Oakdale West Development – Kemps Creek

Western North South Link Road Design Report

CLIENT/ GOODMAN

DATE/ OCTOBER 2018

CODE/ 15-272-R002-04

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02	SSD Application	14-03-17	Russell Hogan	☒	☒
03	Client Review	28-09-18	Anthony McLandsborough	☒	☒
04	RTS Submission	5-10-18	Anthony McLandsborough	☒	☒
				☐	☐

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Abbreviations

OWE	Oakdale West Estate
WNSLR	North South Link Road
GPS	Goodman Property Services (Aust) Pty Ltd
SWC	Sydney Water Corporation
RMS	Roads and Martine Service
LD	Lenore Drive
PCC	Penrith City Council

1 Introduction

1.1 Scope of Report

Objective of Report

The objective of this design report is to outline the design criteria used for the Engineering design of all components of the Western North-South Link Road (WNSLR) and compare to the requirements of the Roads and Maritime Services (RMS) Design Guidelines and the Penrith City Council Development Control Plans (DCP).

This report should be read in conjunction with Civil Engineering drawings prepared by AT&L titled Oakdale West 3000- Series North-South Link Road Civil Works Package. Refer to Appendix A for a list of all these drawings.

Summary

This report generally discusses the design philosophy behind the following components of the design of the WNSLR.

- Road Design
- Stormwater Management
- Services

1.2 Project Objectives

The project specific objectives for the design are:

- To provide the primary road connections for the Oakdale West Estate (OWE) with the Lenore Drive (LD) to the north.

The project will also meet the following objectives that are common to road design projects:

- Develop a cost-effective solution.
- Provide appropriate levels of safety for road users.
- Minimise land acquisition.
- Minimise disruption to adjacent property owners/ authorities including Transgrid, WaterNSW, Goodman Property Services (GPS) and Fitzpatrick Property

2 Existing Site Conditions

2.1 Locality

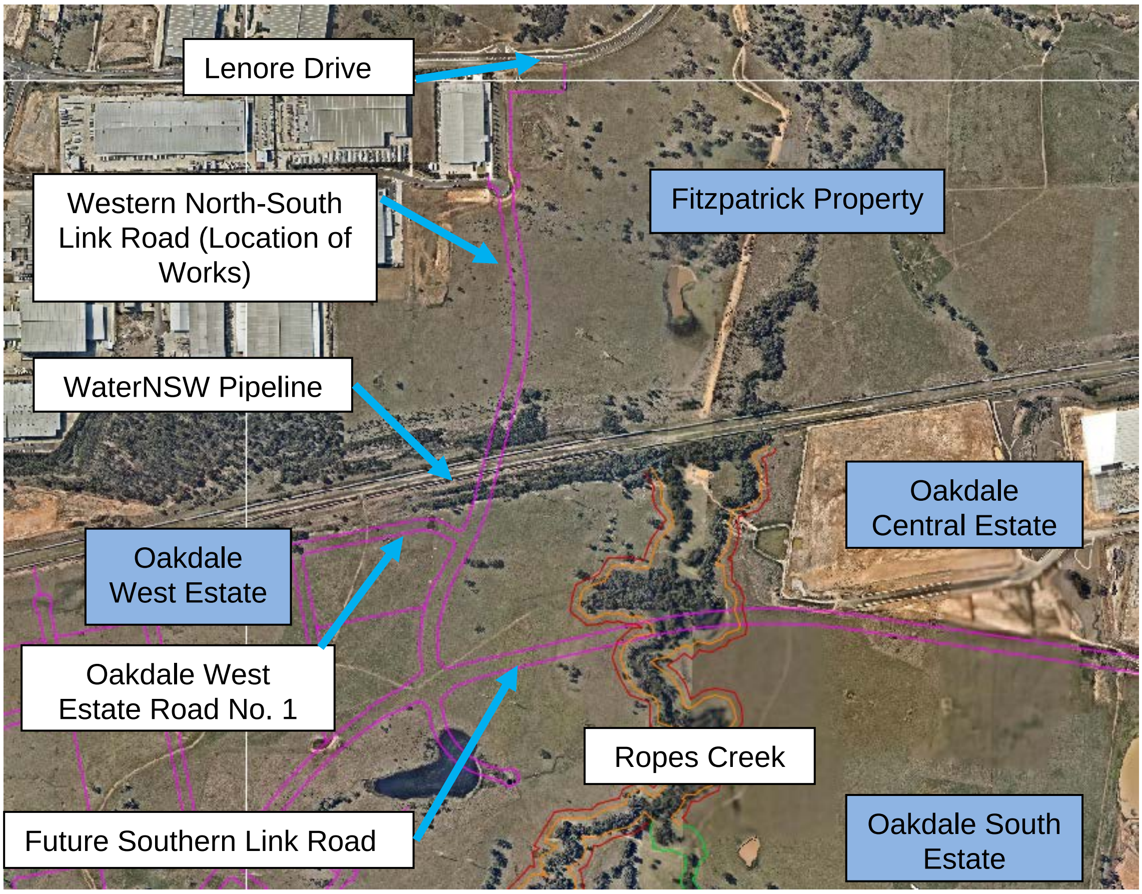


Figure 1 - Locality Sketch

The proposed WNSLR is approximately 1.3km long and situated on vacant land between the intersection of LD to the north and the intersection of Road No.1 of the proposed OWE to the South.

It should be noted the site is currently zoned within General Industrial with the land surrounding the road being developed progressively for Industrial purposes.

Refer to Drawing 15-272-C3003 within Appendix A for General Arrangement Plan indicating route of proposed road.

The works are located in the LGA of Penrith City Council (PCC).

2.2 Site Photos

	Site photo of proposed North-South Link Road location at approx. CH800 looking south over WaterNSW Pipeline.
	Site photo of proposed North-South Link Road location at approx. CH780 looking north.

	Site photo of proposed North-South Link Road location at approx. CH400 looking north.
	Site photo of proposed North-South Link Road location at approx. CH60 looking south.

	Site photo of proposed North-South Link Road location at approx. CH40 looking north onto the intersection of Lenore Drive.
	Site photo of proposed North-South Link Road location at approx. CH220 looking south onto the turn head and swale of Lockwood Road.

	Site photo of proposed North-South Link Road location at approx. CH280 looking north onto the turn head and swale of Lockwood Road.
	Site photo of grass swale along Lenore Drive.

	Site photo of basin along Lenore Drive.

2.3 Utility Information

Existing services which are located within the boundary of the proposed WNSLR Link Road are as follows:

- WaterNSW pipeline which runs under the proposed road
- Overhead transmission cables
- Existing underground high voltage adjacent to the existing Viridian Development
- Existing Underground services within Lenore Drive including High and Low voltage cables, Communications and Water.

3 Design Planning

3.1 Design Parameters

The design parameters used are listed below, in order of priority:

1. Austroads Guides to Road Design.
2. Published RMS Supplements to Austroad Guidelines.
3. Australian Standards referenced in the Austroads Guides to Road Design.
4. Published RMS Supplements to Australian Standards.

3.2 Road Function

The WNSLR will provide a link between the OWE and the RMS state road, LD. The WNSLR will connect the north east corner of OWE and cross over the WaterNSW Pipeline via a proposed bridge and connect into the LD approximately 1km to the north. A large majority of vehicles that will use the proposed road will be heavy vehicles including B-Doubles and semi-trailers.

Refer to Civil Drawings within Appendix A for location and extent of Western North South Link Road.

3.3 Proposed Road Classification

The proposed WNSLR is understood to be owned and maintained by PCC as a Regional Road. Both RMS and Department of Planning have confirmed this.

The acquisition of land for the proposed road will be dedicated as a public road reserve to PCC.

3.4 Design Speed

The design speed for the proposed WNSLR is 70km/hr and will be signposted at 60km/hr.

Whilst the majority of the design is based on a Design Speed of 100km/hr, the introduction of Roundabouts at both Lockwood and Estate Road 1 has limited the approach Design Speed as such it is envisaged the posted speed will be 60km/hr for the entire length of the road.

The final location of advisory speed signs along the road will be subject to requirements and negotiations with RMS.

Traffic modelling will specifically look at each of the intersections and tie-ins that are affected by the proposed works.

3.5 Minimum Curve Radius

The minimum curve radius is governed by the proposed design speed. The minimum curve radius will be based on a design speed of 100km/h and will be designed to conform to the relevant design standards, where possible.

If required, superelevation will be used if smaller curve radii are required.

Final minimum curve radii will be determined during the detailed design stage.

3.6 Design Vehicles

Design Parameter	Design Vehicle	Purpose
Design Heavy Vehicle	B-Double	Turning Path
Design Light Vehicle	Car	Stopping Site Distance

Table 1 - Design Vehicles

The choice of design heavy vehicle was influenced by the high level of heavy vehicle usage that is expected for the WNSLR.

4 Road Design

4.1 Horizontal and Vertical Geometry

The WNSLR has generally been designed to meet Austroads requirements and Australian standards to accommodate B-double truck movements.

The North-South Link Road has been designed as such:

- 30.0m wide road reserve
- 2x 8.0m wide Carriageway comprising of
    - 2x3.5m wide traffic lanes
    - 2x4.5m wide traffic lanes adjacent kerb
- 5.0m raised median
- 4.5m wide verge
    - 2.5m wide footpath along the western carriageway complying with RMS requirements

Refer to Figure 2 below indicating a typical road section and Civil drawings within Appendix A.

Design Parameter	Value adopted in the current design	Within guideline limits*	Reason for use of values that are outside guideline limits
Left carriageway (northbound)	8.0m	Y	N/A
Right carriageway (southbound)	8.0m	Y	N/A
Median	5.0m	Y	N/A
Left Verge (western side)	4.5m	Y	N/A
Right Verge (eastern side)	4.5m	Y	N/A

Table 2 - Road Scape Allocation
*refer Austroads Guides to Road Design Part 3, Table 4.3

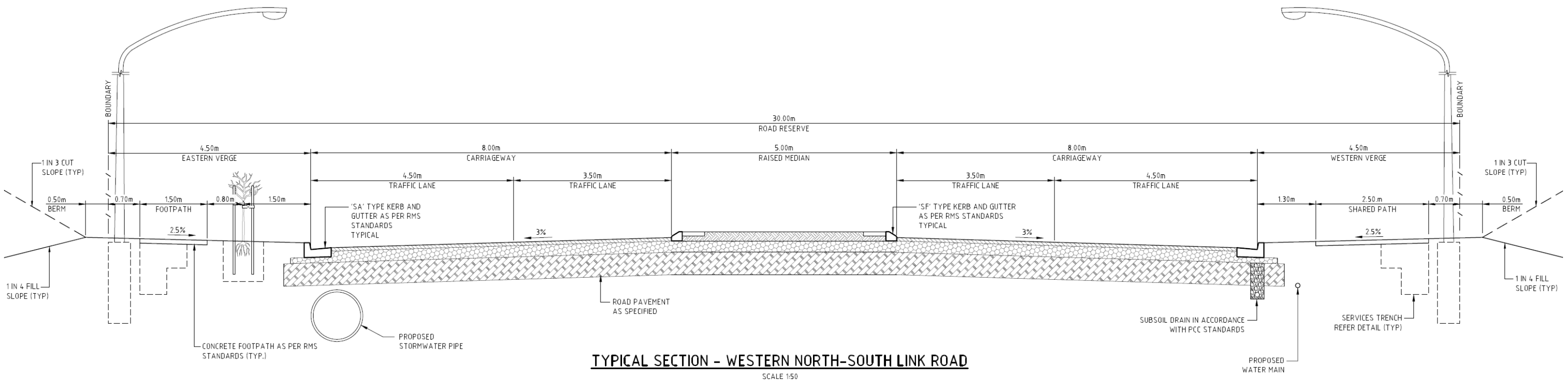


Figure 2 - North-South Link Road - Typical Section

4.1.1 Lane Widths

The proposed North-South Link Road will be a dual carriageway consisting of a 4.5m kerbside lane and a 3.5m median side lane.

4.1.2 Median Type

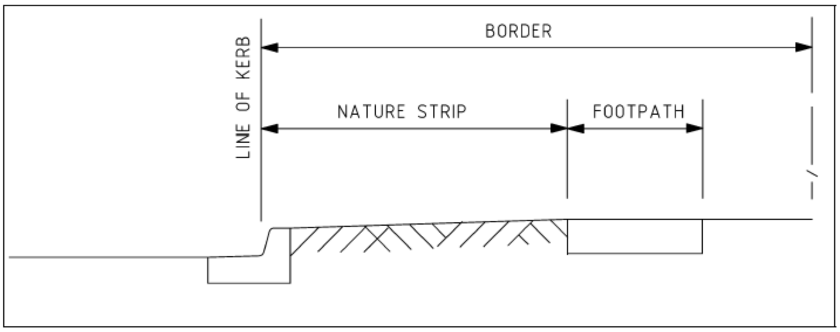
The proposed median will be a 5.0m wide raised concrete median.

4.1.3 Allocation of road space for utilities, pedestrians and bicycles

A sufficiently wide verge of 4.50m has been allowed along the eastern and western side of the proposed road. It is proposed to provide a 2.5m wide shared footpath as per Penrith City Council standards along the western side of the road with a 1.5m along the Eastern side.

The verge in all areas is wide enough to include the proposed footpaths and for the inclusion of all proposed services including light poles.

As per the Austroads Guides to Road Design, the verge width is referred as a 'Border'. The 'Border' is described in the figure below:



Source: VicRoads (2002b).

Figure 3 – Austroads Guides to Road Design - Border Diagram

4.1.4 Allocation of Road Space for Landscaping

Minimal landscaping works can occur within the verges. Along the western verge, (where the shared path is proposed) turf is proposed, along the eastern verge (where the 1.5m path is proposed) turf is proposed along with the installation of 3m high trees at 20m centres located 1.8m from the kerb line.

Where landscape is proposed within the centre median, low level native, minimal maintenance planting will be planted

4.1.5 Crossfall

Nominal crossfall along the proposed WNSLR will generally be at 3.0%. Superelevation lengths with be at 3.0% maximum, which suits the proposed curve radii.

4.1.6 Staging

During detailed design, it may be deemed to only construct half of road between the OWE site and the Lockwood intersection due to the funding arrangements agreed between Goodman and the Department of Planning.

Concept design has been prepared for this interim arrangement and is located in Appendix A

4.2 Horizontal Curves and Alignment

4.2.1 Horizontal Sight Distance

The horizontal alignment has been designed to be within the acceptable sight distant. Any proposal for planting of the median will need to be assessed for sight distance requirements, particularly on the inside of horizontal curves. It should be noted the current project scope does not propose planting other than turf and 3m high trees.

Horizontal sight distances will comply with the Austroads Guides to Road Design and the RMS Supplement to the Austroads Guidelines, with reference to Section 5.4.

4.2.2 Superelevation Transitions

Superelevation Transition lengths will be designed in accordance with the Austroads Guides to Road Design and the RMS Supplement to the Austroads Guidelines.

4.2.3 Vertical Sight Distance/Stopping Distance

Vertical stopping sight distance along the proposed WNSLR will comply with the Austroads Guides to Road Design and the RMS Supplement to the Austroads Guidelines.

4.3 Pavement

The final pavement will be designed in accordance with Austroads guidelines/specifications and is proposed to be a deep lift asphalt pavement over a granular base on compacted subgrade.

4.4 Cut and Fill Batter Slopes

The proposed WNSLR has been designed so that the final pavement levels will batter back to the surrounding existing surface levels at a nominal 4:1 (H:V) slope and 8:1 within the Transgrid easement. All batters are intended to be outside the road reserve.

The table below summarises the desirable and maximum batter slopes, as per the Austroads Guides to Road Design.

Table 4.12: Typical design batter slopes

	Cut		Fill	
	Desirable	Maximum	Desirable	Maximum
Earth batter	3:1	2:1	6:1	4:1 (2)
Rock batter	0.5:1	0.25:1 (1)	–	–
Median	10:1	6:1 (2)	10:1	6:1 (2)

1. May be steeper if geotechnical conditions permit.
2. Steeper slopes may be considered in combination with safety barriers to protect errant vehicles; however consideration should be given to safe maintenance practices and the surfacing treatment adopted.

Figure 4 - Austroads Guides to Road Design - Batter Slopes

Adjacent to the proposed Fitzpatrick development site, it is proposed to construct a reinforced earth wall in an alignment which suits the proposed kerb to be potentially constructed in advance of the WNSLR.

4.5 Roundabout Design

The design of both roundabouts have generally been designed in accordance with Austroads Guide to Road Design – Part 4B – Roundabouts. Whilst the majority of the horizontal design is in accordance with the above guidelines however due to the physical constraints including existing boundaries and the Transgrid easement, the design has a slight non-conformance with section 4.5 of the above code. As the design of the Roundabouts have been designed to cater for B-Doubles, it will be almost impossible to strictly meet the code and in our expert opinion and based on previous experience and as constructed similar roundabouts nearby, we are confident the design of the Roundabouts is adequate.

Subject to Council review and detailed design, we don't expect further review of the Roundabouts will impact the adjoining properties.

The pavement design for the Roundabout will be in accordance with PCC guidelines.

The Centre island is intended to be slightly raised and landscaped with low maintenance planting with a light pole located in the centre.

5 Stormwater Management

5.1 Existing Site Stormwater Drainage

Currently the site comprises of farmland and is classified as a 'greenfield' site with an entire coverage of pervious areas.

Generally, the entire length of the North South Link Road is located on an existing ridge line with the Water NSW pipeline splitting the catchment in a north/south direction.

To the south of the Water NSW pipeline all overland flows drains to the south east into the existing Ropes Creek to the south.

North of the Water NSW pipeline to the proposed LD intersection, the road alignment is located on a ridge line. Overland flow currently sheds to the north west into the existing sediment basin south of Lockwood Road and north east into a low-lying area to the south of LD.

Refer to Drawing 15-272-C3057 within Appendix A for the existing stormwater catchment plan for the length of the WNSLR.

5.2 Proposed Stormwater Details

The proposed stormwater network will be split into northern and southern catchments as per the existing case as highlighted within Section 5.1.

The northern catchment drains to the existing Fitzpatrick basin located approximately 350m north of Lenore Drive. This basin has been approved separately by PCC and constructed recently by Fitzpatrick. This basin is connected to the intersection of Lenore Drive and WNSLR by twin 1500dia RCP which were installed by RMS during the construction of LD. The northern basin acts as an OSD and WSUD basin and has been checked as part of the design taken thus far to ensure the as design and constructed basin meets the design intent of the WNSLR.

The southern catchment is proposed to discharge to the Basin 1 which will also serve a developed catchment within the Oakdale West Estate. Refer to Oakdale West Civil, Stormwater and Infrastructure Services Report prepared as part of the Oakdale West SSD application.

Refer to the Civil Drawings within Appendix A for layout and details for the proposed stormwater network along the length of the road.

5.3 Council and RMS Requirements and Recommendations

All road reserve stormwater drainage for the proposed WNSLR is designed to comply with the following:

- Austroads – Guide to Road Design Part 5: Drainage – General and Hydrology Considerations
- Austroads – Guide to Road Design Part 5A: Drainage – Road Surface, Networks, Basins and Subsurface

- Penrith City Council WSUD Technical Guidelines – Version 3 – June 2015
- Penrith City Council Design Guidelines for Engineering Works

A summary of the design requirements adopted is listed below:

- Precinct based basins will serve the road reserve as bio-retention basins
- All stormwater drainage within the WNSLR and OSD/bio-retention basins will be dedicated to PCC (this only relates to Basin 1).
- All OSD/bio-retention basins have been designed with a 3.0m wide sprayed seal access road along the berm to ensure maintenance vehicles can access the entire exterior of the basin
- WSUD to achieve target reductions:
    - 80% Total Suspended Solids (TSS)
    - 45% Total Phosphorus (TP)
    - 45% Total Nitrogen (TN)
    - Retention of litter greater than 50mm for flows up to 25% of the 1 year ARI peak flow
    - Retention of sediment courser than 0.125mm for flows up to 25% of the 1 year ARI peak flow
    - In areas with concentrated hydrocarbon deposition, no visible oils for flows up to 25% of the 1 year ARI peak flow

5.3.1 Modelling Software

DRAINs modelling software has been used to calculate the Hydraulic Grade Line (HGL) of the road stormwater pipes. DRAINs is a computer program used for designing and analyzing urban stormwater drainage systems and catchments. It is widely accepted by Council and RMS across NSW as the basis for stormwater design and has been confirmed by Penrith City Council and RMS as the preferred stormwater software analysis package.

MUSIC modelling software has been used to evaluate pollutant loads from each developed lot. For a detailed description of the MUSIC modelling refer to Section 5.6.1 of this report. MUSIC data files and output results are attached in Appendix C.

5.3.2 Hydrology

- Pipe drainage within the WNSLR shall be designed to accommodate the 10-year ARI storm event in accordance with Austroads 2013 - Guide to Road Design Part 5A: Drainage, Section 2.2

- The combined piped and overland flow paths shall be designed to accommodate the 100-year ARI storm event.

- Where trapped low points are unavoidable and potential for flooding private property is a concern, an overland flowpath capable of carrying the total 100-year ARI storm event shall be provided. Alternatively, the pipe and inlet system may be upgrade to accommodate the 100 year ARI storm event.

- Rainfall intensities shall be as per the Intensity-Frequency-Duration table in accordance with the Australian Rainfall and Runoff (AR&R) volume 2.
- Times of concentration for each sub catchment shall be determined using the kinematic wave equation.
- Runoff coefficients shall be calculated in accordance with AR&R. The fraction impervious shall be determined from analysis of the sub catchments.
- Flow width in gutter shall not exceed 2.5m for the minor design storm event.
- Velocity depth ratios shall not exceed 0.4 for all storms up to and including the 100 year ARI event.
- Inlet pits to be spaced so that flow width shall not exceed 80l/sec
- Bypass from any pit on grade shall not exceed 15% of the total flow at the pit
- Blockage factors of 20% and 50% shall be adopted for pits on grade and at sags respectively.

5.3.3 Hydrology

- A hydraulic grade line HGL design method shall be adopted for all road pipe drainage design. The HGL shall be shown on all drainage long sections.
- The minimum pipe size shall be 375mm diameter RCP.
- Maximum spacing between pits shall not exceed 75m.
- The minimum pipe grade shall be 0.5%.
- All pipes shall be Rubber Ring Jointed unless noted otherwise.
- The minimum cover over pipes shall be 450mm in grassed areas and 600mm within carriageways.
- Where minimum cover cannot be achieved due to physical constraints the pipe class shall be suitably increased.
- All trafficable shall be Reinforced Concrete Pipes or Fibre Reinforced Cement equivalent.
- The pipe friction coefficients to adopted shall be:

Materials	Mannings – n	Colebrook-White – k	Min. Pipe Class
RCP	0.012	0.6	3
FRC	0.01	0.15	3

Table 3 - Pipe Details

- All pipes classes shall be designed for the ultimate service loads and where applicable, construction loads will be designed for.
- Pipes discharging to the overland flow path shall adopt a minimum tailwater level equivalent to respective overland flow level.
- Pit Loss coefficients shall be calculated in accordance with Missouri Charts.
- A minimum 150mm freeboard shall be maintained between pit HGL and pit surface levels.
- Overland flowpaths shall maintain a minimum of 300mm freeboard to all habitable floor levels.
- Pits deeper than 1.2m shall contain step irons at 300 mm centres.

5.4 Stormwater Catchments

A Stormwater Catchment Plan for each Catchment and flow paths into the bio-retention basins are shown in Appendix B. As indicated in the Catchment Plan the basins are combined OSD and bio-retention basins designed to treat the nutrients within the stormwater flows to PCC treatment rates outlined above.

The northern catchment drains to the existing Fitzpatrick basin located approximately 350m north of LD. This basin has been approved separately by PCC and constructed recently by Fitzpatrick. This basin is connected to the intersection of LD and WNSLR by twin 1500dia RCP and were installed by RMS during the construction of LD. The northern basin acts as an OSD and WSUD basin and has been checked as part of the design taken thus far to ensure the as design and constructed basin meets the design intent of the WNSLR.

The southern catchment is proposed to discharge into the Basin 1 which will also serve a developed catchment within the Oakdale West Estate. Refer to Oakdale West Civil, Stormwater and Infrastructure Services Report prepared as part of the Oakdale West SSD application.

5.5 Overland Flows

Overland flows within the roads have been designed to be safely conveyed within the road carriageway to comply with flow widths and velocities within the Austroads – Guide to Road Design Part 5 & 5A – Drainage.

5.6 Water Sensitive Urban Design (WSUD)

Water Sensitive Urban Design encompasses all aspects of urban water cycle management, including water supply, wastewater and stormwater management. WSUD is intended to minimise the impacts of development upon the water cycle and achieve more sustainable forms of urban development.

The WSUD strategy, MUSIC Model and subsequent WSUD designs prepared by AT&L are based upon requirements within the PCC WSUD Technical Guidelines.

All stormwater runoff from the northern and southern catchments as mentioned in Section 5.4 is proposed to drain into Bio-Retention basins for the water to be detained, treated and discharged at rates acceptable to Penrith City Council. As mentioned the northern catchment is proposed to drain into the existing bio-retention basin to the north of Lenore Drive whilst the southern catchment will drain into Bio-Retention basin 1 as part of the Oakdale West Estate development.

Both these catchments drain into bio-retention basins and as such met the WSUD requirements of PCC engineering guidelines.

Refer to attached Civil Drawings list in Appendix A.

5.7 Conclusion

As highlighted in the above section all stormwater drainage within the WNSLR has been designed in accordance with the PCC Water Sensitive Urban Design Guideline. This includes design of all pipework and WSUDs infrastructure. To summarise:

- WSUD to achieve target reductions:
    - 80% Total Suspended Solids (TSS)
    - 45% Total Phosphorus (TP)
    - 45% Total Nitrogen (TN)
    - Retention of litter greater than 50mm for flows up to 25% of the 1 year ARI peak flow
    - Retention of sediment courser than 0.125mm for flows up to 25% of the 1 year ARI peak flow
    - In areas with concentrated hydrocarbon deposition, no visible oils for flows up to 25% of the 1 year ARI peak flow

6 Services

6.1 Water Main

It is proposed to install water main sized in accordance with the Oakdale LASP along the verge of the WNSLR.

6.2 Telecommunications

It is proposed to install telecommunication conduits and cables along the verge of the WNSLR.

6.3 Electrical

It is proposed that low voltage power to be installed along the eastern and western side verge of the WNSLR. It is also proposed to install high voltage power on the western side verge.

In addition to the high and low voltage cables within the verge, 132kV conduits and jointing pits will be installed within the carriageway to enable the cables to be pulled to service the future Electrical Zone Sub Station located in Oakdale West

6.4 Street Lighting

It is proposed to install street lighting on both sides of the road. In accordance with PCC standard's. The lighting will be designed in accordance with AS1158.1 to a category V3 standard. (subject to PCC acceptance)

6.5 Tie In

6.5.1 Oakdale West Estate Road No. 1

The WNSLR will connect at the south to Road No.1 of the OWE and a turn head will be provided beyond the proposed roundabout. It should be noted that it is proposed that the WNSLR will be extended to connect to the future Southern-Link Road however the SLR is not part of this application.

6.5.2 Lenore Drive

The intersection of WNSLR and the LD will be upgraded to accommodate the proposed upgrade cross section and proposed turn lanes. The upgrade will include the installation of new signals at the intersection. Initial comments have already been received from the RMS in regards to this intersection and will be incorporated at the detailed design phase.

6.6 WaterNSW Pipeline

Due to the WaterNSW pipeline running under the WNSLR it is proposed to provide adequate crossing over the existing WaterNSW pipeline by installing a 100m long bridge. The bridge will provide adequate clearance from the pipes and allow for the existing access track to be used/ maintained.

GHD have been engaged to prepare a concept bridge design report for the crossing

Through discussions with Water NSW, they identified their requirements and a provision has been made to satisfy Water NSW. Further consultation is required to ensure Water NSW are satisfied. Refer to drawing GHD Report in Appendix E for proposed bridge crossing.

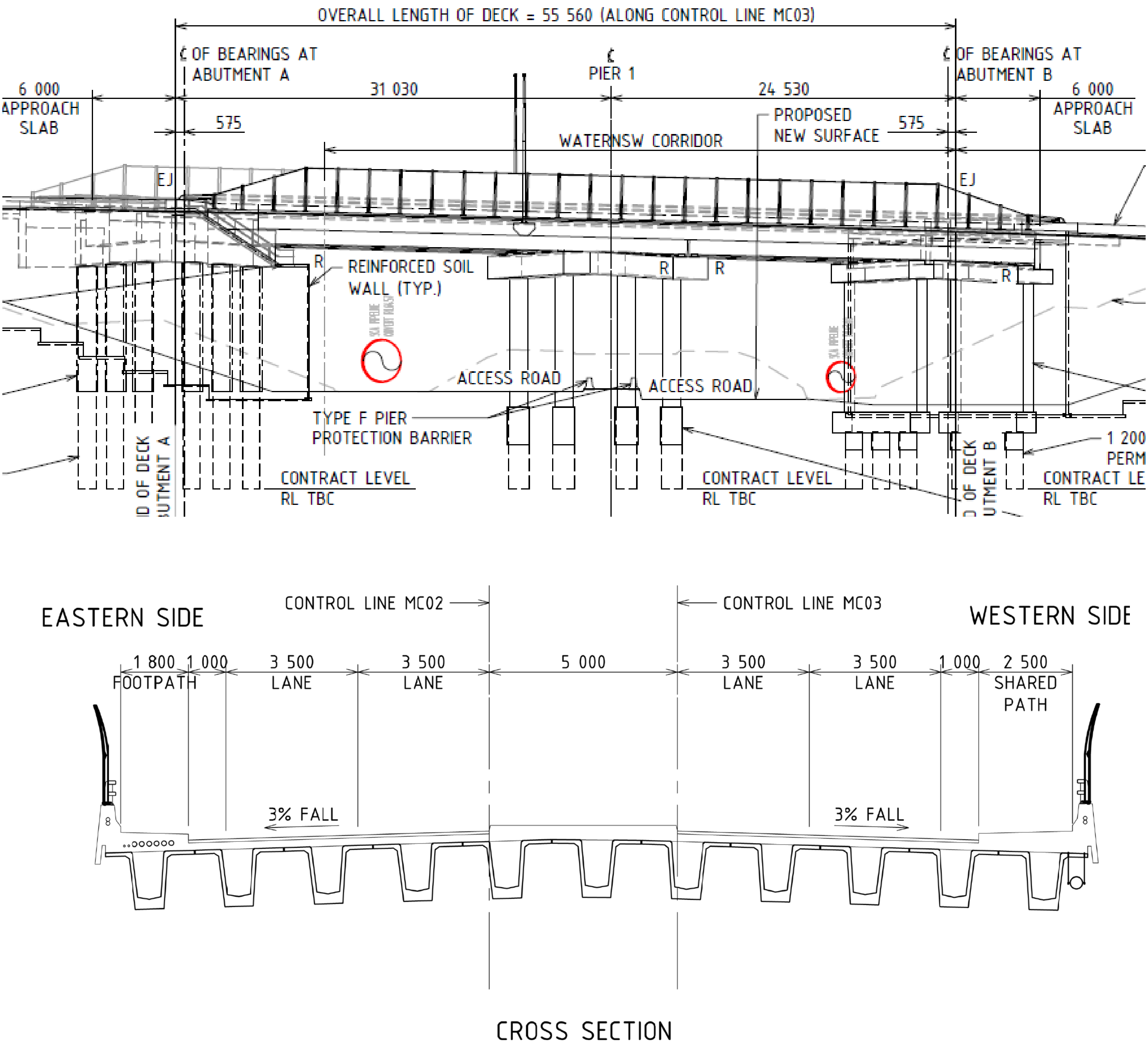


Figure 8 – WaterNSW pipeline bridge crossing

7 Finalisation

Once DA approval is approved, the following is required:

- Constructability Review.
- Road Safety Audit.
- Detailed Design including:
  - Civil Design.
  - Stormwater Design (based on DRAINS modelling)
  - Geotechnical Investigation.
  - Pavement Design.
  - Electrical Design.
  - Water Relocation design.
  - Bridge Design
- Detailed Cost Estimation.
- Design reviews.
- Submission to RM, Water NSW and PCC for approval.

8 Conclusion

The design to date has been prepared for inclusion in the development application giving due consideration to the existing stake holders, physical features on site, design constraints and relevant design guidelines.

It is concluded the design could be further advanced through to a Detailed Design/Construction documentation level, as further design will ensure with certainty that there will be no major unknown constraints.

Once complete, the road will operate at the intended design speed, safely and efficiently as a regional road.

The design is generally in accordance with the relevant RMS and Austroad Design Guidelines. Upon approval, detailed design shall be completed to comply with the relevant standards and to the satisfaction of RMS, PCC and WaterNSW, as well as any conditions of the approval.

WNSLR will act as a link road between the RMS state controlled road, Lenore Drive and the OWE. Future developments within the area will further utilise WNSLR as a link road, providing access to additional local roads and other regional/state roads within the area.

We do finally conclude by recognising the SSD design is at a 60% completion stage and whilst the fundamental design principals and arrangement have been resolved, additional design will be necessary to ready the project for construction. As such, changes to the SDD design documentation are expected although the intent of the SSD design will be consistent with the final design documentation.

Appendices

Appendix A – AT&L North-South Link Road Drawings

3000 SERIES - WNSLR PACKAGE	
DRAWING No.	DRAWING TITLE
15-272-C3000	COVER SHEET
15-272-C3001	DRAWING LIST
15-272-C3002	GENERAL NOTES
15-272-C3003	GENERAL ARRANGEMENT PLAN
15-272-C3010	TYPICAL ROAD SECTIONS
15-272-C3020	ROADWORKS PLAN AND LONGITUDINAL SECTION SHEET 1 OF 5
15-272-C3021	ROADWORKS PLAN AND LONGITUDINAL SECTION SHEET 2 OF 5
15-272-C3022	ROADWORKS PLAN AND LONGITUDINAL SECTION SHEET 3 OF 5
15-272-C3023	ROADWORKS PLAN AND LONGITUDINAL SECTION SHEET 4 OF 5
15-272-C3024	ROADWORKS PLAN AND LONGITUDINAL SECTION SHEET 5 OF 5
15-272-C3030	ROAD LONGITUDINAL SECTIONS
15-272-C3040	BRIDGE ELEVATION AND TYPICAL SECTION
15-272-C3050	STORMWATER DRAINAGE PLAN SHEET 1 OF 5
15-272-C3051	STORMWATER DRAINAGE PLAN SHEET 2 OF 5
15-272-C3052	STORMWATER DRAINAGE PLAN SHEET 3 OF 5
15-272-C3053	STORMWATER DRAINAGE PLAN SHEET 4 OF 5
15-272-C3054	STORMWATER DRAINAGE PLAN SHEET 5 OF 5
15-272-C3057	STORMWATER DRAINAGE CATCHMENT PLAN (PRE-DEVELOPED)
15-272-C3058	STORMWATER DRAINAGE CATCHMENT PLAN (POST-DEVELOPED)
15-272-C3060	BIO-RETENTION BASIN No.1 DETAIL PLAN
15-272-C3070	PAVEMENT PLAN SHEET 1 OF 5
15-272-C3071	PAVEMENT PLAN SHEET 2 OF 5
15-272-C3072	PAVEMENT PLAN SHEET 3 OF 5
15-272-C3073	PAVEMENT PLAN SHEET 4 OF 5
15-272-C3074	PAVEMENT PLAN SHEET 5 OF 5
15-272-C3075	LEAD IN POTABLE WATERMAIN PLAN
15-272-C3080	RETAINING WALL PLAN AND ELEVATION
15-272-C3081	RETAINING WALL SECTIONS SHEET 1 OF 4
15-272-C3082	RETAINING WALL SECTIONS SHEET 2 OF 4
15-272-C3083	RETAINING WALL SECTIONS SHEET 3 OF 4
15-272-C3084	RETAINING WALL SECTIONS SHEET 4 OF 4
15-272-C3090	WNSLR AND LOCKWOOD RD INTERSECTION VEHICLE TURNING PATH PLAN SHEET 1
15-272-C3091	WNSLR AND LOCKWOOD RD INTERSECTION VEHICLE TURNING PATH PLAN SHEET 2
15-272-C3092	WNSLR AND LOCKWOOD RD INTERSECTION VEHICLE TURNING PATH PLAN SHEET 3
15-272-C3093	WNSLR AND ROAD No.1 INTERSECTION VEHICLE TURNING PATH PLAN SHEET 1
15-272-C3094	WNSLR AND ROAD No.1 INTERSECTION VEHICLE TURNING PATH PLAN SHEET 2

Appendix B – Catchment Plan

Issue	Description	Date
A3	ISSUED FOR SSD APPROVAL	21-09-18
A2	ISSUED FOR SSD APPROVAL	04-05-18
A1	ISSUED FOR SSD APPROVAL	14-03-17

Status
FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION
A1

Scales	1 : 3000	15-272-C0007.dwg	
		Drawn	GB
		Designed	GB
Height Datum	AHD	Checked	AM
Grid	MGA	Approved	AM

Client
Goodman

Civil Engineers and Project Managers
at&l
Level 7, 153 Walker Street
North Sydney NSW 2060
ABN 96 130 882 405
Tel: 02 9439 1777
Fax: 02 9923 1055
www.atl.net.au
info@atl.net.au

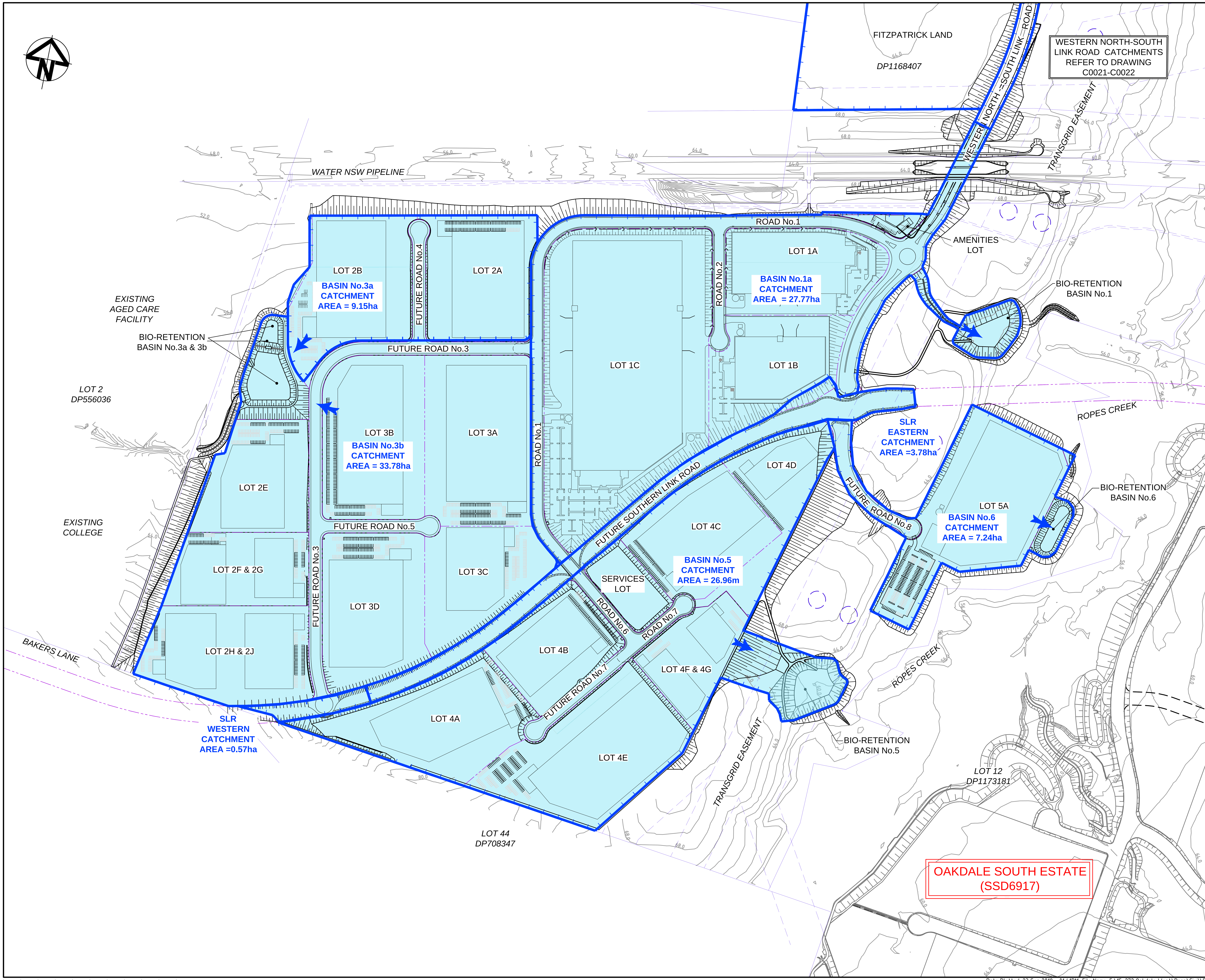
Project
PROPOSED INDUSTRIAL DEVELOPMENT OAKDALE WEST

Title
STORMWATER DRAINAGE CATCHMENT PLAN (PRE-DEVELOPED)

Drawing No.	Project No.	Issue
15-272-C0007	15-272	A3

100mm on Original

Date Plotted: 23 Sep 2018 - 01:39PM File Name: F:\15-272 Oakdale West\Drgs\Civil\Final\SSDA\0000_Masterplan Package\15-272-C0007.dwg V1



LEGEND

- EXISTING BOUNDARY
- EXISTING EASEMENT
- PROPOSED BOUNDARY
- STORMWATER CATCHMENT BOUNDARY
- FLOW DIRECTION

Bar Scales
0 50 100 150 200 250
1 : 3000 @ A1

Issue	Description	Date
A3	ISSUED FOR SSD APPROVAL	21-09-18
A2	ISSUED FOR SSD APPROVAL	04-05-18
A1	ISSUED FOR SSD APPROVAL	14-03-17

Status: FOR APPROVAL
NOT TO BE USED FOR CONSTRUCTION
A1

Scales	1 : 3000	15-272-C0008.dwg	
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		Designed	GB
Height Datum	AHD	Checked	AM
Grid	MGA	Approved	AM

Client: Goodman

Civil Engineers and Project Managers

at&l
Level 7, 153 Walker Street
North Sydney NSW 2060
ABN 96 130 882 405
Tel: 02 9439 1777
Fax: 02 9923 1055
www.atl.net.au
info@atl.net.au

Project: PROPOSED INDUSTRIAL DEVELOPMENT OAKDALE WEST

Title: STORMWATER DRAINAGE CATCHMENT PLAN (DEVELOPED)

Drawing No.	Project No.	Issue
15-272-C0008	15-272	A3

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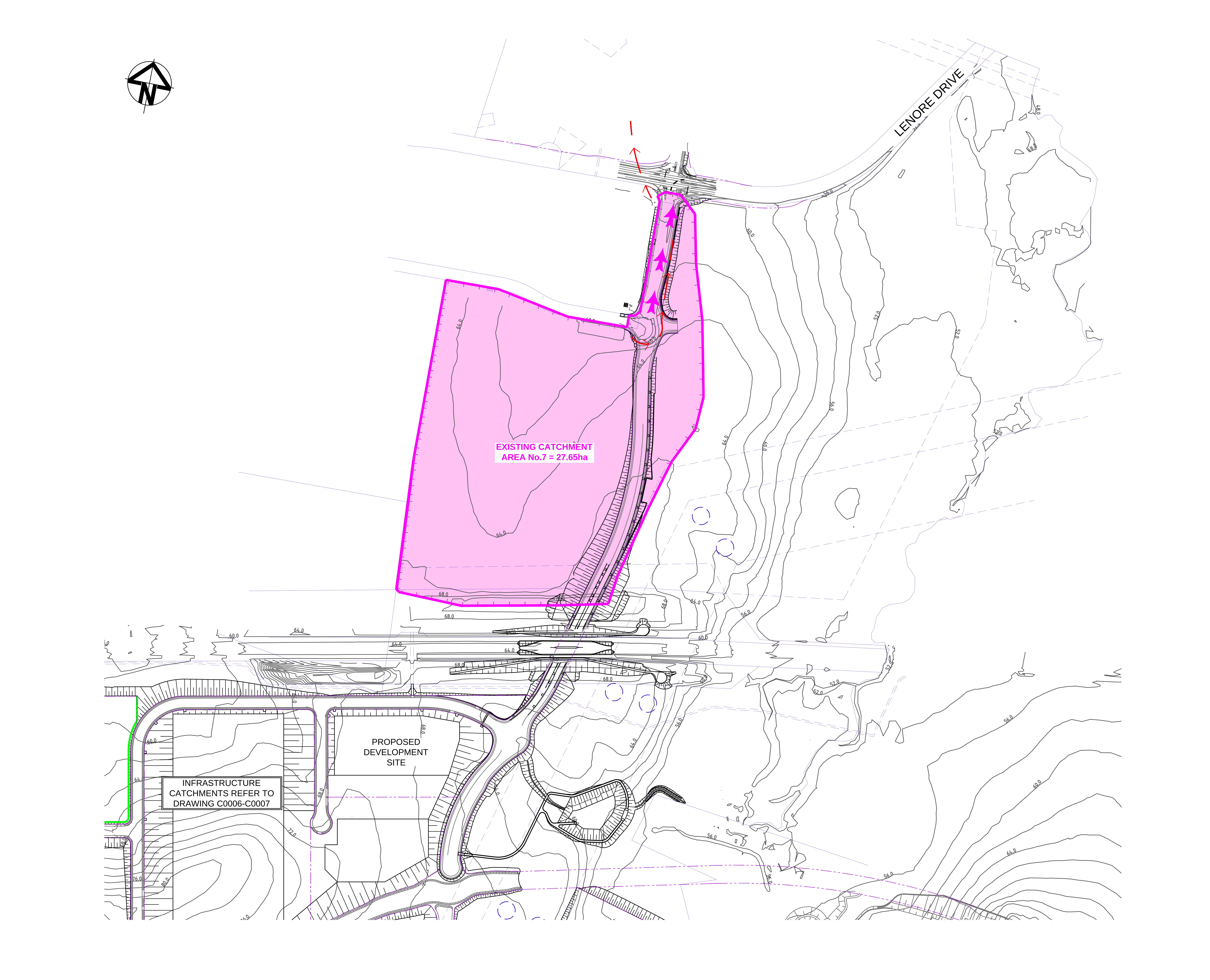

LEGEND

- EXISTING BOUNDARY
- EXISTING EASEMENT
- PROPOSED BOUNDARY
- EXISTING STORMWATER FLOW PATH
- EXISTING STORMWATER CATCHMENT BOUNDARY
- FLOW DIRECTION

Bar Scales

0 50 100 150 200 250

1 : 3000 @ A1

Issue	Description	Date
A3	ISSUED FOR SSD APPROVAL	21-09-18
A2	ISSUED FOR SSD APPROVAL	04-05-18
A1	ISSUED FOR SSD APPROVAL	14-03-17

Status

FOR APPROVAL

NOT TO BE USED FOR CONSTRUCTION

A1

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		Designed	GB
Height Datum	AHD	Checked	AM
Grid	MGA	Approved	AM

Client

Goodman

Civil Engineers and Project Managers

at&l

Level 7, 153 Walker Street
North Sydney NSW 2060
ABN 96 130 882 405
Tel: 02 9439 1777
Fax: 02 9923 1055
www.atl.net.au
info@atl.net.au

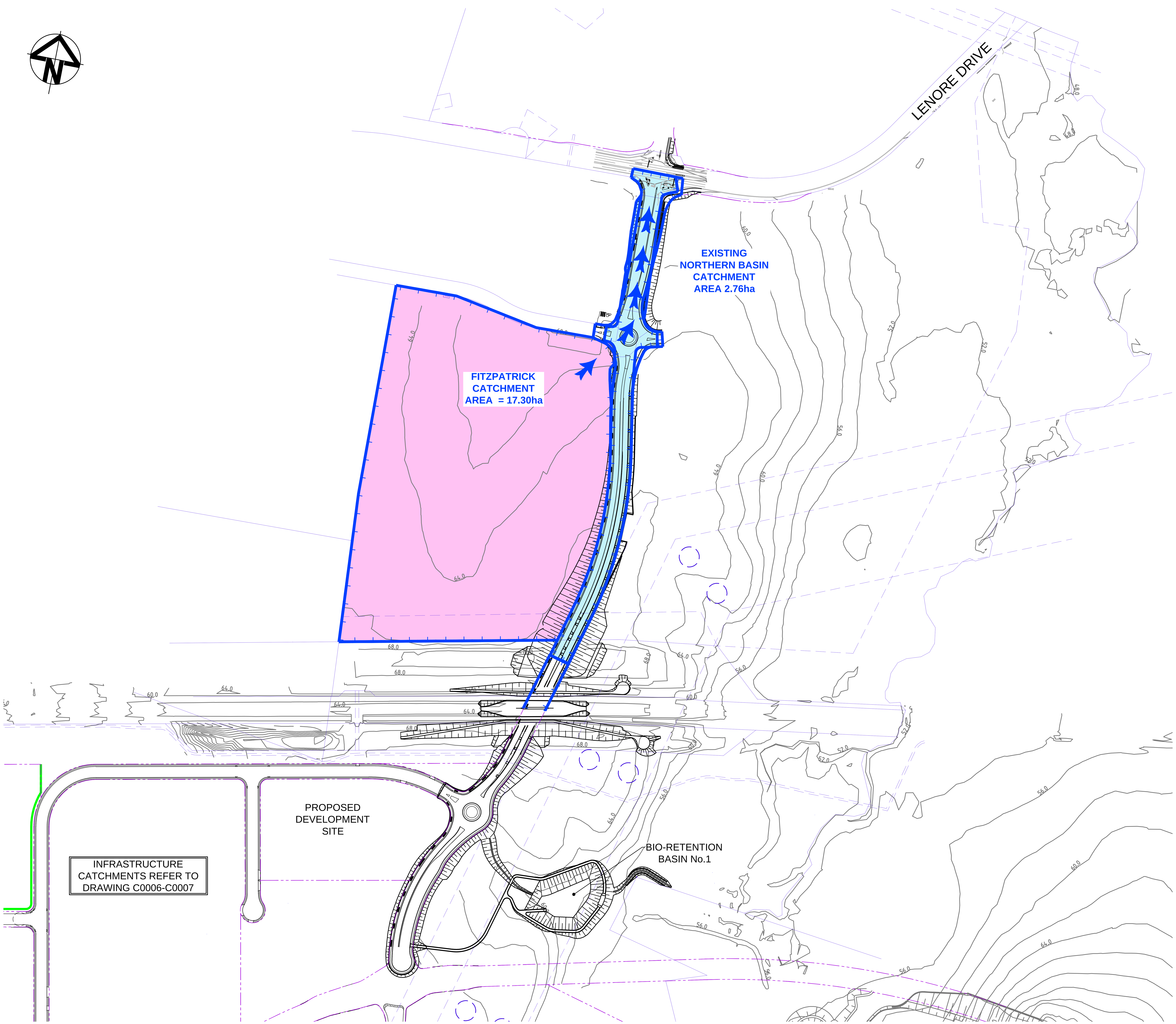
Project

PROPOSED INDUSTRIAL DEVELOPMENT OAKDALE WEST

Title

WESTERN NORTH-SOUTH LINK ROAD STORMWATER DRAINAGE CATCHMENT PLAN (PRE-DEVELOPED)

Drawing No.	Project No.	Issue
15-272-C0021	15-272	A3



LEGEND

- EXISTING BOUNDARY
- EXISTING EASEMENT
- PROPOSED BOUNDARY
- EXISTING STORMWATER CATCHMENT BOUNDARY
- WNSLR STORMWATER CATCHMENT BOUNDARY
- FLOW DIRECTION

Bar Scales

0 50 100 150 200 250

1 : 3000 @ A1

Issue	Description	Date
A3	ISSUED FOR SSD APPROVAL	21-09-18
A2	ISSUED FOR SSD APPROVAL	04-05-18
A1	ISSUED FOR SSD APPROVAL	14-03-17

Status
FOR APPROVAL A1
NOT TO BE USED FOR CONSTRUCTION

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		Designed	GB
Height Datum	AHD	Checked	AM
Grid	MGA	Approved	AM

Client
Goodman

Civil Engineers and Project Managers
at&l
Level 7, 153 Walker Street
North Sydney NSW 2060
ABN 96 130 882 405
Tel: 02 9439 1777
Fax: 02 9923 1055
www.atl.net.au
info@atl.net.au

Project
PROPOSED INDUSTRIAL DEVELOPMENT OAKDALE WEST

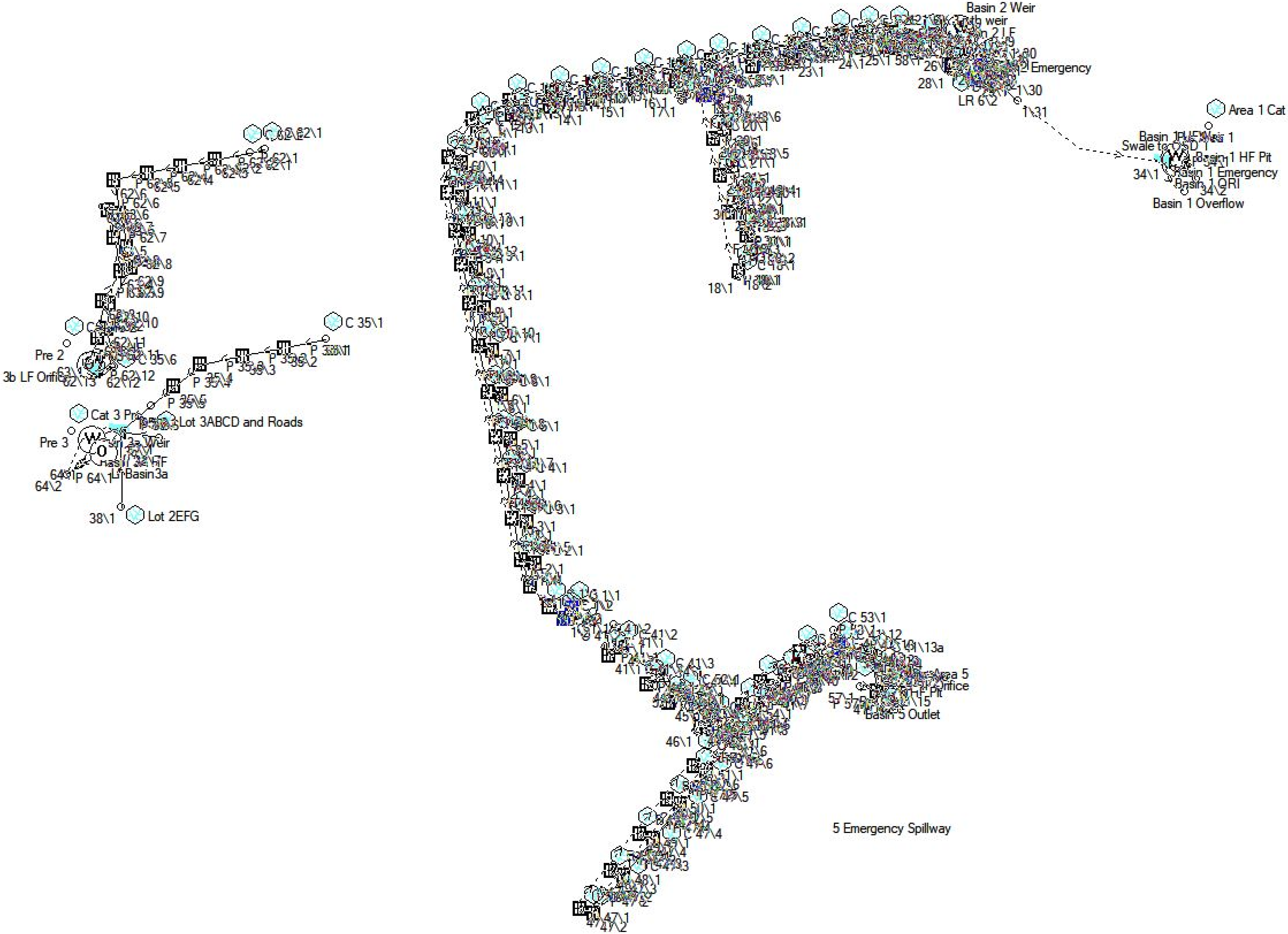
Title
WESTERN NORTH-SOUTH LINK ROAD STORMWATER DRAINAGE CATCHMENT PLAN (DEVELOPED)

Drawing No.	Project No.	Issue
15-272-C0022	15-272	A3

100mm on Original

Date Plotted: 23 Sep 2018 - 01:44PM File Name: F:\15-272 Oakdale West\Drgs\Civil\Final\SSDA\0000_Masterplan Package\15-272-C0022.dwg V1

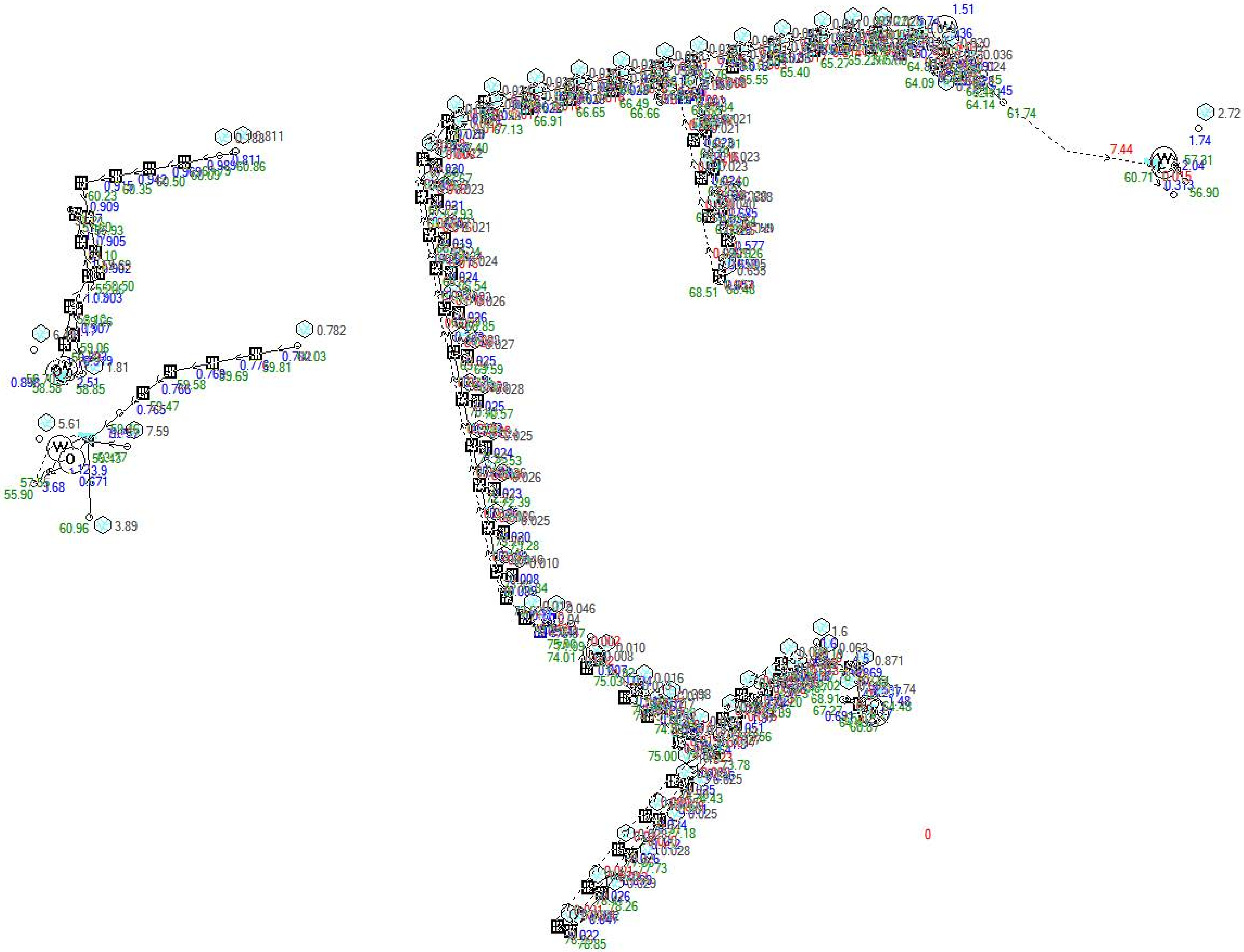
Appendix C – MUSIC Model and Results

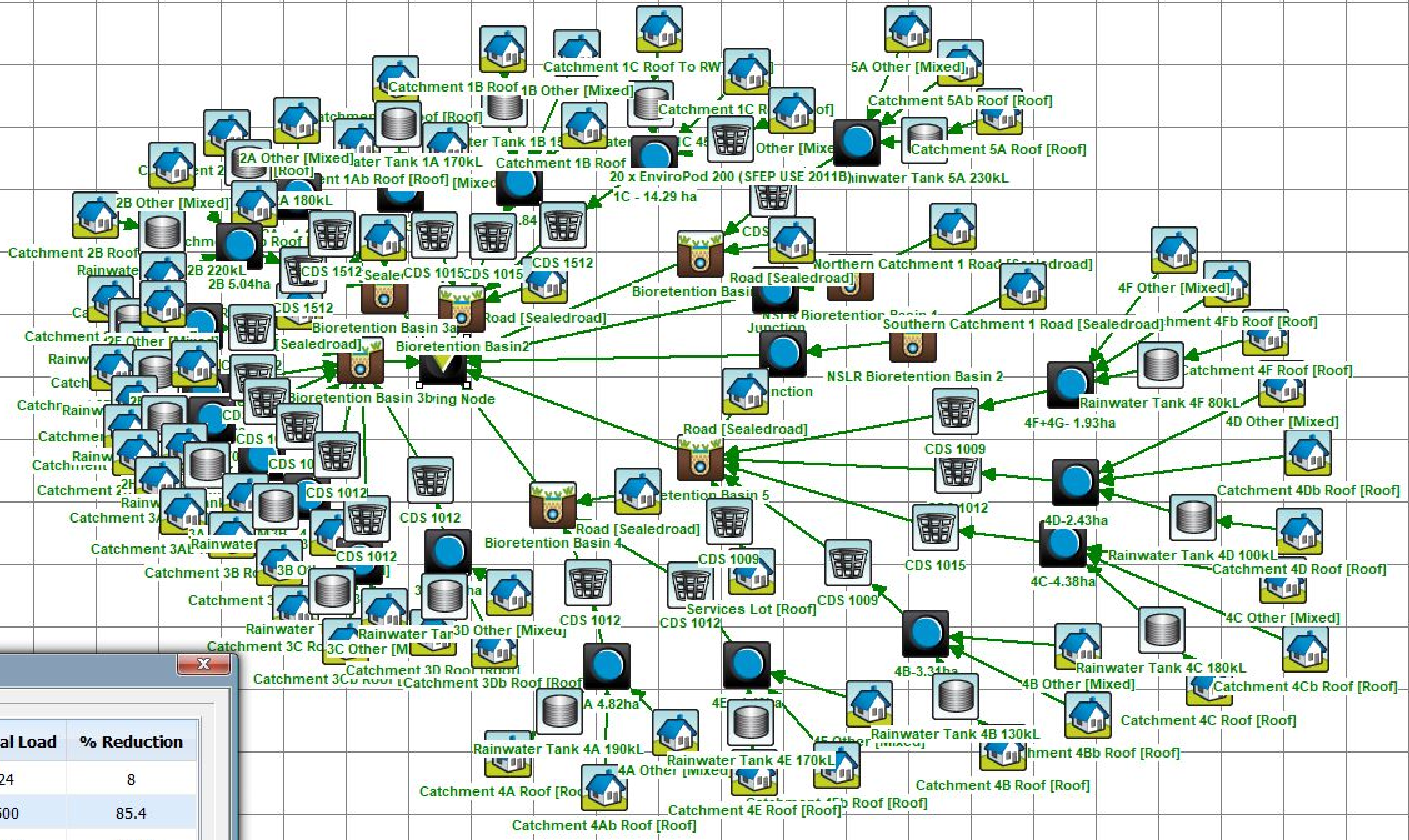


Basin 2 Weir
Emergency
LR 6\2
28\1
23\1
1\30
1\31
Area 1 Cat
Swale to OSD 1
Basin 1 HF Pit
Basin 1 Emergency
Basin 1 ORI
Basin 1 Overflow
34\1
18\1
C 35\1
P 35\4
P 35\5
Lot 3ABCD and Roads
Cat 3 Pre
Pre 2
3b LF Orifice
62\6
P 62\7
P 62\12
Pre 3
Basin3a
P 64\1
64\2
38\1
Lot 2EFG
C 53\1
C 41\3
41\2
46\1
Area 5
Basin 5 Outlet
C 41\6
C 47\4
5 Emergency Spillway
47\1
47\2

Worst case major storm

Worst case minor storm





Treatment Train Effectiveness - Receiving Node

	Sources	Residual Load	% Reduction
Flow (ML/yr)	570	524	8
Total Suspended Solids (kg/yr)	65000	9500	85.4
Total Phosphorus (kg/yr)	144	53.7	62.7
Total Nitrogen (kg/yr)	1270	635	49.8
Gross Pollutants (kg/yr)	16400	154	99.1

Appendix D – GHD Concept Bridge Design Report

Goodman Group

WNSLR - Bridge over WaterNSW Pipeline
50% Bridge Design Report

September 2018

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1. Introduction

1.1 Project background and scope

Goodman Property Services (Goodman) is developing the Western North South Link Road (WNSLR) as part of a State Significant Development (SSD) for Oakdale West Estate (OWE). AT&L (Civil Engineers) engaged GHD Pty Ltd on 2nd April 2016 to prepare a concept bridge design for inclusion into the SSD application submission. Following concept design iterations, GHD commenced the development of the detailed bridge design in June 2018.

The project will involve construction of dual carriageway twin bridges across the Warragamba to Prospect pipelines (owned and operated by Water NSW). Each carriageway will contain 2 traffic lanes, the western bridge will include a 2.5m wide shared path, and the eastern bridge will include a 1.5m footpath.

During the collation of submissions for the OWE development application, Transport for NSW (TfNSW) advised Goodman of their future intention to construct an intermodal train network along the southern side of the WaterNSW Warragamba Pipelines. The design of the WNSLR Bridge has been developed to make provisions for being extended in the future in order to accommodate this rail corridor.

1.2 Purpose of this report

This report has been developed from the previous concept design report to document the development of the detailed design of the WNSLR Bridge over the WaterNSW Pipeline. This report is proposed as support information for the construction tender EOI documents. Although design development is still underway at the time of issuing, information to facilitate indicative pricing of the bridge construction has been included as support information for this report.

2. Design information and criteria

2.1 Site locality

The project is located approximately 530 m south of Lockwood Road in Erskine Park, NSW. The road bridges form part of the WNSLR connecting the proposed Southern Link Road in the south to Erskine Park Link Road (EPLR) in the north. The bridges traverse over two water supply lines (Warragamba to Prospect) which are located within the Water NSW corridor. The location of the proposed bridges is shown on Figure 1.

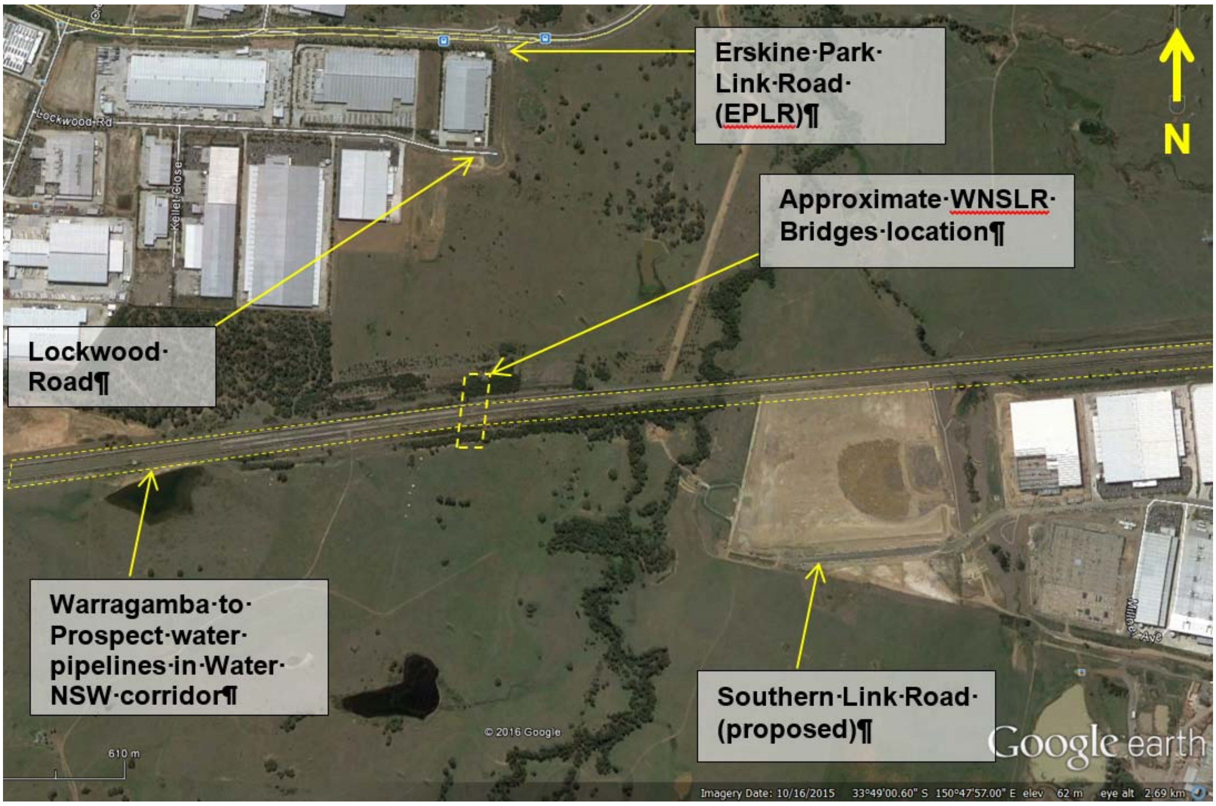

Figure 1 - WNSLR Bridges Locatoin Plan

2.2 Existing obstacles and constraints

The primary obstacles to be crossed by the WNSLR Bridge are the Warragamba to Prospect water supply lines. The design also makes provision for being extended with additional span(s) to cross a future rail corridor.

The bridge has been designed to accommodate electrical, communications and water services, these are discussed in further detail in Section 2.7 below. The relocation of existing services in the vicinity of the bridge is currently underway and will be discussed in future versions of this report (where relevant to the bridge).

2.3 Design development

2.3.1 Bridge alignment

An alignment of the WNSLR has been provided by AT&L. The bridges will be designed to suit the road alignment in order to minimise any changes to the road levels at the interchanges near each bridge abutment.

The skew of the bridge is 26° spanning over the Water NSW corridor and there is no horizontal curve of the road within the proposed extents of the bridges.

The bridge is on a vertical crest curve, with a longitudinal grade falling from the northern abutment (Abutment A) towards the southern abutment (Abutment B). The longitudinal grade at abutment A is approximately 1.7%, and the longitudinal grade at abutment B is approximately 3%.

2.3.2 Concept design development

The concept design for the WNSLR has undergone multiple iterations as the understanding of the site constraints has developed, and also in response to inputs from key stakeholders. The concept design development is summarised below.

Initial concept design report – October 2016

The following three options were considered for crossing the Warragamba to Prospect water supply lines:

- 5 span bridge with 700mm deep, 17.8 m long prestressed concrete planks
- 3 span bridge with 2 x 23 m and 1 x 15m long spans consisting of 1000 mm deep super-T girders
- 4 span bridge with 20 m end spans and 25 m interior spans, each span consisting of 1200 mm deep super-T girders.

AT&L and Goodman selected to progress with the 3 span option as it was the most cost effective of the three solutions, and also offered suitable clearance between the foundations and the existing water infrastructure to avoid undertaking protection works or further investigation. Refer to this report for further discussion on the development of these options.

Review of proposed concept design changes – March 2018

During the collation of submissions for the OWE development application, TfNSW advised of their future intention to construct an intermodal train network along the southern side of the WaterNSW pipelines. GHD were engaged to undertake a review of the previous concept design in order to make provision for the future TfNSW rail corridor, the options identified include:

- Designing the bridge with provision for future extension with an additional span, maintaining the 1000 mm deep super-T girder
- Designing the bridge with provision for future extension with an additional span of up to 37 m, utilising 1800 mm deep super-T girders for the additional span.

Making provision for the 1800 mm deep 37 m long future span offers more flexibility in the lateral positioning of the rail track alignment in the future. It was concluded that making the provision for extending the bridge in the future with an additional southern span was feasible, refer to this report for further discussion on this review.

Development of concept design for preliminary pricing – June 2018

In consultation with Goodman and AT&L, the concept design for the WNSLR Bridge was further refined as follows:

- The span arrangement changed from 2 x 23 m and 1 x 15 m span, to 1 x 31.03 m span and 1 x 23.03 m span. These spans utilise 1500 mm deep super-T girders in lieu of the previously specified 1000 mm deep girder.
- The central pier is located between the two water supply pipes, and WaterNSW access roads are to be provided either side of this pier.
- The overall shortening of the structure from 61.8 m to 54.06 m allowed the southern abutment (future pier 2) to be moved further from the future rail corridor, providing greater flexibility for its eventual alignment. This did however locate the piled foundations for this pier closer to the existing WaterNSW pipeline, and brought them within the 5 m exclusion radius that was previously mentioned in the initial concept design report. This issue was raised for confirmation with AT&L and Goodman in Appendix D. *Note that this has been revised in detailed design to be outside of the exclusion zone.*
- The bridge cross section was updated to provide medium performance barriers between the roadway and the shared path / footpath (previously located on outside of paths)
- The suitability of the bridge deck to rely on longitudinal drainage was confirmed by the civil design team. Provisions for the collection of surface water and drainage pipes were removed from the concept drawings. *Note that collection of surface water off the bridge may commence after the ends of the approach slabs.*

2.3.3 Detailed design development

Development to 50% detailed design – July 2018

The above design concept has been developed for detailed design throughout July 2018. The design changes listed below have been due to either technical requirements or changes requested by various stakeholders following review of the concept design.

- TfNSW stated that the width of the future rail corridor is not known, however may be much wider than 37 m additional span noted for in the concept design. GHD have confirmed that the design allows for the bridge to be extended with multiple spans of super-T girders in the future if required, with further details provided in Section 4.2 below.
- AT&L confirmed that the 5 m clear separation from the existing WaterNSW pipelines to the Abutment B foundations was to be maintained. The length of span 2 was increased to allow relocation of Abutment B.
- Further review of existing geotechnical information, and refined analysis of the structure has allowed the reduction of piles required at Pier 1 and Abutment B. Pier 1 has reduced from 3x1500 dia piles to 2x1500 dia piles, and Abutment B has reduced from 4x1200 dia piles to 3x1200 dia piles. Note that at 50% design stage the detailed geotechnical investigation is still yet to be completed, and changes may result from the findings when available.
- The depths of the footpath on the eastern carriageway and the shared path on the western carriageway have both increased. This increase was necessary to suit the roadway and path geometry off the structure, and also to provide the requested concrete encasement of services within the footway.

- The need for a shoulder on the right hand side of each carriageway, and the suitability of the footpath width was questioned during roadway geometry reviews. Confirmation of these changes (if required) is still underway, as such the developed design still shows the roadway geometry as per the concept design. The developed drawings will include hold clouds on these areas to indicate a potential change until it is confirmed.

2.4 Project inputs

2.4.1 Road Authority

The relevant road authority for bridge review has not been confirmed at this stage of design. Once confirmed, the design will be presented for review and details of inputs received from the road authority will be recorded in Appendix D

2.4.2 Input from Goodman and AT&L

Inputs received from Goodman and AT&L to date are summarised in Appendix D.

2.4.3 Design standards

Design standards used in the preparation of the design include but are not limited to:

- Australian Standards including:
  - AS5100:2017 Series
  - AS1170.2
  - AS2159-2009 - Pile Design and Installation
  - AS4678 - Earth Retaining Structures
- RMS QA Specifications for Roadworks and Bridgeworks including:
  - RMS Bridge Policy Manual which includes Bridge Technical Direction Manual, Bridge Policy Circulars
  - RMS Standard Drawings
  - RMS Bridgeworks QA Specifications
  - RMS PS361 – Bridge and Structure Detail Design

2.4.4 Design loading

Table 2-1 Design loading

Load Effect	Design Component	Design Value	Reference
Dead Load	Reinforced concrete (precast)	26.5 kN/m3	
	Reinforced concrete (in-situ)	25.5 kN/m3	
	Steel	77.0 kN/m3	
	Fill Density	20 kN/m3	
	Barriers	Actual weight	
Superimposed Dead Load	Asphalt	22 kN/m3	
Live Loads	Road Traffic	SM1600 HLP400 (speed controlled to 10 km/hr and positioned centrally on the bridge within ±1 m)	AS5100.2 Section 7

Load Effect	Design Component	Design Value	Reference
	Braking Force	Single vehicle stopping Fbs = 0.45Wbs (200 kN <Fbs<720 kN) Multi-lane moving traffic Fbm = 0.15Wbm	AS5100.2 Section 7.8.2
Barrier impact loads	Medium level performance barriers	As per AS5100.2	AS5100.2 Section 12
Minimum Lateral Restraint	Superstructure – at any point, and any angle between horizontal and vertical	500 kN or 5% of Structure DL, whichever is greater.	AS5100.2 Section 10 RMS BTD2011/05
Earth pressure	Fill density	20 kN/m3	
Surcharge Load	General UNO	20 kPa	AS5100.2 Cl 14.2
Earthquake Design	Bridge Classification	TBC (refer Appendix D)	AS5100.2 Section 15.4.1
	Seismic hazard factor	TBC	
	Acceleration spectral shape factor	TBC	
	Probability factor	TBC	
Wind Loading (on structure)	Region A3	Terrain Category	AS5100.2 Section 17
	Site Wind Speed	Vu = 48 m/s, (2000 year ARI), Vs = 37 m/s (20 year ARI)	AS5100.2 Cl 16.2 & AS1170.2
Flood Loading (Bridge over Parsons Gully)	N/A		
Thermal Effects	Max. Shade Air Temp	45 °C (Region II - inland)	AS5100.2 Table 18.2 (1)
	Min. Shade Air Temp	-5 °C (Region II - inland)	AS5100.2 Table 18.2 (1)
Shrinkage and Creep	Temperate inland (Approx. RH 60%)		AS5100.5 Section 3

2.5 Form 62

The design criteria and assumptions will be documented in the Form 62 attached to Appendix B. This is to be complete prior to final submission.

2.6 Matters for resolution

The matters for resolution as detailed in AS5100.1-2017 Section 6 will be prepared and attached to Appendix C for review and acceptance prior to submission to the relevant road authority.

2.7 Services and utilities

The primary existing utilities to be accommodated by the WNSLR Bridge are the Warragamba to Prospect water supply lines.

The bridge has also been designed to carry power, communications, and water main (Sydney Water). Refer to design drawings for details.

The design relocated services in the vicinity of the bridge is currently underway and will be discussed in future versions of this report where relevant to the bridge.

2.8 Hydrology and hydraulics

The civil design manager has stated that no significant hydraulic effects are anticipated to impact the design of this structure.

2.9 Geotechnical

Detailed geotechnical investigation for the bridge foundations is still underway at the time of writing this report, with preliminary geotechnical investigation available as provided at the concept design stage. A preliminary Geotechnical Design Report has been produced to document the bridge foundation design to date, this is attached in Appendix J.

2.10 Road parameters

A summary of the road design parameters relevant to the bridge design is as follows:

- Design speed: 80 km/h
- Road geometry:
  - 2x3500 mm lanes and a 1000 mm wide left hand shoulder on each carriageway. (need for right hand shoulder TBC, refer Appendix D)
- Traffic volumes:
  - AADT at bridge opening: 2300 veh/day
  - AADT in 2026: 24200 veh/day
  - AADT in 2036: 29000 veh/day
- Barrier performance level determination: Medium
  Note that the risk assessment method provided in AS5100.1 for determining bridge barrier performance level uses the AADT at bridge opening, however this assumes a 2% increase in traffic per year. It can clearly be seen above that the increase in traffic following the bridge opening is significantly higher than 2% per year (due to ongoing development of the surrounding area). To account for this, an AADT of 21500 veh/day has been used in the barrier risk assessment, this corresponds to 24200 veh/day in 2026 assuming 2% annual increase.
- The Civil Design Manager has confirmed that the bridge deck can be longitudinally drained without additional scuppers and collection pipes. Any extension of the bridge length in the future however will likely require collection of water on the deck for the additional spans.
- Accommodation of pedestrians and cyclists:
  - 1500 mm footpath on eastern carriageway (TBC, refer Appendix D)
  - 1800 mm shared path on western carriageway
- Anti-throw screens have been confirmed as required for protection of the significant water infrastructure below the bridge, this has been specified by WaterNSW rather than a risk assessment carried out by the design team. These are proposed to be provided on both sides of each carriageway, and to be 3300 mm high. This height complies with the requirements of RMS Bridge Technical Direction BTD2012/01, specifically:
  - A minimum height of 3 m above the roadway or footway surface, and

- A minimum height of 2 m above the top rail of any adjacent barrier.

3. Design review and development

As the design develops, reviews from the road authority and other stakeholders will be undertaken as required. Note that at the 50% design stage, confirmation has still not been received for the relevant road authority for bridge reviews. Any significant changes reflected in the design documentation due to this process will be listed in the sections below.

3.1 Concept design review

Outcomes of concept design review are as follows:

- TfNSW stated that the width of the future rail corridor is not known, however may be much wider than 37 m allowed for with an additional span of 1800 super-T girders. GHD have confirmed that the design allows for the bridge to be extended with multiple spans of these girders in the future if required, and noted that this would result in piers located within the future rail corridor.
- AT&L confirmed that the 5 m clear distance to the WaterNSW pipelines needs to be maintained. To achieve this clearance to the piles foundations, the length of the second span has been increased and the centreline of Abutment B adjusted.
- AT&L have provided updates to the alignment of the RSS walls either side of the bridge. This update has no significant impact on the main bridge structure other than it being shown on the bridge general arrangement drawings. The RSS wall drawings will be developed to show this updated arrangement, and the roadside barrier specification off the bridge will need to be confirmed as it now runs adjacent to the RSS wall drop (separated by the footpath and shared path). Once the roadside barrier is confirmed, the bridge drawings will be updated with a suitable transition between bridge barrier and roadside barrier off the bridge.
- Internal GHD reviews of the concept design have queried whether a shoulder is required on the right hand side of each carriageway, and whether Penrith City Council have accepted the 1.5 m wide footpath or if a 1.8 m wide footpath is required. The bridge arrangement can be updated to provide for the 1.8 m footpath without the addition of extra girders, however if additional shoulders are required on the roadway then additional girders will be required resulting in more significant redesign. The query has been raised with AT&L and GHD are awaiting confirmation.

3.2 Non-conformances

The design has been undertaken in accordance with the design standards listed in Section 2.4.3 above. Identified non-conformances to these requirements or agreed variations to the project scope have been outlined below in Table 3-1.

Table 3-1 Identified non-conformances

Reference	Design brief requirement	Non-conformance	Status
1	Minimum footway width of 1.8 m “unless specified otherwise by the relevant authority” (AS5100.1 CL13.10)	Footway width of 1.5 m provided in road design continuing over bridge (low pedestrian numbers expected)	Awaiting confirmation from road authority

4. Description of the design

Current drawings for the Bridge (50% design) are attached to Appendix A.

4.1 General

Detailed descriptions of each structural element will be included in future revisions of this report once detailed design has been completed.

- **General arrangement**, the bridge superstructure consists of 5 No. precast concrete super –T girders per span. The girders support a composite concrete slab with a 75mm thick asphaltic concrete wearing course including a deck waterproofing membrane. The bridge substructure consists of RSS wall abutments with portal style piers supporting each span along the length of the bridge.
- **Abutments and approaches**, Abutment A consists of a 1300mm deep reinforced concrete headstock supported on 1200mm diameter piles. Abutment B consist of wall type pier supported on 1200mm diameter piles and an RSS wall behind the pier to allow for the future additional third span of the bridge. The approach slab will span between the pier wall and the RSS wall backfill.
- **RSS walls**, RSS wall are provided at Abutment A and B. The RSS wall returns along the roadway, running adjacent to the footpath and shared path.
- **Piers**, the bridge pier is located between the water supply pipelines and consists of 1600 deep reinforced concrete headstock, 1500mm cast in place piles and 1300mm columns. Note that the headstock thickness has been increased from the concept to allow for the reduced number of piles and columns.
- **Foundations**, bored cast in place reinforced concrete piles, constructed using permanent steel casing have been nominated as the pile type. It's expected that these piles will be socketed into rock.
- **Articulation**, Expansion joints are located between the approach slab and the deck slab at the top of the curtain wall of each abutment. The Granor Series AC-AR 125D cast-in aluminium strip seal expansion joint system will be adopted to cater for longitudinal movements at all joint locations.

  The super-tee girders will be supported on elastomeric bearings at each end. 530 mm diameter, 237 mm tall (AS [50] 151511C) have been specified at each abutment and pier location to provide for the necessary vertical load, shear deflection, and rotational capacity.

  The proposed bridge articulation allows for expansion on every support for all the design load cases
- **Off structure barriers**, standard off structure barriers restrained by the footway behind will be provided adjacent to the RSS walls, the test level of these barriers is to be confirmed by AT&L through their risk assessment for roadside barriers.
- **Anti-throw screens**, will be provided, with balustrade rails and cycle rails to be incorporated with these screens.
- **Barriers**, twin rail medium performance level bridge barriers with a height of 1.4 m will be provided on both sides of the carriageway. The standard RMS details for these barriers will be utilised where possible, however it is important to note that the design requirements for Medium Performance barriers has changed in the 2017 update of AS 5100 which is not yet reflected on RMS standard drawings. The final details for the

barriers are still being developed, but are expected to incorporate the standard details with a closer post spacing of 2.25 m. The solid component of barriers are proposed to be cast in situ concrete, however alternative precast barriers solutions may be proposed by the contractor and would be suitable to consider for this structure.

- **Accommodation of services**, a 300mm water main and provisions for electrical, communications and lighting utilities within the footpath has been included in the bridge configuration.
  The pipe is proposed to be supported in a pipe clamp supported by dual hangers cast into the bridge deck. An expansion joint as per the Sydney Water DTC drawing 1128 will be provided to allow transverse movement in the pipe at abutments and facilitate bridge jacking in the future. Because the level of the water main follows the grade of the road on and immediately off the bridge, there is no high point in the pipe on the structure - the high point of the pipe is expected to coincide with the crest of the road. A ball valve will still be specified on the pipe at Abutment A as advised by AT&L for maintenance reasons.

4.2 Significant features of the design

Provision for future extension

A significant feature of the WNSLR Bridge is the provision for extending the bridge with additional span(s) in the future. The concept design to allow for this considered the following options:

- Constructing a full height reinforced concrete retaining abutment which could serve as a blade pier in the future when the bridge is extended.
- Constructing a blade pier immediately in front of an RSS abutment wall. This blade pier would serve as the abutment support, and the short distance to the embankment would be bridged with a short spanning slab.

The full height reinforced concrete retaining abutment option was reviewed in detail. It was found that significant deflections at the top of the wall would need to be accommodated when the wall was backfilled initially, and when the embankment fill was removed in the future. Depending on assumptions for foundation stiffness, this deflection when unloading the wall was in the range of 30 mm to 100 mm. Allowing for this movement when the wall was unloaded in the future was not feasible.

The options for constructing a full height blade pier in front of an RSS abutment wall offers the advantage that no earth pressure is applied or removed during the structures life, and the deflections discussed for the previous option are not applicable. This option was progressed for the concept design, including checks on eccentricity on the structural components in the initial and the ultimate configuration.

Following the concept design report review, TfNSW reinforced that the width of the future rail corridor is not known, however may be much wider than 37 m additional span allowed for in the concept design. GHD have confirmed that the design allows for the bridge to be extended with multiple spans of 1800 mm deep super-T girders in the future if required, however noted that extending the bridge with multiple spans would result in piers located within the future rail corridor.

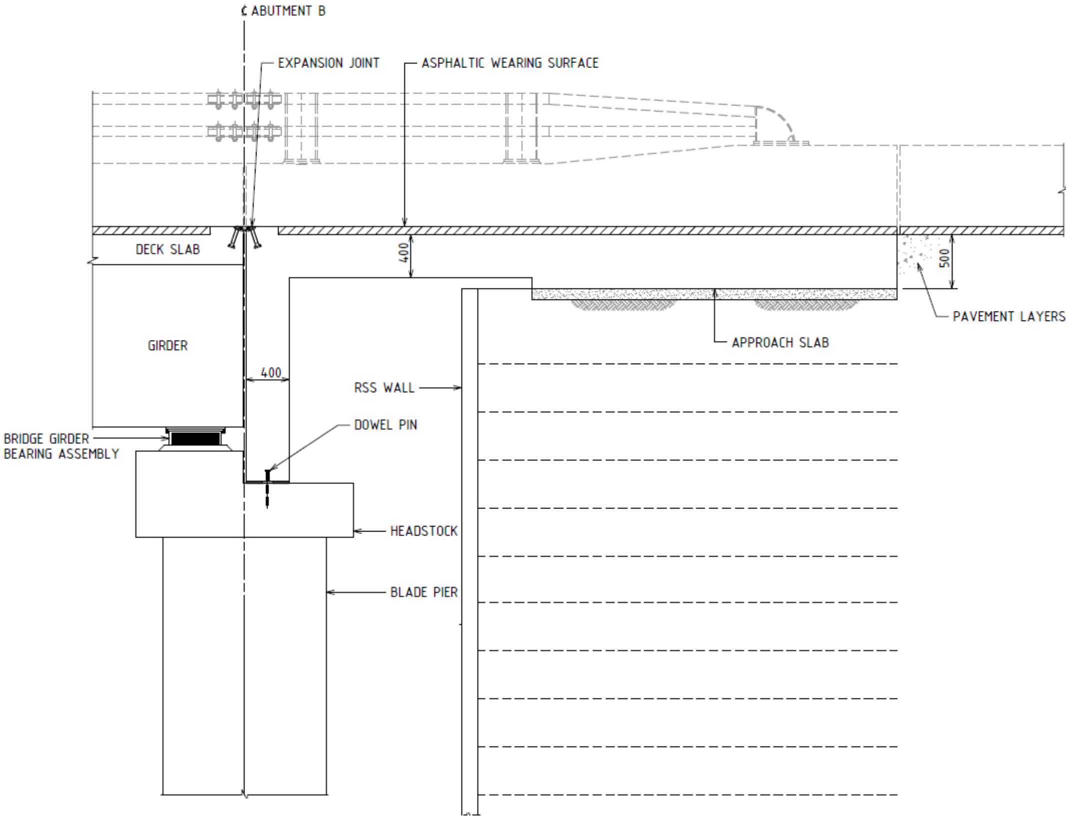

Figure 2 Provision for future extension

4.3 Additional information provided for preliminary pricing purposes

The below information is supplied as support information for the construction tender EOI documents. Although design development is still underway at the time of issuing, information to facilitate indicative pricing of the bridge construction has been included as support information

4.3.1 Indicative details for pricing

The following information is contained in Appendix L to assist with preliminary pricing at the tender EOI stage:

- Indicative road barrier details
- Indicative anti throw screen details
- Indicative water pipe support misc details

4.3.2 RSS wall information

The layout of the RSS wall has been revised prior to issuing this report. The bridge GA plan has been updated to reflect this, however updated elevations of this wall are not yet available for inclusion with the bridge package. The visible face areas of the walls are indicated below to assist in preliminary pricing:

Abutment A: 980 m^2 (approximately)

Abutment B: 765 m^2 (approximately)

Important information to note for the above areas:

- Above areas are for visible face area only, they do not include the area off wall panels embedded below finished surface level in front of the wall.
- Above areas include the projected area of the abutment headstocks, although there will not be panels for the full extent of this area, the headstocks at abutment A are proposed to have RSS straps attached which will need to be included in the RSS construction scope. The RSS wall at abutment B continue full height behind the abutment (refer details for provision of future bridge extension)
- An inspection platform with a handrail is proposed along the top of the RSS wall at Abutment A to facilitate inspection and maintenance of the bridge bearings. A section of RSS wall will be required from this footway level to the finished level between the carriageways. This wall is offset from the main wall (by the width of the footway) and is included in the face area above.
- The water main running along the western side of the bridge continues into the RSS wall at each abutment. Provision will need to be made for a circular penetration in the Abutment B panels to accommodate this, and a drainage zone around the pipe of no fines concrete (extending for the full height of both walls beneath the pipe).

4.3.3 Preliminary Reinforcement rates for bridge elements

The following reinforcement rates have been determined from previous experience, and assessment of the demand on certain structural elements during the development of the bridge design.

Element	Reinforcement Rate (kg/m^3)
Abutment A piles	160
Pier piles	210
Abutment B (future pier 2) piles	200
Pilecaps	180
Abutment A Headstocks	160
Abutment B and Pier 1 Headstocks	180
Abutment B blade wall	160
Concrete deck slab	220
Concrete barriers	160
Relieving slabs	220

5. Methods and results of analysis

5.1 Methods

The detailed design is being developed with the aid of a variety of analytical, numerical and simulation techniques. These included Autodesk Structural Bridge Design, SpaceGass frame analysis, a variety of proprietary systems, specialised in house spreadsheets, and hand calculations.

The superstructure has been idealised using a two dimensional grillage created within SpaceGass on the basis of individual simply supported spans. A complete deck grillage model with appropriate longitudinal and transverse stiffness has been created to determine the actions on the girders, and the capacities of the girders at various limit states has been reviewed using Autodesk's Structural Bridge Design.

The substructures has been modelled for each span to determine the worst case foundation loads. An estimation of foundation loads is presented below, this is still under development to balance the loads more efficiently and to account for any changes to the deck width.

5.2 Results

The maximum applied loads and the design capacities for the structural elements of the bridge will be presented in the complete detailed design revision of this report.

5.2.1 Foundations

Preliminary sizing of these foundation are based on the loads given below in Table 5 1. Refer to the preliminary Geotechnical Design Report in Appendix J for details of the pile design details. Note the limited geotechnical information available at this stage of design as discussed in Section 2.9.2 above, any planning or pricing activities that rely on the preliminary pile design should take this into consideration.

Table 5-1 Preliminary loads on bored piled foundations

Location	ULS vertical load estimation (KN / pile)	SLS vertical load estimation (KN / pile)	ULS lateral load estimation (KN / pile)	SLS lateral load estimation (KN / pile)	Assumed pile configuration
Abutment A	4500	3400	600	450	3 x 1200 dia
Pier 1	10000	7500	1500 (2500 collision load)	900	2 x 1500 dia
Abutment B (for future pier 2 configuration)	6500	4800	800 (1500 collision load)	400	3 x 1200 dia

6. Materials selection and durability

6.1 Design life

All new structural elements will be designed in accordance with design life standards to provide:

- Principal elements of the bridge, culvert and retaining wall structures: 100 years (as per AS5100)
- Ancillary elements (e.g.: bearings, expansion joints etc.): 50 years (typical)

Refer to Appendix I for the project Durability Assessment Report.

6.2 Concrete

The exposure classification for the above ground concrete elements will be **Exposure Classification B1** as the bridge and associated structures are located in a near coastal environment up to 50 km from the coastline. The concrete elements in the bridge and associated structures will need to be designed to satisfy the durability provisions of Australian Standard AS 5100.5-2017 Bridge Design Part 5: Concrete.

The exposure classification, compressive strength of concrete and minimum cover for each major element will be presented in a table in this section in future versions of this report.

7. Maintenance provisions

Providing a structure that is easily maintainable throughout its service life is a key goal of any design and required by RMS bridge technical direction BTD2008/02.

7.1 Bearing inspection and replacement

To facilitate future bearing replacement, a diaphragm is provided between the girders at the end of each span. This provides a position to jack the deck off its bearings and replace as required. The final drawings will provide details of the jacking methodology, position of jacks and loads required.

Access for inspection to Abutment A bearings is provided via a maintenance pathway along the top of the proposed RSS wall. It is proposed that this will be access from the roadway above.

Access for inspection to Pier 1 and Abutment B bearings could be completed using elevated work platforms (EWP) from beneath the proposed structure, alternatively an Under Bridge Inspection Unit (UBIU) could be used. Access tracks within the WaterNSW corridor would need to be utilised to allow for this access. For bearings replacement, temporary scaffolding will be required.

Note that a typical access path in front of Abutment B has not been provided, as it is impractical to do so due to the proximity to the WaterNSW pipelines, and this abutment is designed as a pier for the final bridge configuration.

7.2 Maintenance of steel sections

Steel is prone to corrosion and if not adequately protected will have a reduced service life. Where possible it is proposed to adopt stainless steel or aluminium alloys which have better durability performance.

Regular maintenance regimes should include wash downs to prevent excessive build-up of salts and other materials that promote corrosion. Protective coatings will need to be reapplied (painting, galvanising etc.) throughout the life of particular elements unless the element is to be replaced.

7.3 Drainage system

Drainage systems are likely to get blocked over the life of the structure. It has been identified in during the concept design that the bridge deck may be longitudinally drained for this structure, as such bridge deck drainage pipes have been omitted to avoid unnecessary maintenance.

7.4 Sydney Water DN300 water main.

The height of the DN300 water main on the bridge has been set at 1200 below the finished footpath level. This is within the suitable depth for the buried pipe just after the bridge, and locates the pipe just below the barrier skirt.

Although this configuration is not ideal for aesthetics, setting the pipe height below the barrier skirt facilitates easier access for inspection and maintenance of the pipe.

8. Constructability

8.1 Constructability

The main construction constraint identified during concept design of the WNSLR Bridge was the interface with the existing WaterNSW pipelines, and this remains the main constraint during detailed design. Allowance for these will need to be made during both foundation works, and installation of girders in order to avoid causing damage to these assets.

Key constructability issues identified to date relating to the construction of the bridge are as follows:

- Proximity of the existing WaterNSW pipeline to the piling works for Abutment B.
- Lifting of PSC girders over the WaterNSW pipeline and suitable locations for piling platforms.
- The constructability of the future extension span has been considered in the concept design development, and will continue to be considered as the design develops and details will be included with the full detailed design report. .
- Existing and proposed utilities around the proposed foundations.

A detailed construction methodology will be documented in the completed Detailed Design Report, the following is the currently assumed sequence:

1. Carry out necessary earthworks on site to prepare access tracks, piling platforms, pilecap construction levels, and reach the level specified by the RSS supplier for RSS wall construction. Contractor to design temporary works required for protection of any services impacted by the works.
2. Complete piling works at each abutment and pier location
3. Construct free standing columns at Abutment A and Pier 1, up to nominated level at underside of headstocks.
4. Cast pilecap at Abutment B and backfill to the pilecap.
5. Construct blade wall and headstock at Abutment B (alternatively may be constructed after RSS wall)
6. Sleeve Abutment A columns and fill void with compressible material to maintain isolation
7. Build RSS wall at Abutment A up to underside of headstock level. Build RSS wall at Abutment B up to underside of water pipe. RSS panel with water pipe penetration to be in place at this stage. Note the drainage requirements around and beneath the water pipe on the western side of the wall.
8. Build headstock at Abutment A, inclusive of RSS strap attachment points as specified by the RSS supplier. Build headstock at Pier 1
9. Construct all mortar pads to the levels shown on the drawings.
10. Erect girders onto laminated elastomeric bearings for all spans.
11. Install water pipe hangers through formed holes in girders.
12. Construct main deck slab for spans 1 and 2

13. Install water pipe on bridge, through penetration in Abutment A and through penetration in abutment B RSS panel. Pipe to be temporarily supported as required above RSS completed height if required.
14. Construct link slab over pier (observing standard RMS limitations on time between main slab and link slab pours).
15. Complete construction of RSS walls at both abutments. Water pipe installation through RSS block to be coordinated with this stage of RSS construction.
16. Complete barriers, relieving slabs, surfacing and pier protection works

9. Safety in design

Risk management for the project has been integrated throughout the development of the design. Identified issues throughout the project will be documented in the Project Risk Register.

Issued identified to date have been captured in the table in Appendix H.

A SiD workshop will be held for incorporating the wider design team, once this has been completed the table in Appendix H will be incorporated in the wider team SiD records.

Safety in design (SiD) is a strategy aimed at preventing injuries and disease by considering hazards as early as possible in the planning and design process and enhancing safety through choices of controls in the design sequence.

Safety in design has been and will continue to be incorporated into the Project with milestone view at key stages, including:

- Review of previous risk workshops and registers
- Road safety audits – strategic and concept phases
- Progress reviews
- Safety in Design workshops

During the development of the detailed design, every effort will be made to eliminate or mitigate these risks further. Upon completion of the detailed design a safety report will be completed for inclusion in the contract documentation. This report will document the process and identify those residual risks that could not be closed out in the design process and will be handed over to the next phase of the project.

10. Verification status

10.1 Proof engineering and independent verification

The structural design and critical calculations will be proof checked by relevant GHD technical staff independent to the Project in accordance with the requirements PS361 following submission of the 80% Design Issue. Final review and certification will be received following completion of the 100% Design Issue.

Comments from the Proof Engineer will be documented and addressed in the final design. Refer to Appendix E for IV comments and Designers responses along with Project certification.

10.2 Internal verification

Internal design verification will be undertaken at each stage of the design in accordance with the GHD Quality Assurance procedures to ensure that the documented design complies with the requirements of the project including any statutory requirements. Comments from internal design verifier will be incorporated into future revisions of this report.

10.3 Client review

Goodman property group will be provided documentation for review at each stage of the Project, to distribute to relevant stakeholders as required. Comments from these stakeholders will be recorded in a Project Specific register and Designer comments included to allow each item to be closed out formally.

Refer to Appendix G for the Road Authority bridge review comments.

Appendices

Appendix A –Bridge drawings

This Appendix contains the current design drawings for the WNSLR Bridge. Note that this includes all current drawing, and proposed drawings for detailed design. Not all are included with this submission

Sheet No:	Description
1	COVER SHEET
2	SCHEDULE OF DRAWINGS
3	GENERAL ARRANGEMENT - SHEET A
4	GENERAL ARRANGEMENT - SHEET B
5	GENERAL ARRANGEMENT - SHEET C
6	GENERAL ARRANGEMENT - SHEET D
7	CONSTRUCTION STAGING
8	CAST-IN-PLACE PILES - SHEET A
9	CAST-IN-PLACE PILES - SHEET B
10	ABUTMENT A CONCRETE - SHEET A
11	ABUTMENT A CONCRETE - SHEET B
12	ABUTMENT A CONCRETE - SHEET C
13	ABUTMENT A CONCRETE - SHEET D
14	ABUTMENT A REINFORCEMENT - SHEET A
15	ABUTMENT A REINFORCEMENT - SHEET B
16	ABUTMENT A REINFORCEMENT - SHEET C
17	ABUTMENT A REINFORCEMENT - SHEET D
18	ABUTMENT A REINFORCEMENT - SHEET E
19	ABUTMENT B CONCRETE - SHEET A
20	ABUTMENT B CONCRETE - SHEET B
21	ABUTMENT B REINFORCEMENT - SHEET A
22	ABUTMENT B REINFORCEMENT - SHEET B
23	ABUTMENT B REINFORCEMENT - SHEET C
24	PIER CONCRETE - SHEET A
25	PIER CONCRETE - SHEET B

Sheet No:	Description
26	PIER REINFORCEMENT - SHEET A
27	PIER REINFORCEMENT - SHEET B
28	BEARINGS - SHEET A
29	BEARINGS - SHEET B
30	BEARINGS - SHEET C
31	PSC SUPER-T GIRDERS CONCRETE - SHEET A
32	PSC SUPER-T GIRDERS CONCRETE - SHEET B
33	PSC SUPER-T GIRDERS CONCRETE - SHEET C
34	PSC SUPER-T GIRDERS CONCRETE - SHEET D
35	PSC SUPER-T GIRDERS REINFORCEMENT - SHEET A
36	PSC SUPER-T GIRDERS REINFORCEMENT - SHEET B
37	PSC SUPER-T GIRDERS REINFORCEMENT - SHEET C
38	PSC SUPER-T GIRDERS REINFORCEMENT - SHEET D
39	PSC SUPER-T GIRDERS REINFORCEMENT - SHEET E
40	PSC SUPER-T GIRDERS REINFORCEMENT - SHEET F
41	PSC SUPER-T GIRDERS REINFORCEMENT - SHEET G
42	PSC SUPER-T GIRDERS REINFORCEMENT - SHEET H
43	PSC SUPER-T GIRDERS REINFORCEMENT - SHEET I
44	PSC SUPER-T GIRDERS REINFORCEMENT - SHEET J
45	PSC SUPER-T GIRDERS REINFORCEMENT - SHEET K
46	PSC SUPER-T GIRDERS REINFORCEMENT - SHEET L
47	PSC SUPER-T GIRDERS REINFORCEMENT - SHEET M
48	DECK CONCRETE - SHEET A
49	DECK CONCRETE - SHEET B
50	DECK CONCRETE - SHEET C
51	DECK CONCRETE - SHEET D
52	DECK CONCRETE - SHEET E
53	DECK REINFORCEMENT - SHEET A
54	DECK REINFORCEMENT - SHEET B

Sheet No:	Description
55	DECK REINFORCEMENT - SHEET C
56	DECK REINFORCEMENT - SHEET D
57	DECK REINFORCEMENT - SHEET E
58	DECK REINFORCEMENT - SHEET F
59	DECK JOINTS AND COVER PLATES - SHEET A
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80	APPROACH SLABS - SHEET F
81	STAIR AND ACCESS DETAILS
82	RS WALL DETAILS - SHEET A
83	RS WALL DETAILS - SHEET B

Sheet No:	Description
84	BAR SHAPES DIAGRAM

Appendix B – Form 62

This Appendix contains the RMS Bridge Design Proposal – Summary and Approvals - Form 62.
(To be included prior to submission to RMS for review)

Appendix C – AS5100 matters for resolution

This Appendix contains the AS5100 matters for resolution.

(To be included prior to submission to Road Authority for review)

Appendix D – Register of bridge design input received

Register of inputs from Goodman and AT&L

Details	Input received from Goodman and AT&L
Longitudinal drainage of bridge deck suitable, no requirement for collection of surface water and drainage pipes may be removed.	Confirmed 14th June 2018 (Phone call Russell Hogan to Matthew Williams)
Civil design manager stated that no significant hydraulic effects are anticipated to impact the design of this structure.	Discussed 12th June 2018 (Phone call Russell Hogan to Matthew Williams)
Confirmation of suitability of Abutment B piles located within 5 m clear radius of water pipeline	Confirmed by AT&L to provide full clearance to water pipeline. Refer email 20th June Anthony McLandsborough to Mat Williams.
Confirmation of whether WaterNSW require anti-throw / protection screens on spans crossing existing pipelines.	These are required for protection of key water assets – confirmed in design meeting 19th June 2016
Confirmation of lighting locations on bridge	Awaiting confirmation
Confirmation of vehicle numbers to conduct risk assessment for barrier performance level	Traffic report provided by Anthony McLandsborough 20th June, applicable parameters confirmed by Ason on 12th July.
Geotechnical investigation report at bridge site for design of bridge foundation.	Provided following 50% design and will be incorporated in final bridge design.
Awaiting appointment of RMS design manager – generally for review of design progress, and specifically for: -Confirmation of BEDC (to be classified by relevant authority as per cl15.4.1 of AS5100.2:2017)	Goodman have confirmed that RMS will not be a review body for this bridge.
Awaiting confirmation of overall bridge width to allow for: • Shoulders adjacent to right hand lane (none currently shown) • Increase of footway width to 1.8m to comply with AS5100.1 CL 13.10 (currently 1.5m provided as desirable minimum from austroads)	AT&L confirmed the bridge width to increase to incorporate 500 mm median shoulders. Footway width to remain as 1500mm.
Awaiting confirmation of roadside barrier requirements adjacent to the RSS wall off the bridge. The bridge barrier transitions currently assume a standard 820 mm high type F barrier.	Awaiting confirmation

The DN300 Sydney Water water main is set at 1200 mm below the footpath finished level on the bridge, and continues at this same height off the bridge. As there is no high point on the structure (usually due to pipe dropping immediately off the structure), no valve has been specified at the high abutment. AT&L services coordinator to confirm that this is suitable.	AT&L have confirmed that although the valve is not required at the high point, it is beneficial to include it for maintenance.

Appendix E – Independent verification (IV) records

Completed verification records for the bridge design will be included in this appendix at an appropriate stage of the design.

Appendix F – Internal verification

Relevant records of internal verification will be included in the appendix as the design develops.

Appendix G – Road Authority review

This Appendix will contain the comments register from the reviewing Road Authority as the design progresses.

Appendix H – Safety in design

A preliminary Safety in Design (SiD) risk assessment has been developed and shown in the table below:

Design Ref	Design Life Cycle Stage	Hazards What could cause injury or ill health, damage to property or damage to the environment	Risk What could go wrong and what might happen as a result	Existing Control Measures	Potential Control Measures (Consider Hierarchy of Control - Elimination, Substitution, Isolation, Engineering Controls, Administrative Controls, PPE)
Material	Investigation and Design	Material deterioration over time.	Reduced structural strength and affect operation safety and reliability	Structure material selected is concrete precast units. All concrete elements will be designed in accordance with AS5100 durability requirements. Concrete slump and test core samples will be taken prior to concrete pour and strength will be verified under laboratory conditions.	NA – Existing control measure sufficient.
Structural	Investigation and Design	Underground services	Hitting and damage to underground services	Dial Before You Dig plans.	Verify location of services on site prior to construction.
Structural	Investigation and Design	Vehicle falling onto Water NSW pipelines	Damage to pipelines	Medium performance traffic barriers for high containment.	NA - Existing control measure sufficient.
Construction	Setup, Construction and Commissioning	Fauna and flora.	Affect habitat of flora and fauna.	REF is prepared for this project by Goodman Group.	NA - Existing control measure sufficient.
Construction	Setup, Construction and Commissioning	Manual handling of large construction materials and equipment.	Injury from weight handling.	N/A	Ensure construction personnel are appropriately trained in the use of specified equipment, complete manual handling training courses and attend construction site induction. Ensure that lifting equipment are tested and follow relevant safety protocol during operation.
Construction	Maintenance	Personnel walking along bridge structure during construction.	Fall from structure and result in injury	N/A	Ensure construction personnel to have fall arrest or fall prevention systems in place prior to undertaking work on the bridge decks and in other areas where working at heights is applicable.
Construction	Setup, Construction and Commissioning	Falling objects and construction debris.	Objects or debris damaging passing Water NSW maintenance vehicles.	NA	Prior to construction, consultation must be sought between contractor and Water NSW on safety protocols when Water NSW maintenance vehicles require to pass through construction zone.

Appendix I – Durability assessment report

This Appendix will contain the Durability Assessment Report once developed for the detailed design.

Appendix J – Geotechnical Design Report

The geotechnical design report will be included with this appendix once available.

1. Purpose of this report

This geotechnical design report (Appendix J) and its attachments present a summary of the preliminary geotechnical analytical and design work undertaken for the Western North South Link Road (WNSLR) Bridges that traverse over two water supply lines within the Water NSW corridor at approximately 530 m south of Lockwood Road in Erskine Park, NSW (Refer to Figure 1)1.

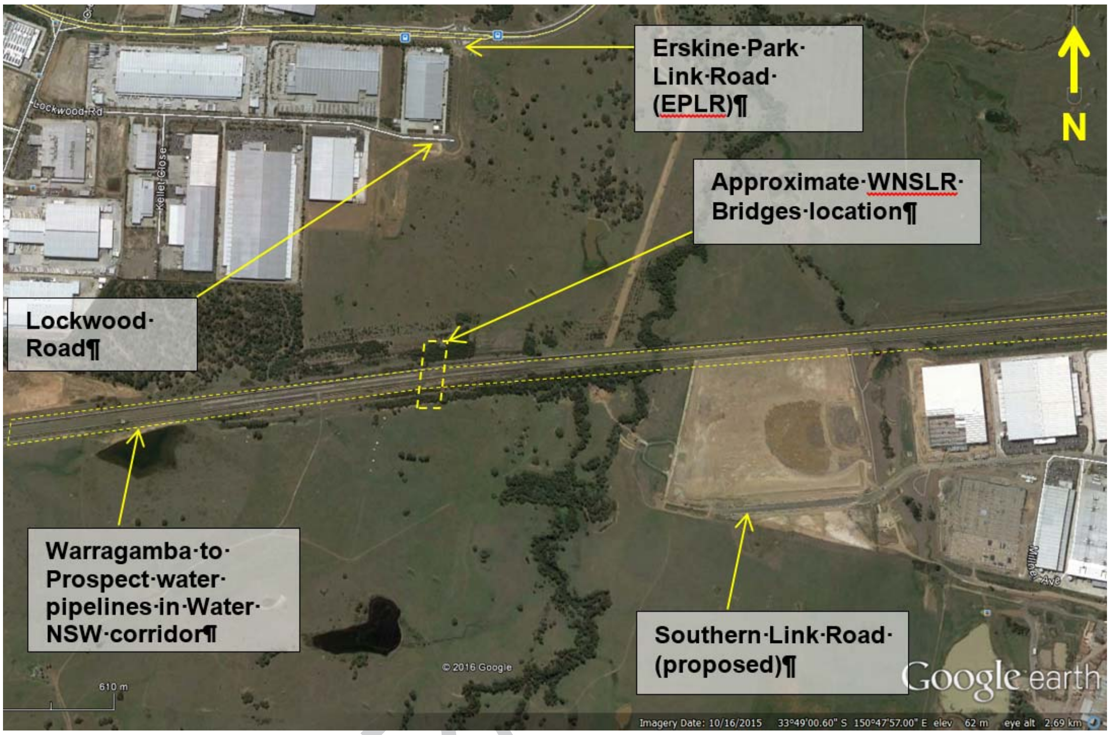

Figure 1 - WNSLR Bridges Location Plan

2. Assumption for pile design

2.1 Available geotechnical data

Geotechnical investigation for the bridge foundations is yet to be conducted. Pells Sulivan Meynink (PSM) has completed two preliminary geotechnical investigations for the proposed WNSLR within the Oakdale West Estate [Ref: PSM1541-123R and PSM1541-140R]. However, the coverage of this information is limited to one borehole at each bridge abutment with a maximum depth of 15.2m

In the absence of further geotechnical data in the vicinity of the bridges, assumptions have been made in order to develop the ground model for the bridge site and to undertake the preliminary geotechnical design presented in this Appendix. Consequently, the results presented in this Appendix will need to be assessed and reviewed once the geotechnical investigation for the bridge foundations is carried out.

2.2 Proposed foundation system

The new WNSLR Bridges consist of twin 56 m long double-span bridges simply supported on two abutments and one pier, namely: Abutment A, Abutment B and Pier 1 as shown in Figure 2.

Pile groups of three 1200 mm diameter piles in a single row, spaced at roughly 4 pile diameters centre to centre will be bored at the underside of the two abutment headstocks of the WNSLR Bridges. Similarly, pile groups of two 1500 mm diameter piles in a single row, spaced at more than 4 pile diameters centre to centre will be bored at the underside of the central bridge pier.

Thus, given the pile spacing at the bridge abutments, the pile groups were analysed as single piles with loads for the most critically loaded pile supplied by the structural team.

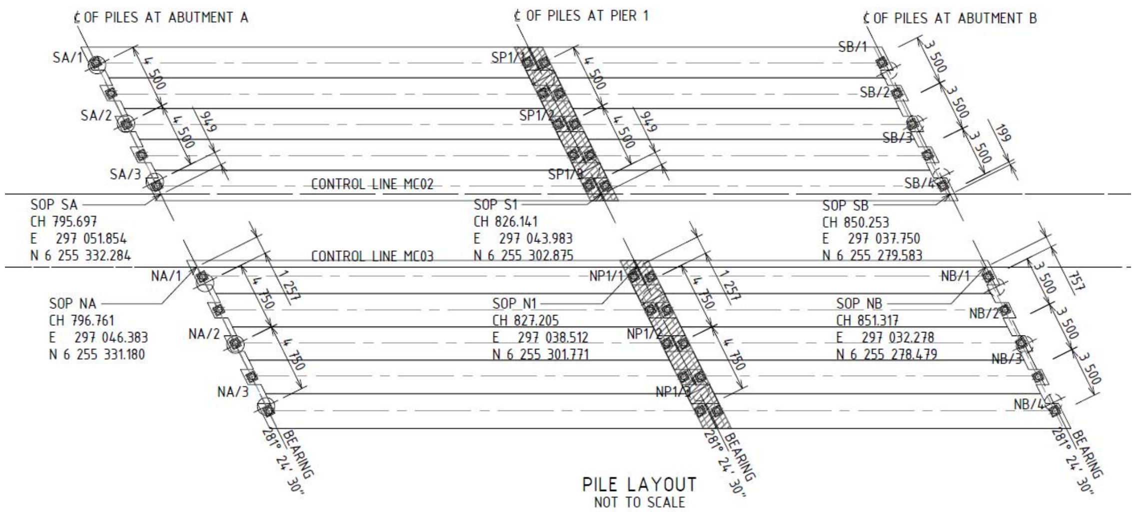

Figure 2 - WNSLR Bridges Location Plan

Based on the available test hole logs produced during the PSM investigations at the proposed location of the twin bridges, the preliminary design conducted for the bridges foundation has adopted the assumption that the bridge piles will not require casing within the soil layers. This assumption will need to be reviewed once the geotechnical investigation for the bridge foundations is carried out.

3. Geotechnical model and adopted design parameters

Figure 3 presents the latest geotechnical investigation conducted by PSM in June 2016 at the proposed bridges location. The following observations are highlighted:

- The depth of the relevant test holes for the bridges foundation design, viz: BH-A and BH-B, is not sufficient to develop the full ground profile at the bridge location. The deepest borehole, BH-A, was terminated at a depth 15.2m and BH-B was terminated at 11.6m depth. The bridges pile lengths are expected to terminate below the current investigation depth.
- BH-A presents a combination of thicker soil profile and thicker class V shale compared to BH-B. Thus, BH-A has been adopted to develop the ground model used for all the bridge pile analysis.

Figure 3 – Geotechnical Investigation at WNSLR Bridges Location

Due to the shallow termination depth of the available geotechnical investigation at the proposed WNSLR Bridges location, the adopted ground model for the bridges foundation design has been extended under the assumption that an infinite layer of medium strength class III shale or better will be encountered below 15.5m depth. This assumption will need to be confirmed once the geotechnical investigation for the bridge foundations is carried out.

Table 3.1 shows the adopted ground model for the bridges foundation assessment.

Table 3.1 – Adopted subsurface profile

Description	Depth to base layer (m)	RL to base layer (m)	*Unit weight γ (kN/m^3)*	Undrained cohesion S_u * (kPa)	UCS range Bertuzzi & Pells. (2002) (MPa)
Alluvial Soils (St CLAY)	4.0	63.6	20	100	-
Alluvial Soils (VSt CLAY)	5.5	61.6	20	150	-
Bringelly Shale Class V	10.1	57.0	22	-	1 - 2
Bringelly Shale Class IV	11.3	55.	22	-	1 - 2
Bringelly Shale Class III (Lower Bound)	15.0	52.1	24	-	2 - 15
Bringelly Shale Class IV [1]	15.5	51.6	22	-	1 - 2
Bringelly Shale Class III (Upper Bound) [1]	-[2]	-[2]	24	-	2 - 15

Notes:

(1) Assumed material below current geotechnical investigation depth

(2) Adopted infinite depth

3.2 Design parameters

The assessment of design parameters, including shaft friction f_s, end bearing f_b, lateral yield pressure p_y, Young's modulus E_v for vertical loading and Young's modulus E_h for horizontal loading for the bored piles is presented below.

3.2.1 Shaft adhesion for soils

All piles at the WNSLR Bridges are treated as end bearing piles.

The soil shaft friction along the pile for vertical loading, f_s, has not been relied upon in the design due to strain incompatibility.

3.2.2 Shaft adhesion in rocks

Based on the available geotechnical site investigation in the vicinity of the proposed twin bridges location and published values for similar geological conditions from Pells et al. (1998), the adopted shaft friction values are presented in Table 3.2.

3.2.3 End bearing in rocks

Based on the available geotechnical site investigation in the vicinity of the proposed twin bridges location and published values for similar geological conditions from Pells et al. (1998), the adopted end bearing values are presented in Table 3.2.

3.2.4 Ultimate lateral yield pressure

The ultimate lateral yield pressure, p_y is assessed as follows (based on Poulos and Davis, 1980):

For cohesive soil, p_y is calculated by:

$p_y = 2\ s_u$ at ground surface, varying to

$p_y = 9\ s_u$ for soil depth greater than 3 pile diameters below ground surface

For rock, p_y is estimated as:

$p_y = 0.5\ f_b$

3.2.5 Vertical and lateral bearing stiffness

For the design of piles undergoing small strain deformation, it is considered appropriate to adopt a soil Young's modulus for vertical loading E_v based on:

For fine grained soils

$E_v = 300 \times s_u$ (MPa) (for long term loading)

$E_v = 600 \times s_u$ (MPa) (for short term/impact loading)

The adopted rock mass modulus (E_m) has been derived based on the combination of site specific data and experience with similar materials on other projects and published values (Pells et al, 1998).

The Young's modulus for horizontal loading, E_h, has been taken to be 75% of E_v.

3.2.6 Summary of adopted geotechnical design parameters

Following from the above methodology, and to be consistent with the adopted design parameters for the site soil/rock units, the geotechnical design parameters for bored piles are presented in Table 3.2.

The assessed values are characteristic ultimate (unfactored) values and the derived capacity values are subject to the application of a geotechnical strength reduction factor, Φ_g for ULS design.

Table3.2 Summary of adopted geotechnical parameters used in the bridge design

Description	Ult. end bearing f_b (MPa)	Ult. shaft friction f_s (kPa)	Ult. lateral yield pressure p_y (MPa)	Vertical Young's Modulus E_v (MPa)	Horizontal Young's Modulus E_h (MPa)
Alluvial Soils (St CLAY)	-	-[2]	0.6	30/60 [3]	23/46 [3]
Alluvial Soils (VSt CLAY)	-	-[2]	1.4	45/90 [3]	34/68 [3]
Bringelly Shale Class V	3	75	1.5	150	112
Bringelly Shale Class IV	5	150	2.5	200	150
Bringelly Shale Class III (Lower Bound)	10	400	5	500	375
Bringelly Shale Class IV [1]	5	150	2.5	200	150
Bringelly Shale Class III (Upper Bound) [1]	20	500	10	750	560

Notes:

(1) Assumed material below current geotechnical investigation depth

(2) Shaft adhesion from soil ignored in calculation of ultimate geotechnical vertical capacity

(3) Two Young's Modulus values have been used in the pile capacity analyses to account for long term and short term loading, respectively

4. Pile design approach

4.1 Design methodology for piles

The design methodology was developed in accordance with AS5100-2017 (Bridge Design) and AS2159-2009 (Piling-Design and installation), such that a pile or pile group be proportioned to satisfy the following:

$$R_{d,g} = \Phi_g R_{d,ug} \geq E_d$$

Where:

$R_{d,g}$ = Design geotechnical strength;
Φ_g = Geotechnical strength reduction factor;
$R_{d,ug}$ = Design ultimate geotechnical strength; and
E_d = Design action effect

The piled foundation was checked for Serviceability Limit State (SLS) and Ultimate Limit State (ULS) cases, including profiles with an allowance for zones near the surface with zero support of the piles where relevant, using an appropriate Φ_g value selected based on the detailed level of investigation, testing and monitoring regime in accordance with AS2159-2009.

4.2 Geotechnical reduction factor (Φ_g) and pile load testing requirements

The geotechnical strength reduction factor, Φ_g, for assessing the ultimate geotechnical capacity of the piles under long term loading has been adopted as 0.5. This was assessed based on the expected level of geotechnical investigation that is to be conducted for the bridges foundation in conjunction with a risk assessment procedure following the guidelines given in AS2159 – 2009. The following observations are made for this assessment:

- The quantity of final borehole investigation has been assumed to comply with typical RMS QA PS331: "*One borehole must be drilled within 2 m from the centreline of each pier location. Where the width of the top of a pier or abutment is greater than 12 m measured along the pier or abutment centreline, a minimum of two boreholes is to be drilled within 2 m of the centreline and 5 m along the long axis from each pier or abutment. The two boreholes should not be on the same side of these lines and should be within the footprint of the bridge. Twin bridges must be treated as two separate bridges*".
- Conservative Individual Risk Ratings (IRR) have been adopted for the site and installation risk factors to estimate the Average Risk Rating (ARR) when conducting the AS2159 - 2009 risk assessment. These IRR's will need to be reviewed once the geotechnical investigation for the bridge foundations is completed.

The geotechnical strength reduction factor, Φ_g, for assessing the ultimate geotechnical capacity of the piles under short term/impact loading has been adopted as 0.7 in accordance with AS2159 – 2009 risk assessment procedure. In this case, aggressive IRR have been adopted for the design risk factors as the design methodology employed has remained the same despite the short term and relatively low probability nature of the loading.

Pile load testing has not been assumed in the current design assessment on the basis of the piles to be founded in medium strength Class III Shale or better in accordance with Table 1 of RMS Bridge Technical Direction BTD2011/08.

5. Pile design analysis results

5.1 Design loads

The preliminary loads provided by the structural team are presented in Table 5.1. However, it should be noted that load combinations with significantly lower pile head loads have not been considered critical for design purposes and hence, they have not been assessed in this Appendix J.

Table 5.1 Assessed preliminary loads applied at pile head level

Analysis	Location	Max. Axial Load (kN)	Max. Lateral Load (kN)
SLS	Abutment A	3400	450
	Pier 1	7500	900
	Abutment B	4800	400
ULS (Short Term/Impact Loading)	Abutment A	4500	N/A
	Pier 1	10000	2500
	Abutment B	6500	1500
ULS (Long Term)	Abutment A	4500	600
	Pier 1	10000	1500
	Abutment B	6500	800

5.2 Design configuration of pile group

The foundation design for the WNSLR Bridges is summarised in Table 5.2.

Table 5.2 Foundation design summary

Location	Pile type	Founding material	Minimum length of socket into founding material (m)	Approx. pile length (m)
Abutment A/B	1 row of 3 x 1200mm diameter bored piles	Class III Shale	0.5m in Medium Strength Class III Shale	16.0
Pier 1	1 row of 2 x 1500mm diameter bored piles	Class III Shale	0.5m in Medium Strength Class III Shale	16.0

5.3 Pile axial capacity

Attachment J-1 includes the axial capacity calculations for the adopted ground model at the bridge abutments and pier.

All bridge piles at the WNSLR bridges are designed as end bearing piles founded in the assumed existing medium strength Class III Shale below depth 15.5m. With the adopted geotechnical strength reduction factor, Φ_g, of 0.50, and disregarding the shaft friction of the soil profile, the results show that pile lengths required to be terminated in the medium strength Class III Shale to achieve capacity.

5.4 Pile lateral capacity

The induced maximum bending moment and shear force of the piles under ULS, as well as the deformations under SLS have been assessed using a spreadsheet software modified from DEFPIG. It calculates the deformations and load distribution within a group of piles subjected to vertical, horizontal and moment loading. The software considers piles supported by a linear elastic medium, allowing for slippage between the piles and the soil; and for the development of soil yield due to lateral loading. Table 5.3 and Table 5.4 summarise the analysis results, including maximum bending moments, axial forces, shear forces and pile deformations for the critical design load cases at each abutment. Attachment J-2 provides the corresponding graphical plots of pile reactions and deformations.

Note that the displacements summarised in the tables below are for the top of the piles. The horizontal and vertical displacements along the pile shaft can be delineated in the figures given in Attachment J-2. The horizontal displacements at the base of all piles are effectively zero.

Table 5.3 Foundation design analysis summary under SLS loads

Geotechnical Reduction Factor, Φg	Location	Vertical Displacement (mm)	Horizontal Displacement (mm)	Rotation (rads)
Φg = 1.0	Abutment B	4	8.6	0.0018
Φg = 1.0	Pier 1	3.0	12.5	0.0022

Table 5.4 Foundation design analysis summary under ULS loads

Load Case	Geotechnical Reduction Factor, Φg	Location	Shear Force		Bending Moment	
			Max. Value (kN)	Depth (m)	Max. Value (kNm)	Depth (m)
Long Term	Φg = 0.5	Abutment B	800	0.0	2100	4.7
		Pier 1	1500	0.0	5300	5.6
Short Term	Φg = 0.7	Abutment B	1500	0.0	4100	4.1
		Pier 1	2500	0.0	8300	5.6

ATTACHMENT J-1 - PILE AXIAL CAPACITY RESULTS

Project:	**Western North South Link Road Bridge**
Location:	**Erskine Park**
Details:	**1200mm bored pile**
	Abutment_B

Pile Type	Bored Pile
Pile Shape	Circular
Pile Diameter	1.2 m
Φg	0.5

Tubular Pile Thickness	0.016
Plugging	Search for Plugging
RL of Ground	67.1
Pile top RL	67.1
Borehole Number	BH-A

Click to Update Data

Depth to base of the layer (m)	Unit	Thickness (m)	Description	Soil type	Consistency	Bored Pile f_s (kPa)	f_b (MPa)	p_y (MPa)	E_{sv}' (MPa)	E_{sh}' (MPa)	f_s(internal) (kPa)
0.50	A	0.5	Alluvium	Clayey Silt	Firm	0.0	0	0.001	25	18.75	0
3.50	A	3	Alluvium	Clay	Stiff	0.0	0	0.001	35	26.25	0
5.50	A	2	Alluvium	Clay	Very Stiff	0.0	0	0.001	50	37.5	0
10.10	Bsa	4.6	Shale V	Shale V	EL	75.0	3	1.5	150	112.5	0
11.30	BSb	1.2	Shale IV/III	Shale IV	VL-L	150	5	2.5	200	150	0
15.00	BSb	3.7	Shale IV/III	Shale III	VL-L	400	10	5	500	375	0
15.50	BSb	0.5	Shale IV/III	Shale IV	VL-L	150	5	2.5	200	150	0
20.00	BSb	4.5	Shale IV/III	Shale III	M	500	20	10	750	562.5	0
-	-		-	-	-						
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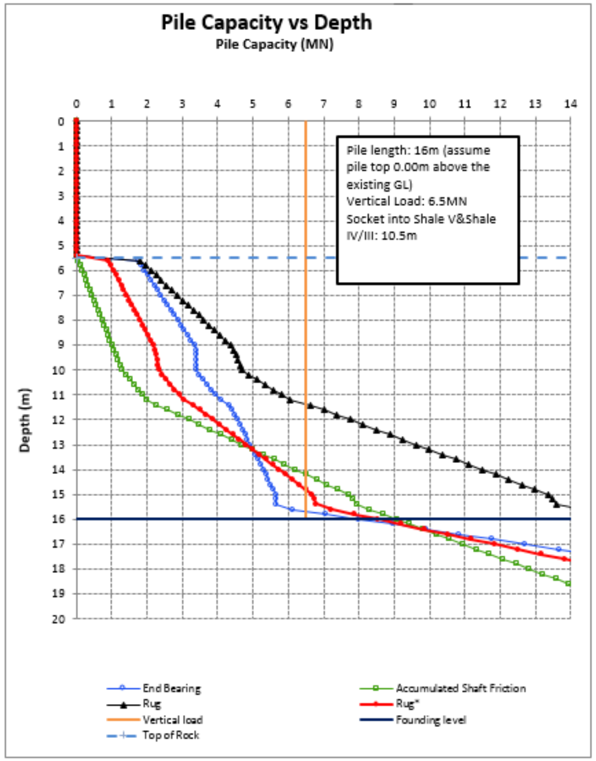

Figure J-1– Assessed pile axial capacity displacements under ULS for Piles at Abutment B

Project:	Western North South Link Road Bridge
Location:	Erskine Park
Details:	1500mm bored pile
	Pier_1

Pile Type	Bored Pile
Pile Shape	Circular
Pile Diameter	1.5 m
Φg	0.5

Tubular Pile Thickness	0.016
Plugging	Search for Plugging
RL of Ground	67.1
Pile top RL	67.1
Borehole Number	BH-A

Click to Update Data

Depth to base of the layer (m)	Unit	Thickness (m)	Description	Soil type	Consistency	Bored Pile f_s (kPa)	f_b (MPa)	p_y (MPa)	E_{sv}' (MPa)	E_{sh}' (MPa)	f_s(internal) (kPa)
0.50	A	0.5	Alluvium	Clayey Silt	Firm	**0.0**	0	0.001	25	18.75	0
3.50	A	3	Alluvium	Clay	Stiff	**0.0**	0	0.001	35	26.25	0
5.50	A	2	Alluvium	Clay	Very Stiff	**0.0**	0	0.001	50	37.5	0
10.10	Bsa	4.6	Shale V	Shale V	EL	**75.0**	3	1.5	150	112.5	0
11.30	BSb	1.2	Shale IV/III	Shale IV	VL-L	150	5	2.5	200	150	0
15.00	BSb	3.7	Shale IV/III	Shale III	VL-L	400	10	5	500	375	0
15.50	BSb	0.5	Shale IV/III	Shale IV	VL-L	150	5	2.5	200	150	0
20.00	BSb	4.5	Shale IV/III	Shale III	M	500	20	10	750	562.5	0
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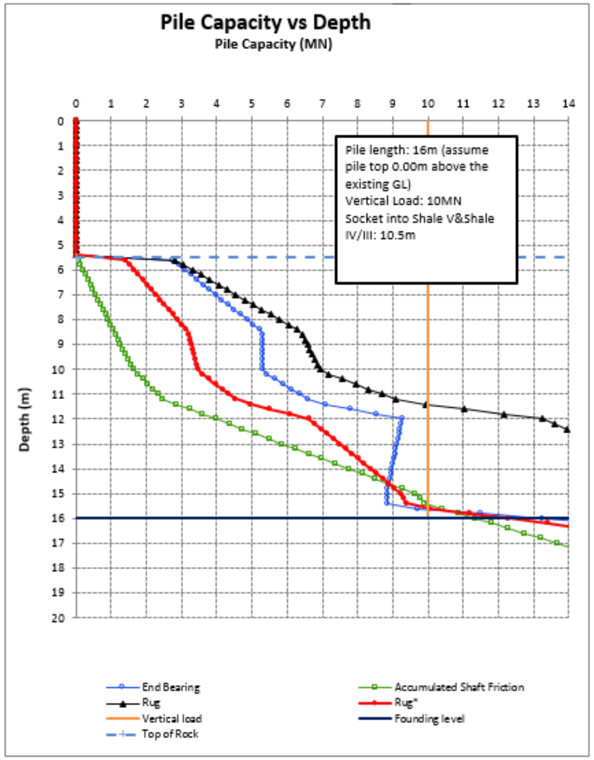


Figure J-1– Assessed pile axial capacity displacements under ULS for Piles at Pier 1

ATTACHMENT J-2 - PILE AXIAL CAPACITY RESULTS

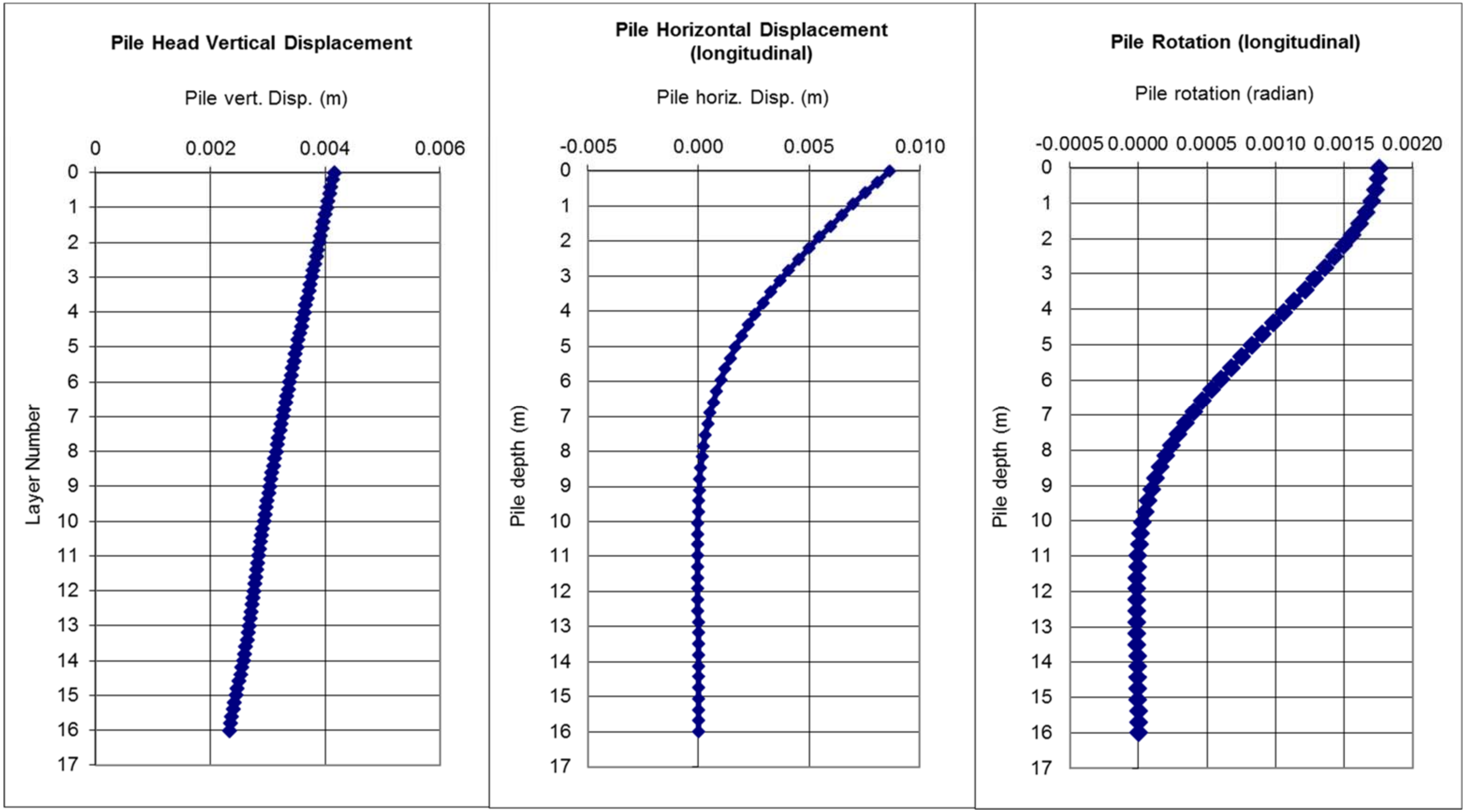


Figure J-3– Assessed lateral and vertical pile displacements under SLS for Piles at Abutment B

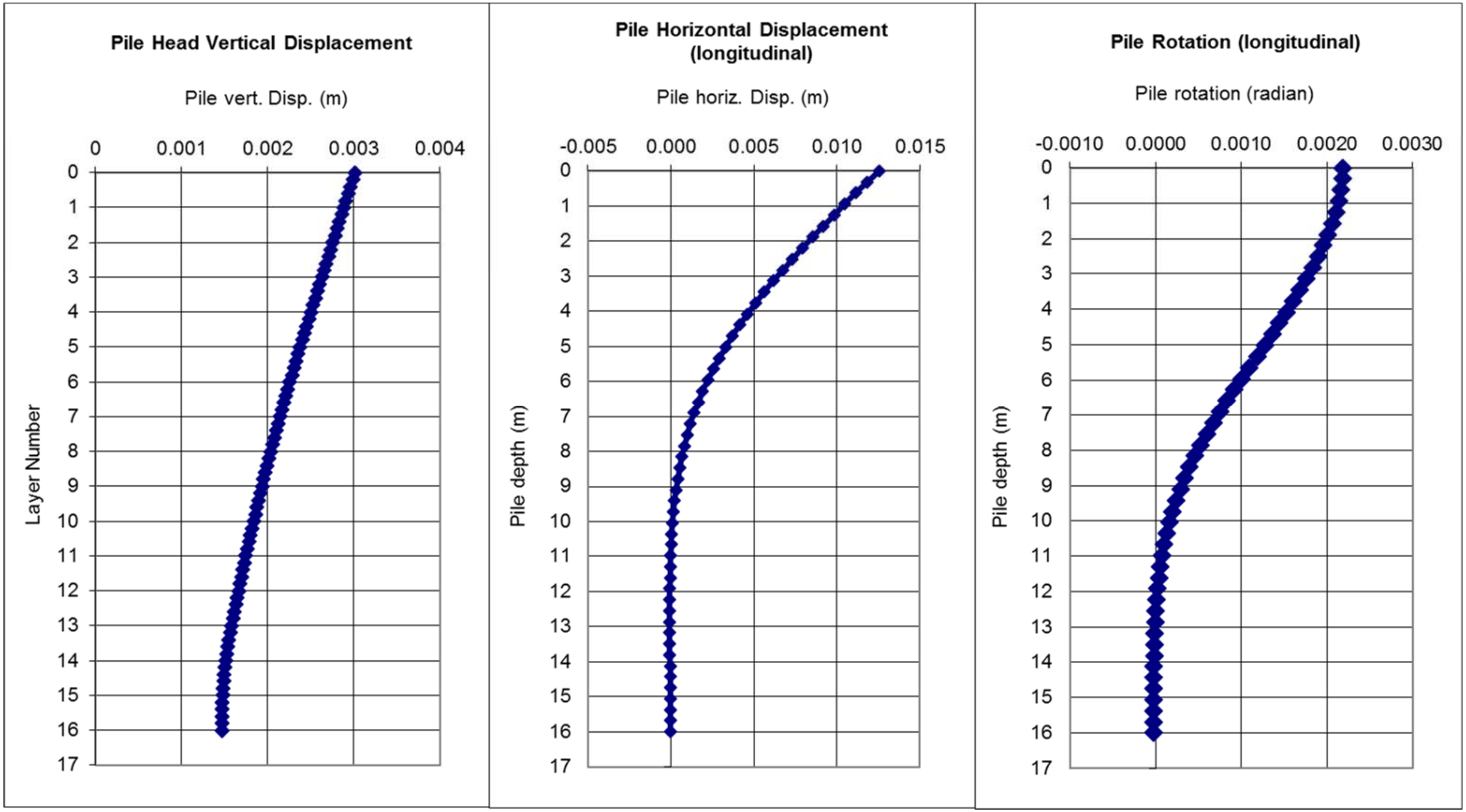


Figure J-4– Assessed lateral and vertical pile displacements under SLS for Piles at Pier 1

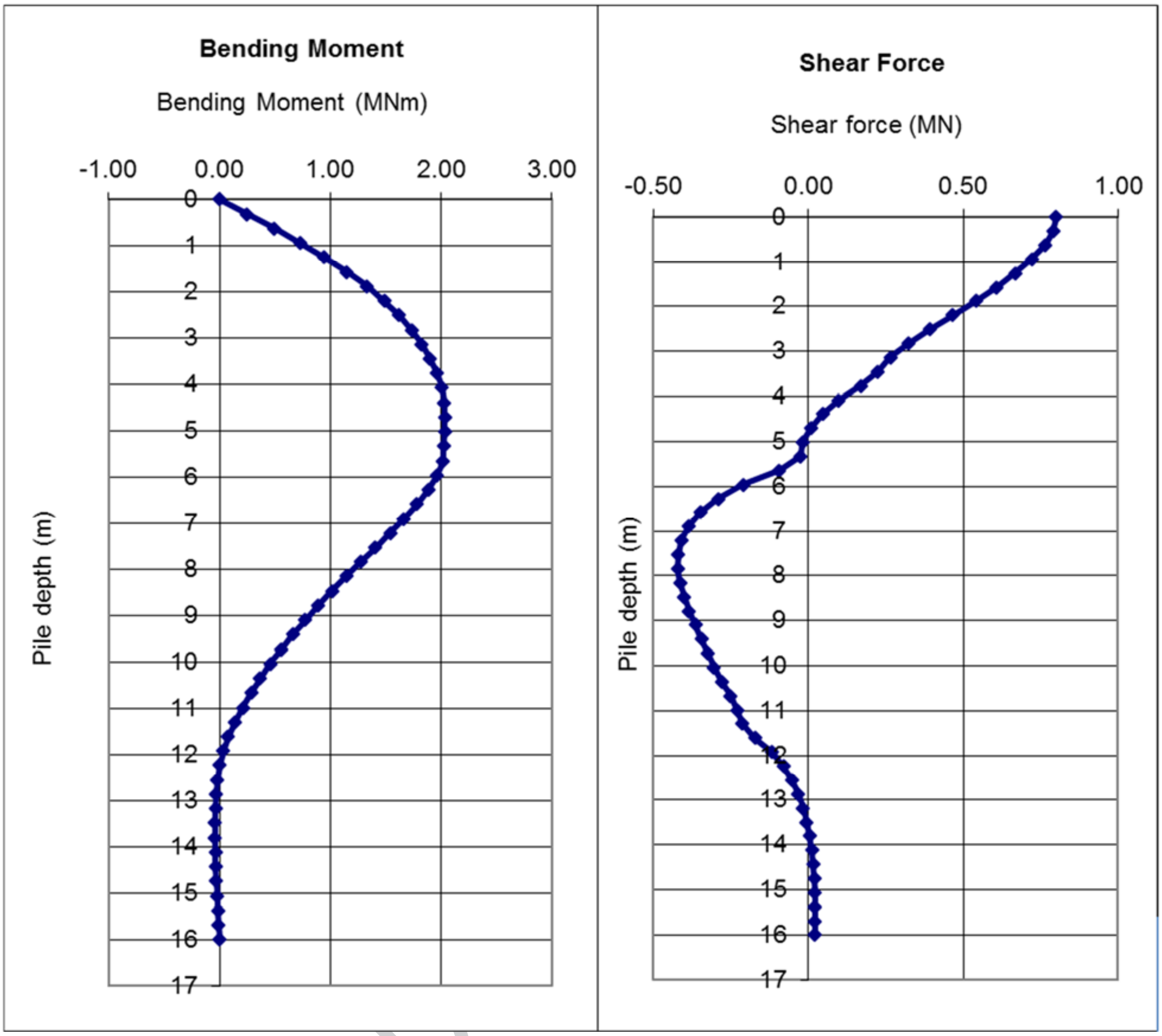


Figure J-5– Assessed lateral bending moment and shear force under ULS for Piles at Abutment B, Φ_g = 0.5

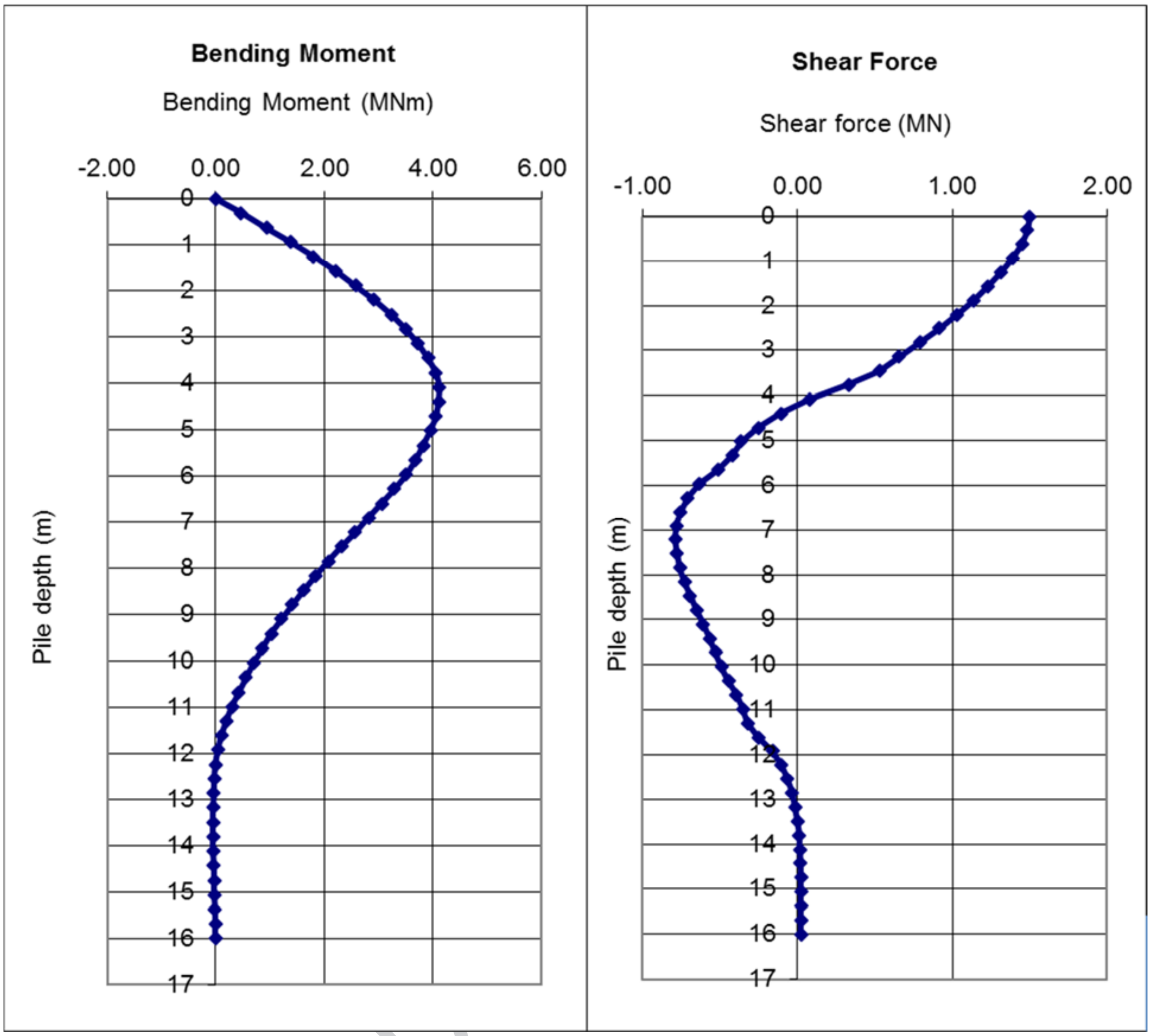


Figure J-6– Assessed lateral bending moment and shear force under ULS for Piles at Abutment B, $\Phi_g = 0.7$

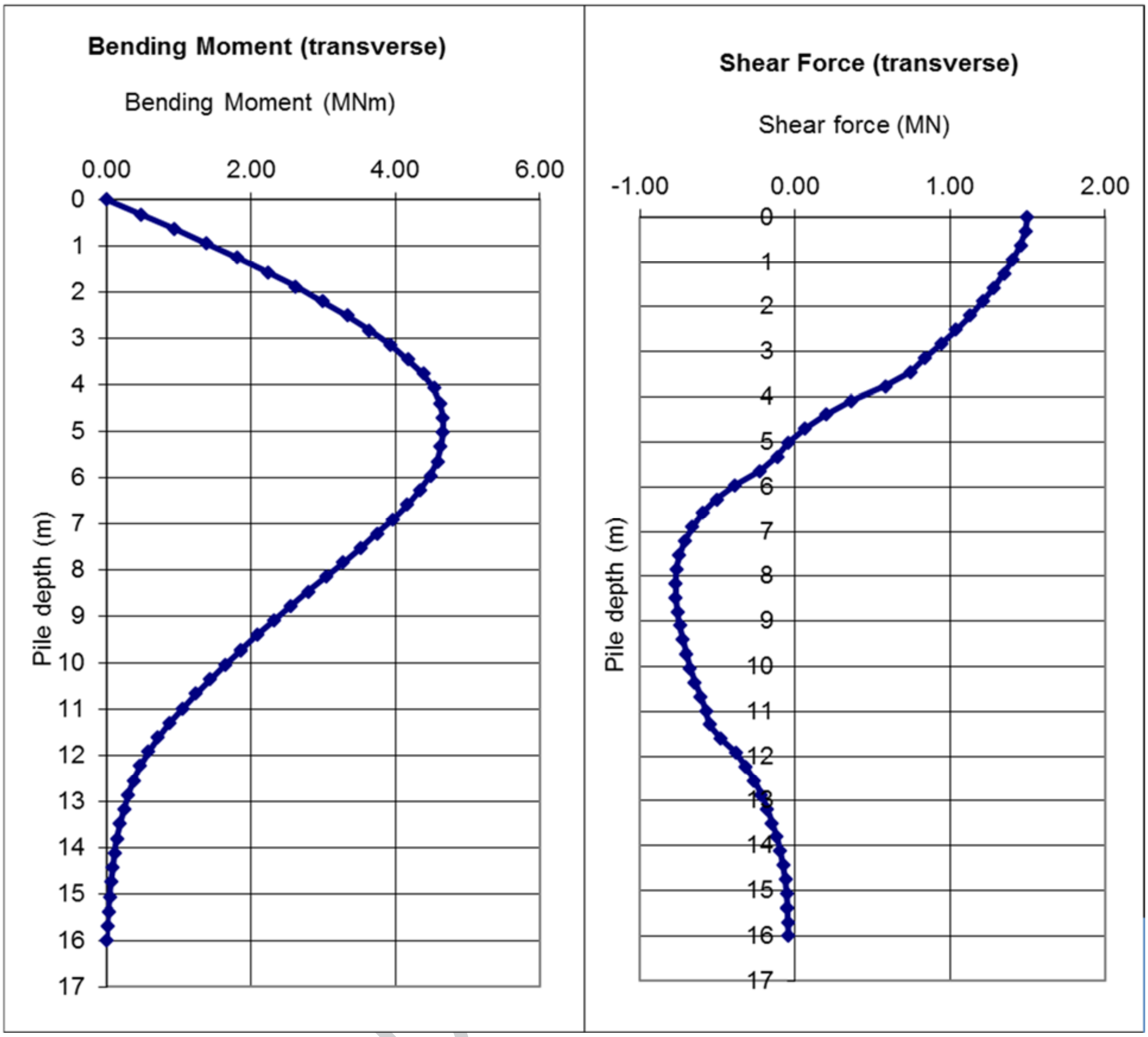


Figure J-7– Assessed lateral bending moment and shear force under ULS for Piles at Pier 1, Φ_g = 0.5

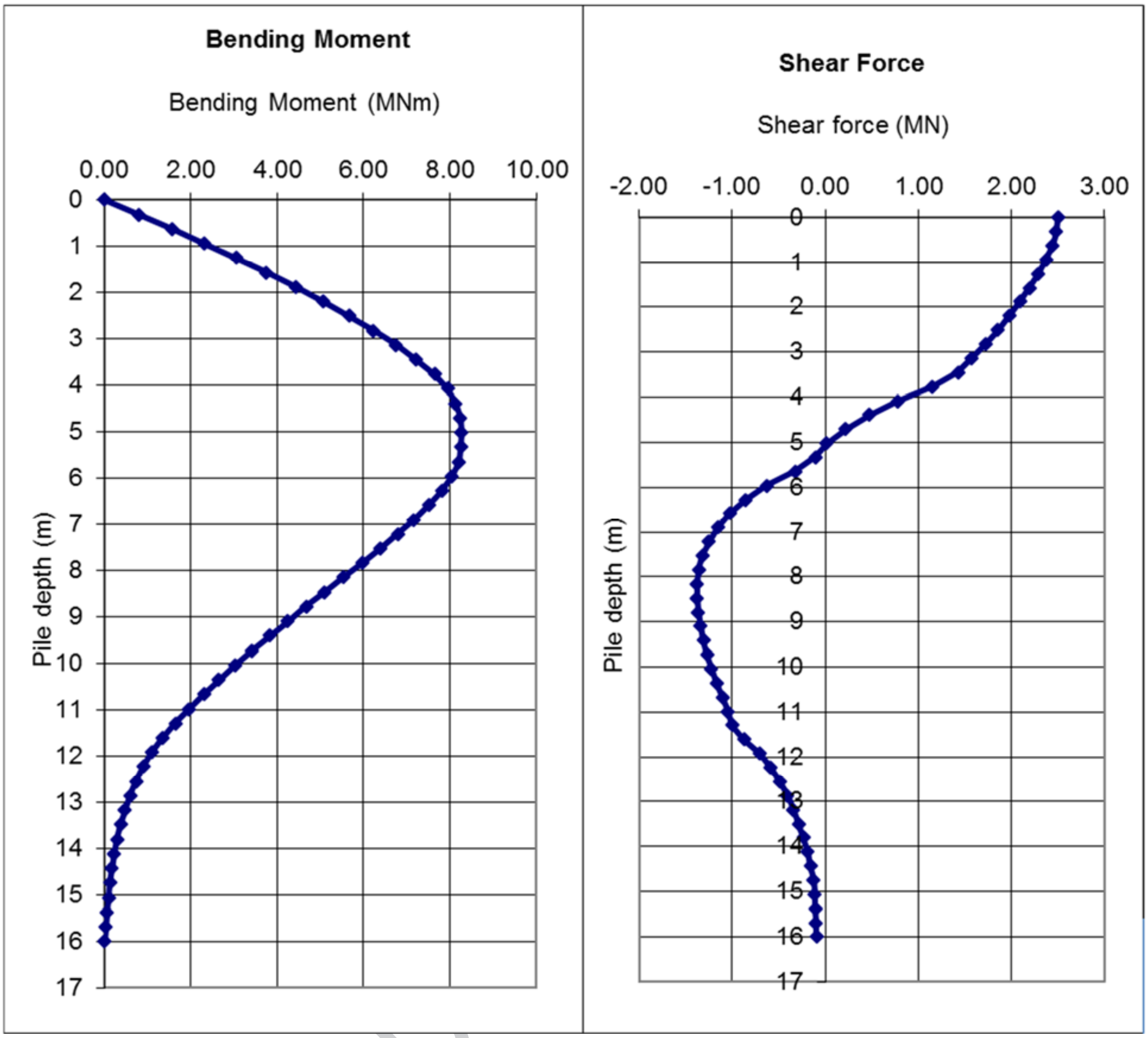


Figure J-8– Assessed lateral bending moment and shear force under ULS for Piles at Pier 1, $\Phi_g = 0.7$

Appendix K – Specifications

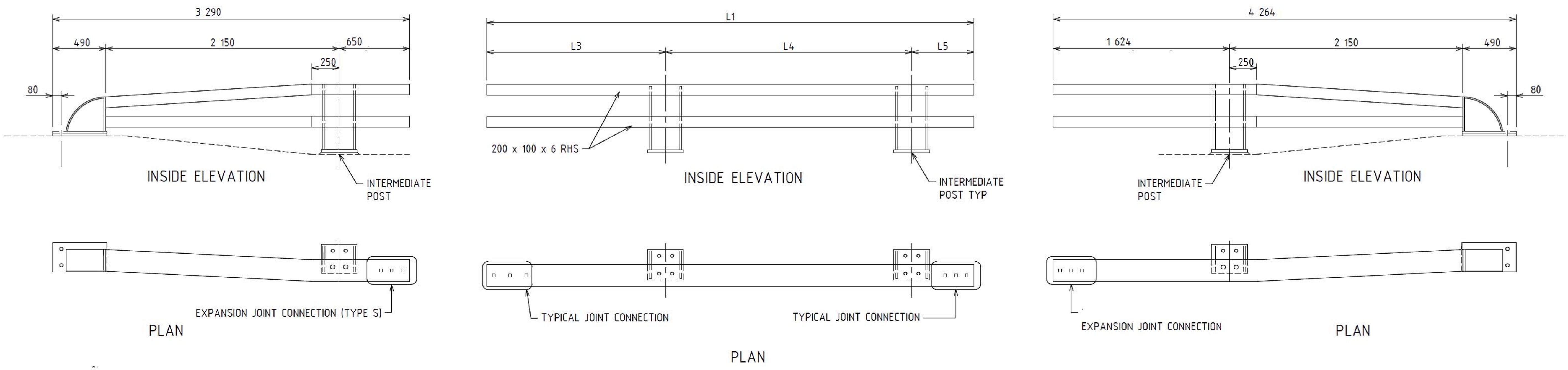
This Appendix will be updated in future versions of this report to contain a list of the specifications relevant to the project.

Appendix L – Indicative details for pricing

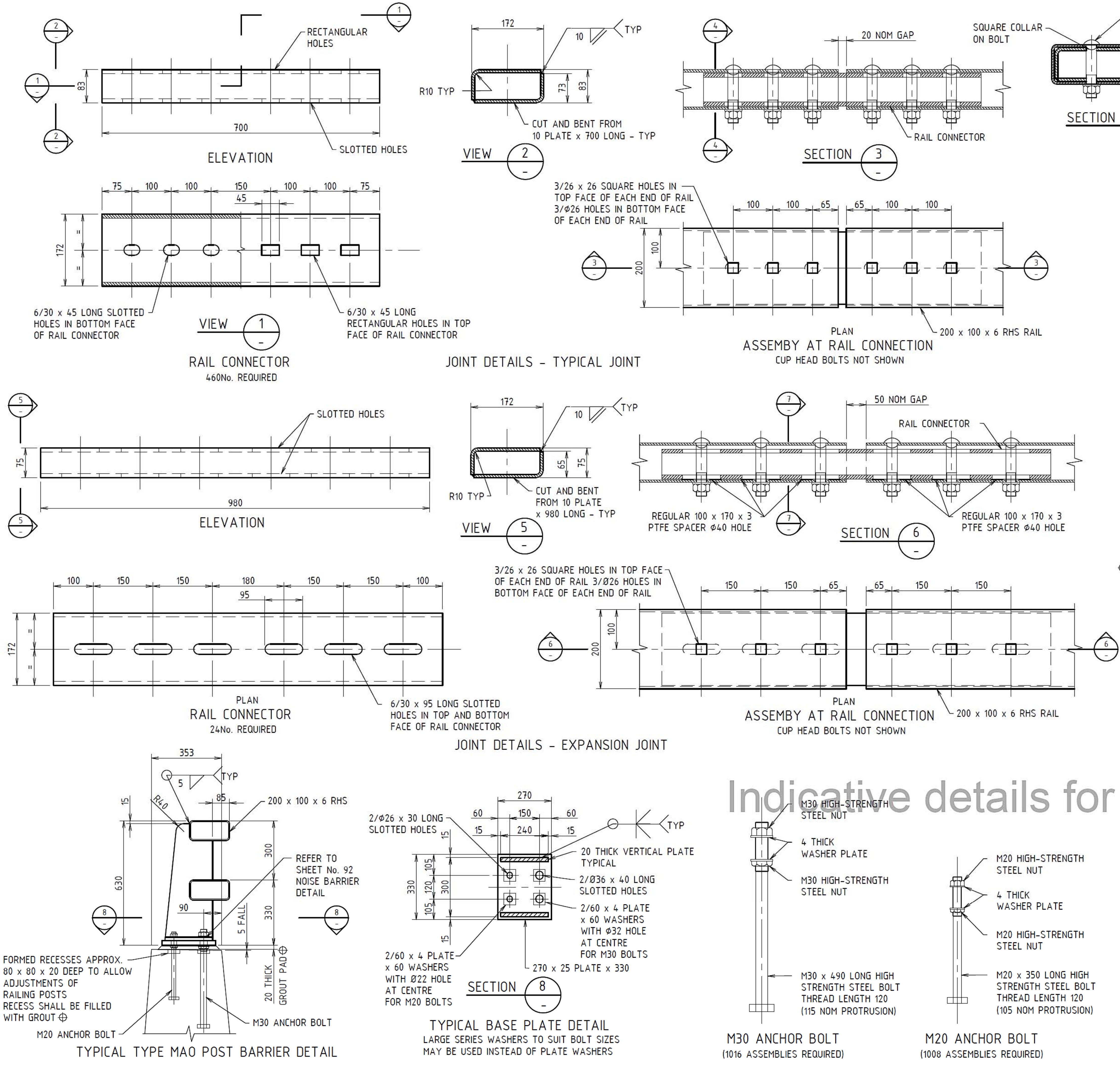
Appendix K – Specifications

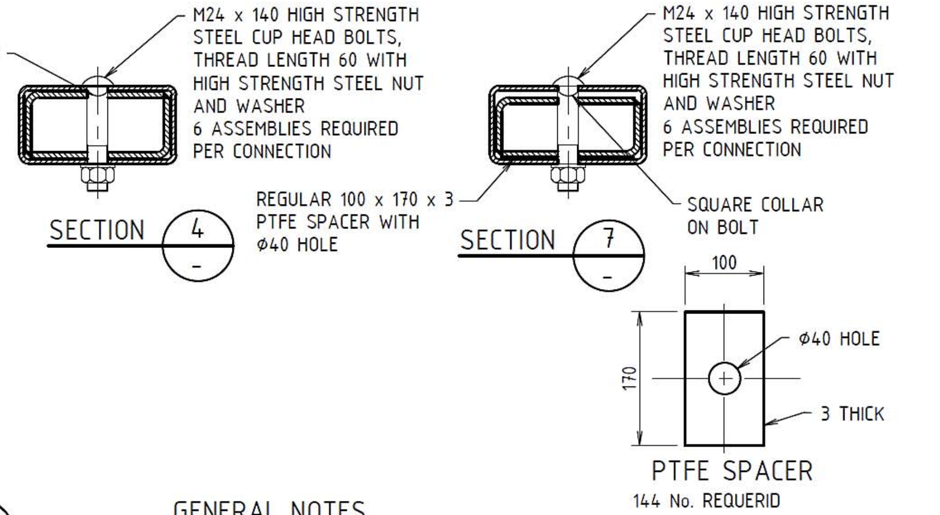
This Appendix will be updated in future versions of this report to contain a list of the specifications relevant to the project.

Appendix L – Indicative details for pricing



Indicative details for preliminary pricing barriers

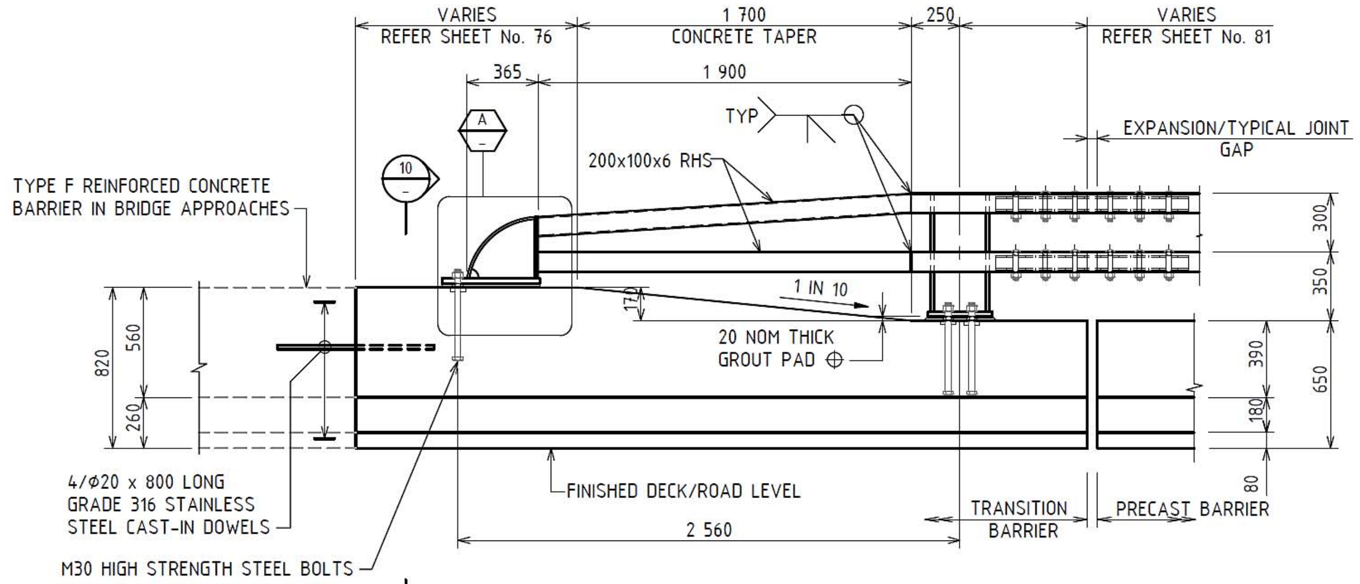




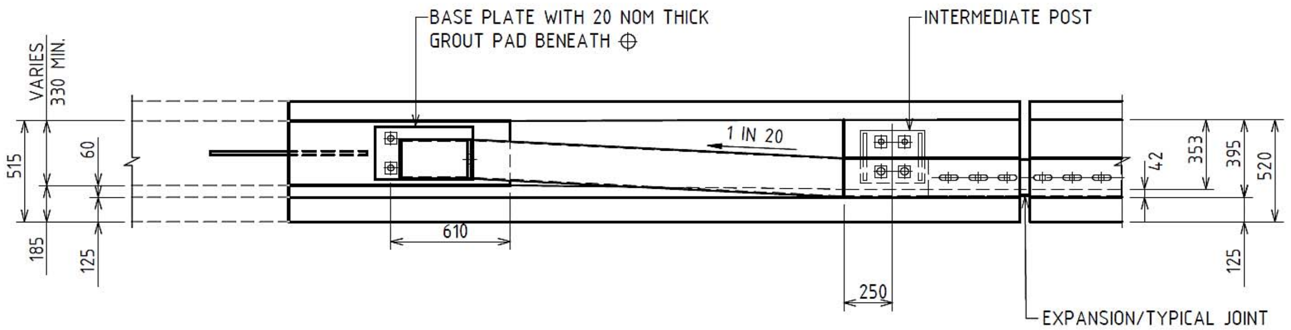
GENERAL NOTES

SCALE 0 100 200 300mm OR AS SHOWN

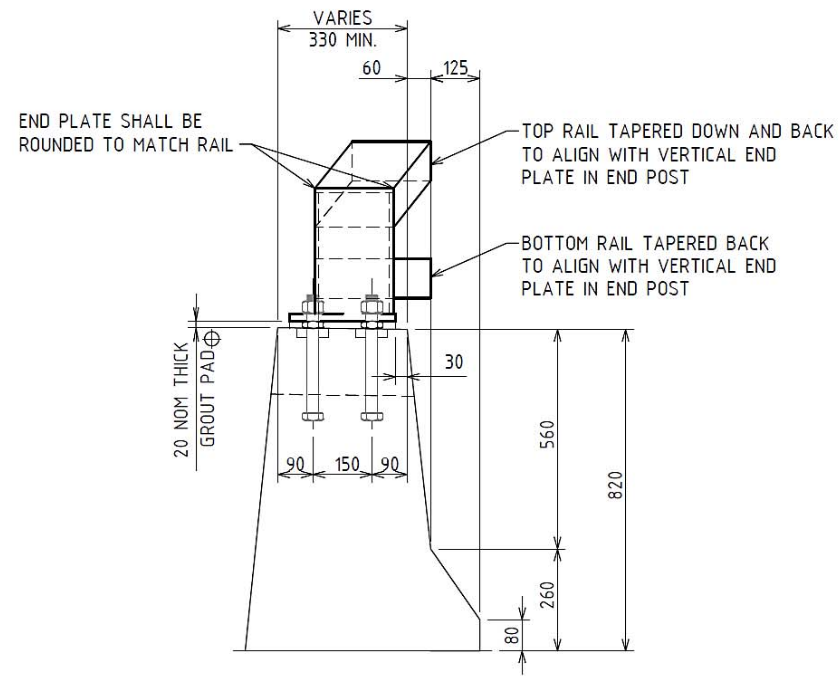
STEEL PLATE SHALL CONFORM TO AS/NZS 3678-250.
RECTANGULAR HOLLOW SECTIONS SHALL CONFORM TO AS 1163-C350L0.
ALL FASTENERS MUST CONFORM TO THE REQUIREMENTS OF ROADS AND MARITIME SERVICES QA SPECIFICATION B240.
DIMENSIONS AND SHAPE FOR CUP HEAD BOLTS SHALL BE IN ACCORDANCE WITH AS/NZS 1390. HEAD CUP BOLTS SHALL BE 8.8/S WITH MATERIAL AND MECHANICAL PROPERTIES IN ACCORDANCE WITH AS/NZS 15
HIGH STRENGTH STEEL BOLTS FOR STRUCTURAL ENGINEERING SHALL BE PROPERTY CLASS 8.8 TO AS/NZS 1252.
HIGH STRENGTH STEEL NUTS FOR STRUCTURAL BOLTING SHALL BE PROPERTY CLASS 8 TO AS/NZS 1252.
BOLTING CATEGORY FOR HIGH STRENGTH STEEL BOLTS SHALL BE 8.8/S IN ACCORDANCE WITH AS 5100.6.
STEEL WASHERS, LARGE SERIES, SHALL CONFORM TO AS 1237.1, PRODUCT GRADE A.
BOLTS, NUTS AND WASHERS SHALL BE HOT-DIP GALVANIZED IN ACCORDANCE WITH AS 1214.
ALL STEEL COMPONENTS SHALL BE HOT-DIP GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH ROADS AND MARITIME SERVICES SPECIFICATION B241.
THE WELD CATEGORY SHALL BE SP IN ACCORDANCE WITH AS/NZS 1554.1.
ALL WELDING SHALL CONFORM TO AS/NZS 1554.1 WITH ADDITIONAL REQUIREMENTS AS GIVEN IN ROADS AND MARITIME SERVICES SPECIFICATION B204.
WELDING SYMBOLS COMPLY WITH AS 1101.3.
⊕ DENOTES THE GROUT USED TO CONSTRUCT GROUT PADS AND FILL FORMED RECESSES SHALL BE SHRINKAGE COMPENSATED HIGH FLOW CEMENTITIOUS GROUT.
THE MINIMUM COMPRESSIVE STRENGTH OF THE GROUT SHALL BE 40MPa.
GROUTING SHALL BE CARRIED OUT TO ENSURE THAT THE FORMED RECESSES ARE COMPLETELY FILLED AND THAT THERE ARE NO VOIDS UNDERNEATH THE BASE PLATES.
SIDE FACES OF GROUT PADS SHALL BE VERTICAL AND FLUSH WITH THE EDGES OF BASE PLATES.
THE FORMWORK FOR GROUT PADS SHALL REMAIN IN PLACE FOR A MINIMUM OF 3 DAYS AND CURING COMPOUNDS APPLIED TO THE SIDE FACES OF THE GROUT AFTER THE REMOVAL OF FORMWORK.
THE UNDERSIDE OF BASE PLATES AND SIDE FACES OF THE SLOTTED HOLES IN BASE PLATES SHALL BE PAINTED WITH TWO PACK SURFACE TOLERANT EPOXY PAINT WITH A MINIMUM DRY FILM THICKNESS OF 100μm.
PTFE SPACER SHALL BE 100% VIRGIN POLYTETRAFLUOROETHYLENE CONFORMING TO ISO 13000-1 GRADE 1 AND SHALL BE UNFILLED, NOT LUBRICATED AND NOT DIMPLED.
SEAM WELD INSIDE RHS TO BE GROUND OFF FOR 250mm MINIMUM FROM END OF RAIL.
CONNECTORS TO BE TRIAL FITTED BEFORE GALVANIZING TO ENSURE LOOSE FIT.
THE LONGITUDINAL SEAM IN RHS MEMBERS SHALL BE ON THE UNDERSIDE OF THE RAILS.



ELEVATION

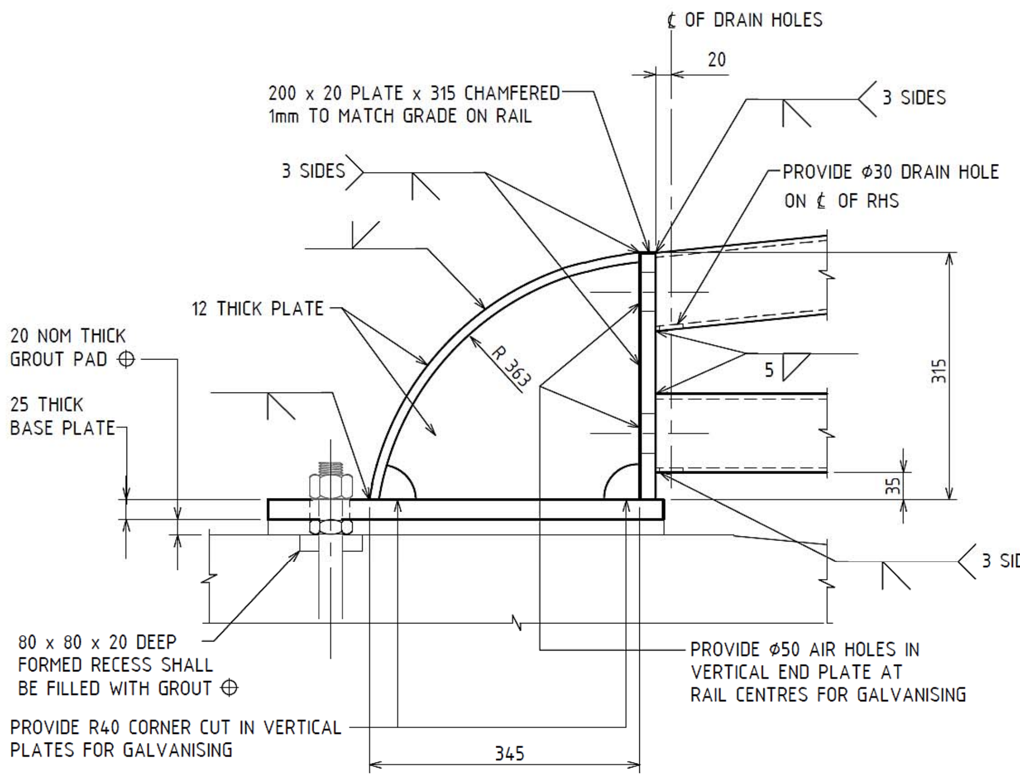


PLAN
BARRIER TYPE MAO
SIZE 30 LARGE SERIES WASHERS MAY BE
USED INSTEAD OF PLATE WASHERS

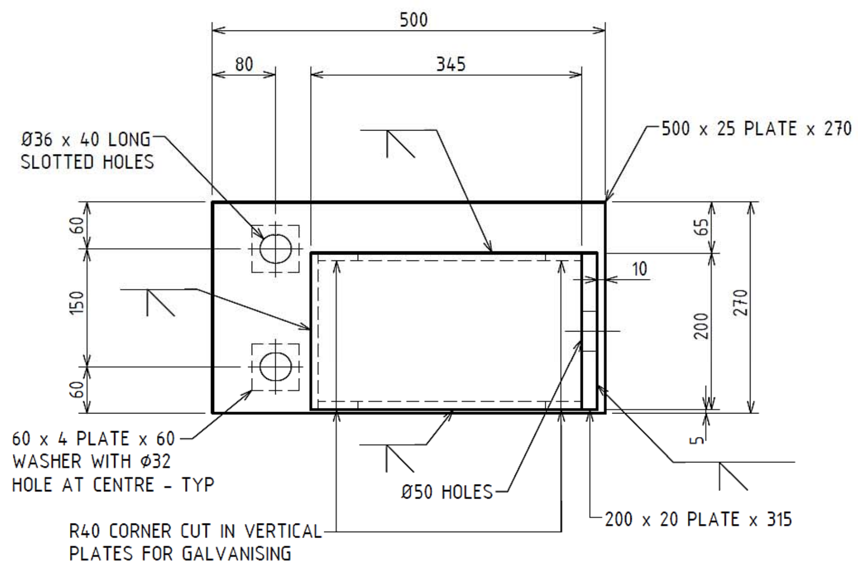


SECTION 10

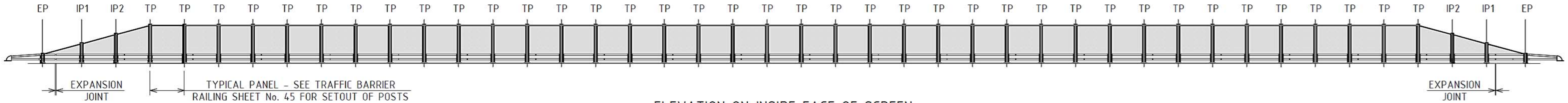
Indicative details for preliminary pricing barriers



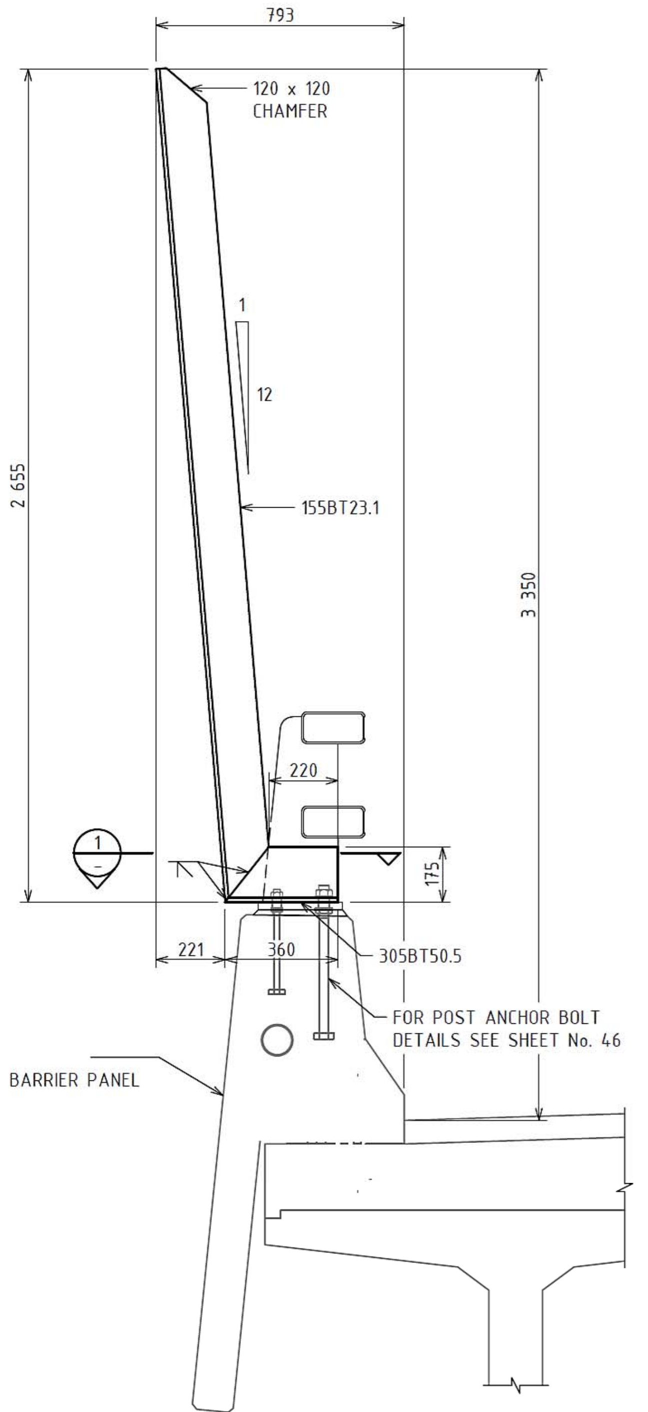
DETAIL A



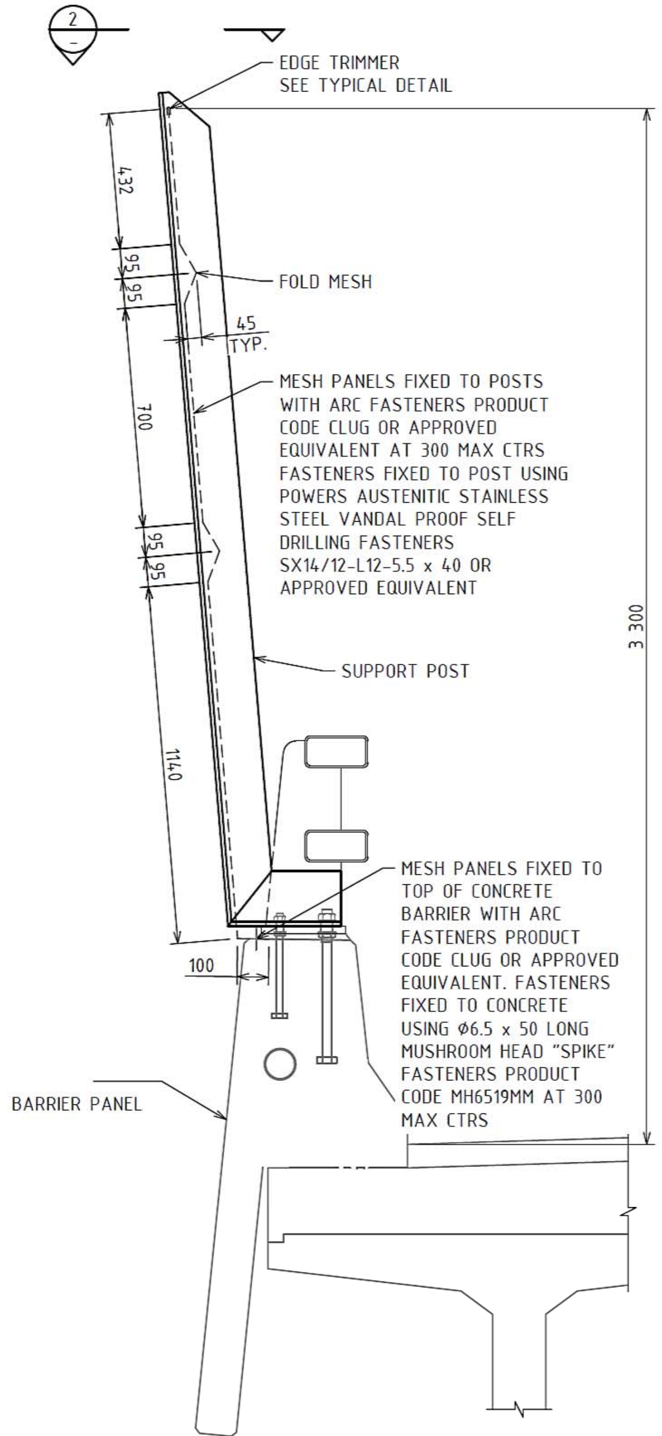
PLAN
END POST ASSEMBLY



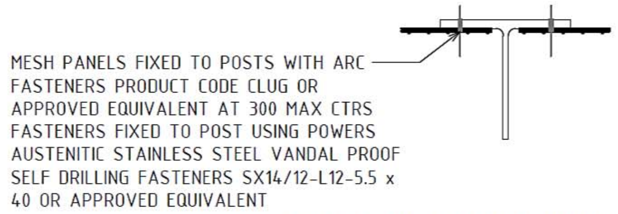
ELEVATION ON INSIDE FACE OF SCREEN



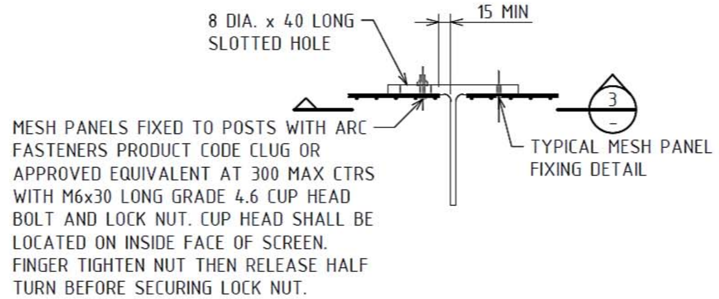
SAFETY SCREEN TYPICAL POST



TYPICAL MESH FIXING DETAIL

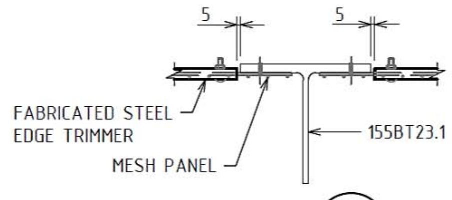


TYPICAL MESH PANEL FIXING DETAIL

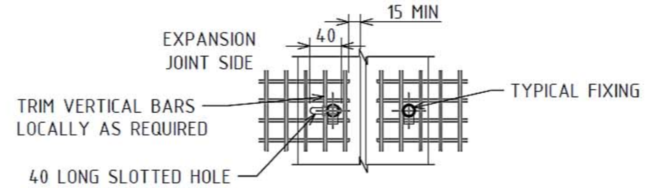


MESH PANEL FIXING DETAIL AT EXPANSION JOINT

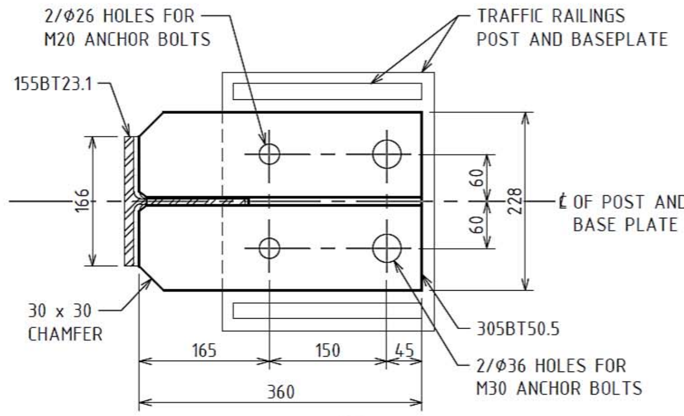
(AT END POST AND INTERMEDIATE POST TYPE 1)



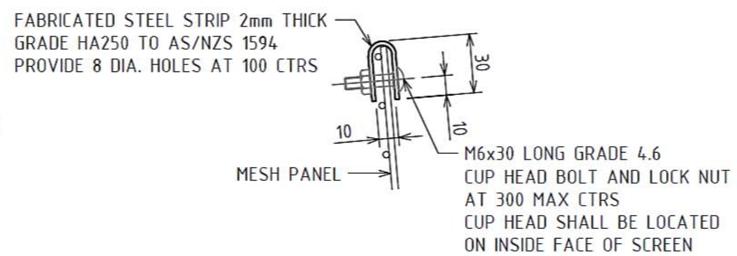
VIEW 2



VIEW 3



SECTION 1



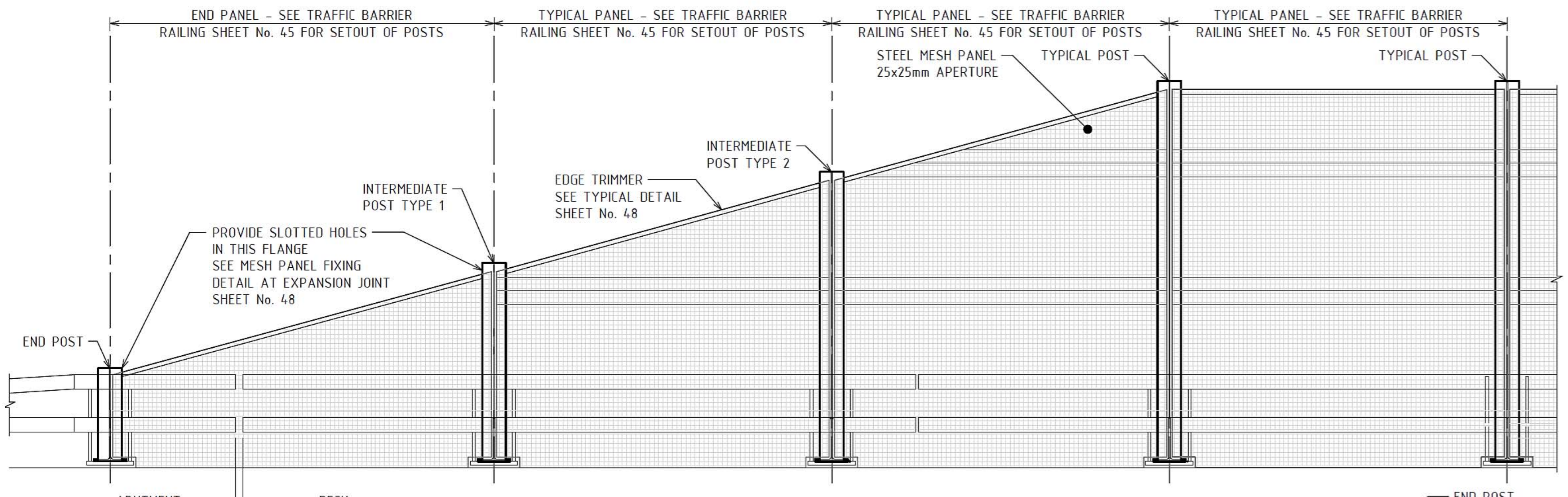
TYPICAL EDGE TRIMMER DETAIL

GENERAL NOTES

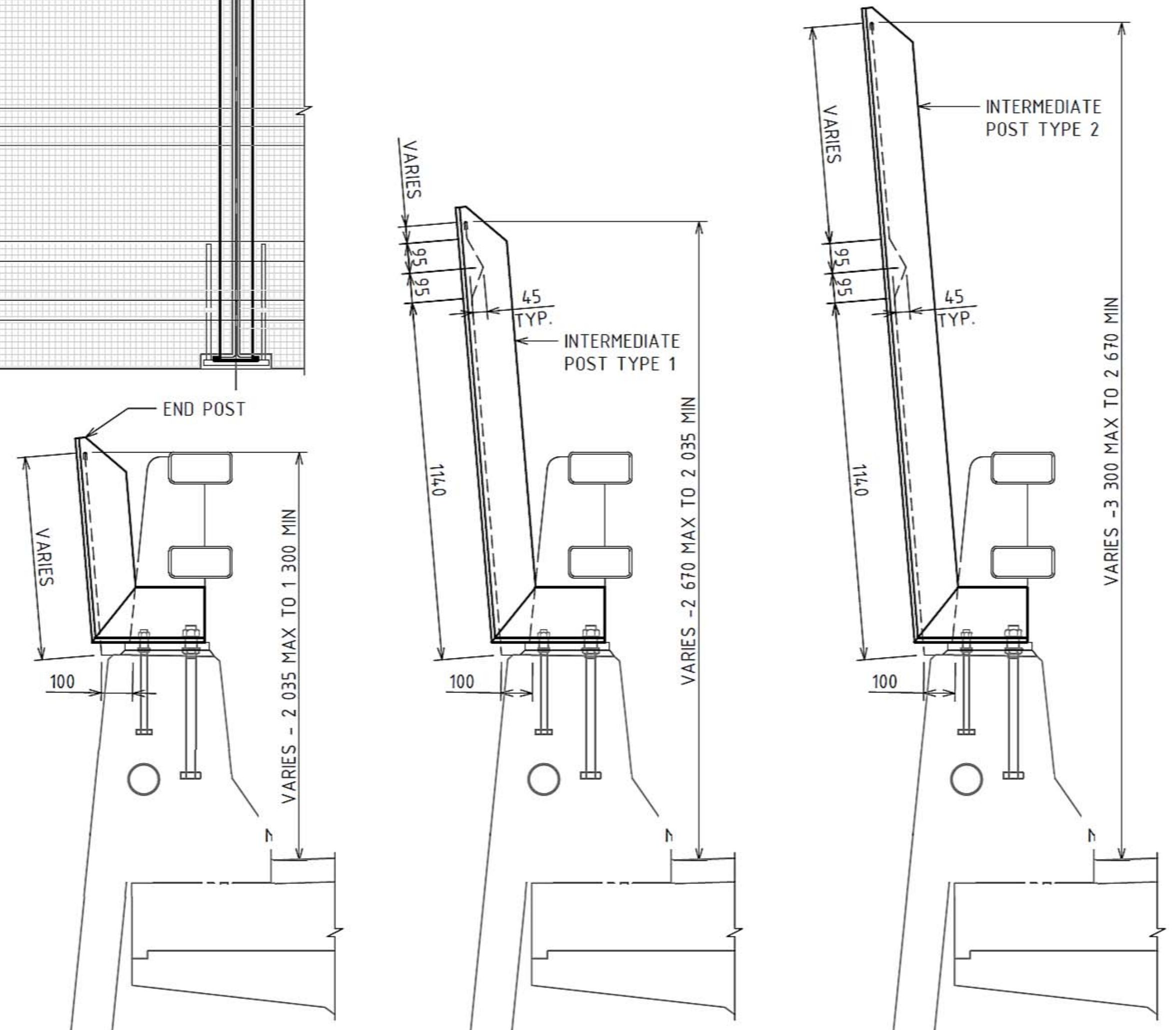
STEEL TEE SECTIONS SHALL BE GRADE 300 TO AS/NZS 3679.1
MESH PANELS SHALL BE 25 x 25 x 3.15 WELDED WIRE MESH AND SHALL CONFORM TO AS 2423
MESH SHALL BE ALIGNED WITH LONGITUDINAL WIRES SET TO THE GRADE OF THE BRIDGE.
SAFETY SCREEN POSTS SHALL BE ALIGNED PERPENDICULAR TO THE PRECAST BARRIERS.
BOLTING CATEGORY SHALL BE 8.8/S IN ACCORDANCE WITH AS 4100
THE WELD CATEGORY SHALL BE SP IN ACCORDANCE WITH AS/NZS 1554.1
ALL WELDING SHALL CONFORM TO THE REQUIREMENTS OF AS/NZS1554.1 WITH ADDITIONAL REQUIREMENTS AS GIVEN IN ROADS AND MARITIME SERVICES SPECIFICATION B204
WELDING SYMBOLS COMPLY WITH AS1101.3
ALL EXPOSED BUTT WELDS SHALL BE GROUND FLUSH.
ALL STEEL COMPONENTS TO BE PROTECTIVE TREATED SHALL BE ROUNDED TO A RADIUS OF 1.5mm UNLESS SPECIFIED OTHERWISE.
ALL STEEL COMPONENTS SHALL BE HOT DIP GALVANISED AFTER FABRICATION IN ACCORDANCE WITH ROADS AND MARITIME SERVICES SPECIFICATION B241
BOLTS, NUT AND WASHERS SHALL BE HOT DIP GALVANISED IN ACCORDANCE WITH AS 1214
NUTS SHALL BE TAPPED TO SUIT GALVANISED THREADS AND OILED FOR PROTECTION.

anti throw screens

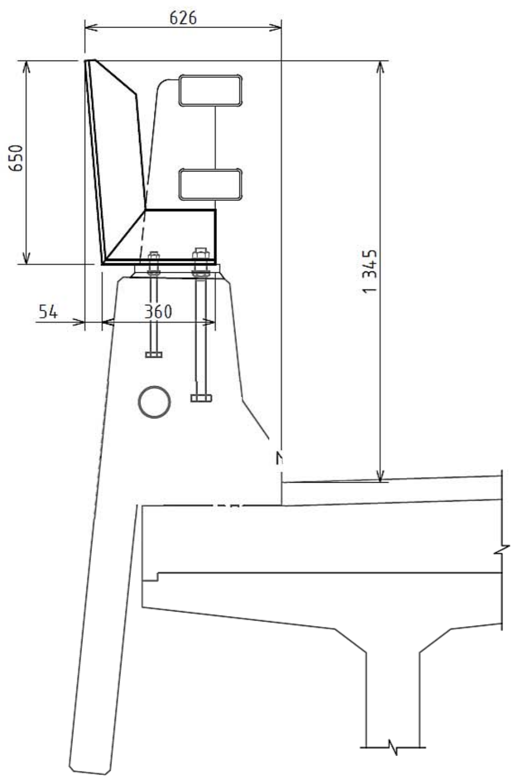
Indicative details for preliminary pricing



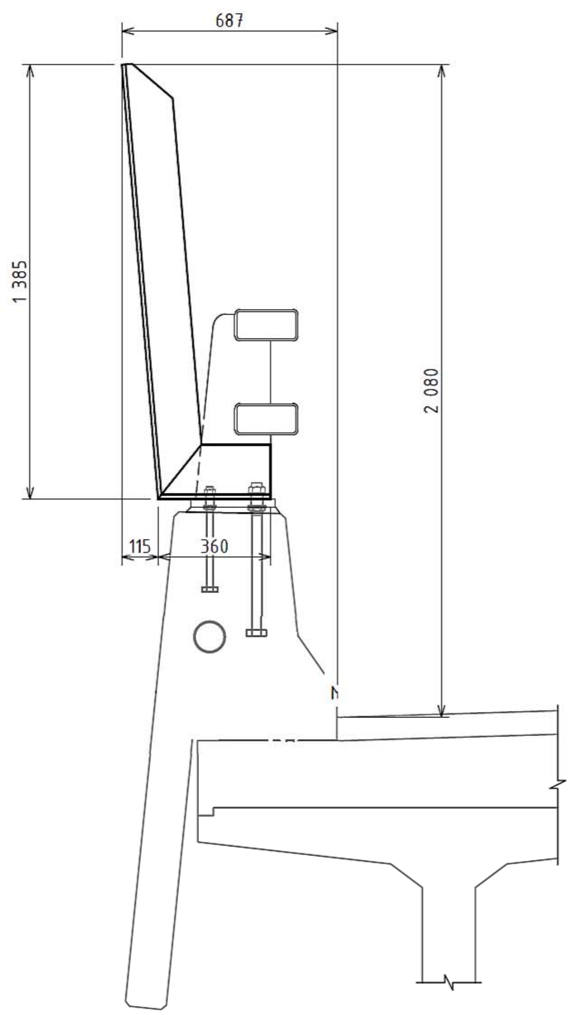
ELEVATION ON INSIDE FACE OF SCREEN
AT END OF BRIDGE



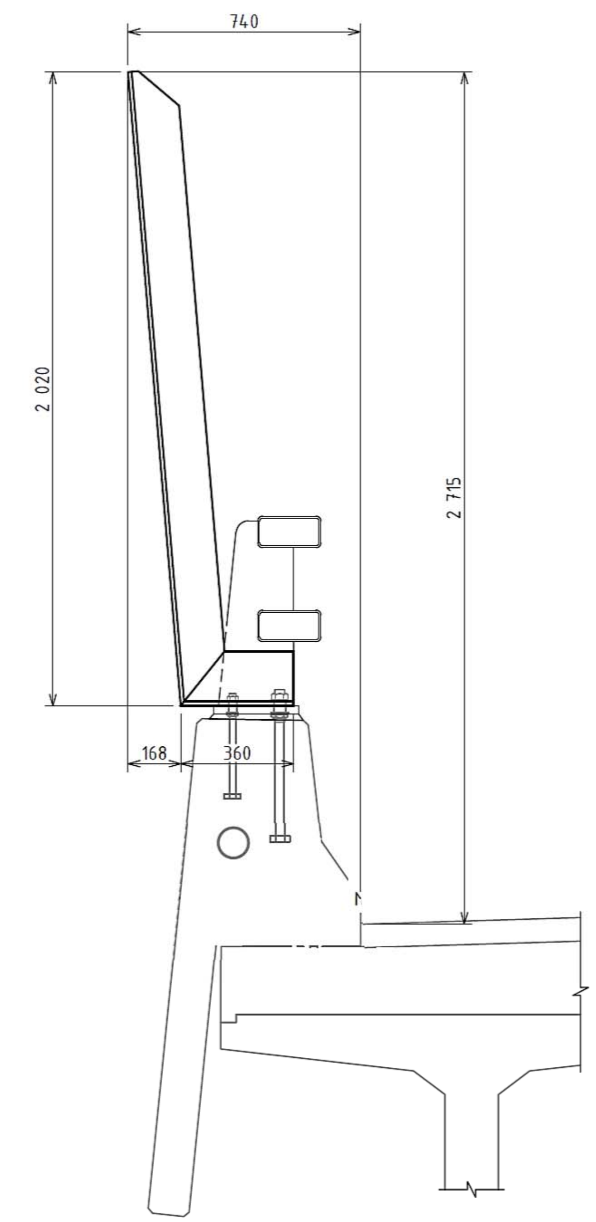
MESH FIXING DETAILS



SAFETY SCREEN END POST (EP)



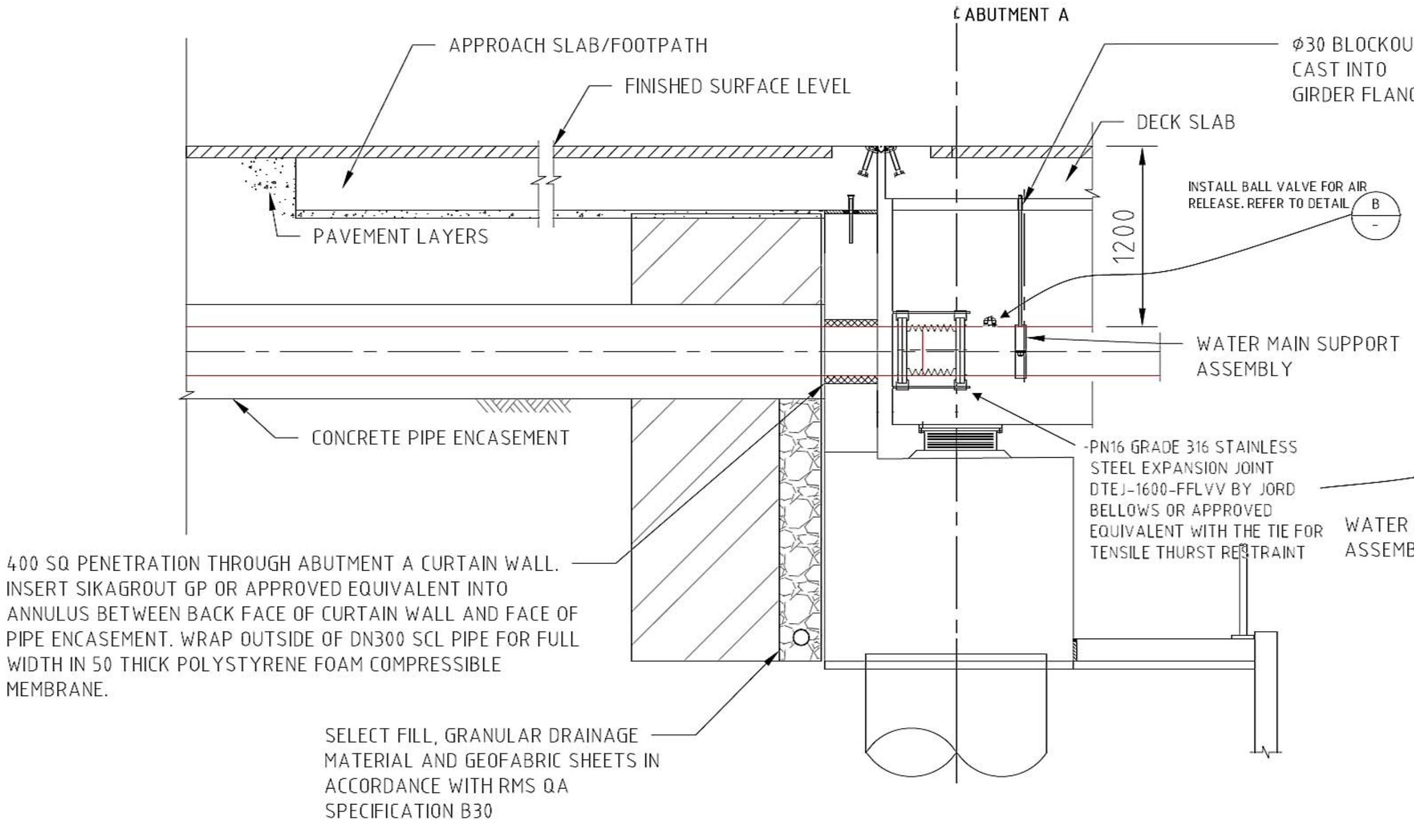
SAFETY SCREEN INTERMEDIATE POST TYPE 1 (IP1)



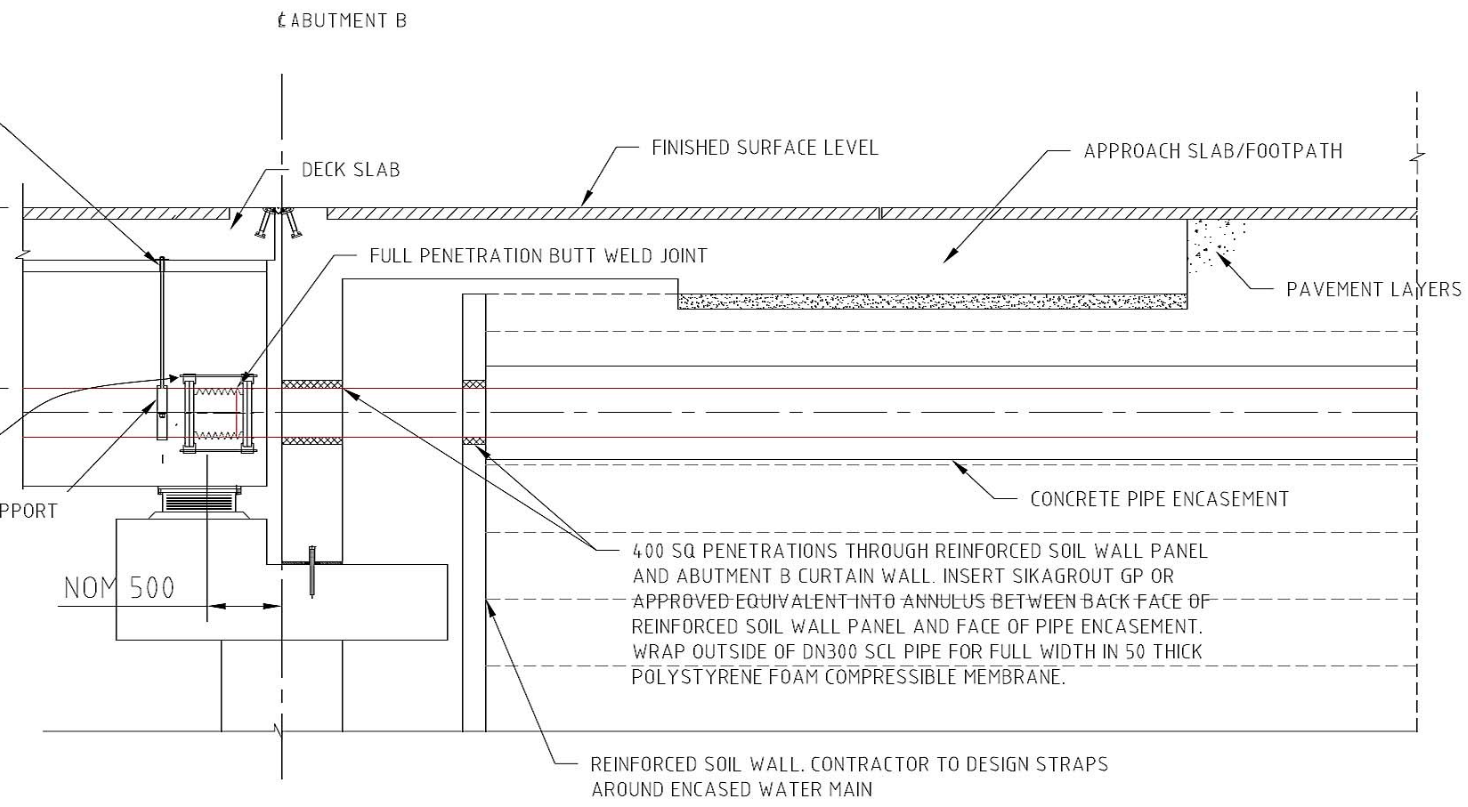
SAFETY SCREEN INTERMEDIATE POST TYPE 2 (IP2)

anti throw screens

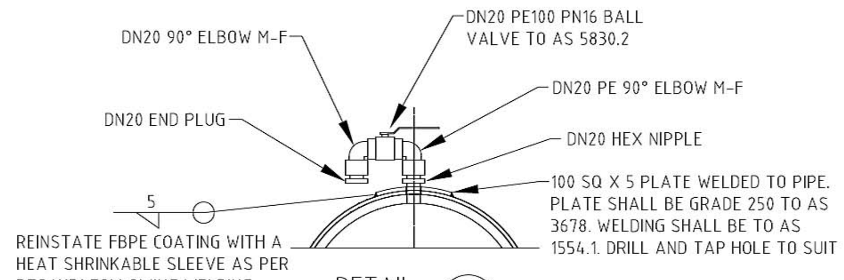
Indicative details for preliminary pricing



WATER MAIN DETAIL THROUGH ABUTMENT A



WATER MAIN DETAIL THROUGH ABUTMENT B



DETAIL B
SCALE 1:10

Indicative details for preliminary pricing water pipe supports

GHD

133 Castlereagh Street
Sydney NSW 2000
T: 61 2 4979 9999 F: 61 2 4979 9988

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Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	Mat Williams	Andres Moreno Lara	**on file*	Kamal Kamalarasa	**on file*	15/06/2018
B	Mat Williams	Andres Moreno Lara	**on file*	Kamal Kamalarasa	**on file*	20/07/2018

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