Appendix B

Water quality and geomorphology assessment (Cardno)

Cardno
Shaping the Future

Macquarie River to Orange Pipeline Proposed Project Refinements – MR5A

Geomorphology and Water Quality

W4916

Prepared for Orange City Council

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GLOSSARY

AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARI	Average Recurrence Interval
BoM	Bureau of Meteorology
DECC	Department of Environment and Climate Change (now NSW Office of Environment and Heritage)
DoP	Department of Planning
GIS	Geographic Information System
ha	hectare
HEC-RAS model	Hydrologic Engineering Center – River Analysis System software package (1 dimensional hydraulic model)
IFD	Intensity Frequency Duration
km	kilometres
km2	Square kilometres
LGA	Local Government Area
m	metre
m2	Square metres
m3	Cubic metres
m3/s	Cubic metres per second
mAHD	Metres to Australian Height Datum
MHWL	Mean High Water Level
mm	millimetre
m/s	metres per second

MSL	Mean Sea Level
NOW	NSW Office of Water
NSW	New South Wales
XP-RAFTS	XP-RAFTS proprietary software package

1 INTRODUCTION

Improvements to the Macquarie River to Orange pipeline route were proposed during the public exhibition period of the route assessed in Cardno's Geomorphology and Water Use report of July 2012 (Cardno 2012).

This report has been prepared to provide the geomorphology assessment and specific hydrology impacts of the project refinements and how they compare to the impacts previously assessed. It is noted that this report does not include water quality or groundwater assessment for the project refinements as no significant differences are expected to arise from those discussed in the July 2012 report.

The location of MR5a is shown in Figure 2.1 and described below.

1.1 Offtake structure and pump station

The location of the offtake structure is shown in Figure 2.1. The offtake structure (which includes a pump station) would be located on the southern bank at Cobbs Hut Hole.

Access to the site is via an unsealed road. The site is surrounded by the river and sparsely wooded banks. Areas in the vicinity of the site are used informally for recreation purposes. There are no structures or residences in the vicinity of the site. Other than landowners there is no real public access to the site except by river craft.

The nearest residence to the offtake structure is 'Fleming's shed' which is a shearing shed located approximately 1.32 km to the south-east. This property has an informal residential component.

1.2 Pipeline

The pipeline would commence at the offtake point on the bank of the southern bank of the Macquarie River. It would be located within the formation of an existing farm track for a distance of approximately 1,200 metres. This farm track has undergone previous vegetation clearing.

At chainage 1200, the pipeline would leave the farm track and traverse cleared paddocks to chainage 1800. The pipeline would be located within road reserves to chainage 6480 near Long Point Road. From chainage 6480 to the discharge structure, the route is as per the exhibited project.

This section of pipeline is approximately 6.5 km in length.

The width of the construction trench and final easement are as described in sections 6.2.2 and 7.2.2 of the EA.

1.3 Access road

The proposed access road would be located between Long Point Road and Cobs Hut Hole at the Macquarie River. The access road would be approximately 6 m wide and 1421.40m long.

1.4 **Power** supply

Construction of new overhead power supply would be required from approximately chainage 1200 to approximate chainage 4328.274 a further section of underground power would be installed from chainage 00 to 1200. The overhead power line would be installed through open paddocks and broadly parallel Long Point Road avoiding large trees where possible. The underground power has been proposed to minimise the extent of clearing required and will be common trenched with the pipeline.

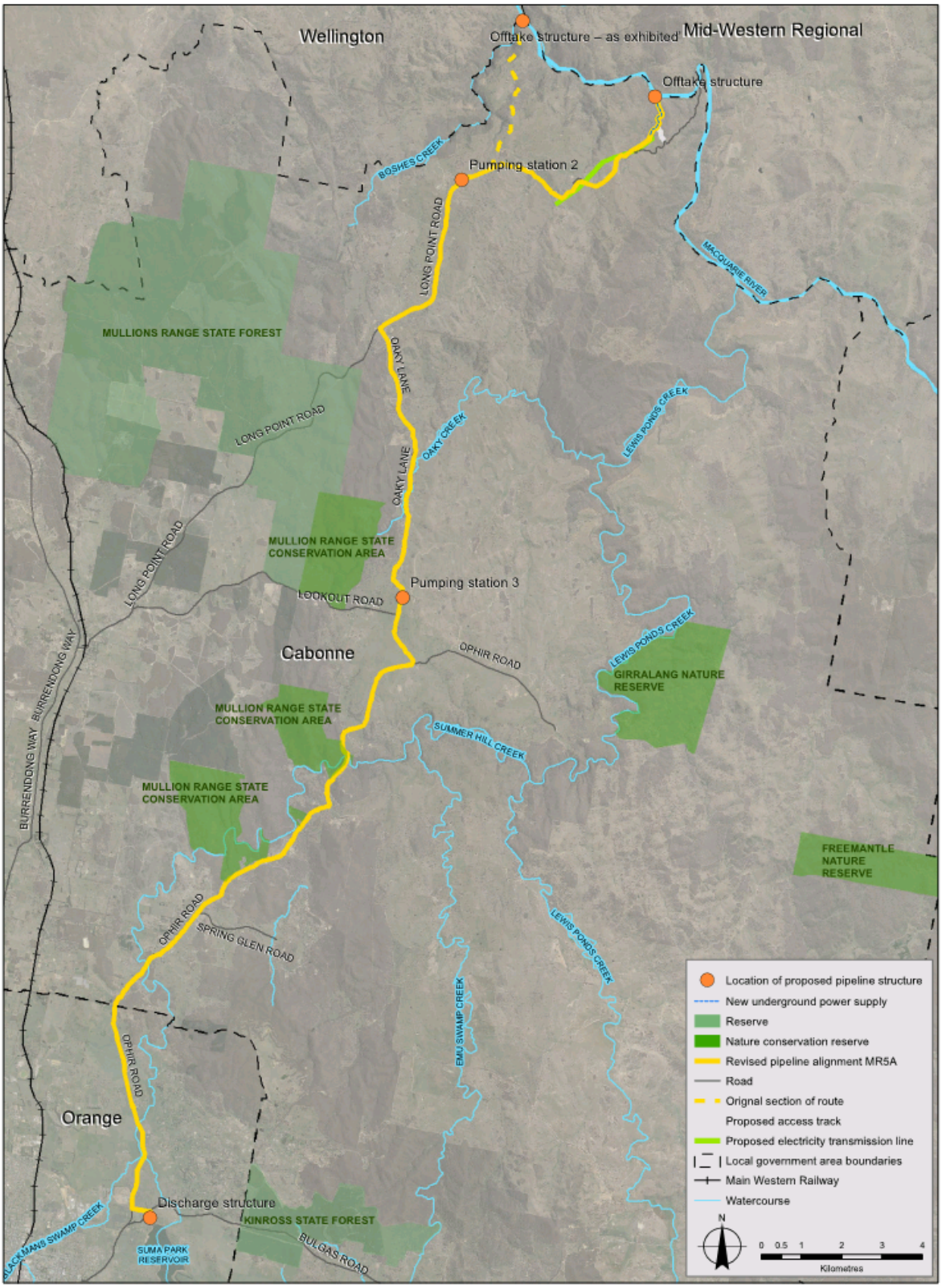

Figure 1-1: Route MR5A location

2 SITE INSPECTION

Cardno undertook a site inspection in October 2012 in order to identify the waterway crossings and their geomorphology along the revised alignment of Route MR5A. Figure 2.1 shows Route MR5A and the major waterway crossings of the new alignment.

There are four stream crossings assessed for Route MR5A and the new Macquarie River offtake point. One of the crossings occurs between the offtake and Long Point Road. Three of the crossings occur along Long Point Road until meeting at previous chainage of approximately 4000. The four stream crossings are in addition to the crossings of the route exhibited (Cardno 2012) because previously there were no significant stream crossings between Long Point Road and the offtake point.

An assessment of the hydrology for each of the waterway crossings is included in Section 4. The detailed topography and geomorphology information about this additional offtake point and four key stream crossings are referred to Section 5.

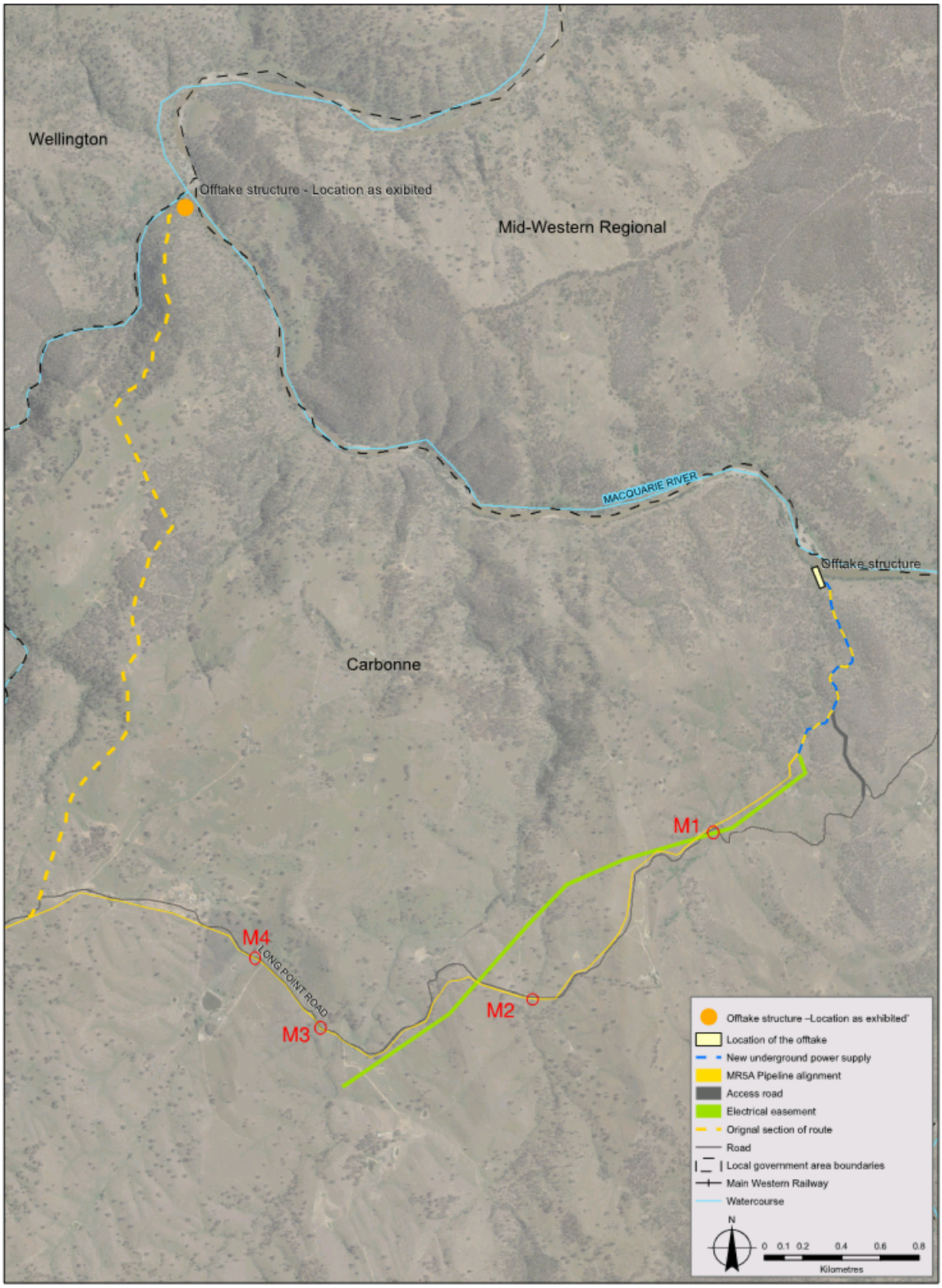

Figure 2-1**: **Route MR5A and the major waterway crossings shown in red circles

3 AVAILABLE DATA

3.1 Proposed Pipeline Design Drawings

GIS data files of the route MR5A were received from Geolyse on 10th October 2012.

3.2 Water Quality Data

No further water quality assessment was undertaken for route MR5A because the offtake point is a relatively short distance upstream and the water quality in Macquarie River is not expected to change.

3.3 River Flow Data

No further assessment was undertaken using river flow data.

3.4 HEC-RAS Model

A HEC RAS model was prepared by Geolyse for Cobbs Hole using river survey undertaken in October 2012. The model was provided to Cardno on 11th April 2012 and is limited to a 260m reach with the offtake location positioned roughly in the centre of that reach. As such the model was prepared for the purpose of flood level estimation and the use of it for estimating flow depths, velocity and the like are reflective of the model in its preliminary form. The model was calibrated using statistical analysis of river flow data using several gauges along the River. Input flows to the model were provided for the 50%, 5%, 1% and 0.5% AEP.

4 HYDROLOGY

The new section of Route MR5A has a length of 6.6km and four key stream crossings (Figure 2.1). The XP-RAFTS model applied in the July 2012 Study was modified to incorporate the additional subcatchments of the waterway crossings of Route MR5A.

4.1 Sub-Catchment Delineation

The study area associated with Route MR5A has a total area of 1,454 hectares, with elevation varied from 810m AHD in the upper reaches of the catchment to 530m AHD in the lower reaches of the catchment.

The study area was divided into 9 sub-catchments based on the topographic features (using 10-metre contour data), the likely flowpaths and the locations of creek crossings. The sub-catchment layout is presented in **Figure 4.1** and the details of these sub-catchments are provided in **Table 4.1**.

Table 4-1: Sub-Catchment Details for Route MR5A

Sub-catchment ID	Area (ha)	Catchment Slope (%)	(%) Impervious	Land Use
C30	137.1	5.1	5	Rural
C31	109.3	4.8	5	Rural
C32	343.7	4.4	5	Rural
C33	120.8	7.6	5	Rural
C34	110.1	6.7	5	Rural
C35	24.4	9.5	5	Rural
C36	200.9	6.1	5	Rural
C37	264.7	4.7	5	Rural
C38	142.7	8.8	5	Rural
Total Area	**1,454**			

Pervious and impervious fractions for each sub-catchment were estimated based on a generic rule reflective of the rural land uses in the study area. The total impervious area is estimated at approximately 73 hectares.

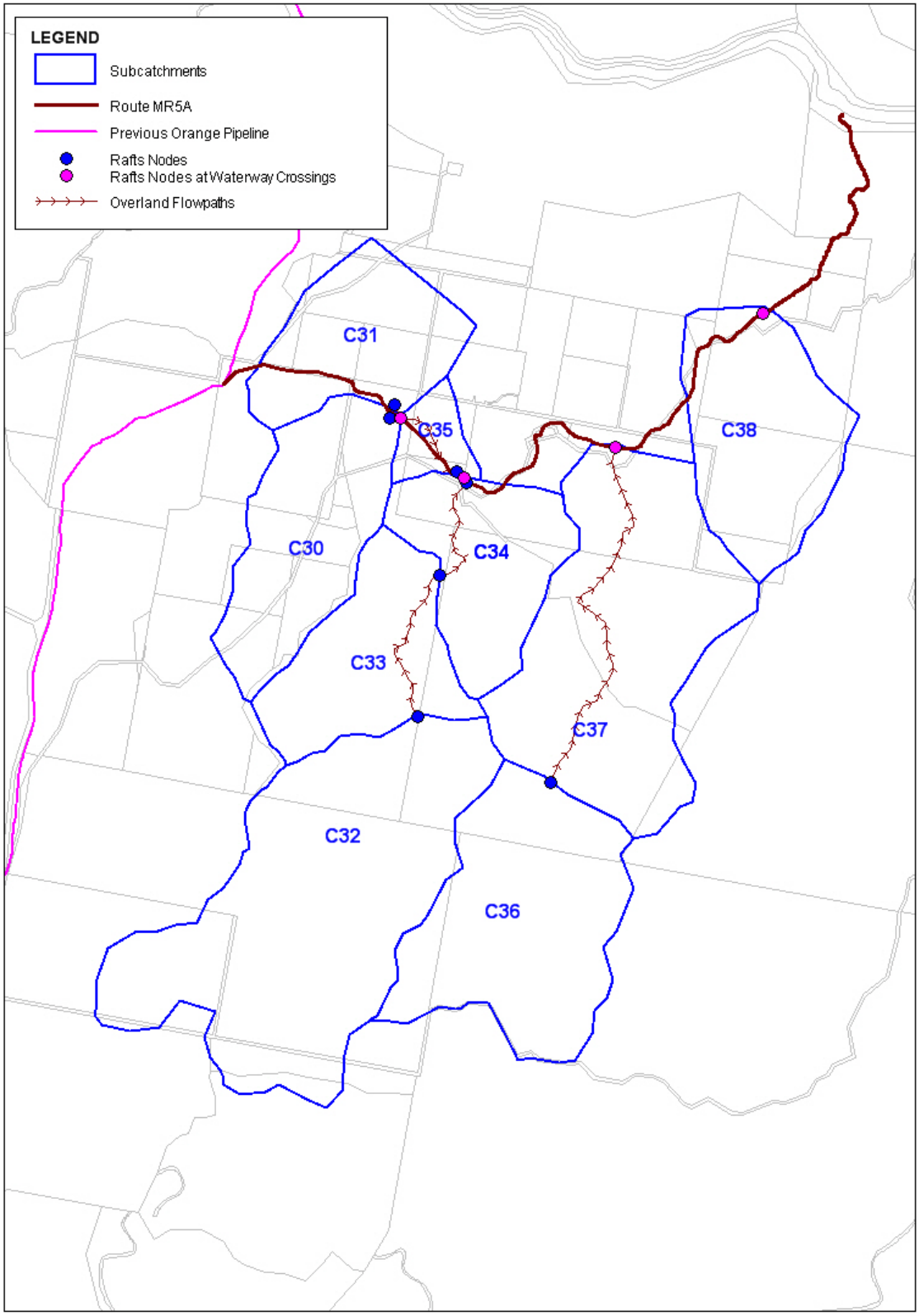

Figure 4-1: Sub-Catchments for Route MR5A

4.2 Sub-catchment and Crossing Descriptions

A general description of each sub-catchment is provided in **Table 4-2**, along with the associated stream or crossing ID that was adopted for the geomorphology assessment.

Table 4-2: Sub-catchment and Crossing Description

Sub-catchment ID (RAFTS)	Crossing/ Stream ID
D10 (C30/C31)	M4
D11 (C34/C35)	M3
C37	M2
C38	M1

4.3 Hydrological Model Parameters

A number of parameters are required in the development of the RAFTS model, including initial and continuing rainfall loss rate, and catchment roughness. Based on the similarity of the new sub-catchments of the new section of the route to those assessed previously the same model parameters were adopted (Cardno 2012).

4.4 RAFTS Connections

The velocities for the hydrograph routing lags were defined for the individual channels in the same manner as that undertaken previously (Cardno 2012).

4.5 Design Rainfall

The design rainfall applied in the July 2012 study was used for the current study.

4.6 Model Results

The RAFTS model results at reference points, whose locations are shown in **Figure 4.1**, are summarised in **Table 4.3**.

Table 4-3: XP-RAFTS Model Results

Nodes	2 Year ARI		5 Year ARI		20 Year ARI		100 Year ARI	
	Peak Flow (m^3/s)	Critical Duration (hr)	Peak Flow (m^3/s)	Critical Duration (hr)	Peak Flow (m^3/s)	Critical Duration (hr)	Peak Flow (m^3/s)	Critical Duration (hr)
C30	4	3h	7	3h	12	1h	20	1h
C31	3	3h	6	3h	10	1h	16	1h
D10	8	3h	13	3h	21	1h	36	1h
C32	8	3h	14	3h	22	1h	38	1h
C33	11	3h	17	3h	28	1h	46	1h
C34	13	3h	21	3h	33	1h	53	1h
C35	8	3h	13	3h	23	1h	39	1h
D11	21	3h	34	3h	55	1h	89	1h

Nodes	2 Year ARI		5 Year ARI		20 Year ARI		100 Year ARI	
	Peak Flow (m^3/s)	Critical Duration (hr)	Peak Flow (m^3/s)	Critical Duration (hr)	Peak Flow (m^3/s)	Critical Duration (hr)	Peak Flow (m^3/s)	Critical Duration (hr)
C36	6	3h	10	3h	17	1h	29	1h
C37	12	3h	19	3h	30	3h	45	1.5h
C38	6	3h	9	3h	16	1h	26	1h

4.7 Discussion & Conclusions

The hydrological modelling discussed above has defined the peak flows for the 2 year ARI, 5 year ARI, 20 year ARI & 100 year ARI design events for the key waterway crossings along Route MR5A. The catchment, waterways and hydrology are similar to the other waterways assessed in July 2012 (Cardno 2012).

This information can subsequently be utilised to assist with the design process for the pipeline. It is understood that the pipeline is proposed to be either trenched or tunnelled under each of the crossings. As such, there should be a limited impact on the hydrology in the study area because the proposed works do not alter the cross section of the creek.

A flood impact assessment would need to be undertaken to ensure no adverse impacts in the events up to the 100 year ARI event.

Similarly, any above ground infrastructure should be located above the 100 year ARI event to minimise impacts of flood behaviour.

If an alternative above ground option is adopted for the pipe, then a flood impact assessment would need to be undertaken. Furthermore, the expected loadings on the pipe from flood flows and debris would need to be determined.

To minimise potential damage to pumping infrastructure, pumps would need to be placed above the 1% AEP flood level plus a freeboard of 500mm.

5 GEOMORPHOLOGY

Route MR5A crosses a number of streams that were not assessed in the exhibited route and it is a requirement of the DGRs to assess the impact of construction and operation of the pipeline to stream geomorphology. This stream stability assessment is limited to the relationship of the construction and operation of the pipeline and the potential for surface water to degrade streams at the crossings. The construction phase of the pipeline is expected to represent the greatest level of impact, albeit at a level that has the ability to be mitigated, to stream stability and geomorphology.

In the absence of further details on the design, it has been assumed that the pipeline would be trenched for the crossings, being the construction method bearing the highest level of impact. Intrusive construction methods with heavy machinery would therefore be required to trench the pipeline in the rock dominated streams. Operation of the pipeline is not predicted to pose hazards to stream stability considering the pipeline is to be buried within a trench.

5.1 Stream Description

5.1.1 Topography

The topography of the MR5A route is not dissimilar from the exhibited pipeline route assessed in Cardno's July 2012 report. However the MR5A terrain did appear to have more narrow valleys, an increased number of undulations and less presence of floodplain. Thus the waterways were generally more confined within the narrow valleys and had little connection with a floodplain. Figures 5-1 and 5-2 show the topography observed.

The waterway channels observed were narrow, shallow and appeared to flow intermittently. An additional four waterways would be crossed by route MR5A in addition to a new offtake location. A detailed assessment of the Macquarie River offtake is provided in Section 5.2.4.

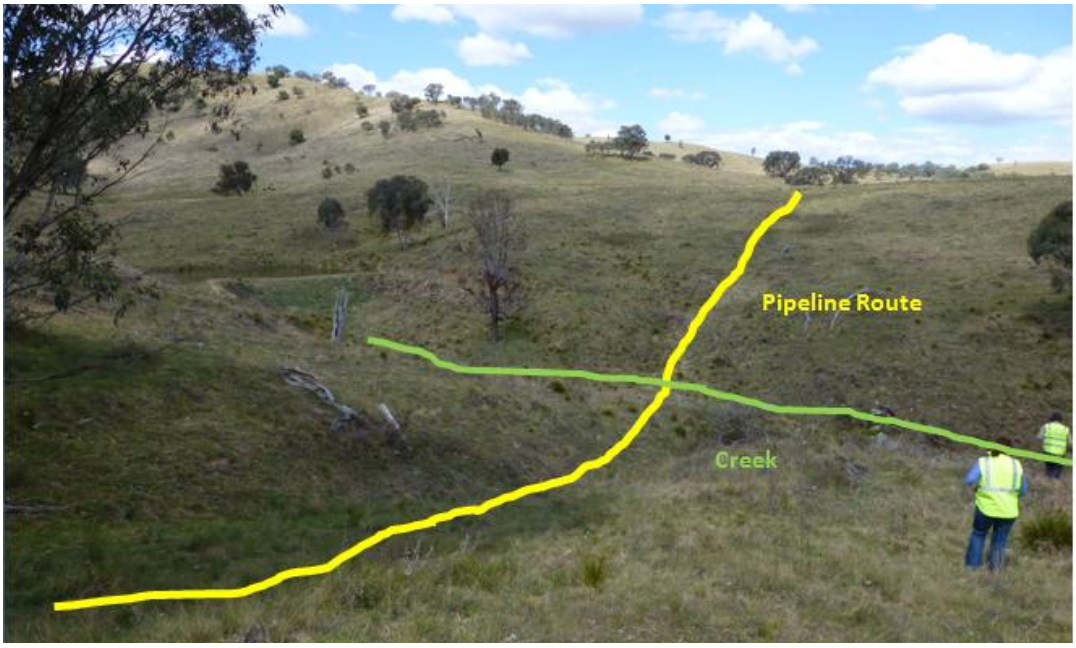

Figure 5-1: Pipeline route between the offtake and Long Point Road – note broad ridge line and confined valley (no floodplain)

Figure 5-2: Pipeline Route along Long Point Road, note undulating hills and absence of floodplain

5.1.2 Geology

In general the geology of the land along the pipeline route is volcanic bedrock with overlying silt/clay soil. At the off-take location the river has exposed Slate, Basalt and Rhyolite on the riverbanks and bed with deposits of weathered rock.

5.1.3 Vegetation

In general trees and shrubs are sparse along the creek crossings. Grasses, both natural and exotic, are predominant along the creek banks and floodplain pockets. A continuous canopy was not observed at any of the stream crossings included in this assessment. Weed species of blackberry and kikuyu were observed.

5.1.4 Stream Stability

It was observed that the streams are generally very stable being controlled by bedrock and rock outcrops in confined valley walls. However the stability of the creek bed and banks can be variable depending on the presence of overlying soil, in-stream alluvial deposits and pockets of floodplain.

Figure 5-3: Typical Creek Channel along Route MR5A