barriers and intervening topography, atmospheric absorption and ground effect.

6.2 Road Alignment

The road alignment, cross sections and ground contours were provided by Connell Wagner.

6.3 Road Surface

The road selected was dense graded asphalt.

6.4 Noise Source Heights

For the noise modelling, source heights of 0.5m, 1.5m and 3.6m above the ground level assigned to cars, trucks and truck exhausts respectively.

6.5 Traffic Data

Table 4 to *6* present summaries of the daytime, night-time, morning and afternoon peak-hour traffic volumes on Hoxton Park Road for the existing condition (2003), at the road opening (2006) and ten (10) years after the road opening (2016).

Table 4 Existing Traffic Data (2003)

Location	Direction	Existing Traffic Data (2003)			
		Daytime[1]	Night-time[2]	AM Peak[3]	PM Peak[4]
East of Illaroo Road/Whitford Road	East Bound	9,310	2,583	742	725
	West Bound	12,157	1,842	673	1191
	Total	21,567	4,425	1,415	1,916
	% HV[5]	11%	13%	15%	11%
East of Glen Innes Road	East Bound	8,334	1,112	556	772
	West Bound	6,368	1,392	490	560
	Total	14,702	2,504	1,046	1,332
	% HV	11%	14%	15%	10%

Notes:
1. Daytime (7:00am – 10:00pm)
2. Night-time (10:00pm – 7:00am)
3. AM Peak is morning peak hour during school hours (8:30am – 3:30pm)
4. PM Peak is afternoon peak hour during school hours (8:30am – 3:30pm)
5. Percentage of heavy vehicles

Table 5 Forecast Traffic Data (2006)

Location	Direction	Forecast Traffic Data (2006)			
		Daytime	Night-time	AM Peak	PM Peak
East of Illaroo Road/Whitford Road	East Bound	8,516	1,972	884	636
	West Bound	9,924	1,751	720	1,000
	Total	18,440	3,723	1,604	1,636
	% HV	11%	15%	17%	10%
East of Glen Innes Road	East Bound	3,275	1,181	308	244
	West Bound	5,028	1,168	306	509
	Total	8,303	2,348	614	753
	% HV	11%	15%	15%	10%

Table 6 Forecast Traffic Data (2016)

Location	Direction	Forecast Traffic Data (2016)			
		Daytime	Night-time	AM Peak	PM Peak
East of Illaroo Road/Whitford Road	East Bound	10,147	2,515	1,099	815
	West Bound	10,695	1,858	695	1,339
	Total	20,842	4,373	1,794	2,154
	% HV	11%	15%	17%	10%
East of Glen Innes Road	East Bound	4,321	1,671	556	315
	West Bound	5,492	1,168	291	713
	Total	9,813	2,839	847	1,028
	% HV	11%	14%	14%	10%

6.6 Traffic Speed

The current speed limit for Hoxton Park Road within the study area is 60km/hr. The proposed posted speed limit for the upgraded road is 70km/hr.

6.7 Receiver Height

Road traffic noise was assessed at the building façades most exposed to the road and at heights of 1.5m and 4.5m above the ground level, representing single and two-storey dwellings respectively.

6.8 Building Façade Correction

In accordance with the CORTN road traffic noise prediction procedures, a correction of 2.5dB(A) has been added to the predicted noise levels to account reflection from building façades.

6.9 Validation of Noise Prediction Procedure

Road traffic noise levels were calculated at the monitoring locations using existing traffic data (2003) recorded simultaneously with the noise measurement. The measured and calculated noise levels were compared to validate the prediction model.

Table 7 presents a comparison of the predicted and measured noise levels. The calculations confirmed that the predicted noise levels are up to 2dB(A) higher than the measured levels. Additionally, the predicted difference between daytime and night-time noise levels is 6dB(A), compared a difference of 5dB(A) from the measured levels (*Table 2*).

Given the small differences between the predicted and measured noise levels, no adjustment has been made to the noise prediction model.

Table 7 Comparison of Measured and Predicted Noise Level

Reference Location	**Daytime Road Traffic Noise Level ($L_{Aeq,15hr}$)**		**Night-time Road Traffic Noise Level ($L_{Aeq,9hr}$)**	
	Measured	**Calculated**	**Measured**	**Calculated**
Location 1. 7 Whitford Road	63	65	58	59
Location 3. 620 Hoxton Park Road	67	69	62	63
Location 4. 2 Glenn Innes Road	72	73	67	67

7.0 PREDICTED TRAFFIC NOISE LEVELS

7.1 Continuous Traffic Noise

Tables 8 and *9* summarise the predicted existing and future $L_{Aeq,15hr}$ (daytime) and $L_{Aeq,9hr}$ (night-time) road traffic noise levels at representative residential receivers. Appendices 3 and 4 present the predicted $L_{Aeq,15hr}$ (daytime) and $L_{Aeq,9hr}$ (night-time) road traffic noise contours along the Hoxton Park Road corridor between Cowpasture Road and Banks Road for receiver heights at 1.5m and 4.5m above ground levels, representing single and two-storey residences respectively.

Table 10 presents the predicted $L_{Aeq,15hr}$ (daytime) road traffic noise levels at the school playground of the Good Samaritan Catholic College and Hoxton Park Recreation Reserve. The noise prediction for the school playground takes account of shielding provided by the existing acoustic barrier, administration and classroom buildings.

The predicted existing and future $L_{Aeq,peak\text{-}hour}$ (peak-hour) road traffic noise levels inside educational facilities and places of worship are presented in *Table 11*. The internal noise levels were calculated from the differences between external and internal levels as follows:

- 21dB(A) for the Seventh Day Adventist Church (based on the results of the noise audit);
- 10dB(A) for the Canteen and gymnasium of the Liverpool Christian Life Centre (where group activities take place) (based on the results of the noise audit);
- 20dB(A) for the classrooms of the Good Samaritan Catholic College as the college is air-conditioned and acoustically treated;
- 10dB(A) for the de-mountable classrooms of the Good Samaritan Catholic College; and
- 10dB(A) for the First Step childcare centre. Additionally, 10dB(A) noise

attenuation was allowed for shielding effect from the existing noise barrier.

The predicted future road traffic noise levels presented in *Tables 8* to *11* are for year 2016 (10 years after the road opening). Based on the traffic forecast shown in *Tables 5* and *6*, the difference in road traffic noise levels between 2006 and 2016 is typically 1dB(A).

Table 8 ***Predicted $L_{Aeq,15hr}$ Road Traffic Noise Levels at 1m from Residential Façade***
dB(A) re 20 × 10⁻⁶ Pa

Group	Receiver Location	Pre-development $L_{Aeq,15hr}$ Noise Level	Noise Assessment Goal		Predicted $L_{Aeq,15hr}$ Noise Level	Change in Noise Level	Compliance	
			Baseline	Allowance			Baseline	Allowance
North of Hoxton Park Road								
A	Cowpasture Road – Glen Innes Road	69 – 72	60	71 – 74	66 – 68	-3 to -4	×	√
B	Glen Innes Road – Good Samaritan Catholic College	68 – 70		70 – 72	68 – 70	0	×	√
C	Whitford Road – Deneb Place	62 – 67		64 – 67	61 – 66	-1	×	√
D	East of Deneb Place	60 – 61		62 – 63	59 – 60	-1	√	√
South of Hoxton Park Road								
E	West of Mullumbimby Avenue	62	60	64	63	+1	×	√
F	Mullumbimby Avenue – Glen Innes Road	65 – 66		67 – 68	67 – 68	+2	×	√
G	Glen Innes Road – Dorrigo Avenue	66 – 72		68 – 74	63 – 69	-3	×	√
H	Dorrigo Avenue – First Avenue	71 – 72		73 – 74	64 – 67	-5 to -7	×	√
I	East of First Avenue	57 – 61		60 – 63	56 – 60	-1	√	√

Notes: *√ denotes compliance*
× denotes non-compliance

Table 9 ***Predicted $L_{Aeq,9hr}$ Road Traffic Noise Levels at 1m from Residential Façade***
dB(A) re 20 × 10^-6 Pa

Group	Receiver Location	Pre-development $L_{Aeq,9hr}$ Noise Level	Noise Assessment Goal		Predicted $L_{Aeq,9hr}$ Noise Level	Change in Noise Level	Compliance	
			Baseline	Allowance			Baseline	Allowance
North of Hoxton Park Road								
A	Cowpasture Road – Glen Innes Road	63 – 66	55	65-68	61 – 63	-2 to -3	×	√
B	Glen Innes Road – Good Samaritan Catholic College	62 – 64		64-66	63 – 65	+1	×	√
C	Whitford Road – Deneb Place	56 – 61		58-63	55 – 60	-1	×	√
D	East of Deneb Place	54 – 55		55-57	53 – 54	-1	√	√
South of Hoxton Park Road								
E	West of Mullumbimby Avenue	56	55	58	58	+2	×	√
F	Mullumbimby Avenue – Glen Innes Road	59 – 60		61-62	62 – 63	+3	×	×
G	Glen Innes Road – Dorrigo Avenue	60 – 66		62-68	57 – 63	-3	×	√
H	Dorrigo Avenue – First Avenue	65 – 66		67-68	58 – 61	-7 to -5	×	√
I	East of First Avenue	51 – 55		55	51 – 55	0	√	√

Table 10 Predicted $L_{Aeq,15hr}$ Road Traffic Noise Levels at School Playground and Recreation Reserve
dB(A) re 20 × 10^{-6} Pa

Receiver Location	Pre-development $L_{Aeq,15hr}$ Noise Level	Noise Assessment Goal		Predicted $L_{Aeq,15hr}$ Noise Level	Change in Noise Level	Compliance	
		Baseline	Allowance			Baseline	Allowance
North of Hoxton Park Road							
Hoxton Park Recreation Reserve (at 20m from existing road)	66	60	68	64	-2	×	√
Good Samaritan Catholic College – School Playground	48	55	N/A	48	0	√	N/A

Table 11 Predicted $L_{Aeq,peak\text{-}hour}$ Internal Road Traffic Noise Levels at Educational Facilities and Places of Worship
dB(A) re 20 × 10^{-6} Pa

Receiver Location	Pre-development $L_{Aeq,1hr}$ Noise Level	Noise Assessment Goal		Predicted $L_{Aeq,1hr}$ Noise Level	Change in Noise Level	Compliance	
		Baseline	Allowance			Baseline	Allowance
North of Hoxton Park Road							
First Step Childcare Centre	50	45	52	46	-4	×	√
Good Samaritan Catholic College- School Classroom	36		N/A	36	0	√	N/A
Good Samaritan Catholic College- De-mountable Classroom	50		52	51	+1	×	√
Seventh Day Adventist Church	44	40	47	43	-1	×	√
South of Hoxton Park Road							
Liverpool Christian Life Centre – Group Activities in Canteen Area and Gymnasium	50	40	55	50	0	×	√

7.2 Intermittent Traffic Noise

Maximum noise levels from heavy vehicles are generally associated with trucks braking and accelerating. The most common source of brake noise is auxiliary braking systems or engine compression brakes.

Previous assessments undertaken by Atkins Acoustics indicated that maximum noise levels from moving truck accelerating are 80-87dB(A) at 7m. For a truck applying engine compression brakes, the sound level at 7m is between 85-94dB(A). *Table 12* presents the predicted single event L_{Amax} noise levels from heavy vehicles at various distances.

Table 12 Predicted L_{Amax} Noise Levels from Trucks
dB(A) re 20 10^{-6} Pa

Distance m	Predicted L_{Amax} Noise Level	
	Truck accelerating	**Truck applying engine compression brakes**
10	77 – 84	82 – 91
20	71 – 78	76 – 85
30	67 – 74	72 – 81
50	63 – 70	68 – 77

Observations from the noise measurement results presented in Appendix 2 confirm the range of the predicted L_{Amax} truck noise levels is consistent with the measured levels. Additionally, predictions confirm that the L_{Amax} noise levels from trucks applying engine compression brakes exceed the night-time $L_{Aeq,9hr}$ by more than 15dB(A).

Table 13 presents a summary of hourly number of heavy vehicle movements for each hour between 10:00pm and 7:00am, based on forecast hourly traffic data provided by Connell Wagner. Areas potentially affected by the increase in frequency of maximum noise levels from heavy vehicles associated with braking and accelerating are those near the following road intersections:

- Hoxton park Road and Illaroo Road and Whitford Road;
- Hoxton park Road and First Avenue; and
- Hoxton park Road and Glen Innes Road.

Table 13 Projected Truck Numbers During Night-time Hours (2016)

Time	Projected Truck Numbers During Night-time Hours					
	Year 2006			Year 2016		
	East Bound	West Bound	Total	East Bound	West Bound	Total
10:00pm – 11:00pm	8	7	15	8	7	15
11:00pm – 12:00am	5	17	22	5	17	22
12:00am – 1:00am	4	7	11	4	7	11
1:00am – 2:00am	7	13	20	7	13	20
2:00am – 3:00am	12	21	33	12	21	33
3:00am – 4:00am	23	40	63	23	40	63
4:00am – 5:00am	14	34	48	14	34	48
5:00am – 6:00am	23	33	56	37	33	70
6:00am – 7:00am	34	51	85	70	51	121

8.0 ASSESSMENT AND RECOMMENDATION

8.1 Assessment

8.1.1 Allowance Goals

The modelling shows that future road traffic noise levels satisfy the allowance goal (existing level plus 2dB(A)) at receivers along the proposed Hoxton Park Road upgrade, except for one (1) residence east of Good Samaritan College (northern side of Hoxton Park Road) and residences between Mullumbimby Avenue and Brunswick Heads Crescent (southern side of Hoxton Park Road). For these receivers, the daytime ($L_{Aeq,15hr}$) and night-time ($L_{Aeq,9hr}$) noise levels in 2016 are predicted exceed the existing levels by typically 3dB(A), and the allowance goals by 1dB(A).

8.1.2 Baseline Goals

The predicted future (Year 2016) noise levels exceed the ECRTN baseline assessment goals up to 10dB(A) at residences along the Hoxton Park Road upgrade; 4dB(A) at the recreation reserve; marginally (1dB(A)) at the First Step childcare centre; 6dB(A) at the de-mountable classrooms of the Good Samaritan Catholic College; 3dB(A) at the Seventh Day Adventist Church and 10dB(A) at the canteen and gymnasium of the Liverpool Christian Life Centre (where group activities take place).

8.1.3 Recommendation

The noise predictions show that control measures are not required to satisfy the ECRTN allowance goals (existing levels plus 2dB(A)) for receivers along the Hoxton Park Road upgrade, except for one (1) residence east of Good Samaritan College and residences between Mullumbimby Avenue and Brunswick Heads Crescent. However, in accordance with the ECRTN, it is recommended that where feasible and reasonable, control measures be considered and applied to reduce noise levels to satisfy the baseline assessment goals.

Additionally, existing and predicted future road traffic noise at residences on Hoxton Park Road exceeds the 'acute' noise exposure levels (defined as 65dB(A) $L_{Aeq,15hr}$ and 60dB(A) $L_{Aeq,9hr}$). Where the existing and predicted future traffic noise levels exceed the 'acute' noise exposure levels, The RTA ENMM recommends greater consideration be given to reduce the external noise levels where feasible and reasonable.

8.2 Conceptual Ameliorative Noise Control Options

The following section of the report presents preliminary options of types of noise controls that may be appropriate to mitigate road traffic noise, providing they are shown to be practical in terms of effectiveness in controlling noise, give rise to minimum secondary impacts ie. loss of views, over shadowing, loss of access to properties, etc. and are cost effective. It is noted that the recommended options are preliminary and that any noise controls should be selected in consultation with Department of Infrastructure, Planning and Natural Resources (DIPNR); Council and individual land owners.

8.2.1 Traffic Speed Reduction

To reduce the marginal noise exceedances (1dB(A)) at one (1) residence on the northern side of Hoxton Rark Road (west of Good Samaritan Catholic College) and residences on the southern side of the road from Mullumbimby Avenue to Brunswick Heads Crescent to within the allowance goals, a possible control measure would be to reduce the proposed sign posted traffic speed of 70km/hr to 60km/hr.

8.2.2 Road Surface

Dense graded asphalt road surface was modelled in the traffic noise calculations. With the use of open graded asphalt surface or similar quieter surfaces, noise reduction in the order of 2dB(A) could be achieved. This measure could be used to reduce traffic noise to within the allowance goals. Albeit, open graded asphalt may not be practical due to the percentage of heavy vehicles on the road. Additionally, noise reduction provided by quieter road surface is limited with traffic speed below 80km/hr.

8.2.3 Road Side Barriers

To reduce the noise levels to within the baseline goals, road side acoustic barriers could be provided. Considering a distance separation between the near-side carriage-way and a residential building facade of 20m, a receiver height of 1.5m above the finished road level, *Table 14* provides an estimate of the noise attenuation that a continuous acoustic barrier within 5m of the near-side carriage-way could provide.

Table 14 Typical Noise Reductions from Barriers

Barrier Height (m)	Noise Reduction, dB(A)
1 – 1.5	2 – 4
1.5 – 2	3 – 5
2 – 3	5 – 10
3 – 4	10 – 13
4 – 5	13 – 15

Table 15 presents a summary of barrier locations and heights required to reduce the road traffic noise levels to within the baseline assessment goals for single-storey along the proposed Hoxton Park Road upgrade. To satisfy the baseline noise assessment goals for two-storey receivers, barrier heights of 5-6m or higher would be required at the nearest residences. For a barrier to be effective for a two-storey residence, the barrier would need to extend approximately 50m past the site boundaries.

Table 15 Barrier Locations and Heights Required

Location	Barrier Height (m)
North of Hoxton Park Road	
Cowpasture Road – West of Good Samaritan Catholic College	3 – 3.5
Hoxton Park Recreation Reserve, Wilson Road – Whitford Road	3 – 3.5
Whitford Road – East of Deneb Place	2.5 – 3
South of Hoxton Park Road	
West of Mullumbimby Avenue – First Avenue	3 – 3.5
East of First Avenue	2

8.2.4 Treatment to Individual Dwellings

Treatments to individual properties or dwellings could include external court yard walls, closing exposed doors and windows, upgraded glazing, sealing off wall openings and exposed wall vents and provisions for ventilating exposed rooms.

In terms of noise reductions, a typical building facade with an open window will reduce the outdoor noise by up to 10dB(A), for a closed window the reduction would be in the order of 20-25dB(A). For a double glazed window system in a normal building facade, noise reductions in the order 25-30dB(A) can be achieved with a closed window. Albeit, when the window is opened the reduction would be in the order of 10dB(A). With the application of acoustic seals to existing exposed windows and doors and sealing off wall openings, the above closed window attenuation (20-25dB(A)) could be improved by 2-5dB(A).

8.2.5 Preferred Noise Control Option

At present, the RTA considers installation of noise barriers and provision of acoustic treatments to individual dwellings to be a preferred option for the Hoxton Park Road upgrade project.

Installation of noise barriers is considered practical for areas between Cowpasture Road and Glen Innes Road, however to maintain visual amenity, the RTA is considering a maximum barrier height of 3m.

For the areas west of Glen Innes Road, acoustic treatment could be considered for affected residences as installation of noise barriers would not be practical due to loss of access to driveways and potentially flooding issues.

For the Hoxton Park recreational reserve, a noise barrier could not be provided as this area is potentially affected by local flooding.

8.3 Future Planning

The local Planning Authority has a role in ensuring that road traffic noise is considered when determining rezoning development and building applications under the provisions of the Environmental Planning and Assessment Act, 1979, and Local Government Act, 1993. It is therefore recommended that the Planning Authorities be encouraged to consider planning strategies for future land zoning and development adjacent to Hoxton Park Road.

8.4 Future Development in Traffic Noise Control

As part of the State Government long term plan to reduce road traffic noise, strategies that are being considered include controlling noise emissions from individual vehicles, developing programs to monitor and control noisy vehicles, controlling noise from trucks and engine brakes and reducing traffic speed. The effective implementation of these plans will assist in further reductions to road traffic noise.

8.5 Overview

The findings of the noise assessment have shown that a number of options are available to reduce traffic noise impacts at the residential properties and other sensitive noise receivers along Hoxton Park Road. The range of noise control options include changes to the finished road surface, reduction in traffic speed, noise barrier and treatments to individual dwellings and other noise sensitive receivers.

However, finalisation of any noise control options should be undertaken as part of a detailed evaluation on the basis of practicability, cost effectiveness, traffic safety, equity, aesthetics and community consultation.

9.0 CONSTRUCTION NOISE AND VIBRATION

9.1 Overview

As the road proposal is conceptual at this time, the road construction program has not been established nor final road plans developed or approved. Details of construction program and activities will be determined when the proposal is approved and a road contractor engaged. However, it is envisaged that the construction activities would be based on established road design and construction procedures. To evaluate the likely level of noise and vibration emitted from the envisaged construction activities, the following construction phases and plant schedules have been considered.

9.1.1 Preliminary Site Works

Preliminary site works involving the relocation of services and access adjustments to local roads. At this stage it is envisaged that trucks, a grader and an excavator could be used to excavate and transport materials during the preliminary site works.

9.1.2 Earthworks

The main construction activities envisaged during the main earthworks phase of the project will involve excavation, filling and compaction. Equipment used to excavate, spread, level and compact the materials could include dozers, excavators, graders, trucks and compactors.

9.1.3 Bridge Construction

It is envisaged that the main plant and equipment used during the construction of the bridge would consist of a pile driver, a crane, trucks, generators, pumps and compressors.

9.1.4 Sub-base Preparation

Following earthworks, the road sub-base would be prepared by a fleet of trucks and a concrete pump.

9.1.5 Road Surfacing

Laying of a bitumen surface would be carried out by an asphalt laying machine and up to three trucks and two rollers.

9.1.6 Construction Compounds

The location of construction compound sites for the establishment of material, plant and stockpile sites would be identified and carried out by the construction contractor. These areas are normally located within the road reservation, or by prior agreement with individual property owners on private property.

9.1.7 Construction Schedule

Table 16 presents a summary of the construction plant and construction schedules adopted for the noise modelling.

Table 16 Operations and Equipment Required

Operation	Plant Type	No. Equipment Required (Av. Max.)
Preliminary Site Works	Grader	1
	Excavator	1
	25T trucks	2
Earthworks	25T trucks	3
	Excavator	1
	Dozer	1
	Compactors	2
Bridge Construction	Pile Driver	1
	Trucks	2
	Generator	1
	Pumps	2
Sub-base Concrete Preparation	Trucks	3
	Concrete Pump	1
Road Paving	Asphalt trucks	3
	Asphalt Laying Machine	1
	Rollers	2

9.2 Construction Hours

To minimise noise impacts during construction, activities would generally be restricted to between 7:00am and 6:00pm, Monday to Friday, and 8.00am to 1.00pm on Saturday. With prior approval from Department of Infrastructure, Planning and Natural Resources (DIPNR) and notification to exposed residents, construction outside these hours could be undertaken.

9.3 Assessment Goals

9.3.1 Goals for Noise Assessment

Goals for assessment of the noise from construction sites are recommended in the DEC's Environmental Noise Control Manual (1994, Chapter 171). The goals depend on the duration of the construction activities and are as follows:

- for construction periods limited to four weeks, the $L_{A10,15min}$ noise levels should not exceed the L_{A90} background by more than 20dB(A);

- for construction periods between four weeks and 26 weeks, the $L_{A10,15min}$ noise levels should not exceed the L_{A90} background by more than 10dB(A); and

- for construction periods longer than 26 weeks, long-term noise goals apply. That is, the $L_{A10,15min}$ noise levels should not exceed the L_{A90} background by more than 5dB(A).

For evening and night-time activities, the DEC normally excepts that the $L_{A10,15min}$ construction noise should not exceed the background noise level by more than 5dB(A).

In setting the above noise goals, the DEC recognises that there is limited opportunity to reduce noise from construction plant and activities, and that the goals are not always satisfied.

From the L_{A90} background noise measurement results (*Table 1*), the assessment goals recommended for evaluating daytime, evening and night-time construction activities are summarised in *Table 17* below.

Table 17 ***Goals for Assessment of Construction Noise***
dB(A) re 20 × 10⁻⁶ Pa

Reference Location	Sound Pressure Level dB(A)							
	Existing Background L_{A90}			Noise Assessment Goal ($L_{A10,15min}$)				
	Day	Evening	Night	Day			Evening	Night
				Short Term	Medium Term	Long Term		
Location 1	53	52	40	73	63	58	57	45
Location 2	48	46	38	68	58	53	51	43
Location 3	55	48	35	75	65	60	53	40
Location 4	57	50	37	77	67	62	55	42

9.3.2 Goals for Vibration Assessment

9.3.2 (i) Annoyance

The DEC, ENCM (Chapter 174) recommends goals in terms of potential disturbance to the occupants of buildings. In accordance with the DEC guidelines, *Table 18* presents a summary of vibration levels for the assessment.

Table 18 ***Vibration Levels for Assessment of Human Comfort***

Type of Occupancy	Time	Vibration Level (mm/s)	
		Continuous Vibration	Intermittent Vibration
Residential	Day	0.2 – 0.6	8 – 12
	Night	0.2	2

Vibration generated from construction activities should be less than the allowable goals for intermittent or impulsive vibrations. Where the levels exceed the goals for continuous vibration, the DEC recommends that the activities be restricted to between 7:00am and 6:00pm Monday to Friday and 7:00am and 1:00pm Saturday.

9.3.2 (ii) Perception

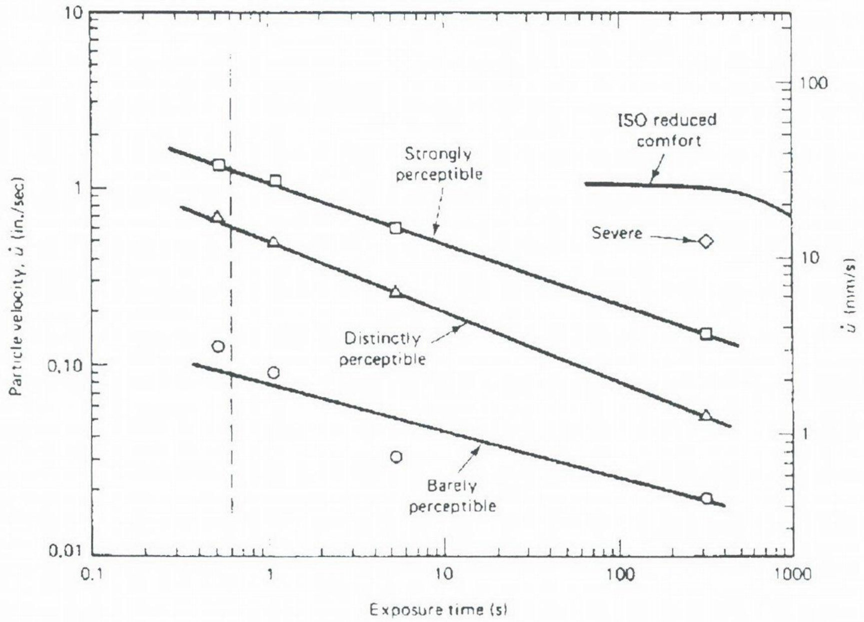
For the purpose of evaluating likely response to vibration exposure, *Table 19* presents a summary of vibration levels referenced to degrees of perception and potential reactions.

Table 19 Human Perception to Vibration
Ref: German Standard DIN 4150 (1986)

Vibration Level mm/s	Likely Perception
0.15	Perception Threshold
0.35	Barely Noticeable
1.0	Noticeable
2.2	Easily Noticeable
6.0	Strongly Noticeable
14.0	Very Strongly Noticeable

Figure 1 shows human response to vibration levels of varying duration. It can be seen that short duration vibration levels are less perceptible than those with long transient and continuous levels. Figure 1 also shows consistency with the data presented in *Table 19*.

Figure 1 Human Response to Vibration (Ref. Charles H. Downing)



9.3.2(iii) Building Structures

German Standard DIN4150 Part 3 (1986) provides guidelines for evaluating the effects of vibration on structures. The values recommended in the standard are summarised in *Table 20.* The values are the maximum vibration levels measured in any direction at the building foundation.

Table 20 Safety Limits for Structural Damage

Type of Structure	Vibration Level (mm/s)		
	< 10Hz	10Hz to 50Hz	50Hz to 100Hz
Commercial/industrial buildings or buildings with similar design	20	20 to 40	40 to 50
Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20
Structures of great intrinsic value (eg. buildings under preservation)	3	3 to 8	8 to 10

Ref: German Standard DIN4150

9.3.2(iv) Building Contents

The threshold for visible movement of susceptible building contents (eg. plants, hanging pictures, etc.) is approximately 0.5mm/s. Audible rattling of loose objects (eg. crockery) generally does not occur until levels of about 0.9mm/s.

9.4 Noise and Vibration from Construction Equipment

9.4.1 Noise Emissions from Construction Equipment

Typical sound power levels of equipment for the envisaged construction activities are summarised in *Table 21*. These are established from data presented in the Australian Standard AS2436-1981 and previous studies conducted by Atkins Acoustics.

Table 21 Construction plant and Sound Power Levels dB(A) re 10^{-12} W

Plant Description	Plant Type	Sound Power Level
Dozer	Caterpillar D7, D9	113
Front End Loader	Wheeled	110
Grader	Caterpillar 16	110
Pile Driver		120
Compactor	Caterpillar 825	110
Vibratory Roller	10-12 tonne	110
Water Cart		106
Excavator	Kato 750	107
Truck		106
Crane	Truck mounted	110
Compressor	600 CFM	100
Backhoe		108
Grader	Caterpillar	106
Tip Truck		106
Asphalt/Concrete Paver		115
Asphalt/Concrete Truck		108
Asphalt/Concrete Pump		109
Asphalt/Concrete Vibrators		105

9.4.2 Vibration from Construction Equipment

Table 22 provides typical ground vibration levels generated by construction equipment.

Table 22 Vibration Levels from Construction Equipment

Plant Description	Vibration Level (mm/s)	
	5m	20m
Pile Driver	10	4
Dozer	2	0.2
Vibrating Compactor	20	2

9.5 Predicted Noise and Vibration Impacts

9.5.1 Noise Impacts from Construction Equipment

Table 23 provides a summary of predicted noise levels from each construction phase at various distances to the equipment. The predicted noise levels represent those under worst case scenario, ie. with all plant items during each construction phase operate simultaneously.

Table 23 Predicted Noise Levels from Construction Activities
dB(A) re 20×10^{-6} Pa

Construction Phase	Predicted Noise Levels at Various Distances			
	20m	30m	50m	100m
Preliminary site works	78	75	70	64
Earthworks	84	80	76	70
Bridge Construction	87	83	79	73
Sub-base preparation	79	75	71	65
Road paving	84	81	77	71

It can be seen from *Table 23*, the predicted construction noise levels exceed the daytime assessment goals for the short-term, medium term and long-term at receivers along the proposed road development.

9.5.2 Vibration Impacts from Construction Equipment

Table 24 provides a summary of predicted vibration levels that could be generated from various plant.

Table 24 Typical Plant Vibration Levels

Plant Description	Vibration Level (mm/s)		
	5m	20m	40m
Pile Driver	10	4	1
Dozer	2	0.2	0.02
Vibratory Compactor	20	2	0.3

The main sources of ground vibration from the envisaged construction equipment are associated with pile driving and compacting. Vibration levels generated by pile drivers and compactors are unlikely to exceed the "safe limit" of 5mm/s for structural damage to residential buildings further than 20m from the construction activities. At distances within approximately 20m from pile driving and compaction, the "safe limit" for structural damage to residential buildings may be exceeded.

It is recommended that investigation be carried out at the detailed design stage after approval is granted to ensure all vibration source are evaluated and excessive vibration levels are not encountered. If required, control measures such as alternative construction methods should be considered.

Ground vibration levels from construction equipment are expected to be below 5mm/s, however they may be felt by residents at some stage. In accordance with DEC guidelines, vibration from construction activities should be restricted to between 7:00am and 6:00pm Monday to Friday, 7:00am and 1:00pm Saturday where vibration levels exceed 0.3mm/s.

9.6 Recommendation

To minimise noise and vibration impacts during construction, an Environment Management Plan (EMP) should be prepared to address issues of noise and vibration. As part of the Environment Management Plan, the following issues should be considered:

- establishment of a construction noise and vibration control plan;
- selection of plant and equipment on acoustic performance, where practical;
- where feasible and practical, any road side noise barriers should be erected prior to the road construction where practical and feasible;
- implementation of a monitoring program to ensure that construction noise and vibration is controlled and that best possible practices are being implemented;
- preparation of dilapidation reports on sensitive structures within 30m of any ground compaction; and
- implementation of an information program to inform local residents of the construction program and time periods when noise and vibration levels could exceed the recommended assessment guidelines.

10.0 SUMMARY

This report presents the results and findings of a noise and vibration assessment for the proposed upgrading of Hoxton Park Road between Cowpasture and Banks Roads.

Site investigations and noise measurements have been conducted to quantify the existing traffic noise levels and establish goals for the assessment of future traffic and construction noise impacts.

The DEC's Environmental Criteria for Road Traffic Noise recommends baseline and allowance goals for assessing of road traffic noise. The baseline goals are 60dB(A) $L_{Aeq,15hr}$ and 55dB(A) $L_{Aeq,9hr}$ for residential properties along Hoxton Park Road. The allowance goals recommends that as a result of the proposed works the existing road traffic noise levels should not increase by more than 2dB(A) (10 years after the road opening). Where practical and feasible, it is the RTA position that noise control will be evaluated and applied to satisfy the recommended baseline goals.

For the Hoxton Park Recreation Reserve, the baseline daytime road traffic noise goal (7:00am to 10:00pm) is 60dB(A) $L_{Aeq,15hr}$. The allowance goal requires the existing traffic noise not to increase by more than 2dB(A).

The traffic noise assessment goal for Good Samaritan Catholic College and First Step Childcare Centre is 45dB(A) $L_{Aeq,peak\text{-}hour}$ inside classrooms during school hours. For places of worship, the internal noise assessment goal is 45dB(A) $L_{Aeq,peak\text{-}hour}$.

The site measurements and predictions show that existing road traffic noise levels exceed the baseline assessment goals by up to 12dB(A). The predicted future road traffic noise levels as a result of the proposed road upgrade are less than 2dB(A) and satisfy the allowance goals, except for one (1) residence on the northern side of Hoxton Park Road (west of Good Samaritan Catholic College) and residences on the southern side of the road from Mullumbimby Avenue and Brunswick Heads Crescent.

Possible control measures to reduce the predicted noise to within the allowance goal include reduction of the proposed sign posted traffic speed from 70km/hr to 60km/hr or the use of open graded asphalt road surface or similar road surfaces.

Control measures in the form of acoustic barriers and acoustic treatment to individual properties have been recommended to reduce traffic noise to within the baseline goals. It is noted that the recommendations are conceptual only and that the final control measures be assessed in terms of practicality, cost effectiveness, secondary impacts (eg. loss of views, over shadowing, loss of access to properties, etc.) and selected in consultation with the appropriate Planning Authority and land owners.

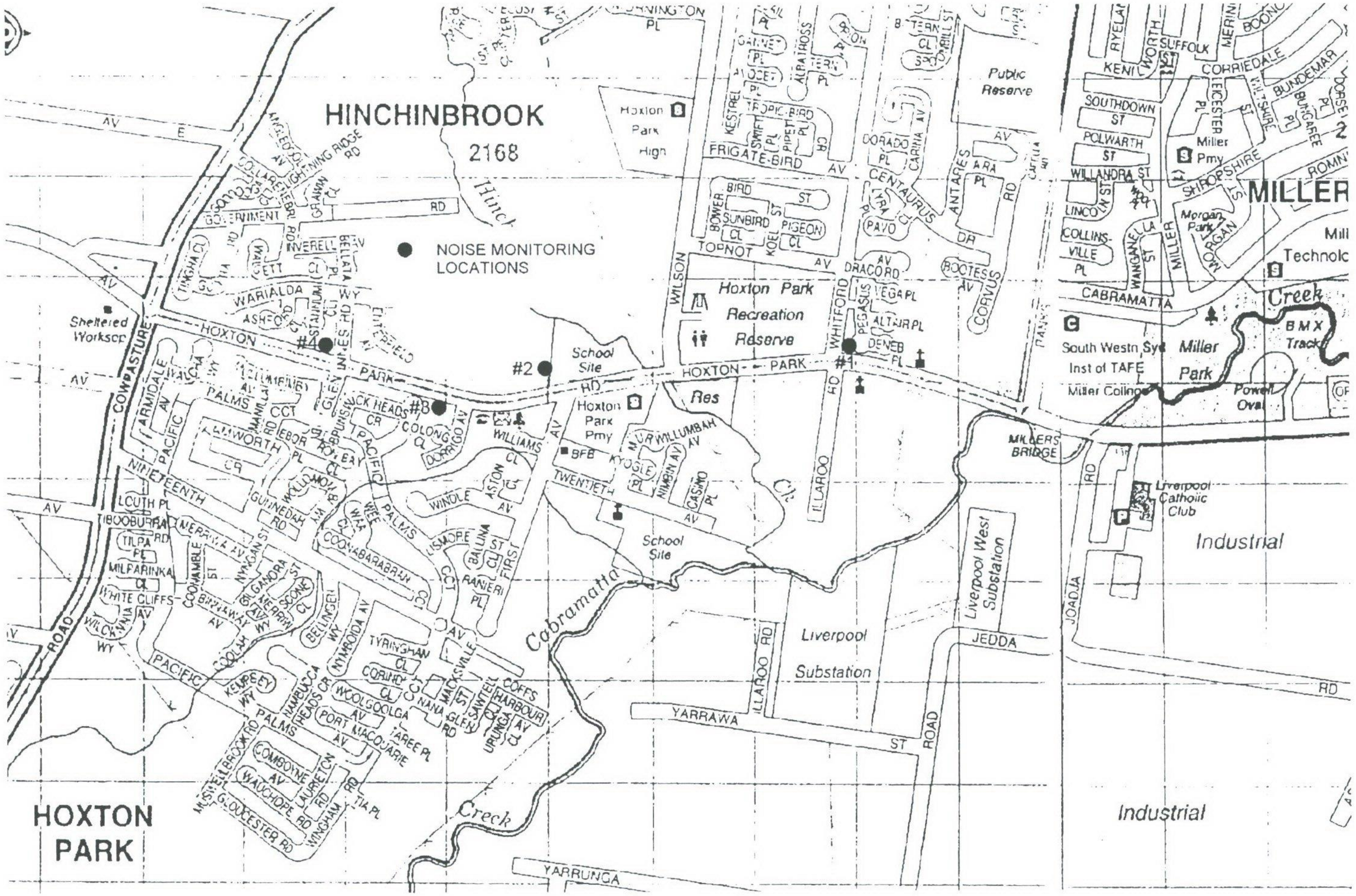
For the assessment of noise and vibration from construction activities, guidelines in the DEC's Environmental Noise Control Manual have been adopted. Additionally, the German Standard DIN4150 has been considered for the assessment of possible structural damage to buildings from vibration during construction.

At present, the proposal is conceptual and no final plan or road contractor approved. Similarly, no final road construction program or construction techniques have been determined. The final construction details will be established when the proposal is approved and a contractor engaged.

The findings of this assessment have shown that during the road construction there could be localised noise and vibration impacts at near residential properties. Additionally, it is recommended that all residential dwellings within 30m from construction activities be inspected and dilapidation reports for sensitive structures prepared prior to construction commencing.

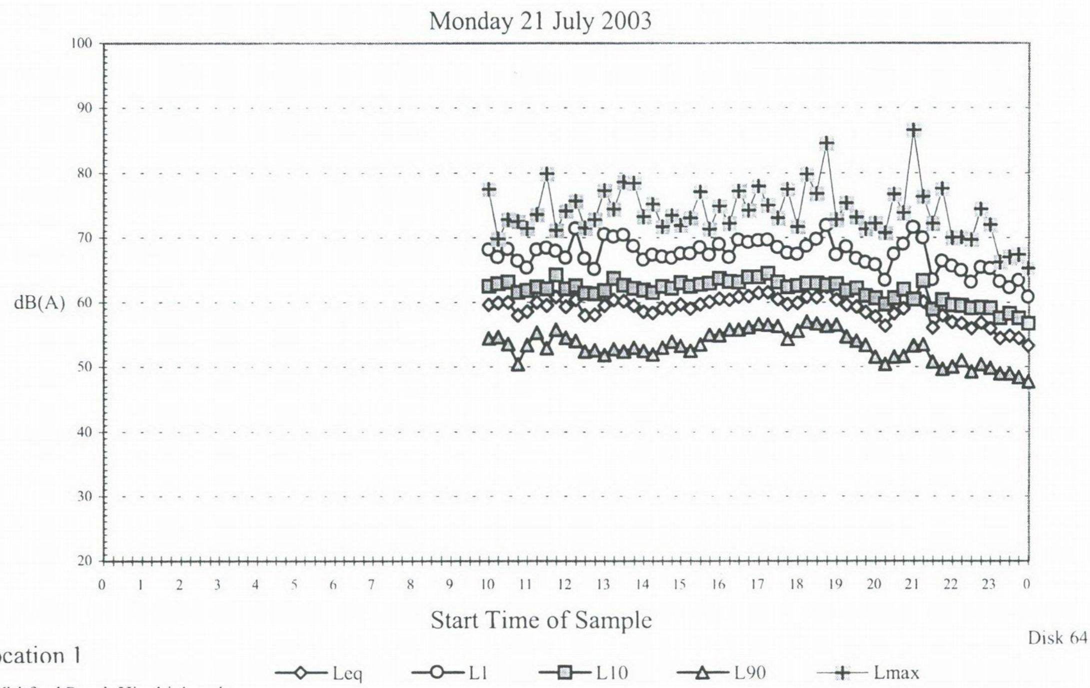
To ensure that construction noise and vibration impacts are minimised, it is recommended that as part of the construction contractors undertakings, an Environmental Management Plan be prepared to address and control construction noise and vibration.

SITE LOCATION



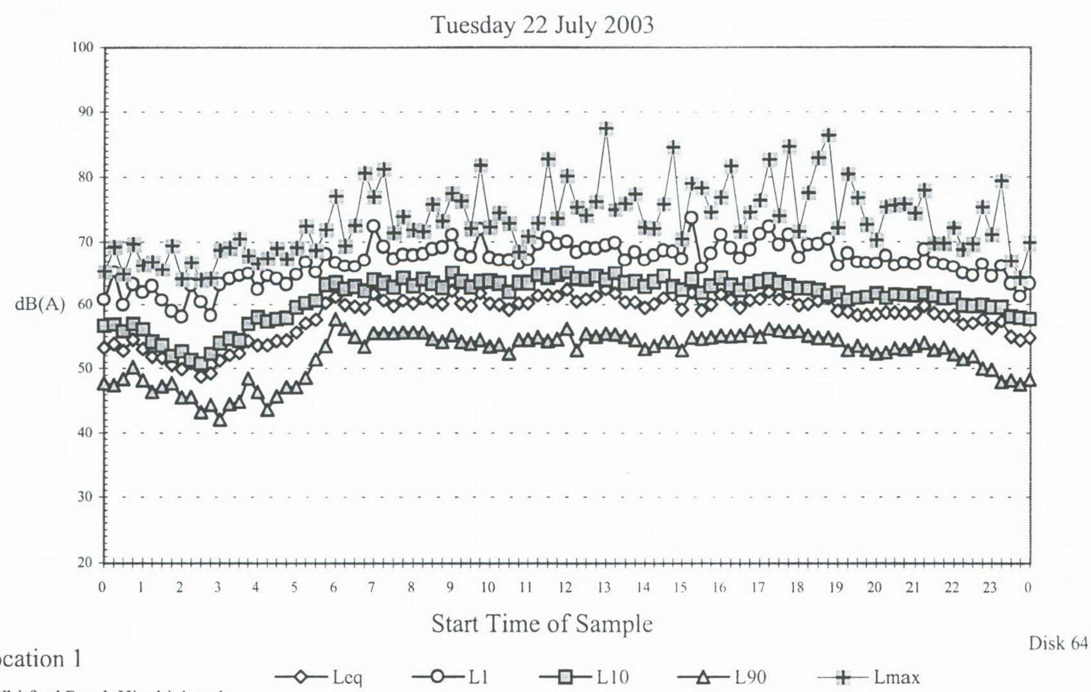
NOISE MONITORING RESULTS

Ambient Sound Pressure Levels



Location 1

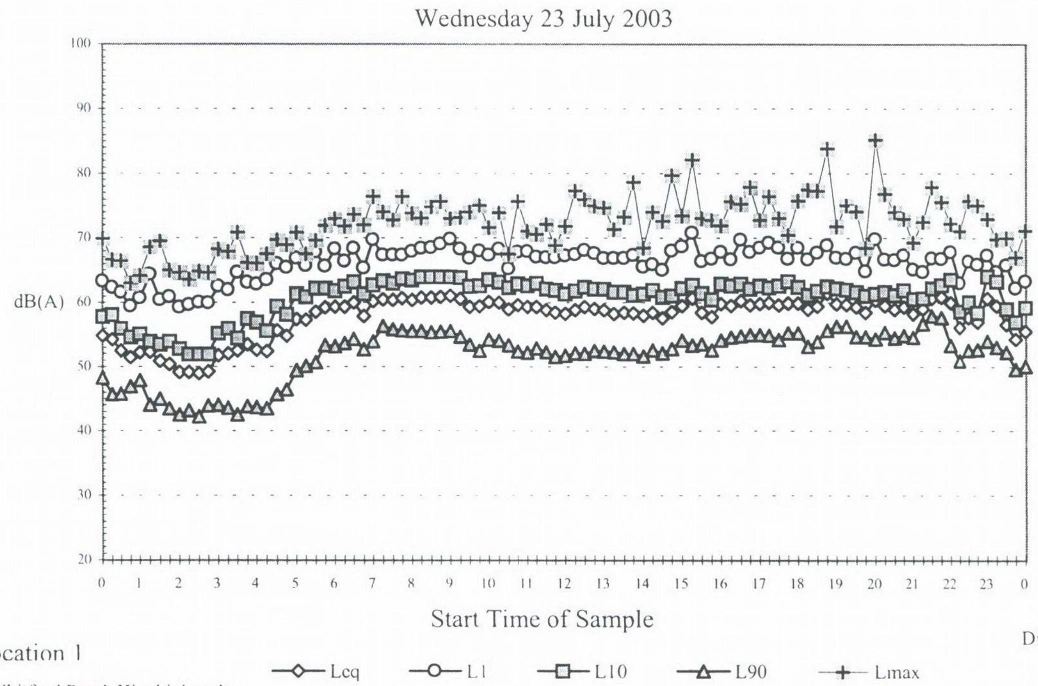
7 Whitford Road, Hinchinbrook



Location 1

7 Whitford Road, Hinchinbrook

Ambient Sound Pressure Levels



Location 1

7 Whitford Road, Hinchinbrook

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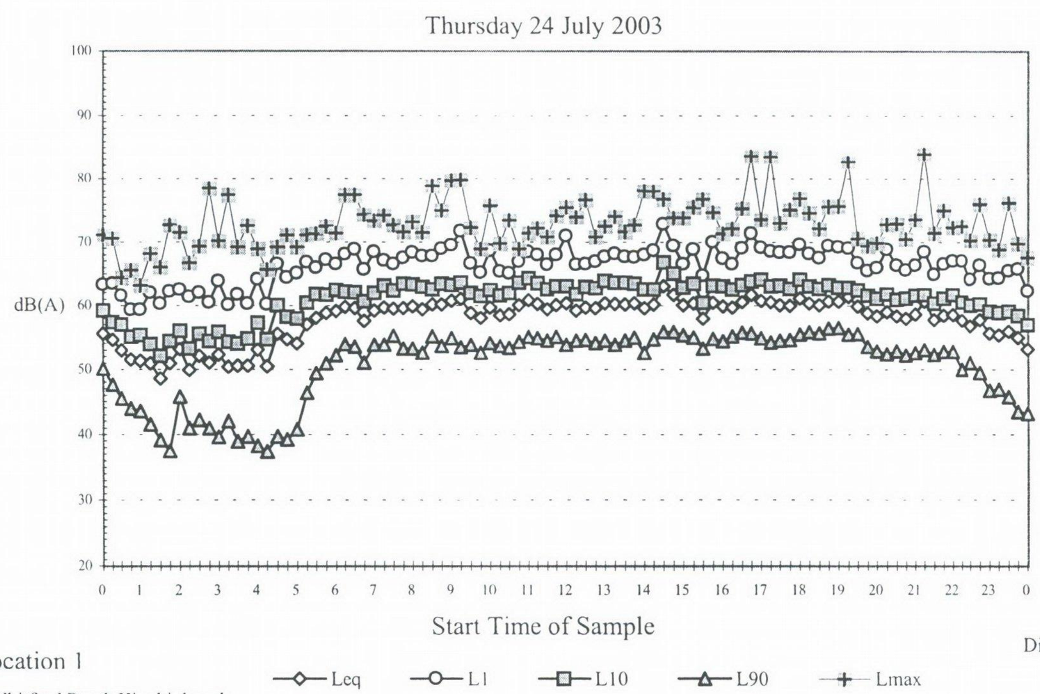

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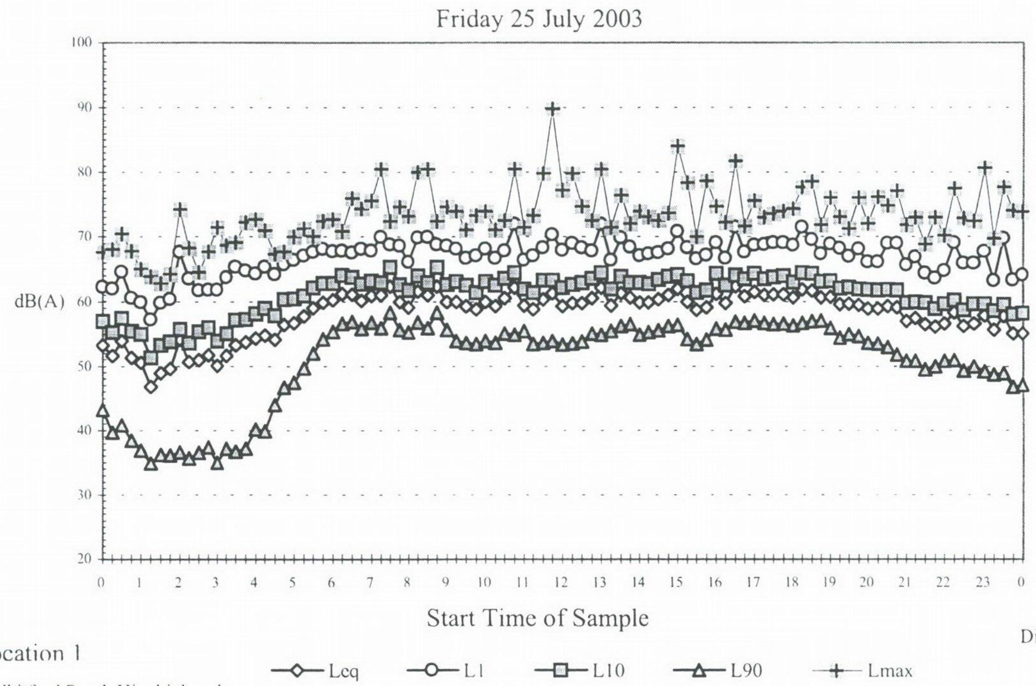
Ambient Sound Pressure Levels



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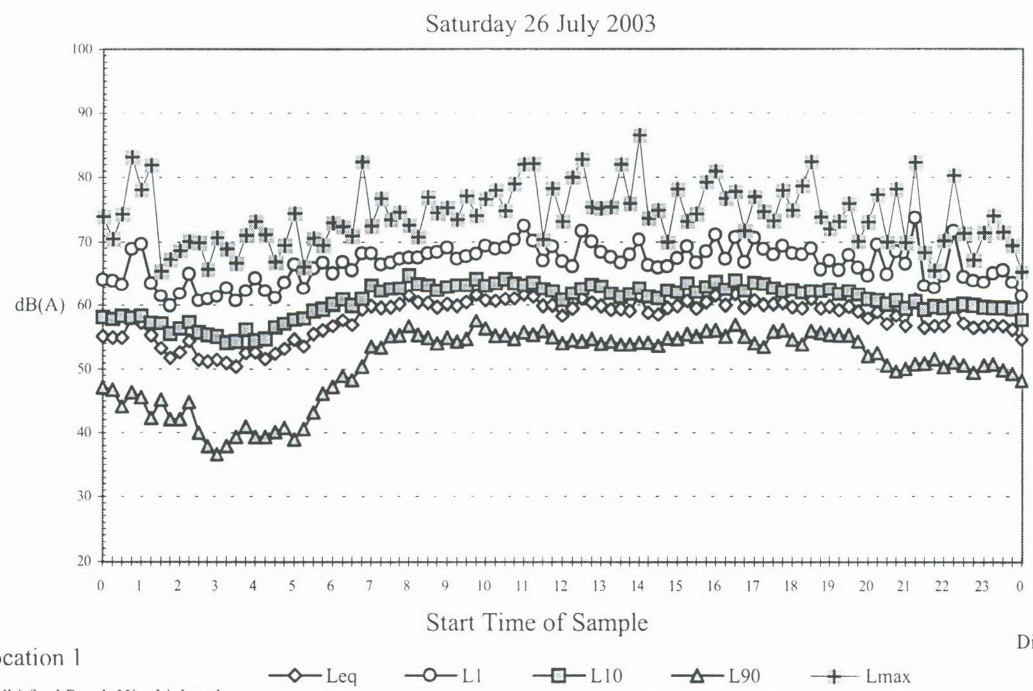

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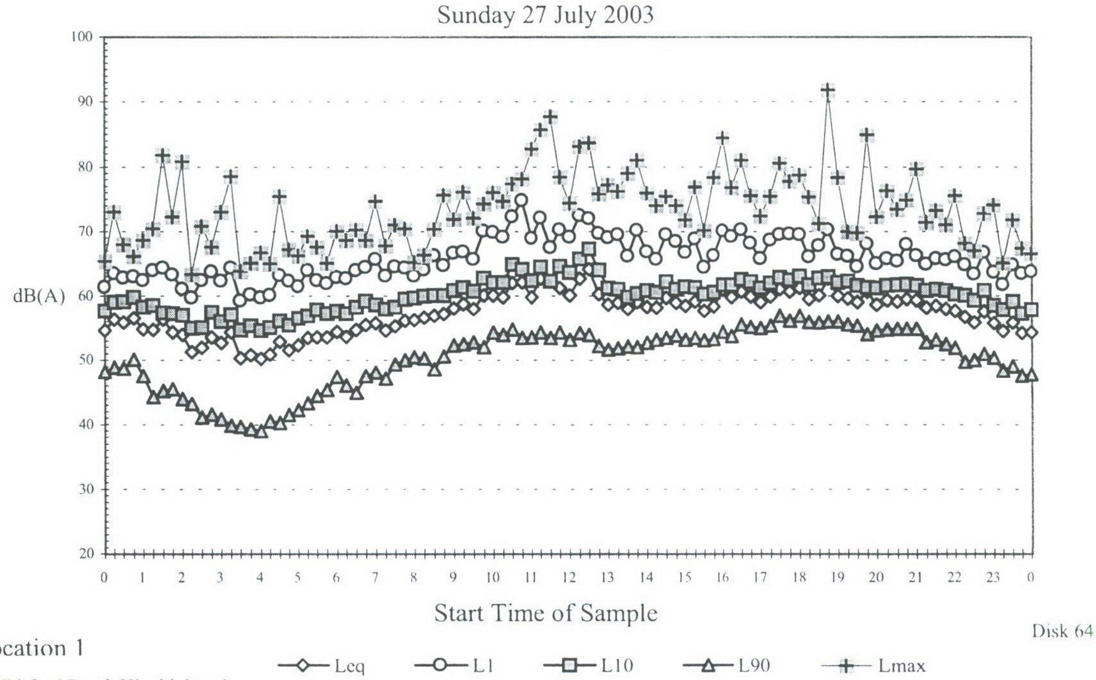

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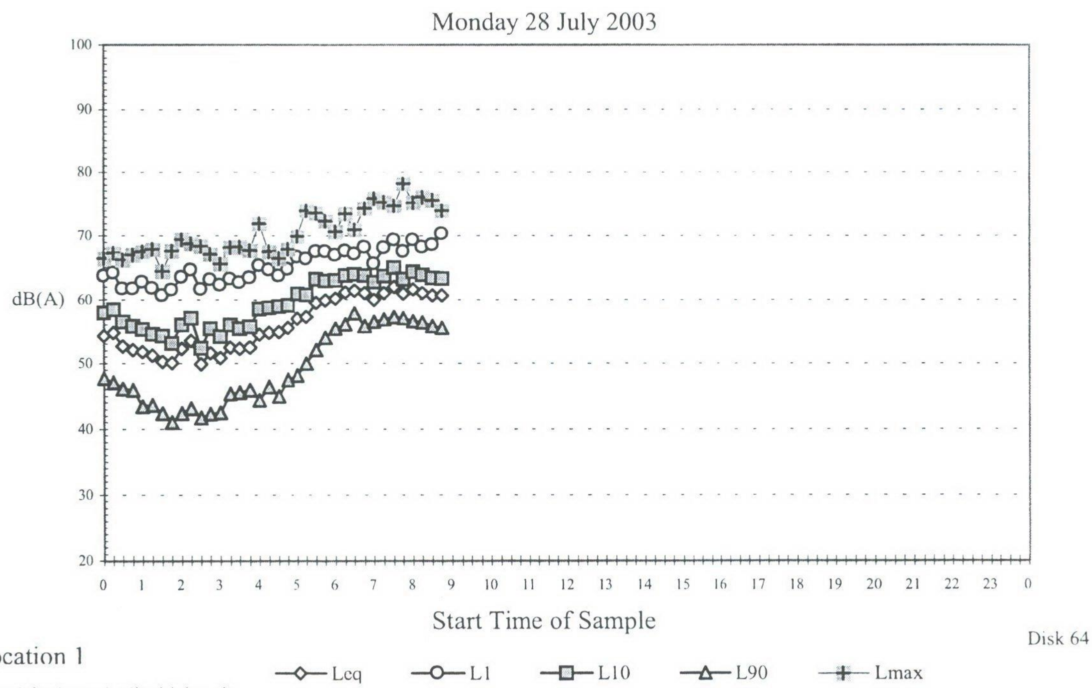

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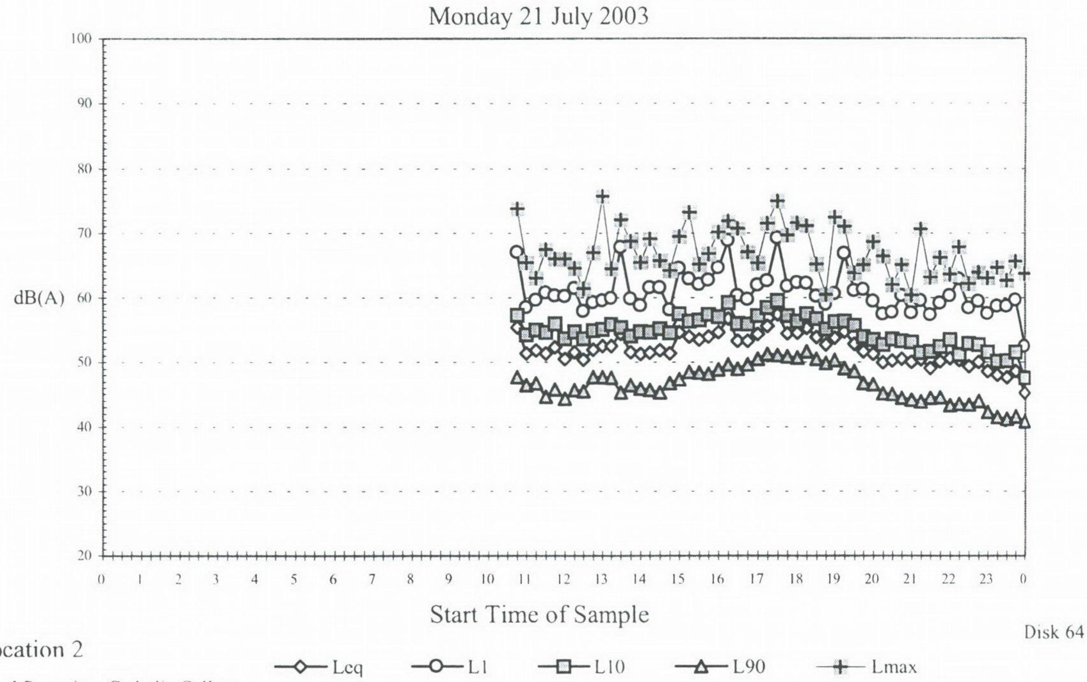
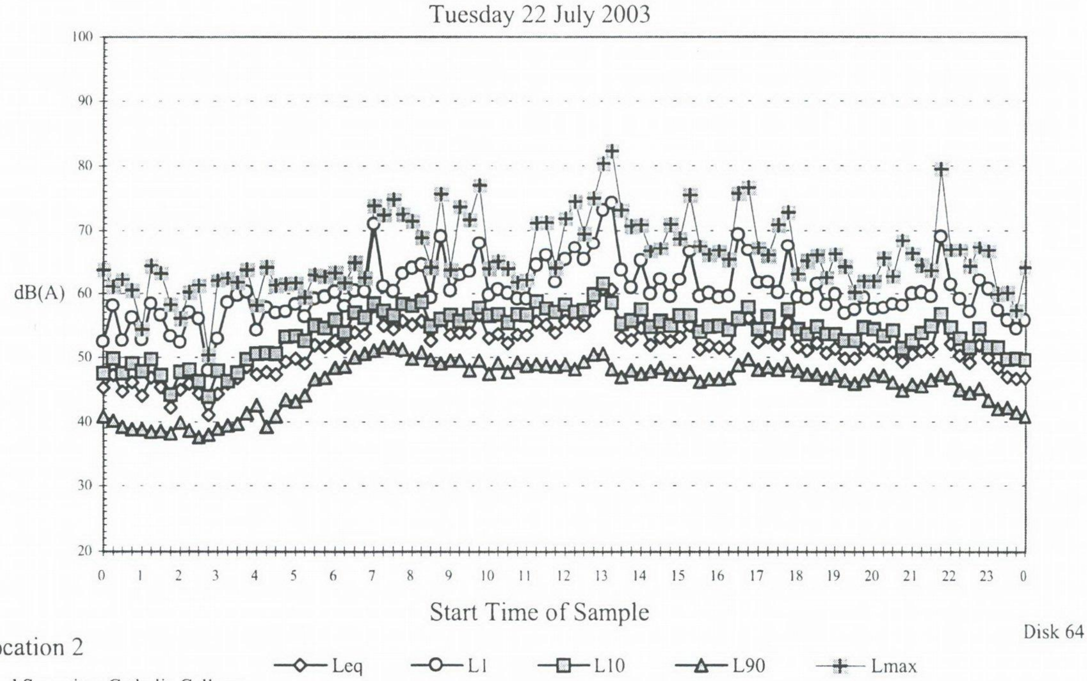
Ambient Sound Pressure Levels



Location 2

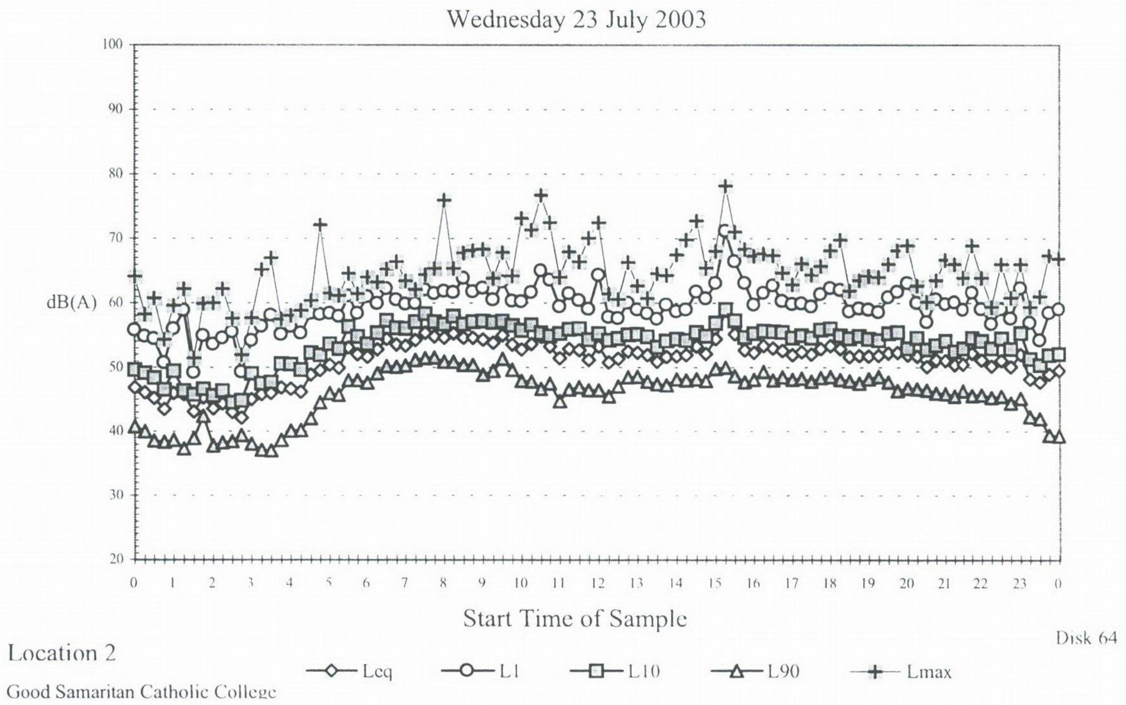
Good Samaritan Catholic College

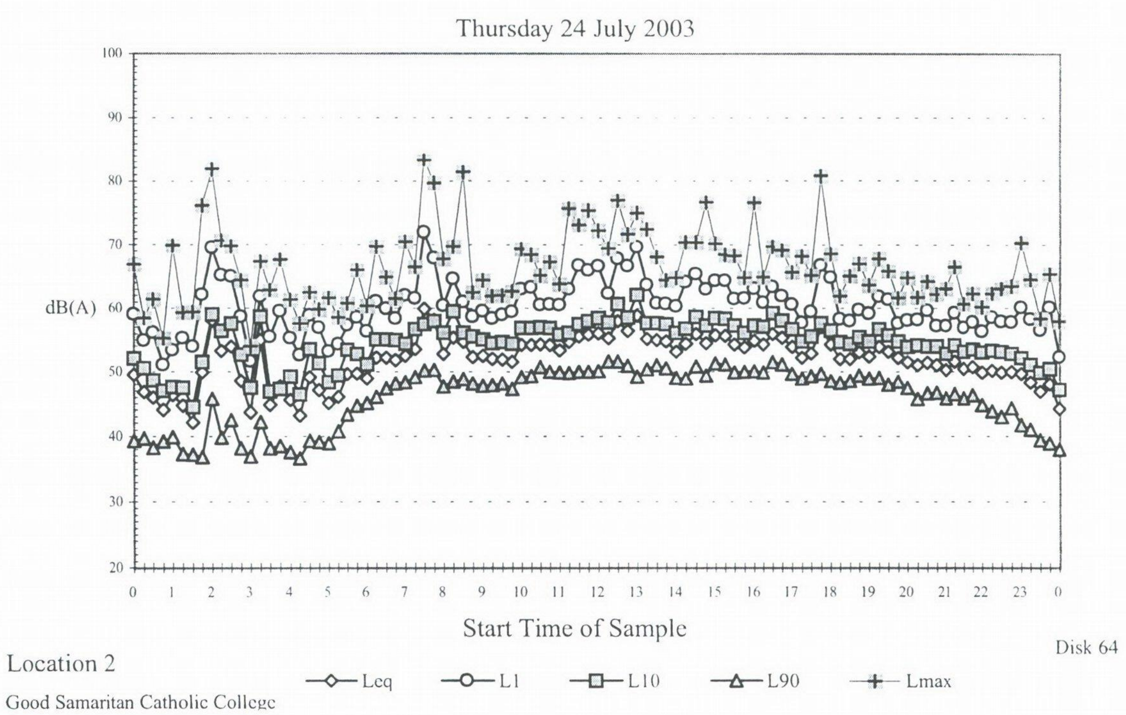


Location 2

Good Samaritan Catholic College

Ambient Sound Pressure Levels





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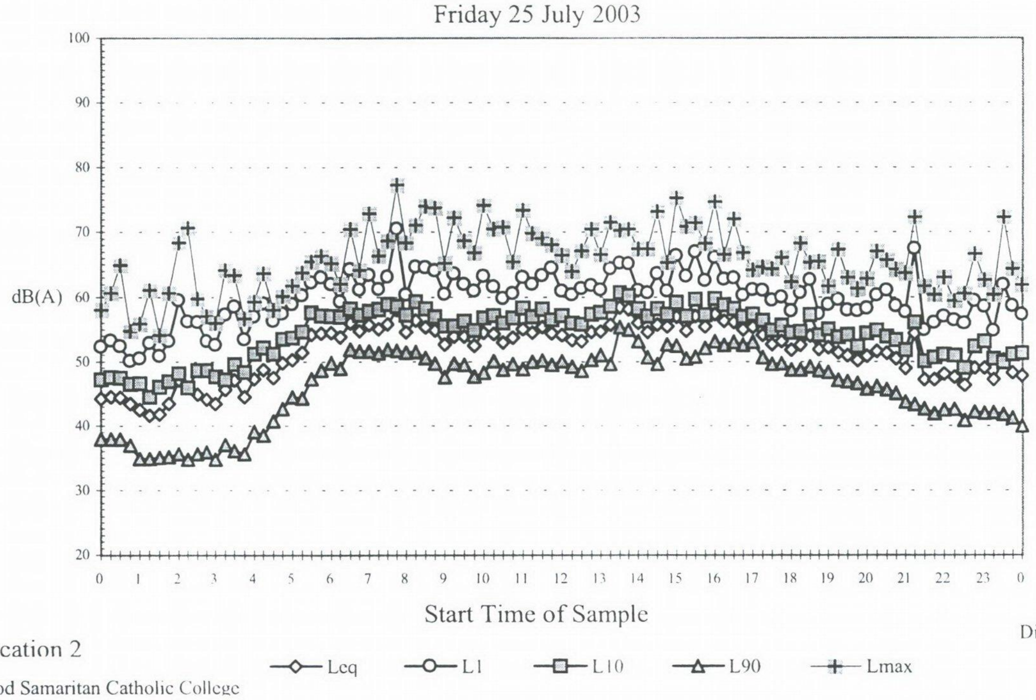

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Good Samaritan Catholic College

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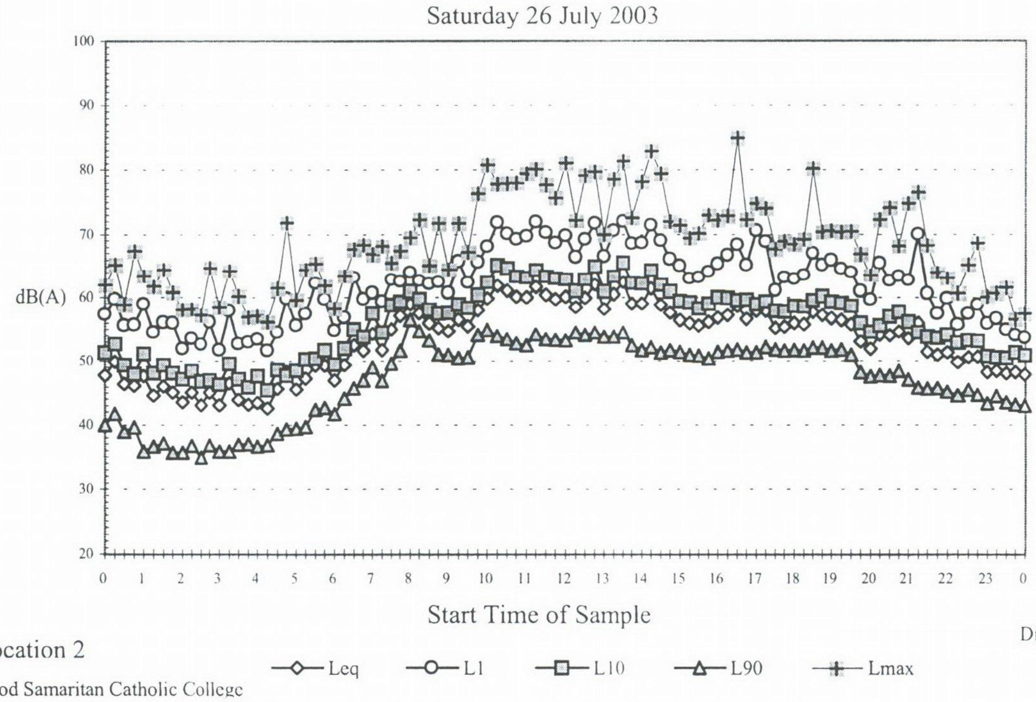

Location 2

Good Samaritan Catholic College

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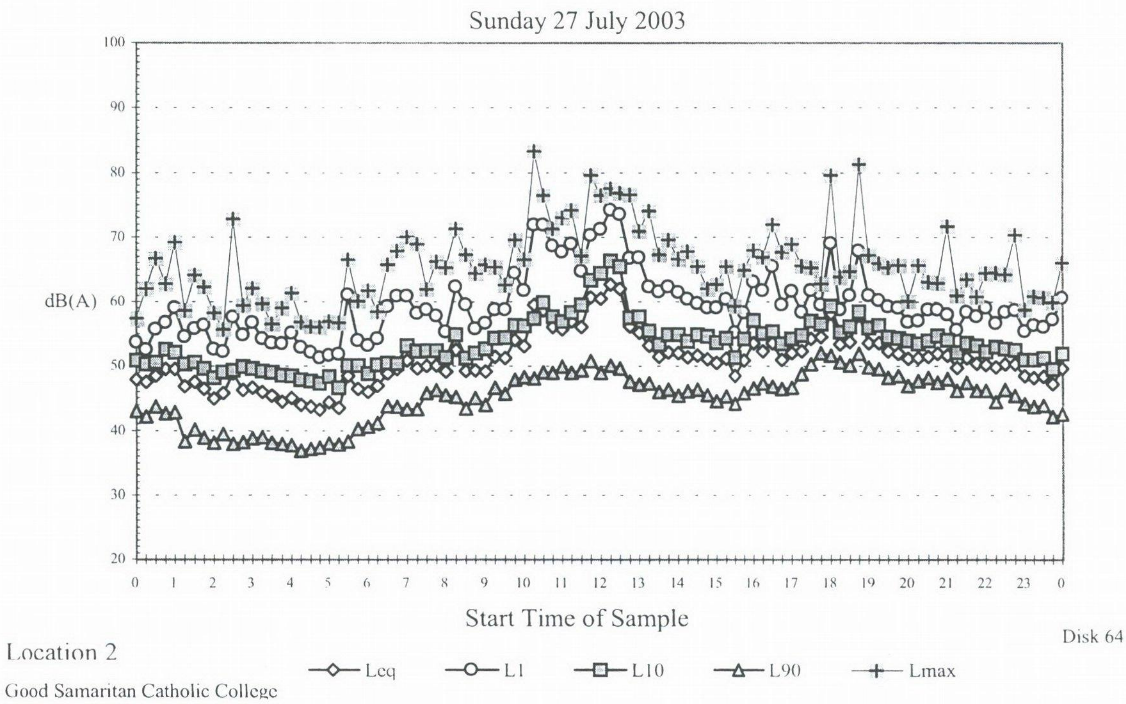
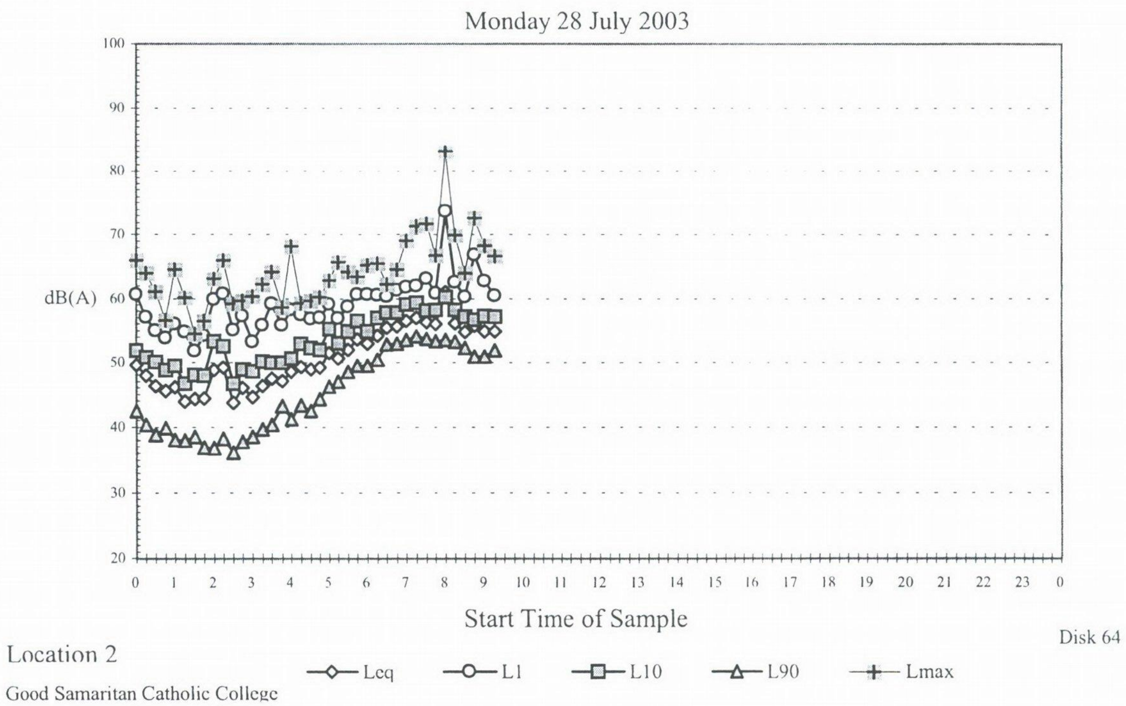
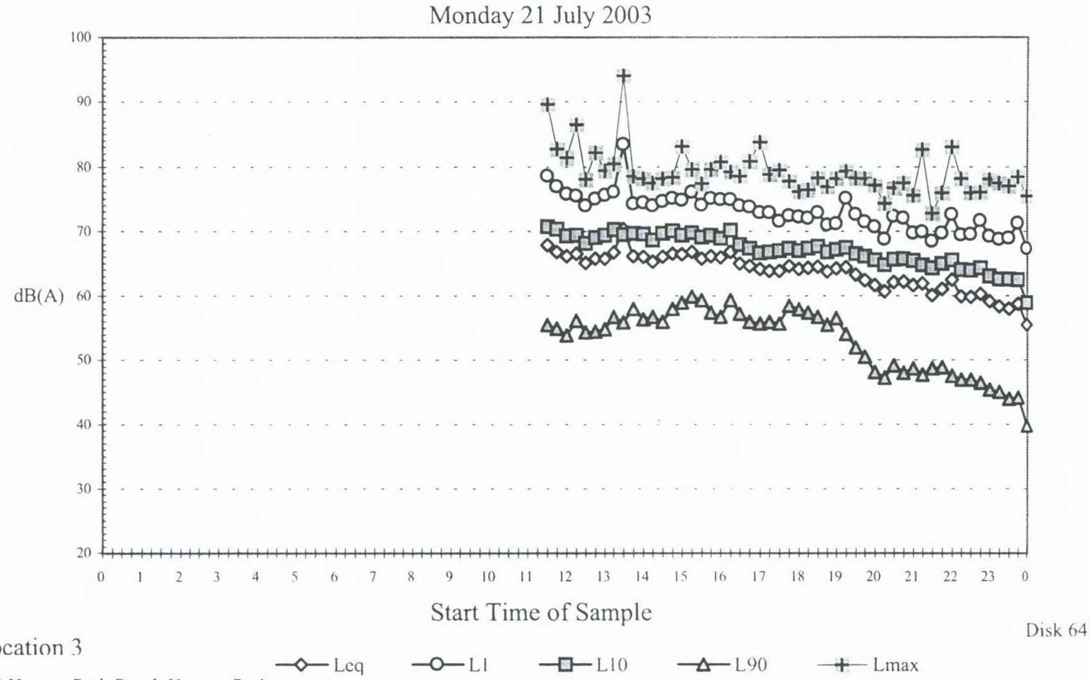
Ambient Sound Pressure Levels



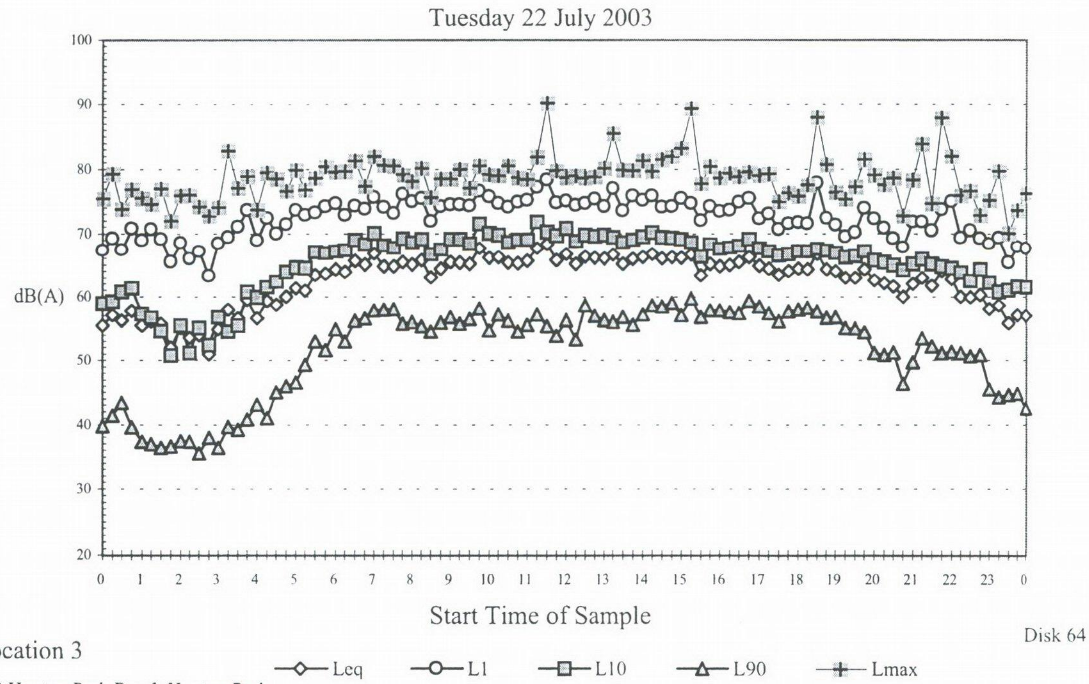


Ambient Sound Pressure Levels



Location 3

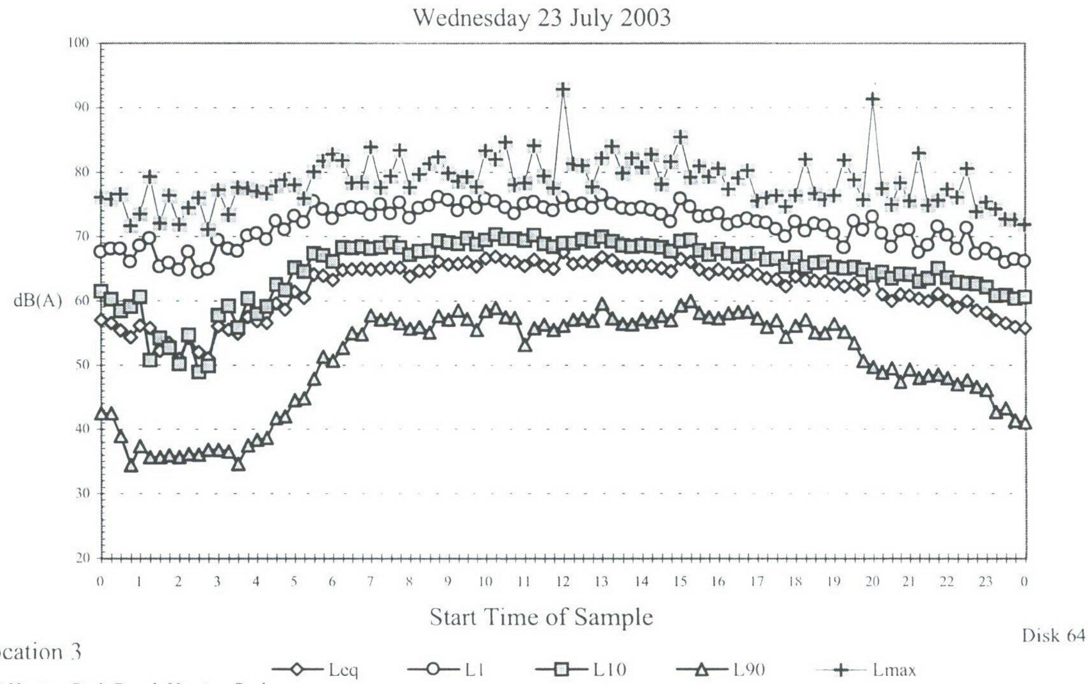
620 Hoxton Park Road, Hoxton Park



Location 3

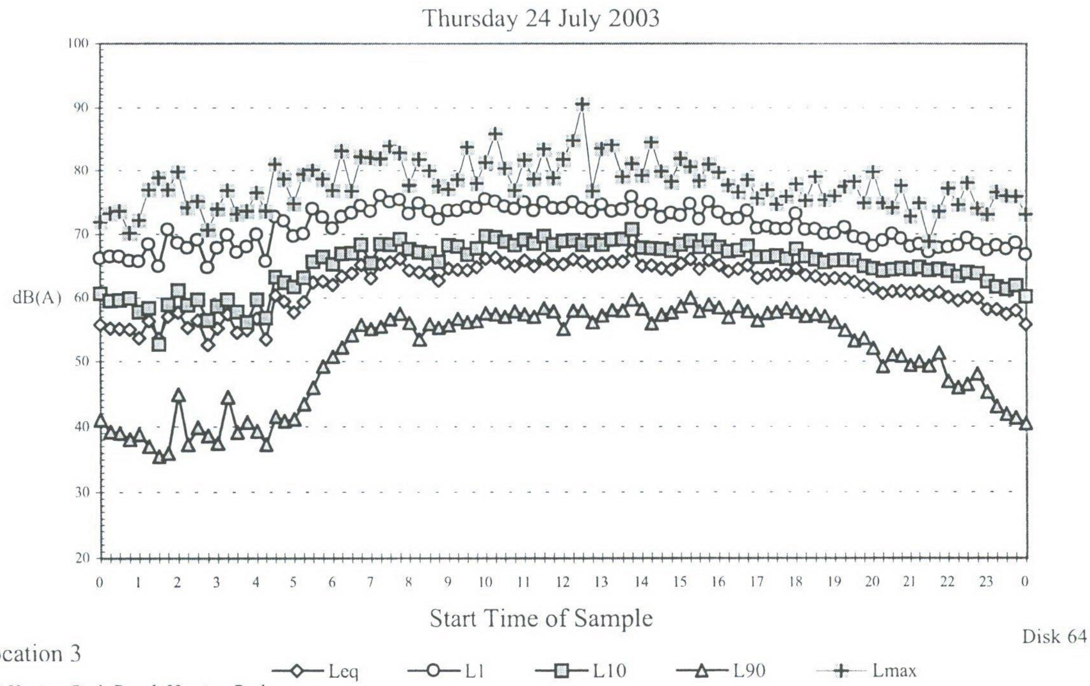
620 Hoxton Park Road, Hoxton Park

Ambient Sound Pressure Levels



Location 3

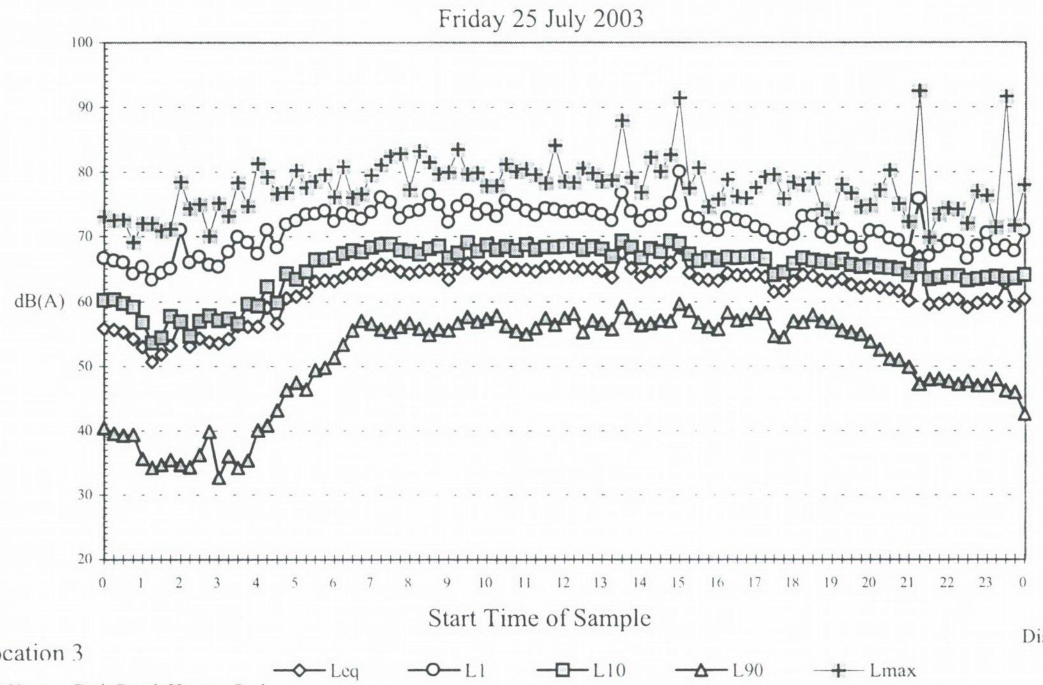
620 Hoxton Park Road, Hoxton Park



Location 3

620 Hoxton Park Road, Hoxton Park

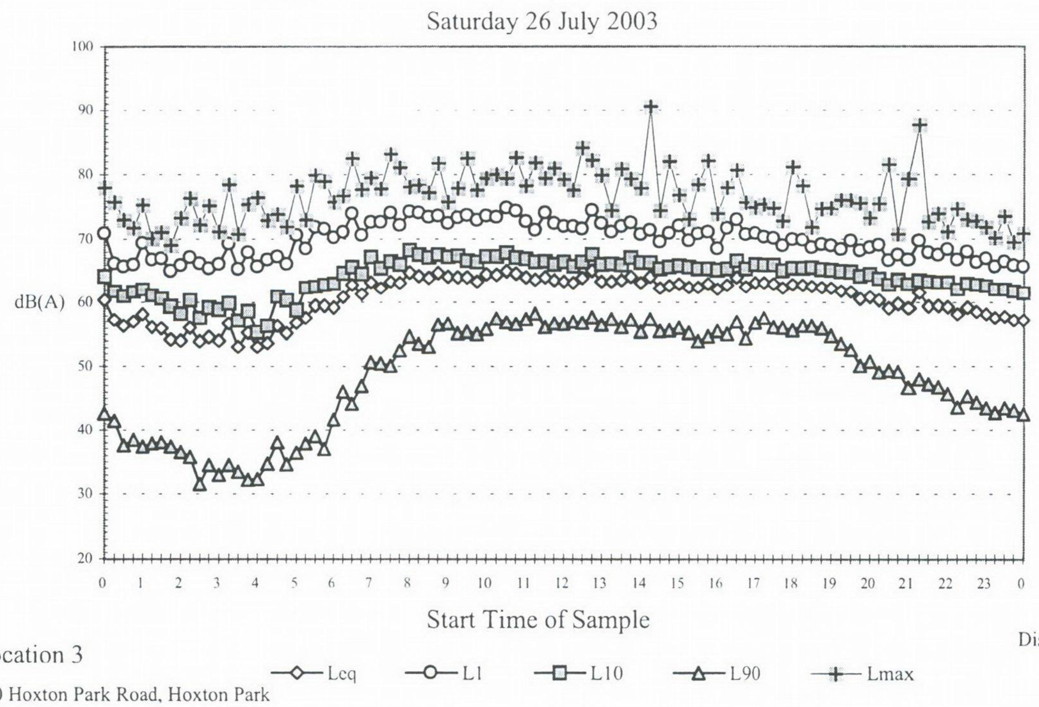
Ambient Sound Pressure Levels



Disk 64

Location 3

620 Hoxton Park Road, Hoxton Park



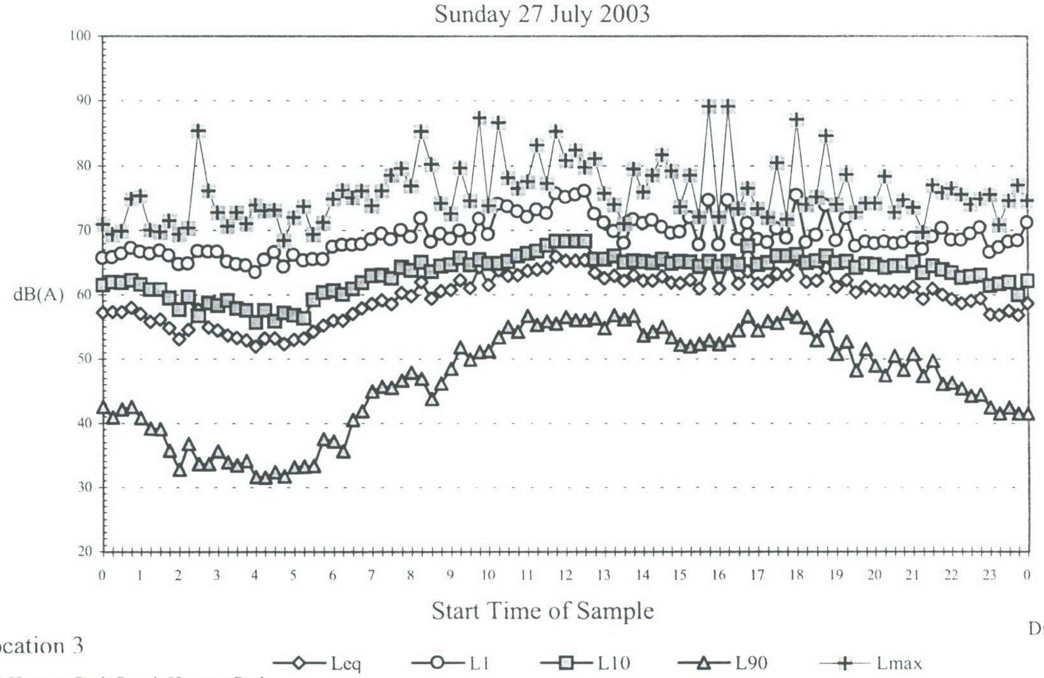
Disk 64

Location 3

620 Hoxton Park Road, Hoxton Park

Ambient Sound Pressure Levels

Sunday 27 July 2003

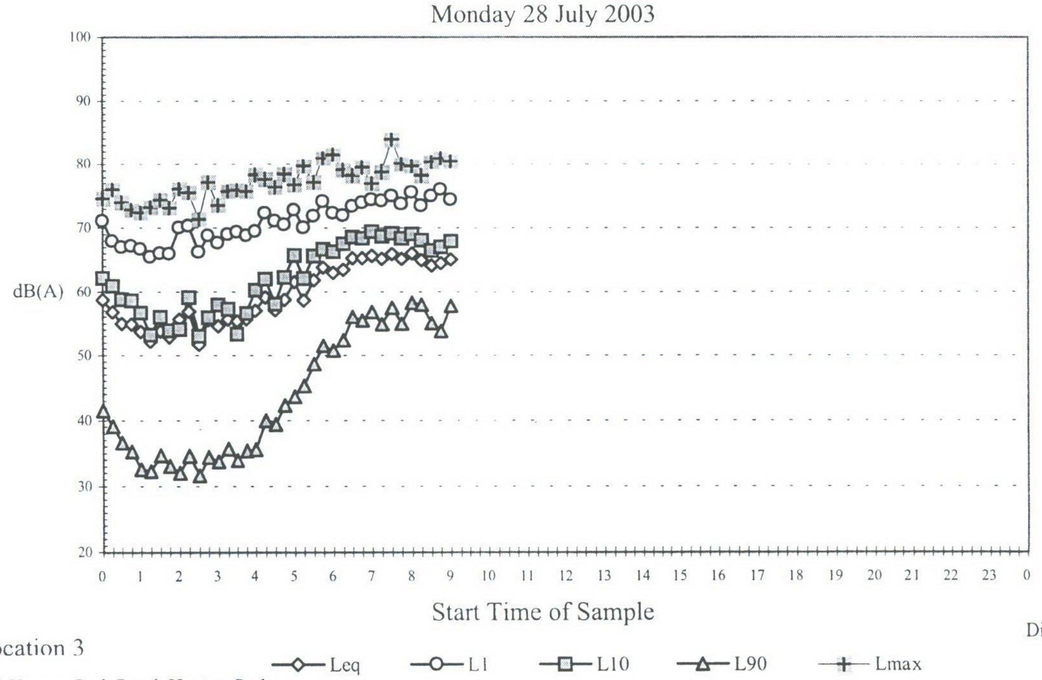


Disk 64

Location 3

620 Hoxton Park Road, Hoxton Park

Monday 28 July 2003

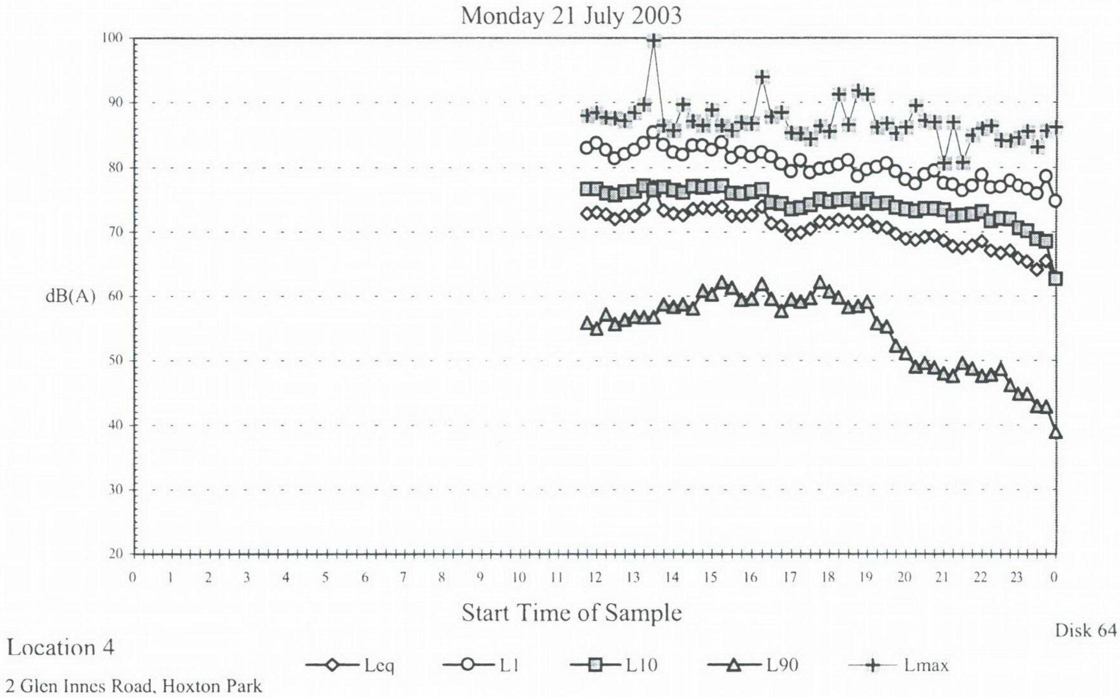


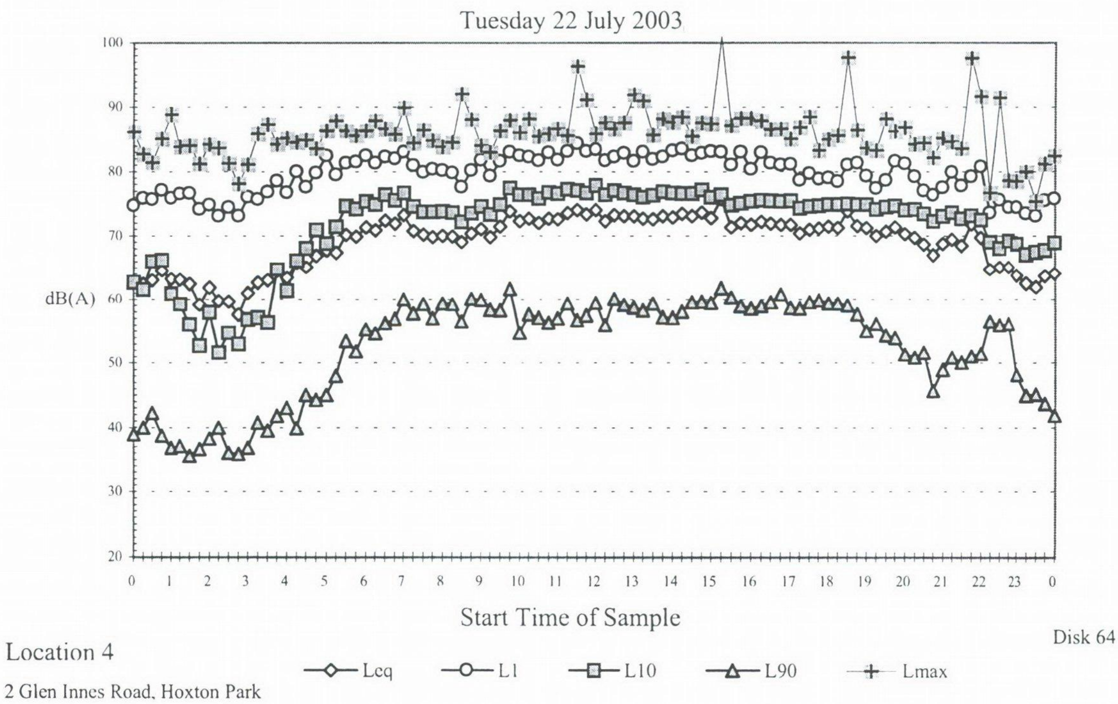
Disk 64

Location 3

620 Hoxton Park Road, Hoxton Park

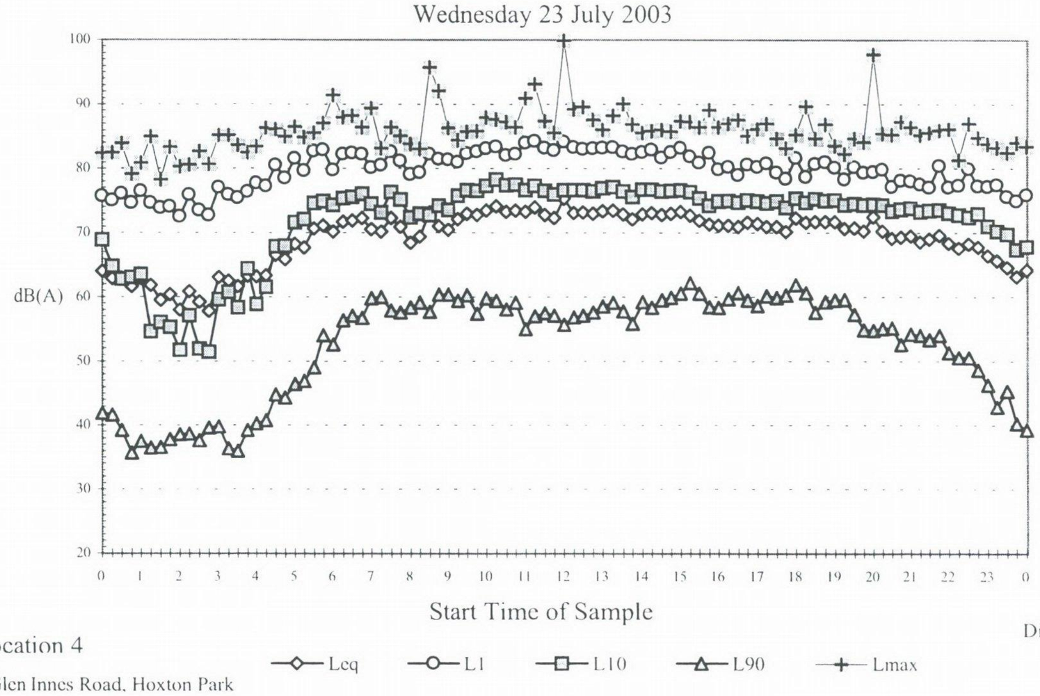
Ambient Sound Pressure Levels





Ambient Sound Pressure Levels

Wednesday 23 July 2003

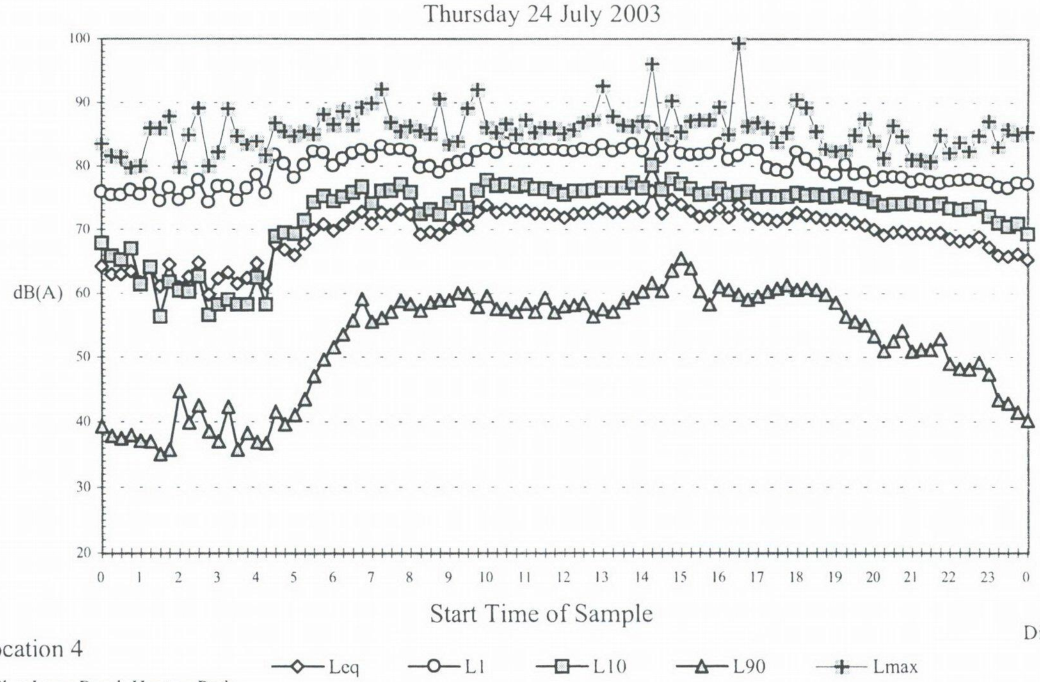


Disk 64

Location 4

2 Glen Innes Road, Hoxton Park

Thursday 24 July 2003

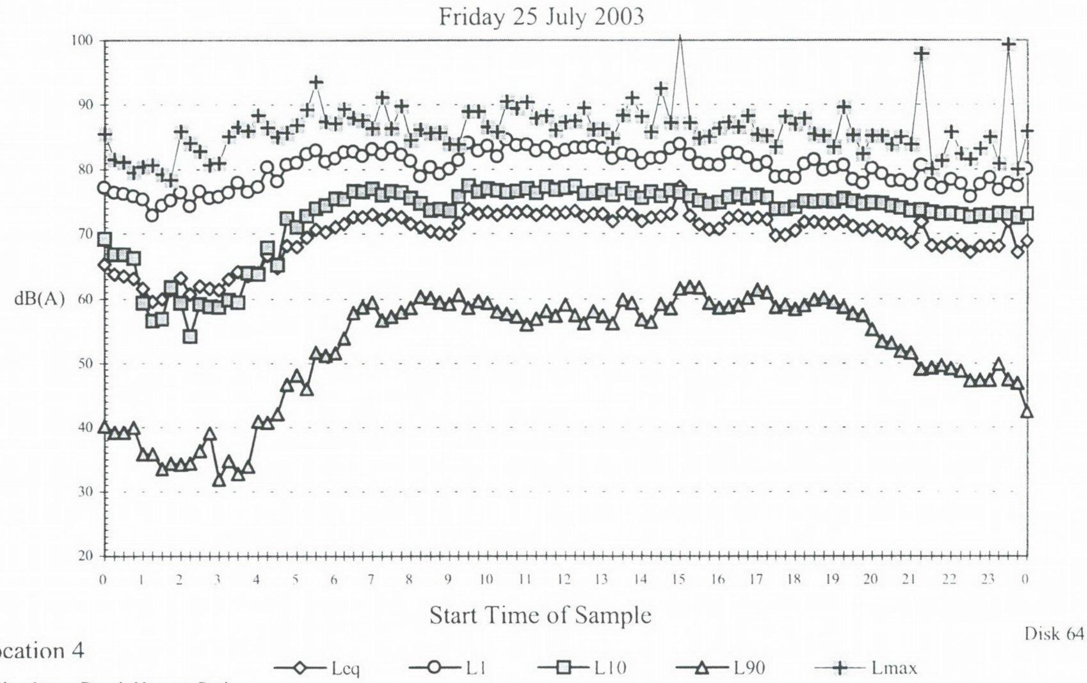


Disk 64

Location 4

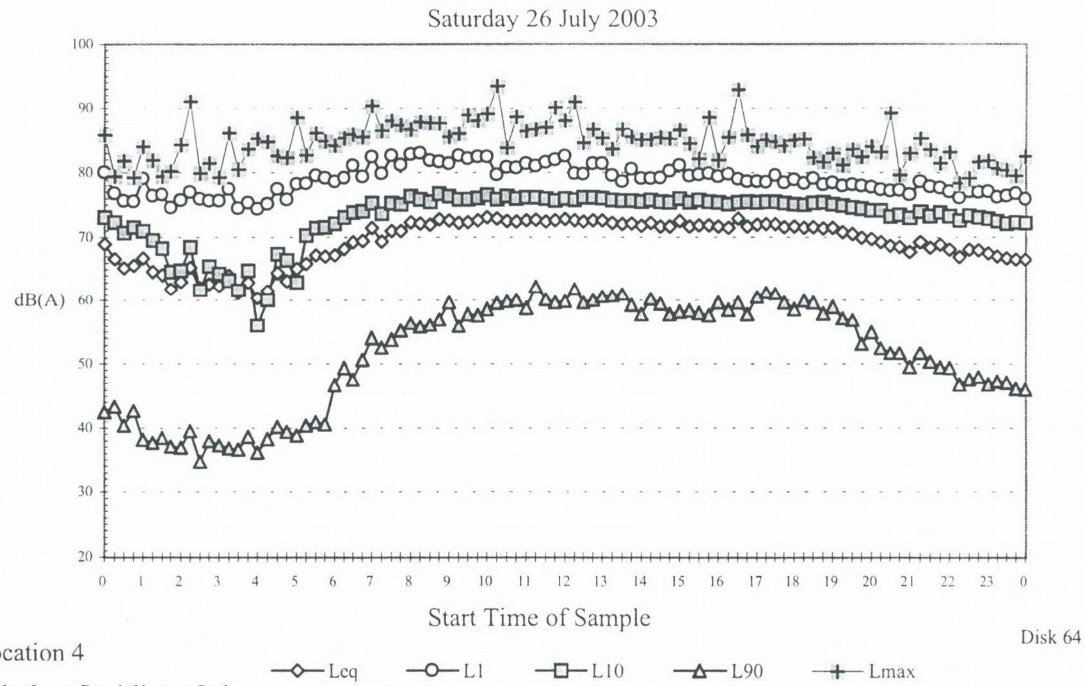
2 Glen Innes Road, Hoxton Park

Ambient Sound Pressure Levels



Location 4

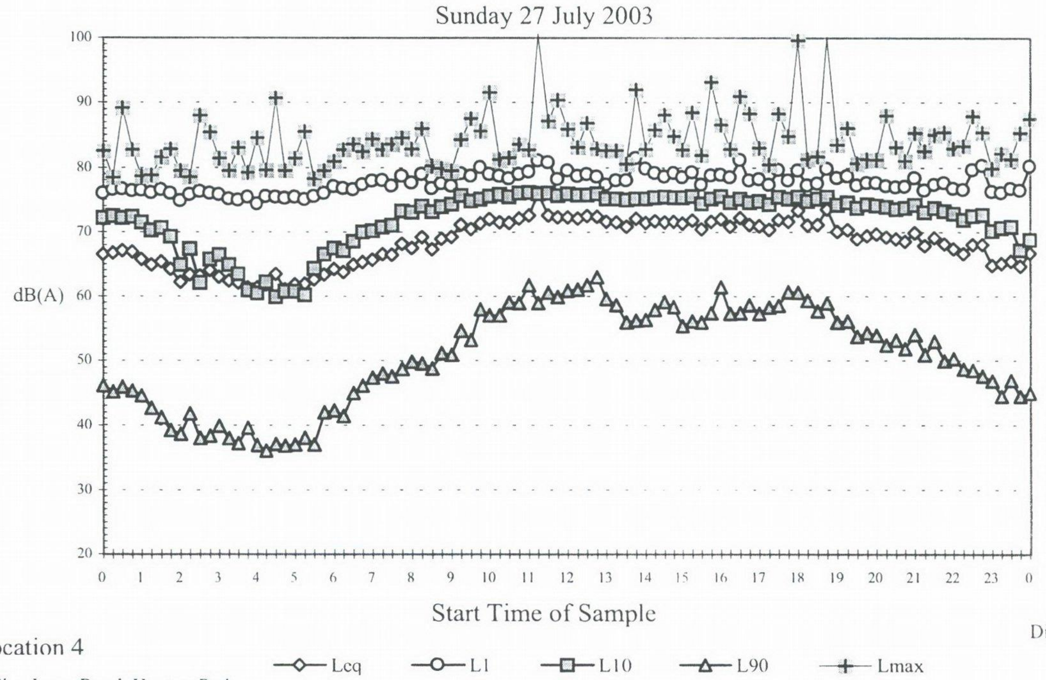
2 Glen Innes Road, Hoxton Park



Location 4

2 Glen Innes Road, Hoxton Park

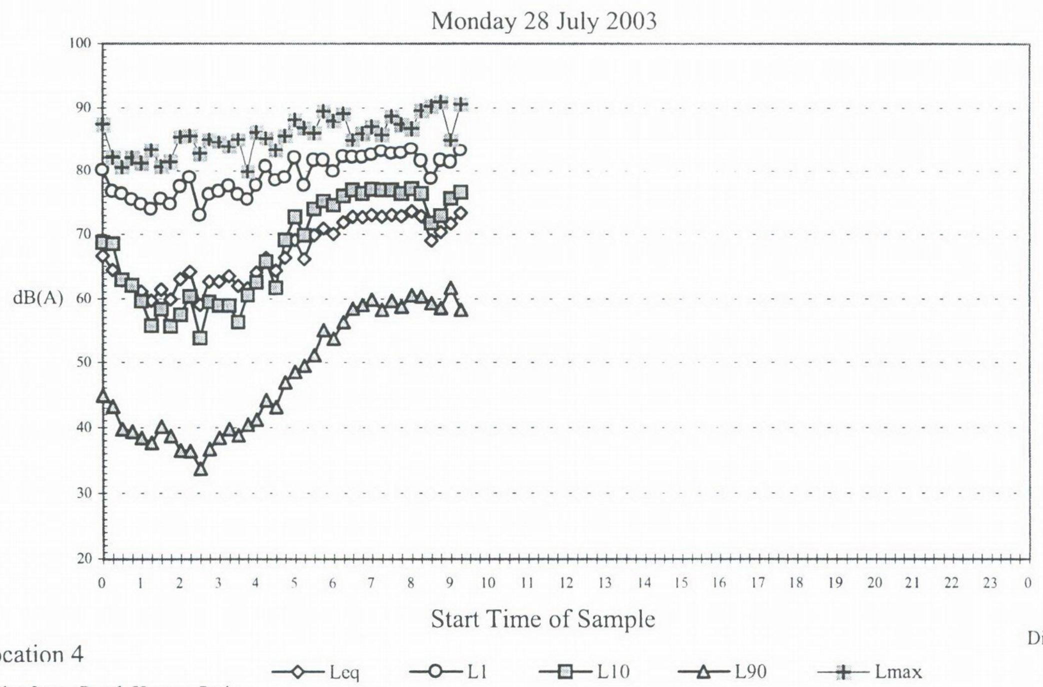
Ambient Sound Pressure Levels



Location 4

2 Glen Innes Road, Hoxton Park

Disk 64



Location 4

2 Glen Innes Road, Hoxton Park

Disk 64

PREDICTED $L_{Aeq,15hr}$ ROAD TRAFFIC NOISE CONTOURS
1.5m ABOVE GROUND LEVELS

PREDICTED $L_{Aeq,15hr}$ ROAD TRAFFIC NOISE CONTOURS
4.5m ABOVE GROUND LEVELS

PREDICTED $L_{Aeq,9hr}$ ROAD TRAFFIC NOISE CONTOURS 1.5m ABOVE GROUND LEVELS

PREDICTED $L_{Aeq,9hr}$ ROAD TRAFFIC NOISE CONTOURS
4.5m ABOVE GROUND LEVELS