Detailed Design Report

Detailed Design of Intersection Upgrades at Prince St, Picton NSW 2571

80019070

Prepared for
Wollondilly Shire Council

12 July 2019

Cardno

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1 Introduction

1.1 Background

The Wollondilly Local Government Area is forecast to experience major population and traffic growth over the next 20-30 years. The new towns of Wilton and West Appin, which form part of the Greater Macarthur Investigation Area, are anticipated to yield up to 100,000 new residents and 19,000 new jobs by 2051. There are also several smaller planning proposals throughout the LGA currently being assessed by Council. In many cases the existing road network is not equipped to cater for the projected future traffic volumes, and this issue is acute in constrained road networks such as Picton.

In planning for these future concerns, Council developed the 'Picton Town Centre Transport Plan 2026'. This plan contains a series of short-term road improvements, informed through microsimulation modelling and engineering / safety reviews. The Prince Street/Argyle Street and Prince Street/Menangle Street/Station Street intersection upgrades are the first such works to be progressed to Detailed Design. Modelling shows that the proposed upgrades will maintain an acceptable level of service until at least 2026.

In January 2019, Cardno was engaged by Wollondilly Shire Council (WSC) to prepare the Detailed Design for the Prince Street/Argyle Street and Prince Street/Menangle Street/Station Street Intersections. This Design Report documents the detailed design process, provides commentary on design intent and outlines the justification for any design departures.

1.2 Project Objectives

The objectives of the project are:

- Improve reliability and safety and reduce delay for vehicles using Prince Street, particularly at peak times.
- Ease congestion for all vehicles on the surrounding road network in Picton and remove through traffic from the historic town centre.
- Provide for the safe movement of traffic and the protection of persons and property through and/or around the project site.

1.3 Project Scope

The scope of works for this project included provision of the following:

- Dedicated left turn lane from the existing southbound lane on Argyle Street to Prince Street.
- Dedicated right turn lane from the existing northbound lane on Argyle Street to Prince Street
- Southbound continuous left turn lane from Prince Street to Argyle Street.
- New traffic signals at the Menangle Street/Prince Street /Station Street Intersection.
- Dedicated left turn lane from the existing northbound lane on Menangle Street to Prince Street.
- Dedicated right turn lane from the existing southbound lane on Menangle Street to Prince Street.

1.4 Key Stakeholders

Key Stakeholders for the project are:

- Wollondilly Shire Council Members and Officers.
- Roads and Maritime Services.
- Local Bus Operators.
- Affected landowners.
- The Wollondilly community at large.

1.5 Locality

The Prince Street/Argyle Street and Prince Street/Menangle Street/Station Street Intersections are located at western and eastern extents of the Prince Street Bridge in Picton, NSW.

The location of the works is shown in Figure 1.

Figure 1 Locality Sketch

1.6 Scope of this Report

The scope of this report includes details of the design development of the project. The purpose of this report is to:

- Provide information on the background to design decisions and justification for any design departures.
- Document the option selection process to avoid re-visiting options that have been investigated and found to be unsuitable.
- Provide information on Safety-in-Design considerations that may be included in a Worker Health and Safety Development Plan.

2 Existing Conditions

2.1 Argyle Street/Prince Street Intersection

Argyle Street is a Roads and Maritime Services road and consists of one 4.5m wide northbound lane with no shoulder and two 3.5m wide southbound lanes with 1.0m wide shoulder. The northbound lane widens to 6.0m at the intersection. There is provision for on-street parking on either side of Argyle Street. There is a 1.2m wide footpath located on the eastern side of Argyle Street.

Prince Street is a Council road and consists of a 4.0m wide eastbound lane and a 6.5m wide westbound lane at the intersection with Argyle Street. The westbound approach to Argyle Street is controlled by stop signage and line marking. There is no provision for parking along Prince Street.

The Prince Street Bridge is a single lane with a 5T load Limit. Two-way traffic flow is regulated via an informal courtesy system.

The intersection is controlled by a Stop Sign located on the Prince Street westbound approach. There is a break in the line-marking on the Argyle Street northbound approach to the intersection to facilitate a right turn.

Figure 2 Argyle Street facing north

2.2 Menangle Street/Prince Street Intersection

Menangle Street is a Roads and Maritime road and consists of two 3.5m wide northbound and southbound lanes with 2.5m wide shoulders. There is on-street parking on both the eastern and western sides of the road.

Prince Street is a Council road and consists of one 3.7m wide eastbound lane and one 3.1m wide westbound lanes. There is no provision for parking along Prince Street.

The intersection is controlled by a Stop Sign located on the Prince Street eastbound approach. There is a break in the line-marking on the Menangle Street southbound approach to the intersection to facilitate a right turn.

There is a 1.2m wide footpath located on the western side of Menangle Street.

Figure 3 Menangle Street facing south

2.3 Menangle Street/Station Street Intersection

The Menangle Street/Station Street Intersection is located approximately 20m north of the Menangle Street/Prince Street Intersection.

Station Street is a Council road and consists of a 5.0m wide eastbound lane and a 6.0m wide westbound lane at the intersection. There is on street parking on both sides of Station Street, a bus stop located outside Picton Station and a commuter carpark at the end of the street.

There are currently no controls are currently no formal line marking or sign controls in place at the Station Street/Menangle Street intersection, however the intersection effectively performs as a conventional priority-controlled T-intersection with Station Street being the minor road.

Figure 4 Station Street facing south

3 Detailed Design Input

3.1 Background Documentation

The following background information has been used as part of the development of the 20% Detailed Design:

- Cardno traffic modelling (SIDRA and Aimsun files) and modelling report.
- Cardno Concept Design, 82018177-01 SK012 and 82018177-01 SK006
- Wollondilly Shire Council Request for Quotation, REF 8722.

3.2 Design Standards

The 20% design has been prepared in accordance with the following Standards:

- Wollondilly Shire Council's Design and Specification Standard.
- Roads and Maritime Supplements to Austroads Guide to Road Design.
- Austroads Guide to Road Design.
- Australian Standards.

3.3 Design Criteria

Table 1 Argyle Street / Prince Street

Proposed Design Vehicle	Purpose	Reference
Design Vehicle: 8.8m service vehicle	Turn Path at Intersections	As Agreed with WSC.
Checking Vehicle: 12.5m single unit truck vehicle		Austroads Design Vehicles and Turning Path Templates Guide
Speed Parameter	**Value**	
Prince Street – Posted Speed	50 km/h	Austroads Part 3 Section 3 .
Prince Street – Design Speed	60 km/h	
Argyle Street – Posted Speed	60 km/h	
Argyle Street – Design Speed	70 km/h	
Minimum Lane Widths	**Value**	
Through Traffic Lane	3.3m	Austroads Part 3 Section 4
Turning Lane	3.0m	
Shoulder (where required)	0.5m	

Table 2 Menangle Street / Prince Street

Proposed Design Vehicle	Purpose	Reference
Design Vehicle: 12.5m bus	Turn Path at Intersections	As Agreed with WSC.
Check Vehicle: 12.5m single unit truck		Austroads Design Vehicles and Turning Path Templates Guide
12.5m single unit truck can perform all manoeuvres at Prince St except for the left turn into Prince St. A 8.8m Service Vehicle will be required for the left turn into Prince St.		
Speed Parameter	**Value**	
Prince Street – Posted Speed	50 km/h	Austroads Part 3 Section 3
Prince Street – Design Speed	60 km/h	
Menangle Street – Posted Speed	60 km/h	
Menangle Street – Design Speed	70 km/h	
Minimum Lane Widths	**Value**	
Through Traffic Northbound Menangle Lane	3.3m	Austroads Part 3 Section 4
Turning Lane	3.0m	
Shoulder	0.5m	

Table 3 Drainage Design Criteria

Design Element	Design Criteria	Reference
Minor Storm	ARI 20 year	Project Brief
Major Storm	ARI 100 year	Wollondilly Council Specification D5 : Stormwater Drainage Design — Clause D5.12
Min longitudinal pipe dia.	375mm	D5.09 AGRD Part 5A Section 6
Min pipe grade	0.5%	D5.09
Self-cleansing velocity	1 in 6 month event - Self-cleaning velocity >0.6m/s.	Austroads Part 5A Section 6
Pit blockage – On Grade	20%	D5.09
Pit Blockage – Sag	50%	
Gutter flow width during minor event	1.5m for carriageway < 8m 2.5m for carriageway > 8m 0.5m at Pedestrian kerb ramps	
HGL Freeboard at Pits	150mm	D5.08
Starting Water Level for HGL Analysis	Known hydraulic grade line level from downstream calculations. Where the downstream HGL is unknown, the surface level of the downstream pit.	D5.08
Surface flow		
Pipe Cover	Top of pipes min 300mm below underside of select material zone.	
Pipe Type & Class	RCP or FRC pipes in accordance with Concrete Pipe Association "Concrete Pipe Guide" or AS 3725	D5.12
Reduction in pipe size along a pipeline	Not permitted due to risk of catching debris	D5.11 & AGRD Part 5A Section 6.6.12

4 Detailed Design Development

4.1 Changes since Concept Design

4.1.1 Prince Street / Argyle Street Intersection

The length of the right turn bay from Prince Street to Argyle Street has been reduced length in line with the requirements of the previous Traffic Report prepared by Cardno. The modelling indicated that the priority movement from Prince Street is the left turn onto Argyle Street. This has reduced the extent of additional pavement required and property impacts at the south eastern corner of the intersection.

The centre line on Argyle Street has been shifted east to provide a compliant painted median on the northern side of the intersection and deter any northbound through movements from the right turn lane into Prince Street.

The proposed chevron between the left lane and through lane on Argyle Street, north of the intersection, has been removed. This is to eliminate the need for road users travelling south on Argyle Street who may be wishing to turn left into Prince Street to merge into the through lane prior to the intersection.

During the inception meeting for the project, Wollondilly Shire Council advised that they are considering providing an off-road shared path along the western side of Argyle Street. This has been subsequently been incorporated into the detailed design.

A copy of the responses to RMS design comments on the Concept Design and WSC's comments on the 20% Design Submission have been included in Appendix A.

4.1.2 Prince Street / Menangle Street / Station Street Intersection

The width of the Station Street has been reduced by approximately 2.0m at the intersection with Menangle Street to improve the proposed phasing by reducing the length of the pedestrian leg of the intersection.

A kerb build out/blister has been provided as a physical barrier to stop road users travelling north through the intersection from the dedicated left turn lane.

A 1.5m wide on-road cycle lane has been provided at the northbound approach to the Menangle Street/Prince Street intersection to cater for cyclists.

4.2 Geometric Design

4.2.1 Prince Street / Argyle Street Intersection

A dedicated eastbound left turn lane from Argyle Street into Prince Street has provided by line marking the kerbside proposed left hand lane.

A dedicated northbound right turn lane from Prince Street into Argyle Street has been provided relocating the centre line on Prince Street to the north. The storage for the right turn will improve traffic flow along Prince Street. The kerb on the north-eastern corner of the intersection will need to be realigned to accommodate the turning paths for an 8.8m service vehicle.

A dedicated eastbound right turn lane from Argyle Street into Prince Street has been provided relocating the centre line on Argyle Street to the east to accommodate the new lane within the existing kerbs. The storage for the right turn will improve traffic flow along Argyle Street.

The location of the shared path on the Western Side of Argyle Street has been indicatively shown for information and discussion as part of the 20% Detailed Design submission. The path extents and tie-ins require confirmation from Wollondilly Shire Council.

A copy of the Stopping Sight Distance and Approach Sight Distance checks have been included in Design Calculations in Appendix B.

4.2.1.1 Critical Design Decisions

During the development of the 80% Detailed Design, it was agreed that in order to maintain a free flowing southbound left turn from Prince Street to Menangle Street and to avoid the need for pedestrians to cross three traffic lanes, the kerb ramps on Prince Street would be relocated approximately 30m east along Prince Street.

4.2.2 Prince Street / Menangle Street / Station Street Intersection

The existing intersection is to be controlled by Traffic Signals with posts located at the south western corner of the Menangle Street/Prince Street intersection and the north eastern corner of the Menangle Street/Station Street intersection.

A dedicated westbound left turn lane from Menangle Street into Prince Street has been provided by line marking the existing shoulder and reducing the existing lane widths. A 1.5m wide on-road northbound cycle lane has also been provided to cater for cyclists at the intersection. The kerb on the south western corner of the intersection will need to be realigned to accommodate the turning paths for an 8.8m service vehicle.

As mentioned in Section 4.1.2, a new kerb build-out is required within the existing shoulder between Prince Street and Station Street to control traffic movements at the intersection.

A copy of the Stopping Sight Distance and Approach Sight Distance checks have been included in Appendix B.

4.2.2.1 Critical Design Decisions

At the Concept Design stage, Cardno had prepared a request for exemption of a pedestrian cross on the southern approach (Menangle Street) of the proposed intersection. The traffic reports prepared by Cardno supported the removal of this pedestrian crossing due to the low traffic volumes, approximately 20 pedestrians per hour. There is no existing footpath on the eastern side of Menangle Street or the southern side of Prince Street to warrant a crossing at this location. A copy of Cardno's request for Pedestrian Leg Exemption has been included in Appendix C.

During the development of the 80% design, a teleconference was held with WSC and RMS to seek initial feedback on the TCS layout. RMS provided the below feedback that has been incorporated into design:

- A No Right Turn sign is not supported by RMS at this location, as RMS do not restrict access to private properties under normal circumstances.
- The pedestrian crossing across Menangle Street is to be removed from C phase (introduce in D phase only).
- The pedestrian crossing across Station Street is to be removed from C phase (introduce in B phase only).
- Provide a complementary left turn from Menangle Street proceeding north into Prince Street in C phase.
- Extend the T1 line on Menangle Street proceeding south to help delineate and guide motorists to remain in the correct lane to reduce confusion.

During the development of the design, Cardno and B-Line had advised that there is a potential risk that residents travelling north along Menangle Street may wish to turn right at the intersection to access properties on the eastern side of the road. Based on the currently signal design, there is no dedicated phase for this movement and it may result in queuing at the intersection or potential collisions if road user misread the gap in traffic. As noted above, Cardno/B-Line has provided "No Right Turn" signs to be installed at this location.

It is understood that residents wish to access their properties from the northbound leg of the intersection would turn left onto Station Street, complete a U-Turn at the existing roundabout and then turn right onto Menangle Street.

Due to the geometry of Prince Street and the location of the existing Telstra pit on the south western corner of the intersection, the left turn from Menangle Street to Prince Street has been restricted to vehicles less than 6.0m.

Details of the design non-conformances have been included in Section 4.3.2.

A copy of the correspondence with RMS has been included in Appendix J.

4.3 Vehicle Turn Paths

A copy of the turn paths at each intersection have been included in Appendix B.

4.4 Design Departures

4.4.1 Prince Street / Argyle Street Intersection

Table 4 Design Departures

Design Standard	Design Requirement	Criteria Achieved	Proposed Mitigation/ Reasoning
Table 4.2: Typical Pavement Cross on Straights (Austroads Guide to Road Design Part 3) Wollondilly Shire Council Design Specification D1 Geometric Road Design (Urban and Rural)	3%	10%	The existing road cross fall exceeds 20%. This has been reduced to 10% as any further reduction will require full reconstruction of the road pavement and will have significant impacts on the existing properties adjacent to the road. As the location of non-compliant cross fall is within close vicinity of the intersection, road users will be either slowing down on the approach to the west bound left turn to Prince Street or accelerating from the left turn from Station Street to Menangle Street.
Table 5.2 Deceleration Distances Required for Cars on a Level Grade – Length of Deceleration including diverge taper	55m	0m	Advance warning signage has been provided to inform road users of the upcoming intersection.

4.4.2 Prince Street / Menangle Street / Station Street Intersection

Table 5 Design Departures

Design Standard	Design Requirement	Criteria Achieved	Proposed Mitigation/ Reasoning
Table 4.2: Typical Pavement Cross on Straights (Austroads Guide to Road Design Part 3) Wollondilly Shire Council Design Specification D1 Geometric Road Design (Urban and Rural)	3%	7%	The existing road cross fall at the northern and southern tie-in along Argyle Street exceeds 7%. This is an existing issue and is outside the scope of the proposed intersection upgrade.
Wollondilly Shire Council Subdivision & Engineering Standard WSC.D1.11	Max 20%	28%	The existing combined driveway for properties 301A and 301B has a grade of 28% from the back of the existing verge. In order to maintain the location of the existing property and garage, the existing grade has been retained. Vehicle scraping checks have undertaken and there are no issues with the change in grade.
Approach Sight Distance (Austroads Guide to Road Design Part 4A Cl 3.2.1 Eq. 1)	83m	40m	Limited by the vertical geometry of existing road. Left turn lane would need to be extended to provide compliant geometry, which would

Design Standard	Design Requirement	Criteria Achieved	Proposed Mitigation/ Reasoning
			result in the removal of on street parking and may introduce undesirable travel speeds along the left turn lane.
Approach Sight Distance (Austroads Guide to Road Design Part 4A Cl 3.2.2 Eq. 2)	Station Street SB – min. 141m (excl. Grade Correction)	Station Street SB – 53m	Limited by the location of the existing building on the north-western corner of the intersection. This intersection will be upgraded with traffic signals and will only be an issue when the signals are blacked out, which will then be controlled as Give Way conditions.
Approach Sight Distance (Austroads Guide to Road Design Part 4A Cl 3.2.2 Eq. 2)	Station Street NB – min. 141m (excl. Grade Correction)	Station Street SB – 50m	Limited by existing vegetation within the property between the Prince Street and Station Street intersections. The intersection will be upgraded with traffic signals and will only be an issue when the signals are blacked out, which will then be controlled as Give Way conditions.
Approach Sight Distance (Austroads Guide to Road Design Part 4A Cl 3.2.2 Eq. 2)	Prince Street SB – min. 141m (excl. Grade Correction)	33	Limited by existing vegetation within the property between the Prince Street and Station Street intersections. The intersection will be upgraded with traffic signals and will only be an issue when the signals are blacked out, which will then be controlled as Give Way conditions.
Approach Sight Distance (Austroads Guide to Road Design Part 4A Cl 3.2.2 Eq. 2)	Prince Street NB – min. 141m (excl. Grade Correction)	156	Limited by the vertical geometry of existing road. The intersection will be upgraded with traffic signals and will only be an issue when the signals are blacked out, which will then be controlled as Give Way conditions.
Approach Sight Distance (Austroads Guide to Road Design Part 4A Cl 3.2.2 Eq. 2)	Menangle St SB right turn into Prince St sight to Menangle St NB	156	Limited by the vertical geometry of existing road. The intersection will be upgraded with traffic signals and will only be an issue when the signals are blacked out, which will then be controlled as Give Way conditions.

4.5 Traffic Signal Design

4.5.1 Prince Street / Menangle Street / Station Street Intersection

Cardno have engaged B-Line Drafting to prepare the TCS design for the Prince Street / Menangle Street / Station Street Intersection.

On 11 March 2019, a meeting was held with Cardno, B-Line, WSC and representatives from RMS to discuss initial comments on the TCS design previously shown on the Concept Design Drawings and provide feedback on the design prior to the submission of the 80% Detailed Design Drawings.

A copy of Cardno's response to the Roads and Maritimes' comments have been attached in Appendix A.

A copy of the 80% TCS layout has been provided in Appendix D.

Cardno has also undertaken a review of the SIDRA modelling and Traffic Model Assessment to reflect the proposed changes to the signalised intersection. A copy of the SIDRA model and memorandum has been included in Appendix B.

4.6 Drainage Design

4.6.1 Available Data

A plan of stormwater infrastructure was requested from Wollondilly Council. Cardno was advised by Council that such information was not available.

Cardno undertook detailed site survey in 2019 locating any drainage pits, headwalls and pipes within the project boundary where accessible. Pit in the Argyle Street sag are inaccessible due to the heavy concrete lids.

4.6.2 Design Criteria

Refer to *Section 3.4 Design Criteria* for details. The minor storm AEP exceeds the requirements of Part 5A of Austroads Road Design Guide which recommends a 10% AEP.

4.6.3 Existing Drainage Network

4.6.3.1 Prince Street / Argyle Street Intersection

There are two stormwater networks in Argyle Street. The first network is south of Prince Street. Its catchment area begins at Conellan Crescent. The network consists of pit on the western side of Argyle Street, two kerb inlet pits on the eastern side, and a surface inlet pit and junction pit in the verge near the corner of Prince Street. The drainage line continues into Prince Street.

The second stormwater network consists of four kerb inlet pits in the Argyle Street sag just north of the limit of road works. As well as runoff from the road and residential properties, this network also receives inflow from a large culvert under the railway line to the west. The stormwater network continues through residential properties on the eastern side of Argyle Street towards Stonequarry Creek.

4.6.3.2 Prince Street / Menangle Street / Station Street Intersection

Inlet pits are located at the south west corners of both Prince Street and Station Streets. This small network outlets through a kerb convertor on the north west corner of Station Street. The next kerb inlet is at Webster Street.

4.6.4 Proposed Drainage System

New pits and pipes are required for the road widening and adjustments to satisfy the design criteria. Drainage works outside of the extent of road works was avoided where possible. However, two proposed drainage pipes need to be extended beyond the extent of road works in order to connect existing stormwater infrastructure.

4.6.5 Analysis of Pipe Drainage System

Analysis of the concept pit and pipe system has been carried out using the drainage analysis module in the 12D software package (v12.0C1m) The latest version of this software uses the ARR 2019 procedures along with the ILSAX hydrologic model. Rainfall intensities and temporal patterns were downloaded from the Bureau of Meteorology and the ARR 2019 Data Hub respectively on the 19 May 2019. A copy of the data is included in Appendix E.

An assessment was made of the directly connected impervious area of each sub-catchment. For the undeveloped lots on the western side of Argyle Street (Lot 1 DP202162) it was assumed that this would be developed in the future in accordance with the Wollondilly LEP.

The results of the analysis were checked to confirm that flow widths satisfied the above criteria and all pits had 50mm freeboard to the Hydraulic Grade Line. There was one location where these criteria was not meet as discussed below.

4.6.6 Utility Conflicts

The existing sewer in Menangle Street runs parallel to and very close to the kerb. Thus, there is very negligible clearance to the proposed stormwater. Where there is a pit, there will only be 150mm horizontal clearance to the adjacent pipe.

The drainage longitudinal sections show a clash between a potable water main and drainage Line A. This is not considered realistic as that length pipe replaces an existing pipe at a similar level. It is possible that there is a localised adjustment of the water main between the pot holing locations.

4.6.7 Non Conformances

It was not possible to meet both the "No reduction in pipe size along a pipeline" and the 5% AEP minor system criteria. Where Line A connects to the existing system there is a decrease in pipe diameter from 450mm to 375mm. The existing pipe sizes at the connection pits for Line B and M are not known, however it is likely there will also be reductions in pipe size at these locations.

Pit A\4 surcharges due to the assumption that the tail water level of the downstream pipe system was at the surface level of the pit. (Pit A\7). It was found that increasing the size of the pipe did not eliminate the surcharging. As a result of the surcharging, flow widths at Pit A\4 also exceed the design criteria.

The hydraulics of Line A could be improved by connecting to the existing pit in Prince Street rather than Pit A\5. This design change will extend the limit of works, has much more potential conflicts with utilities and may require an additional drop pit due to the steep grade of Prince Street. There will also be a reduction in pipe size.

4.7 Pavement Design

Pavement design has been undertaken in accordance with the following reference documents:

- Austroads Guide to Pavement Technology Part 2; Pavement Structural Design (2012)
- RMS Austroads Guide Supplement – Austroads Guide to Pavement Technology Part 2: Pavement Structural Design
- P-G-001 Technical Guide – Standard Pavement Subsurface Drainage Details 30 June 2014
- 0000.000.PT.0011Standard Pavement Subsurface Drainage Details Volumes 1-6
- CIRCLY – Computer Program for Analysis of Multiple Complex Circular Loads on Layered Anisotropic media (Wardle, 1977) Geomechanics Computer Program Version 6.0.

4.7.1 Geotechnical Investigations

Intrusive geotechnical investigation was undertaken by an experienced geotechnical engineer from Cardno, aimed at assessing the existing pavement and underlying subgrade conditions across the proposed alignments. Fieldwork comprised the following:

- Engagement of a qualified underground service locator to clear each of the borehole locations prior to excavation;
- Drilling of twelve (12) boreholes using a Ute-mounted drill rig equipped with a solid flight auger and TC-bit;
- Dynamic Cone Penetrometer (DCP) Tests were undertaken from the underside of the pavement to aide in subgrade assessment; and
- Collection of disturbed and bulk soil samples for geotechnical laboratory testing.

Laboratory testing comprised four (4) Atterberg Limits and four (4) California Bearing Ratio (CBR) tests to assess subgrade composition and strength for subsequent pavement design.

Falling Weight Deflectometer (FWD) testing was undertaken across each of the roads to assess existing pavement condition, and suitability for rehabilitation.

Refer to Appendix F for geotechnical borehole logs.

4.7.2 Design Methodology

Structural design has been undertaken using CIRCLY software for flexible pavement.

Design has been undertaken in a manner that endeavours to balance a range of conflicting requirements. These include requirements to:

- Match existing pavement structures
- Meet CIRCLY structural design thicknesses
- Meet RMS Austroads Guide Supplement criteria
- Minimise impacts on existing underground utilities to minimise relocation costs

4.7.3 Pavement Support Conditions

Expected subgrade conditions have been based on information collected as part of Cardno's geotechnical investigation at the sites of interest: "Picton CBD Road Improvements - Strategic Intersection Deign, report 5017190221, April 2019".

Table 4-3 in the report provides four, ten-day soaked laboratory CBR results from across the site, ranging from 2.0% to 3.5%, with a mean of 2.9%. Based on these results, a design CBR of 2% has been adopted for the pavement design for both intersections. Swell results for the samples tested range from -0.1% to 2.1%, with a mean of 0.7%. The subgrade is classified as low to moderately expansive (AGPT02-12 Table 5.2) and no special design consideration for expansive soils is required.

4.7.4 Design Traffic

Traffic modelling has been undertaken by Cardno's traffic engineers, with 2016 traffic volume survey data utilised and compared with traffic count data from Bargo (Count Station T0492). The Design Traffic calculations are included in Appendix F.

Table 6 Design Parameters

Design Parameter	Design Value
Growth Rate	5.7%
Design Duration*	25 Years
ESA/HV**	0.6
Axle Groups / HV**	2.2

Notes:

* Wollondilly Shire Council Specification D2, Clause D2.05.

** AGPT02-12 Table 12.2 Indicative heavy Vehicle Axle Groups for Lightly Trafficked Urban Streets: Collector with/with no buses

Design traffic adopted for each of the alignments are as follows:

Table 7 Design Traffic

Street	Design Traffic (ESA)
Argyle St	2.02×10^7
Prince St	1.69×10^7
Menangle St	2.58×10^7

Current heavy vehicle traffic along Prince Street is limited by 5 tonne weight and 2.4 metre height restrictions placed on the bridge over Stonequarry Creek. Based on the traffic modelling report and as a conservative measure, allowing for future replacement of the Prince Street bridge, the design has adopted a 10% heavy vehicle traffic for the pavement design for all roads.

4.7.5 Pavement Material Parameters

4.7.5.1 Asphalt Modulus

Asphalt Modulus are based on a Weighted Mean Annual Pavement temperature (WMAPT) for Campbelltown of 27°C and a traffic loading speed of 30 kmh. A15E binder is proposed for AC14 wearing course asphalt due to the significant design loading and geometry, with a C450 binder utilised for the underlying AC20.

Table 8 Calculated moduli for the proposed asphalts

Asphalt Layer	Calculated Modulus
AC14 (A15E)	2,400 MPa
AC20 (C450)	3,400 MPa

Modulus calculations are included in the Attachments. Specification of the asphalt is in accordance with Roads and Maritime Services Specification R116 Heavy Duty Dense Graded Asphalt. These specifications cover asphalt mix design, material supply, placement, compaction and testing.

4.7.5.2 Select Material Modulus

A design modulus of 150 MPa has been adopted for a Select Material layer in accordance with the Clause 5.6 of the Austroads Pavement Structural Design guide (AGPT02-12). The specification of the SMZ material is in accordance with Roads and Maritime Services Specification 3071 Selected Material for Formation.

4.7.6 Pavement Options

As the pavement requirements for this project include both widening and reconstruction, several options were considered including Full Depth Asphalt (FDA), Asphalt on Cement Treated Base (CTB), as well as a thick asphalt on granular base solutions.

Due to the relatively high traffic and constructability considerations, a decision to opt for a full depth asphalt solution across all three roads was deemed to be the most cost efficient solution to minimise traffic disruption.

A 300 mm thick Selected Material Zone over subgrade is provided for each pavement. Full depth asphalt thicknesses are:

1. Argyle Street: 300 mm
2. Menangle Street: 310 mm
3. Prince Street: 295 mm

CIRCLY design calculation summary outputs are included in Appendix F.

The footpath is designed in accordance with Wollondilly City Council Standard Drawing WSC D9.1 and consists of a 125 mm jointed reinforced concrete with f'c = 25MPa and SL72 mesh located centrally and broom finished. The Council drawings specify that the footpath include sawn or formed joints at 3.0 metre intervals and full depth expansion joints at 12.0 metre centres for crack control. A 100 mm subbase of compacted roadbase is provided which sits directly on compacted subgrade.

4.7.7 Pavement Rehabilitation

Falling weight deflectometer testing indicates that all three roads are generally structurally acceptable - the main exception being the left turn lane from Argyle Street into Prince Street.

While this allows Mill and Resheet to be an option that caters for new line marking and minor level adjustments, it does not facilitate more significant level adjustments particularly where existing levels are to be lowered. As a result, full depth pavement reconstruction is required for a significant portion of the Argyle Street and Prince Street intersection and approaches.

The extent of new pavement and Mill and Resheet is shown on the pavement plans PV-1001 to PV-1002 and PV-1080 to PV-1082.

Graphical charts showing FWD deflection with the tolerable deflection limit are included in Appendix F.

4.7.8 Pavement Interface with Existing Road Infrastructure

Pavement construction on all three roads will require interfacing with the existing pavement configurations.

In order to reduce the likelihood of a poor joint developing at the interface of the old and new pavements, it has been proposed that an additional 300 mm width of the exiting pavement is milled out to a depth of 50 mm, to allow the AC14 wearing course to be keyed into the existing construction.

Pavement Edge Details and Interface Details are included in Sheet No PV-1051.

4.7.9 Pavement Drainage Options

Pavement interface drains have been provided at all changes of pavement type. Edge drains have been provided under all kerbs. Design details are in accordance with the RMS Standard Pavement Subsurface Drainage Details and Technical Guide.

4.8 Landscape Design

4.8.1 Prince Street / Argyle Street Intersection

Landscape planting has been proposed on the south-eastern corner of the intersection to provide an additional buffer to residential property. Sandstone boulders on the western side of Argyle St will need to be removed to allow for new shared path. There is an opportunity to reuse these boulders as edging for proposed planting area.

Details of the proposed landscape treatments have been included as part of the 80% Design Submission.

4.8.2 Prince Street / Menangle Street / Station Street Intersection

The existing pathway between Prince Street and Station Street is to be retained. This provides opportunity for planting between footpath and road. This will improve visual amenity as well as ensuring pedestrian safety with a physical buffer between footpath and road.

There is potential to relocate the existing seat along Menangle Street and to the southern side of Station Street. This area can be embellished with landscaping to provide an appealing location to sit.

Cardno have proposed for a strip of planting along the northern side of Station Street.

There is also a potential for the removal of existing wall opposite Station Street to allow for a visual improvement and consistent character of the area. This will be further discussed with WSC as part of the preparation of the Property Adjustment Plans.

Details of the proposed landscape treatments have been included as part of the 80% Design Submission.

Cardno has prepared a photomontage for the proposed signalised intersection, which has been included in Appendix M.

4.9 Retaining Wall Design

4.9.1 Prince Street / Argyle Street Intersection

There is an existing 2.0m high embankment along the western side of Argyle Street. Cardno have proposed a concrete block wall to accommodate the new-shared path and limit the road widening required.

Additional geotechnical investigation are scheduled prior to the submission of the 100% Detailed Design to confirm that this barrier type is suitable for the assumed ground conditions.

4.9.2 Prince Street / Menangle Street / Station Street Intersection

Due to the narrowing of Station Street, the pavement adjacent to the property on the north western corner of the Menangle Street/Station Street intersection main require a small concrete block wall to maintain street access from the front of the property. This will be included as part of the Property Adjustment plans to be developed by Cardno with input from WSC and the property owner.

4.10 Property Impacts

4.10.1 Prince Street / Argyle Street Intersection

Property acquisition will be required along the western side of Argyle Street to accommodate the additional right turn lane and new 2.5m wide shared path. Further consultation with Wollondilly Shire Council is required to confirm the extent of the shared path to be provided as part of this project. It is likely that a retaining wall may be required on the western side of the road due to match existing levels and reduce the property acquisition required.

4.10.2 Prince Street / Menangle Street / Station Street Intersection

Property acquisition will likely be required on the south western corner of the Menangle Street/Prince Street intersection to accommodate the on-road cycle path and turn path for 8.8m service vehicles. This will be further defined as the design develops.

There are two driveways within the vicinity of the signalised intersection. Due to the increased number of traffic lanes and new signals, it is likely that the accesses will need to be restricted to left in/left out. This will be subject to the negotiations with the property owners and findings in the Road Safety Audit.

4.11 Environment

A Review of Environmental Factors (REF) has been prepared by SLR Consulting for Wollondilly Shire Council based on the initial Concept Design.

A summary of the proposed mitigation measures recommended have been included in Table 9.

Table 9 Proposed Mitigation Measures from REF

Impact Area	Proposed Mitigation	Action Undertake
Erosion and Sedimentation	An Erosion and Sedimentation Control Plan (ESCP) will be prepared by suitable qualified persons as per EMS-09-PR-0012 Erosion and Sediment Control and will be fully implemented and managed through all stages of the project.	Erosion and Sedimentation Control Plan to be prepared by the construction contractor.
Water Quality	The project will incorporate only minimal culvert and drainage works, with preservation of the existing infrastructure and road material where practicable. An Environmental Spill Response Protocol (ESRP) will be developed and implemented to minimise the risk of hydrocarbon and chemical spills, and will be included as part of the CEMP.	Where possible, existing kerb and drainage has been retained. Excavation of existing pavement material has been minimized in the design. ESRP to be prepared by the construction contractor.
Air Quality	The following mitigation measures will be implemented during the construction to minimise impacts on air quality and dust generation: • Covering or watering exposed areas; • Spreading of binder, spraying of paint or other light materials will not be carried out during times of strong winds or in weather conditions where high levels of dust or airborne particles are likely; • Materials such as vegetation will not be burnt on site; • Vehicle loads will be covered to prevent release of dust or odours during transportation; and	The construction contractor will be required to incorporate the above mitigation measures (as a minimum) in the CEMP.

	• Any stockpiles of materials will be managed in accordance with the CEMP.	
Noise and Vibration	During detailed design background noise monitoring will be undertaken at adjacent residents to confirm background noise levels. An operational noise assessment will then be undertaken using the finalised design to identify if any perceptible road traffic noise impacts may occur to nearby residents.	Baseline and post construction (12 months after opening) noise monitoring at sensitive local receivers will be undertaken by Wollondilly Shire Council.
Flora and Fauna	The following mitigation measures will be implemented during the construction to minimise impacts on flora and fauna: a) Vegetation clearing footprint will be limited as much as practicable; b) If substantial clearing of vegetation is required to the west of Argyle Street, the area will be inspected by a suitably qualified ecologist to confirm that no protected species or no fauna is present; c) Equipment storage and stockpiling of resources will be restricted, where practical, to designated areas in cleared land; and d) Vehicles and other equipment to be used in clearing within the construction zone and general construction equipment (such as excavators, graders etc.) will be cleaned so that they are completely free of soil, seeds and plant material before entering the site to prevent the introduction of further exotic plant species and pathogens.	The construction contractor will be required to incorporate the above mitigation measures (as a minimum) in the CEMP.
Aboriginal Heritage	In the event that unexpected finds are uncovered, all work likely to affect these finds would cease and the Council's Heritage Officer would be contacted immediately. The Project Manager and Council's Heritage Officer would be responsible for notifying the Office of Environment and Heritage, if required. An investigation would be undertaken by a suitably qualified archaeologist to identify suitable measures to manage impacts to the find prior to work in that area resuming.	The construction contractor will be required to follow the above management procedure in the event of discovery of Aboriginal heritage items during construction and document such in the CEMP.
Non-Aboriginal Heritage	Council's Heritage Officer will be consulted regarding the impacts to sandstone guttering located at the intersection of Menangle and Prince Streets and the following mitigation measures will be implemented during the construction to minimise impacts: • The heritage item will be covered when completing line marking to avoid marking the heritage items;	Heritage kerb to be removed intact and provided back to Wollondilly Shire Council for incorporation into future urban design, to retain the heritage value of the sandstone for the local community. Construction tender documentation will set out explicit instructions in relation to the contractor's obligations to preserve the heritage sandstone.

	• Removal of the heritage item will be avoided, and barriers should be set up to create no go zones; or • Where avoiding removal of the heritage item is not practicable, removal will be done by a suitably qualified archaeological specialist prior to construction to retain the item so it can be re-laid as part of the new intersections design.	
Waste Management	Wastes from the project will be managed in accordance with the CEMP and resource management hierarchy principles of the Waste Avoidance and Resource Recovery Act 2001. The following mitigation measures will be implemented during the construction to minimise waste impacts: • Any waste generated form the project will be assessed in accordance with the Waste Classification Guidelines (DECC 2008) prior to disposal; • All site personnel will be informed of the need to maintain a clean worksite; • Daily inspections will be carried out during the construction period to ensure that the site is left in a rubbish free state (noting that burying or burning of waste will not be permitted); • Construction waste such as spoiled gravel or topsoil may be stockpiled in the council depot or alternative proposed project compound for later re-use in the road verge; • Any noxious weeds and exotic plant species removed will be disposed of at a licensed landfill facility; • Wastes will not be stored for long periods during the construction period; • Waste material will not be left on site following completion of works; • General waste will be collected by a contractor on a weekly basis; • Bulk project waste disposal will be done so to an approved waste disposal centre; and • Construction waste, such as concrete culverts and headwalls, may be reused onsite or disposed of by recycling or to an approved landfill.	The construction contractor will be required to incorporate the above mitigation measures (as a minimum) in the CEMP, to be agreed by Council prior to construction commencing. A suitable compound for the temporary storage of construction materials (possibly the Council depot on Menangle St) will be identified and agreed with Council prior to construction commencing.
Hazardous Materials	An Environmental Spill Response Protocol (ESRP) will be developed as part of the CEMP and will include the following mitigation measures in order to minimise impacts:	The construction contractor will be required to incorporate the above mitigation measures (as a minimum) in the CEMP.

	• Strategies will be developed to minimise the amounts of hazardous materials required for the works; • Hazardous materials will not be located or handled within 40 m from drains or watercourses; • Safety Data Sheets (SDSs) will be maintained in a readily accessible location for all hazardous materials on site; • Hazardous materials will be handled, used, transported and disposed of in accordance with the respective SDS; • Hazardous waste (including contaminated soil and stormwater) will be fully contained prior to removal from site by a suitably licensed contractors and to a suitably licensed facility; • Spill kits with suitable quantities of adsorbent material suitable for the hazardous materials being stored or used will be installed at storage locations and staff appropriately trained in the use of these spill kits; and • On site refuelling of equipment will be limited where practical, with maintenance and refuelling to occur within designated areas surrounded by appropriate bunding and control measures.	
Traffic and Transport	The project will be required to conform to the RMS requirements provided to Wollondilly Shire Council for theproposed works, in order to minimise the impacts the project will have on traffic, as outlined below: a) The traffic signals must be designed in accordance with Austroads Guide to Road Design Part 4a: Unsignalised and signalised intersections, Austroads Guide To Traffic Management Part 6: Intersections, Interchanges and Crossings (2017) and the RTA's Traffic Signal Design (2008). b) Where required, lighting must be upgraded/provided in accordance with Australian Standard AS/NZS1158 Lighting for Roads and Public Spaces. c) Pavement design associated with the signals (i.e. the detectors) must be in accordance with Austroads standards. d) A signposting plan will need to be prepared and implemented to the satisfaction of RMS to ensure motorists are guided to the appropriate lane (at a unique layout).	a) Traffic Signals have been design in accordance with standards provided, refer Appendix D. b) Lighting has been design in accordance with nominated standards, refer Road Lighting drawings. c) Road Pavement has been design in accordance with standards nominated, refer to calculations in Appendix F. d) Signposting plans have been provided, refer to road furniture drawings. e) Design Speeds used are 10km/h higher than the posted speed, refer to the design criteria in Table 3.3. f) Signal phasing has been provided, refer Appendix D.

	e) RMS practice is to adopt a design speed which is 10km/h higher than the posted speed. The design speed should be 70 km/h as per Austroads Guide to Road Design, Part 3, Section 3.1. f) Proposed signal phasing must be provided for review. g) Sight distance requirements are to comply with Traffic Signal Design manual. Details to be provided on the submitted plan. h) The left turn deceleration lane storage length is based on 5 x 8.8m long service vehicles. The length provided does not allow for gaps in between vehicles and assumes that the vehicles are joined which is incorrect. This needs to be considered and addressed. i) The layout does not appear to cater for cyclists. Widening the carriageway to provide two lanes through the intersection has resulted in no shoulder. Consideration needs to be given to how on road cyclists will be managed. j) Sight distance requirements are to comply with Traffic Signal Design manual. It appears sight distance on the southern approach may be restricted due to a crest and also on the northern approach due to the horizontal geometry. Advanced warning signage needs to be considered and, where appropriate, implemented. k) It appears that the proposed median in Station Street will be painted. If it is proposed to be painted, consideration needs to be given to provide a raised concrete median instead to provide physical separation and control vehicle movements on this leg. l) Due to the kerb adjustment, it appears that property acquisition may be required on the north western corner of Prince Street along with drainage pit adjustment. If acquisition is required, this needs to be resolved prior to construction or as otherwise agreed to by RMS. m) A 12.5 m single unit truck can perform all manoeuvres at Prince Street except for the left turn into Prince Street. RMS understands this is an existing issue. The design must identify how this will be addressed as part of the signals. n) Ensure kerb ramps comply with RMS Standard Drawing R0300-11.	g) Sight Distance checks have been provided in Appendix B. h) SIDRA modelling confirms that 95% queues on Menangle St will not exceed the left turn lane storage length in either the 2026 or 2036 scenario. i) A 1.5m wide northbound on-road cycle lane has been provided and the southbound through lane has be widened to 4.5m to cater for cyclists through the intersection. j) A copy of the design check, including sight distance, have been included in Appendix B of the design report (80019070-CI-REP-0001). k) Due to the narrowing of Station Street in order to provide a compliant signal phasing and to allow for the turning paths for buses, a painted median has been provided. l) Property acquisitions have been minimised as far as possible and are detailed on the property acquisition plans (refer property works plans). m) To avoid major impacts on utilities and property, the left turn into Prince St is restricted to vehicles under 6m in length. Due to the load limits on Prince St bridge, the only vehicles expected to exceed 6m are waste collection trucks, which will be able to service residents at the eastern end of Prince St by approaching from the north and turning right from Menangle St. n) Compliant kerb ramps have been provided, refer road furniture drawings. o) Pipe and pit drainage has been provided, refer to drainage plans.

	o) Drainage needs to be compatible with the RMS road network.	
Visual Amenity	Landscaping and re-vegetation is to occur and the heritage 'Remnant sandstone kerbs, gutters and culverts' preserved where practical to aid in retaining local visual amenity. Where required, lighting must be upgraded/provided in accordance with Australian Standard AS/NZS1158 Lighting for Roads and Public Spaces.	Heritage kerb on Menangle St has been retained in the design as far as practicable. The sandstone kerb that needs to be replaced will be removed intact and provided back to Wollondilly Shire Council for incorporation into future urban design, so as to retain the heritage value of the sandstone for the local community. Lighting has been design in accordance with nominated standards, refer Road Lighting drawings..
Social and Economic Impacts	The following mitigation measures will be implemented during the construction to minimise the negative whilst maximising the positive social and economic impacts: a) All works associated with the project will be completed as soon as possible to ensure impacts to local residents are minimised; b) A 'dial before you dig' search will be undertaken prior to any construction occurring to ensure all public utilities identified and effectively managed; c) Local economic benefits will be maximised wherever practicable, such as engagement of local contractors; and d) Sufficient project notification and stakeholder engagement will be completed with local residents to ensure no adverse social impacts are felt.	a) The construction program will be optimized in consultation with the appointed contractor in order to balance the expeditious completion of works with the need to minimize disruption to residents and the travelling public during construction. b) Intrusive surveys have been undertaken to give the design team a high level of confidence regarding the location of underground services. c) Local suppliers have been used to deliver design and project management services. A local weighting is not used in the procurement of WSC construction contracts as Council wishes to encourage a competitive tender process. d) Consultation with directly affected residents on Menangle St has already occurred. Individual property owners and tenants will be consulted one-on-one prior to finalization of the design drawings to ensure that suitable driveway works can be incorporated in the construction contract (if required).

4.12 Schedule of Quantities and Cost Estimate

Cardno have engaged MIEngineers to prepare a Schedule of Quantities and Construction Cost Estimate at the 20% Detailed Design and 100% Detailed Design Stages.

A copy of the 20% Schedule of Quantities and Cost Estimate has been included in Appendix G.

4.13 Construction Staging and Traffic Management

Construction Staging and required Traffic Management Plans will be provided following Wollondilly Shire Council and Roads and Maritime's acceptance of the 80% Detailed Design.

4.13.1 Prince Street / Argyle Street Intersection

Where possible, widening has been limited to the western side of Argyle Street. This will allow the widening works to be undertaken behind concrete barriers with minimal disruption to the existing traffic. It is likely that the pavement resurfacing will need to be undertaken as night works with a temporary road diversion for residents wishing to access Prince Street.

4.13.2 Prince Street / Menangle Street / Station Street Intersection

The majority of the proposed works has been limited between the existing kerbs on Menangle Street. Widening has been limited to the western side of Argyle Street. Traffic barriers will be required to undertake the kerb widening works at the intersections on the western side of Menangle Street. Similarly, to Argyle Street, it is likely that the pavement resurfacing will need to be undertaken as night works with a temporary road diversion for residents wishing to access Prince Street.

5 Public Utilities

A Dial Before You Dig (DBYD) investigation was undertaken as part of the preliminary investigations. The asset owners identified within the project boundary include:

- Endeavour Energy overhead and underground power assets.
- Telstra copper and fibre optic assets.
- NBNco subducted cables in Telstra's underground network.
- Sydney Water potable water and sewer assets.
- Jemena low pressure mains

Cardno has undertaken QL B utilities survey on the 06/03/19. Cardno is currently assessing the utilities that will require potholing in liaison with the utility authorities. Cardno has prepared a Utilities Register for the existing assets onsite including proposed treatments (refer to Appendix H for the Utilities Register).

5.1 Telstra

Telstra assets are located at both Argyle St and Menangle St intersections. On the 22/03/19 Cardno met with a Telstra representative out onsite to discuss the potential impacts of the works. Telstra reviewed and provided a Scope of Works (SOW) for their affected network for the sites. Utilities register was updated to include any new services proposed by Telstra. Existing and proposed utilities were modelled in 12D and included on utilities drawings set. Telstra SOW is attached in Appendix H.

5.2 NBN

NBN is subducted into the Telstra network on both Argyle St and Menangle St intersections. NBN is awaiting the Council's approval to commence scoping works for their affected assets.

5.3 Jemena

Jemena is only located at Argyle St Intersection where the existing kerb and footpath will be retained. A copy of the 80% Detailed Design plans and survey will be issued to Jemena to confirm no protection or relocation of their assets is required.

5.4 Sydney Water

Sydney Water assets are located at both Argyle St and Menangle St. There are a number of potable water and sewer mains located inside the work zone. Cardno has submitted a completed a relocation/deviation application for the assets impacts.

Based on previous experience, the assets may require protection, however this will be confirmed once Sydney Water provide details of the Notice of Requirements.

5.5 Endeavour Energy

Endeavour Energy has overhead assets at both Argyle St and Menangle St intersections. Argyle St also has underground assets near the station. At the 80% design submission no assets have been impacted by the proposed works. Therefore no relocations designs are to be lodged to Endeavour.

A lighting design has been completed for the 80% design and an application will be completed and provided to Endeavour Energy for approval.

6 Design Verification

6.1 Internal Reviews

All documentation has been provided in accordance with Cardno's Approved ISO 9001:2015 Quality Management System. A copy of the internal reviews have been attached in Appendix I.

6.2 Road Safety Audit

A Road Safety Audit has been undertaken off the 80% design drawings. A copy of the Road Safety Audit including initial responses has been included in Appendix K.

6.3 WHS & Safety in Design Requirements

A WHS & Safety in Design review was undertaken with representatives from Wollondilly Shire Council on 7/06/2019. A copy of the risk register has been included in Appendix L. Details of risks that cannot be closed out as part of the design, will be provided to the contractor to close out during construction.

6.4 Community Consultation

Community Consultation is currently being undertaken by Wollondilly Shire Council. Specific drawings for property owners including Property Acquisition and Property Adjustment plans have been provided to WSC to commence negotiations with property owners. Ongoing consultation will be undertaken between property owners and WSC.

APPENDIX A

COMMENTS REGISTER

APPENDIX B

DESIGN CALCULATIONS

APPENDIX C

PEDESTRIAN LEG EXEMPTION REQUEST

APPENDIX D

TCS LAYOUT

APPENDIX E

DRAINAGE DESIGN

APPENDIX F

GEOTECHNICAL DESIGN CALCULATIONS

APPENDIX G

SCHEDULE OF QUANTITIES AND COST ESTIMATE

APPENDIX H

Utilities

APPENDIX

I

Internal Verification

APPENDIX J

Design Correspondence

APPENDIX K

Road Safety Audit

APPENDIX L

Risk Register

APPENDIX

M

Photomontage