

LEGEND

GENERAL

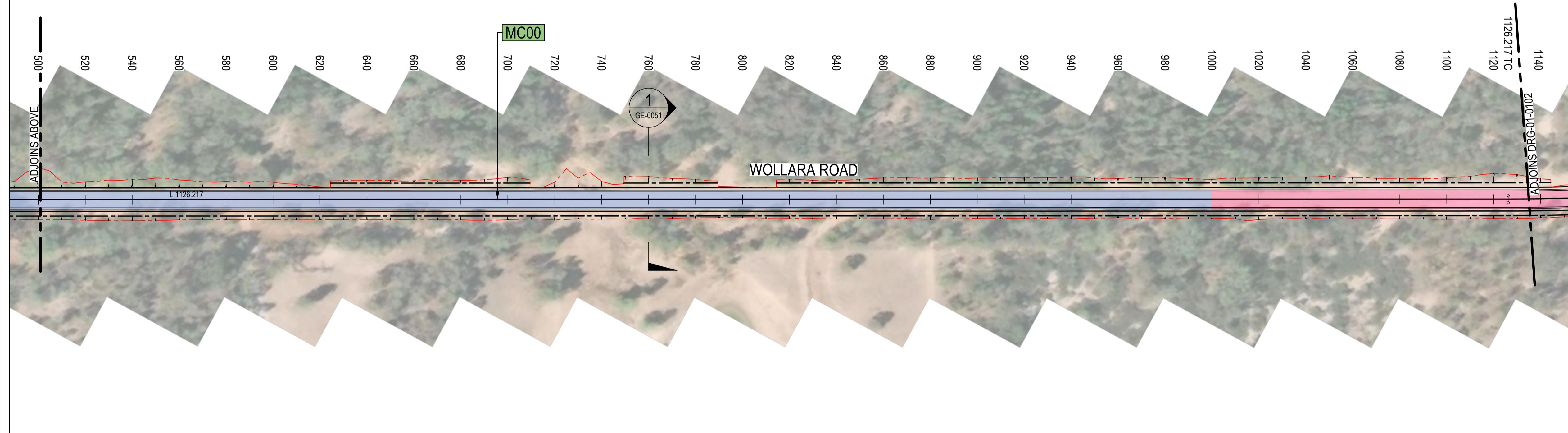
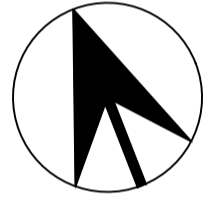
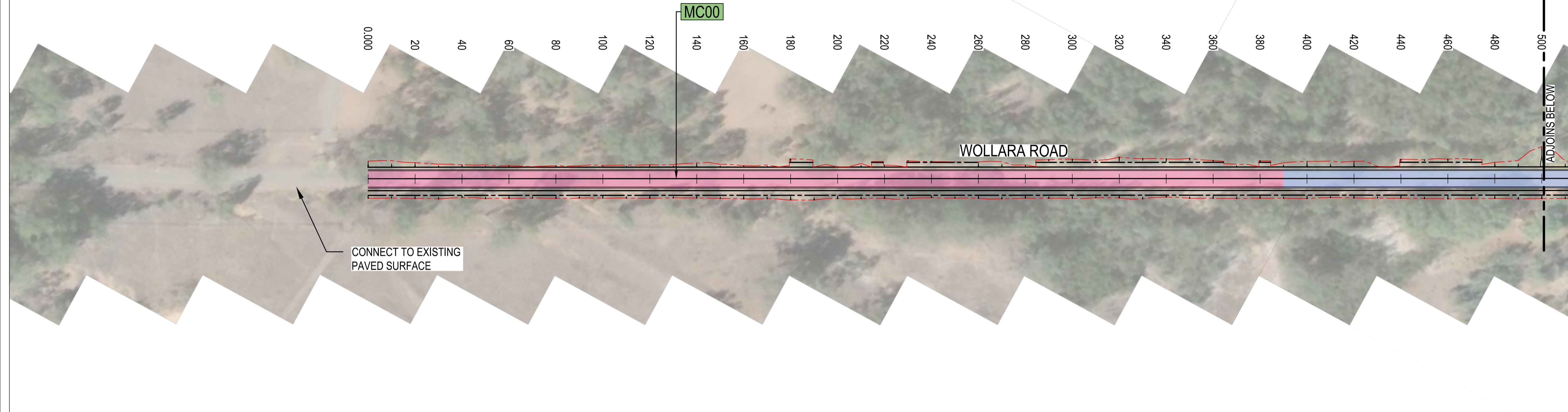
- REF BOUNDARY (Red dashed line)
- DESIGN (Black solid line)

ROAD GEOMETRY

- CONTROL LINE AND CHAINAGE (Black line with cross-ticks)
- CONTROL LINE LABEL (Green box with 'MCXX')


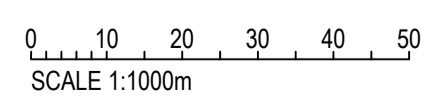
PAVEMENT AND KERBS

- TYPE 1 (Pink fill)
- TYPE 2 (Blue fill)

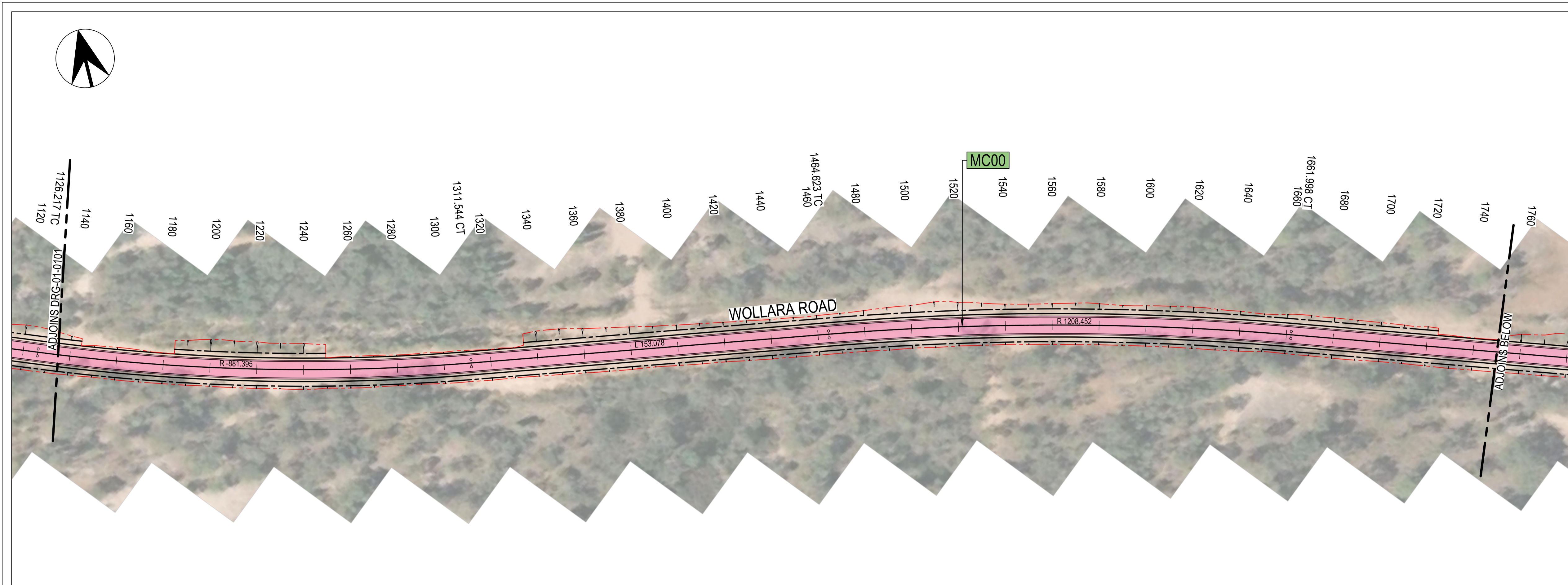


FOR INFORMATION ONLY

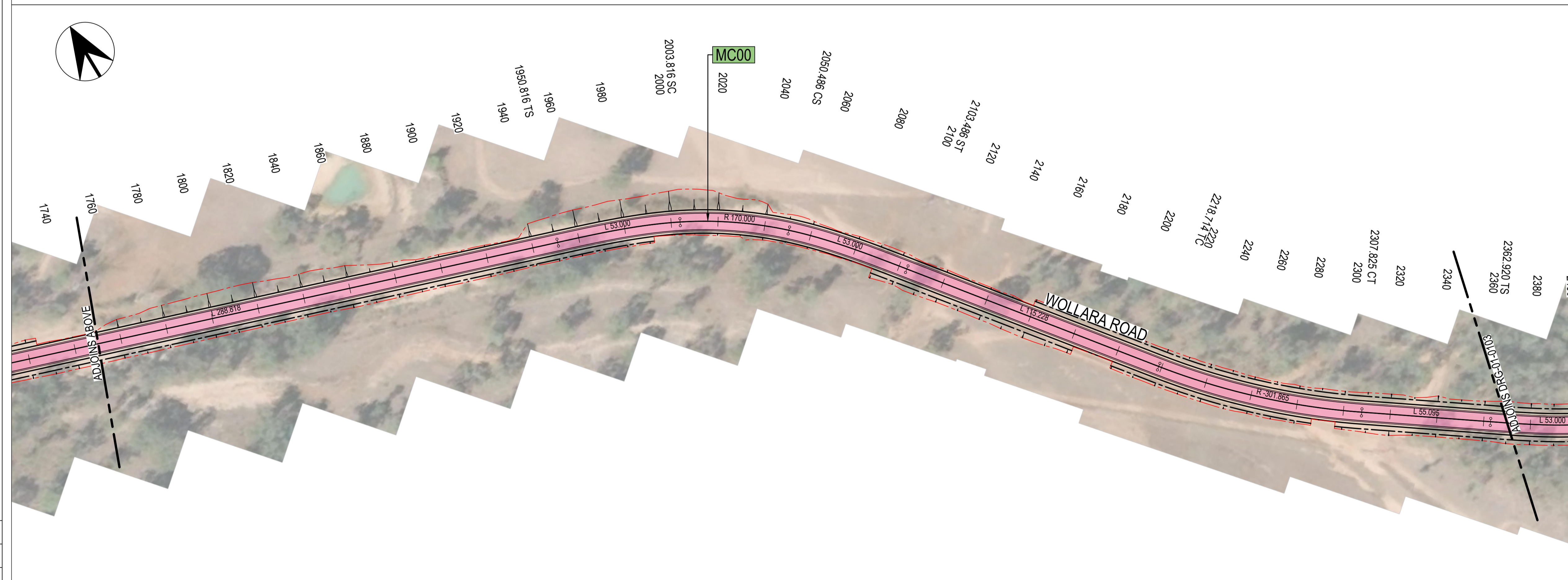
THIS DRAWING MAY BE PREPARED IN COLOUR AND MAY BE INCOMPLETE IF COPIED

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EXTERNAL REFERENCE FILES				REV A	DATE 20.09.22	AMENDMENT / REVISION DESCRIPTION ISSUED FOR INFORMATION				WVR No.	APPROVAL MD	SCALES ON A1 SIZE DRAWING			TITLE DRAWN	NAME K.MERCER	DATE 20.09.22				CLIENT		
 SCALE 1:1000m													DRG CHECK	B.EVANS	20.09.22								
CO-ORDINATE SYSTEM MGA ZONE 56 (GDA2020)													DESIGN	S.SHAMSODIEN	20.09.22								
HEIGHT DATUM AHD													DESIGN CHECK	J.DeWIT	20.09.22								
													DESIGN MNGR	J.DeWIT	20.09.22								
													PROJECT MNGR	R.BANZON	20.09.22								
													DRAWING NUMBER 0305-DRG-00-PV-0102			ISSUE STATUS FOR INFORMATION			SHEET No. 00-PV-0102	ISSUE A			

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 X:\0305-DRG-00-PV-0101.dwg



- LEGEND**
- GENERAL**
- REF BOUNDARY (dashed red line)
 - DESIGN (solid black line)
- ROAD GEOMETRY**
- CONTROL LINE AND CHAINAGE (dashed black line with cross-ticks)
 - CONTROL LINE LABEL (green box with black text)
- PAVEMENT AND KERBS**
- TYPE 1 (pink fill)
 - TYPE 2 (blue fill)



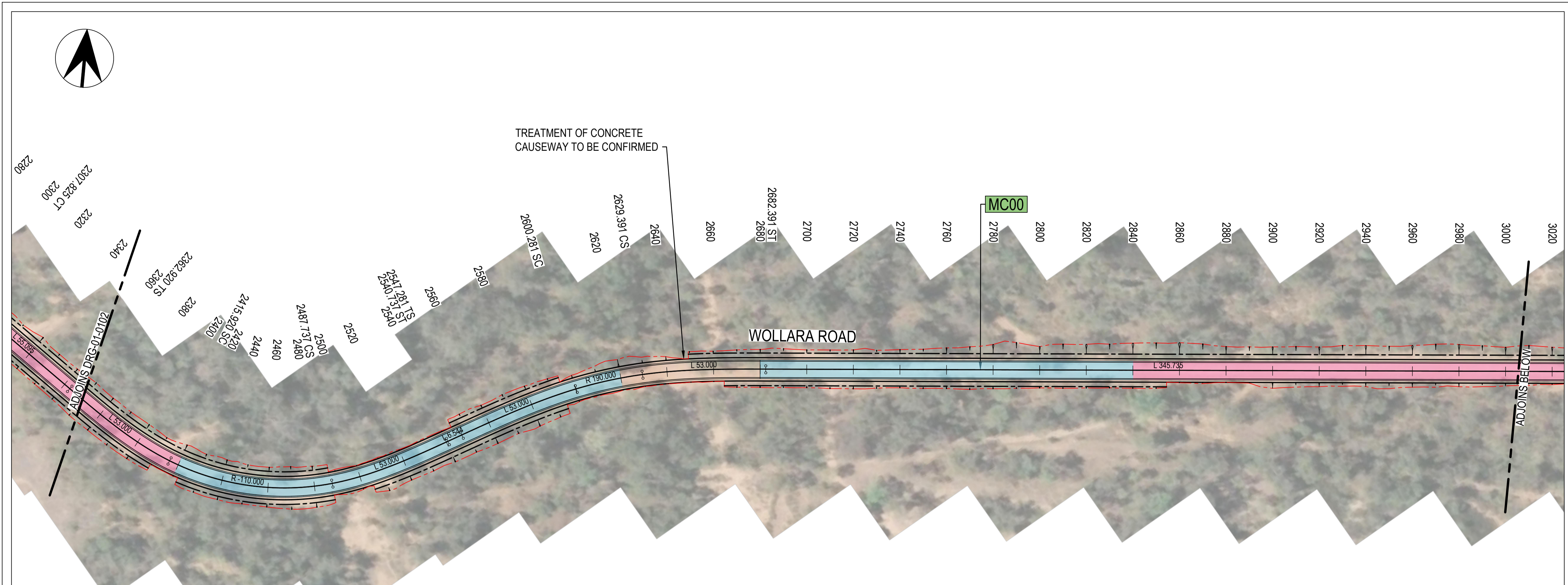
FOR INFORMATION ONLY

THIS DRAWING MAY BE PREPARED IN COLOUR AND MAY BE INCOMPLETE IF COPIED

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EXTERNAL REFERENCE FILES				REV			DATE			AMENDMENT / REVISION DESCRIPTION			WVR No.			APPROVAL			SCALES ON A1 SIZE DRAWING		
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																			HEIGHT DATUM AHD		
																			TITLE K.MERCER		
																			NAME B.EVANS		
																			DATE 20.09.22		
																			DESIGNER		
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																			ISSUE STATUS FOR INFORMATION		
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																			ISSUE A		



DATE PLOTTED: 20/09/2022 12:34:19 PM
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SCALE: 1:1000m



LEGEND

GENERAL

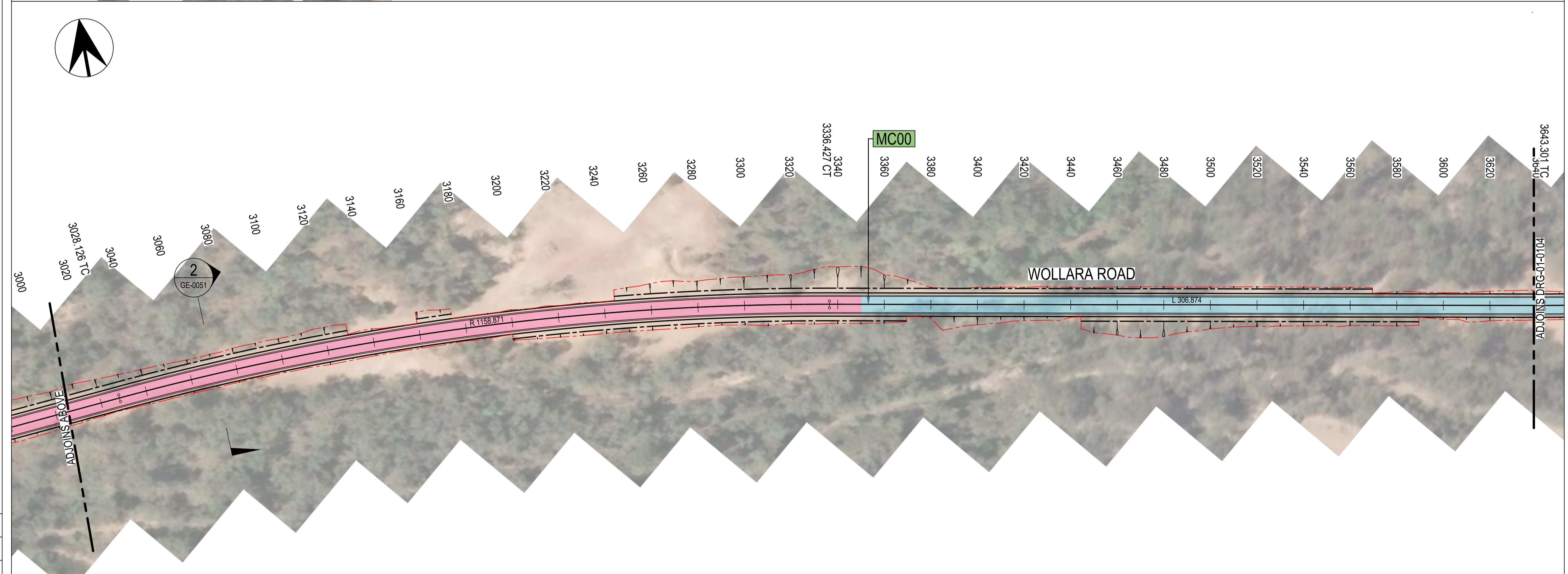
- REF BOUNDARY
- DESIGN

ROAD GEOMETRY

- CONTROL LINE AND CHAINAGE
- 20
- ← MCXX CONTROL LINE LABEL

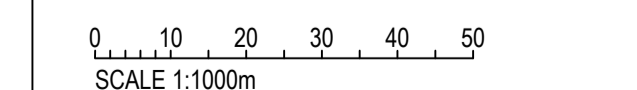

PAVEMENT AND KERBS

- TYPE 1 (Pink)
- TYPE 2 (Blue)

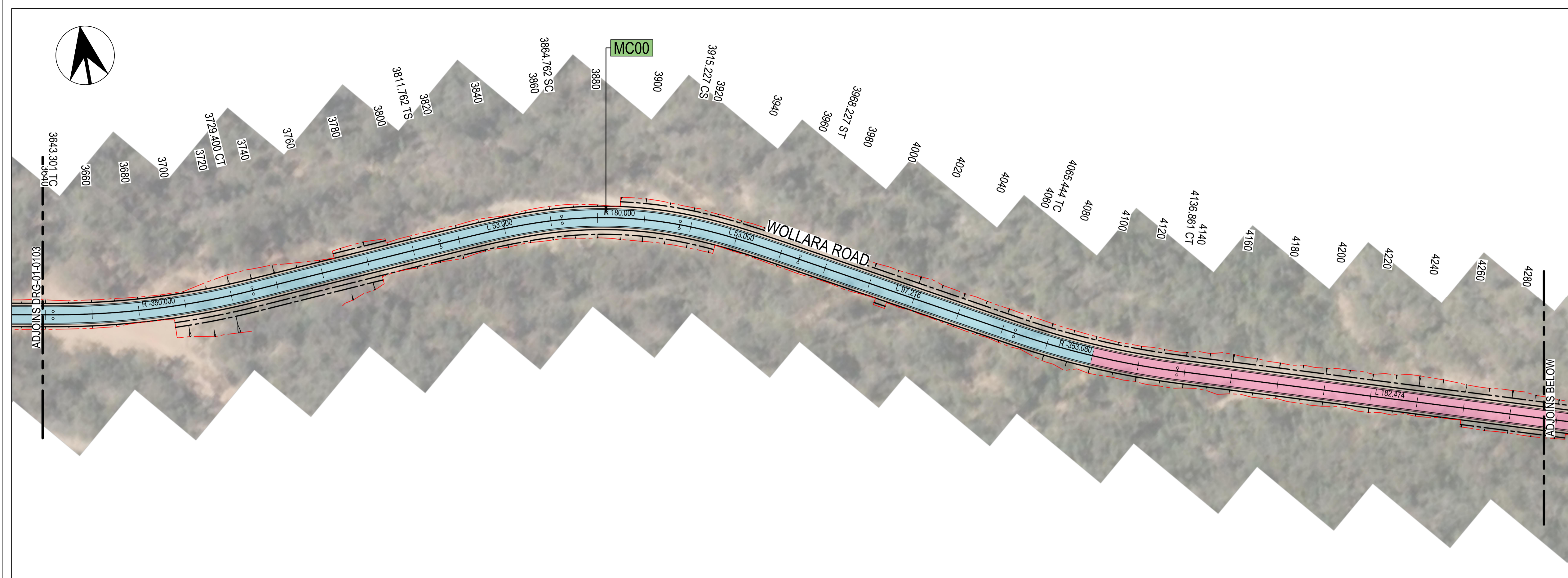


FOR INFORMATION ONLY

THIS DRAWING MAY BE PREPARED IN COLOUR AND MAY BE INCOMPLETE IF COPIED

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EXTERNAL REFERENCE FILES		REV A	DATE 20.09.22	AMENDMENT / REVISION DESCRIPTION ISSUED FOR INFORMATION		WVR No.	APPROVAL MD	SCALES ON A1 SIZE DRAWING		DESIGNER		CLIENT																						
																																		
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TITLE	NAME	DATE																																
DRAWN	K.MERCER	20.09.22																																
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DESIGN MNGR	J.DeWIT	20.09.22																																
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LEGEND

GENERAL

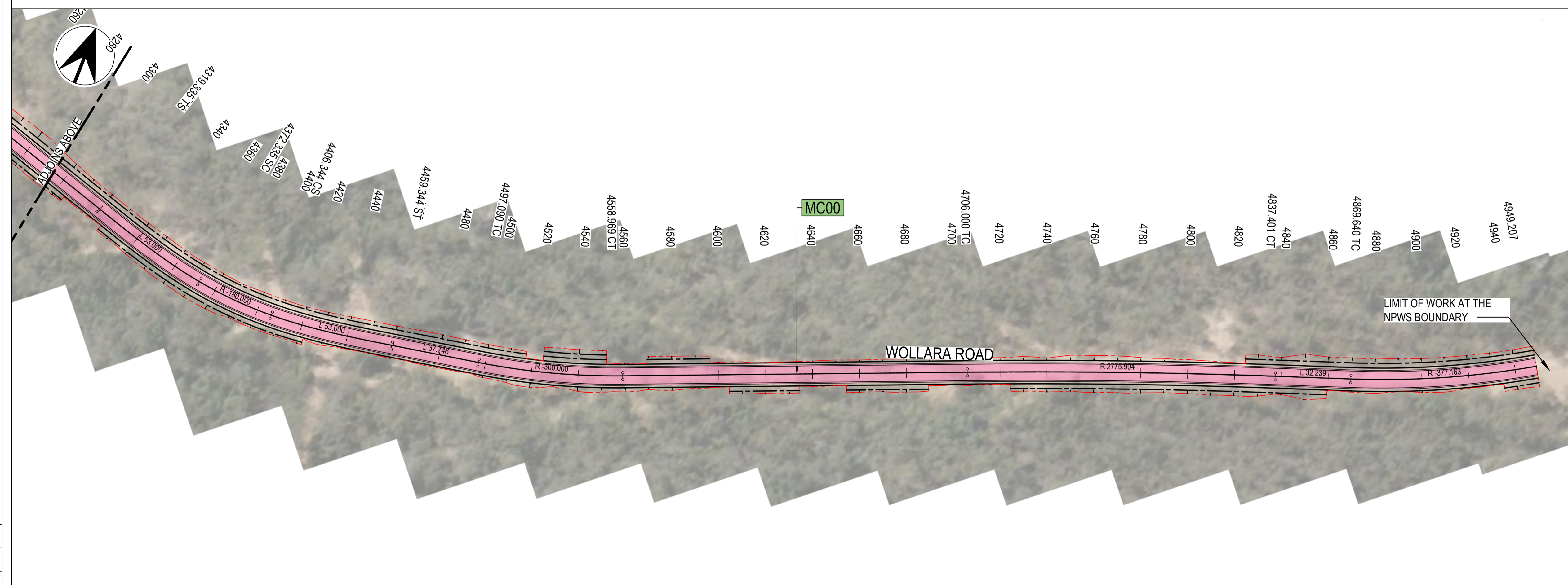
- REF BOUNDARY (dashed red line)
- DESIGN (solid black line)

ROAD GEOMETRY

- CONTROL LINE AND CHAINAGE (dashed black line with ticks)
- CONTROL LINE LABEL (green box with 'MCXX')

PAVEMENT AND KERBS

- TYPE 1 (pink fill)
- TYPE 2 (blue fill)



FOR INFORMATION ONLY

THIS DRAWING MAY BE PREPARED IN COLOUR AND MAY BE INCOMPLETE IF COPIED

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EXTERNAL REFERENCE FILES				REV A	DATE 20.09.22	AMENDMENT / REVISION DESCRIPTION ISSUED FOR INFORMATION	WVR No.	APPROVAL MD	SCALES ON A1 SIZE DRAWING 0 10 20 30 40 50 SCALE 1:1000m			DESIGNER			CLIENT			DRAWING NUMBER 0305-DRG-00-PV-0104		
CO-ORDINATE SYSTEM MGA ZONE 56 (GDA2020)				HEIGHT DATUM AHD				TITLE DRAWN DRG CHECK DESIGN DESIGN CHECK DESIGN MNGR PROJECT MNGR	NAME K.MERCER B.EVANS S.SHAMSODIEN J.DeWIT J.DeWIT R.BANZON			DATE 20.09.22 20.09.22 20.09.22 20.09.22 20.09.22 20.09.22			turnbull			SHEET 4 OF 4		
ISSUE STATUS FOR INFORMATION				SHEET No. 00-PV-0104				ISSUE A												

LEGEND

	CADASTRAL BOUNDARY (DCDB)
	FENCE LINE
	FOG LINE
	CENTRELINE OF ROAD
	EDGE OF BITUMEN
	EDGE OF UNSEALED SHOULDER
	STORMWATER PIPE
	SURVEY CONTROL POINT
	DENOTES TREE
	DENOTES CUT AND FILL



LOT 16
DP 11212

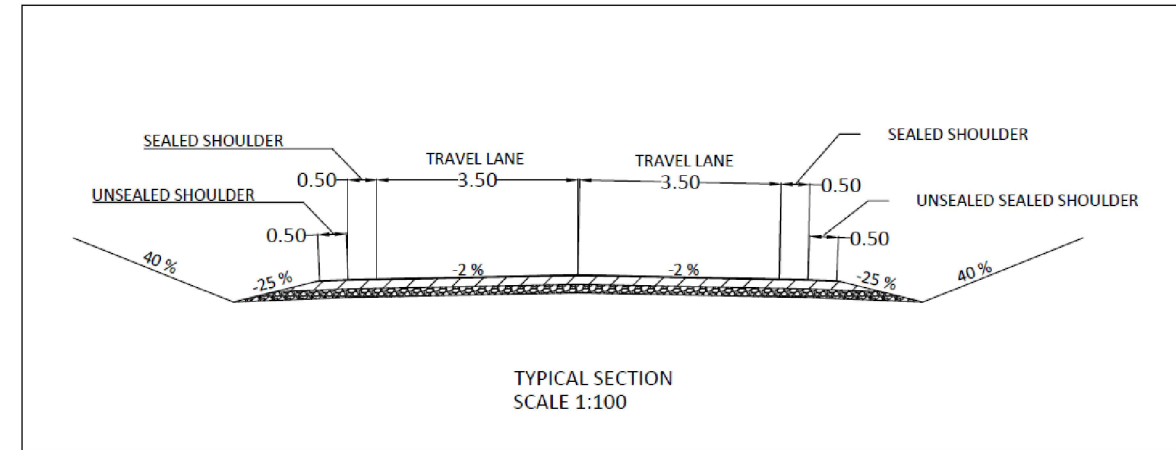
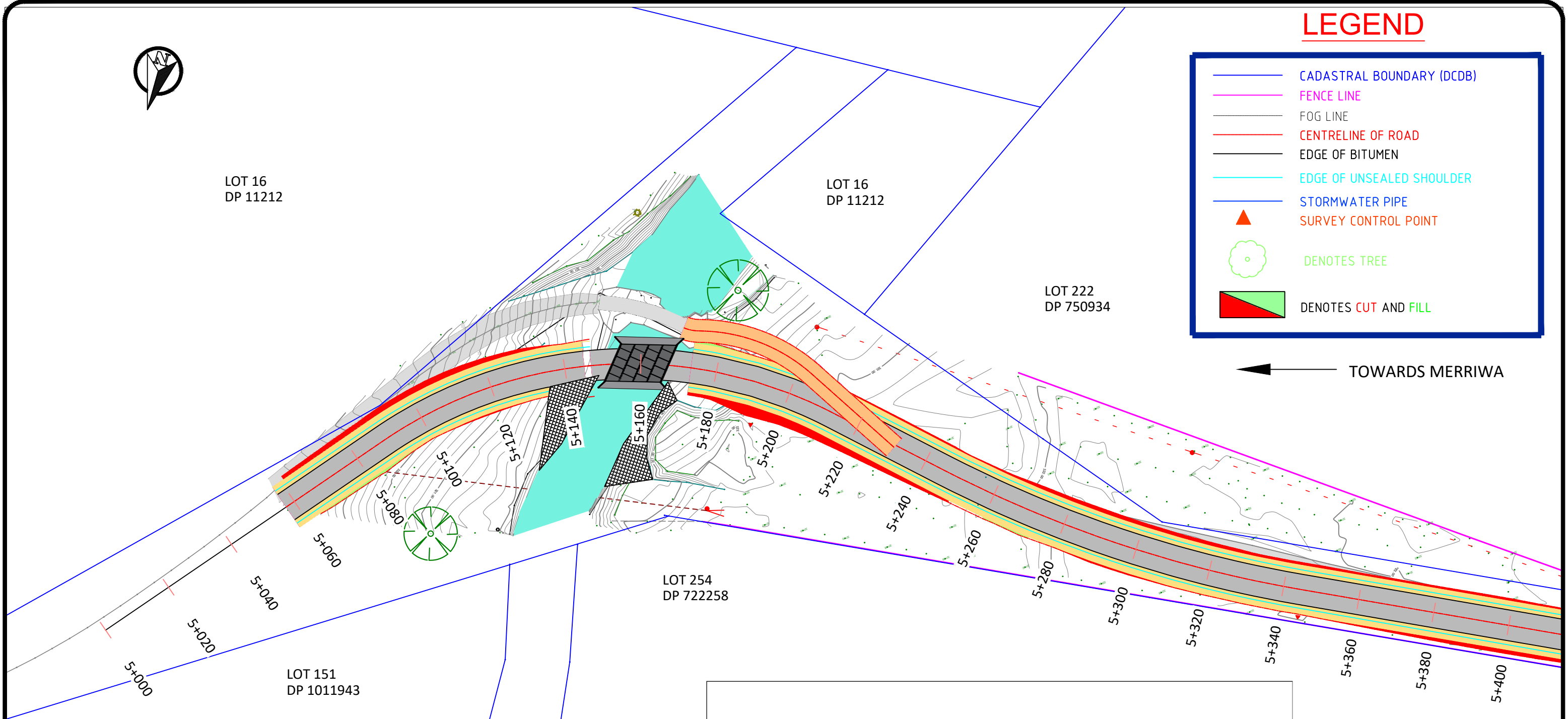
LOT 16
DP 11212

LOT 222
DP 750934

LOT 254
DP 722258

LOT 151
DP 1011943

← TOWARDS MERRIWA



CLIENT:
lightsourcebp

DATE:	REVISION:	DESCRIPTION:
24.01.2023	0	CLIENT REVIEW

PROJECT:
RINGWOOD ROAD UPGRADE

DRAWING TITLE:
Proposed Alignment

ISSUE STATUS:
CONCEPTUAL DESIGN CLIENT REVIEW

SCALE: 1:1000	DWG No: HEC22_
COORDINATE SYSTEM: MGA ZONE 56 GDA 2020	JOB No: 22Q3J3
DATUM: AHD	

SURVEYED: RAP SURVEYING	
DESIGNED: RS	DRAWN: RJ
SHEET: 1	REV: 0

LEGEND

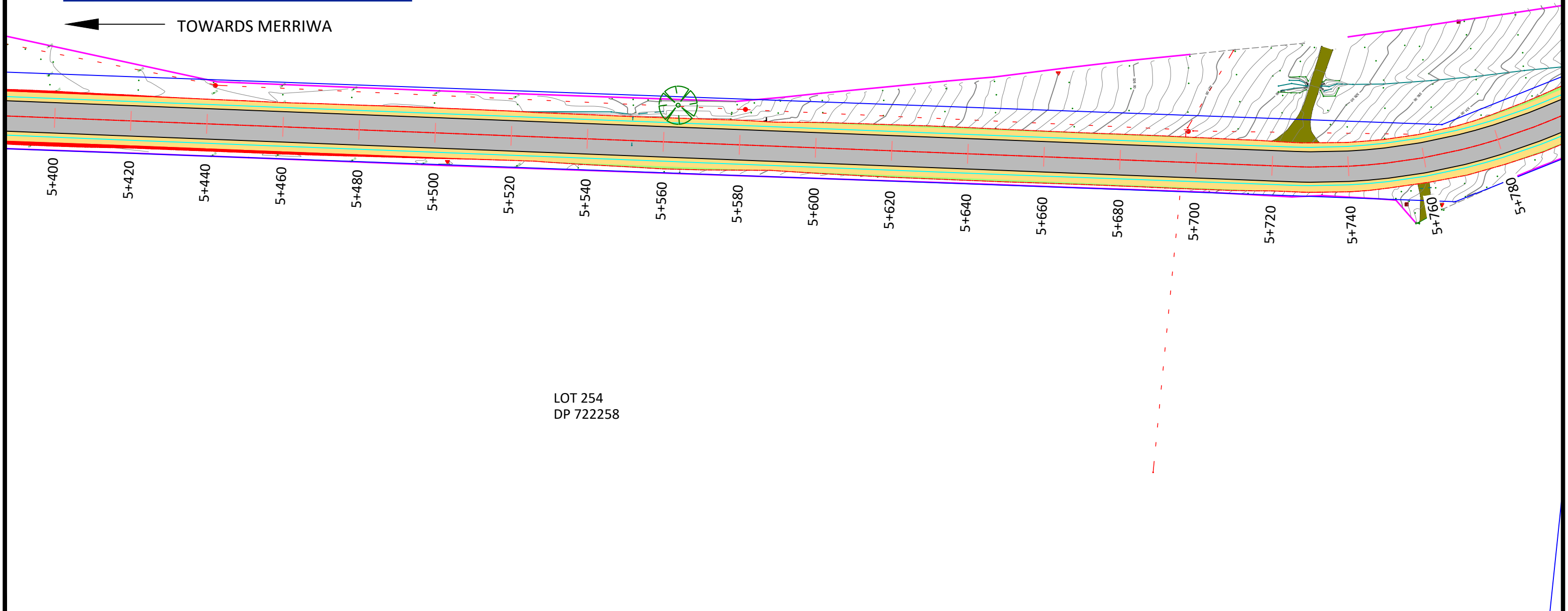


	CADASTRAL BOUNDARY (DCDB)
	FENCE LINE
	FOG LINE
	CENTRELINE OF ROAD
	EDGE OF BITUMEN
	EDGE OF UNSEALED SHOULDER
	STORMWATER PIPE
	SURVEY CONTROL POINT
	DENOTES TREE
	DENOTES CUT AND FILL

LOT 22
DP 750934

LOT 254
DP 722258

TOWARDS MERRIWA



5+400 5+420 5+440 5+460 5+480 5+500 5+520 5+540 5+560 5+580 5+600 5+620 5+640 5+660 5+680 5+700 5+720 5+740 5+760 5+780



DATE:	REVISION:	DESCRIPTION:
24.01.2023	0	CLIENT REVIEW

PROJECT:
RINGWOOD ROAD UPGRADE



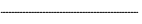

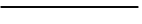





DRAWING TITLE:
Proposed Alignment

ISSUE STATUS:
CONCEPTUAL DESIGN CLIENT REVIEW

SCALE: 1:1000
DWG No: HEC22_
JOB No: 22Q3J3
COORDINATE SYSTEM: MGA ZONE 56 GDA 2020
DATUM: AHD

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DESIGNED: RS	DRAWN: RJ
SHEET: 2	REV: 0

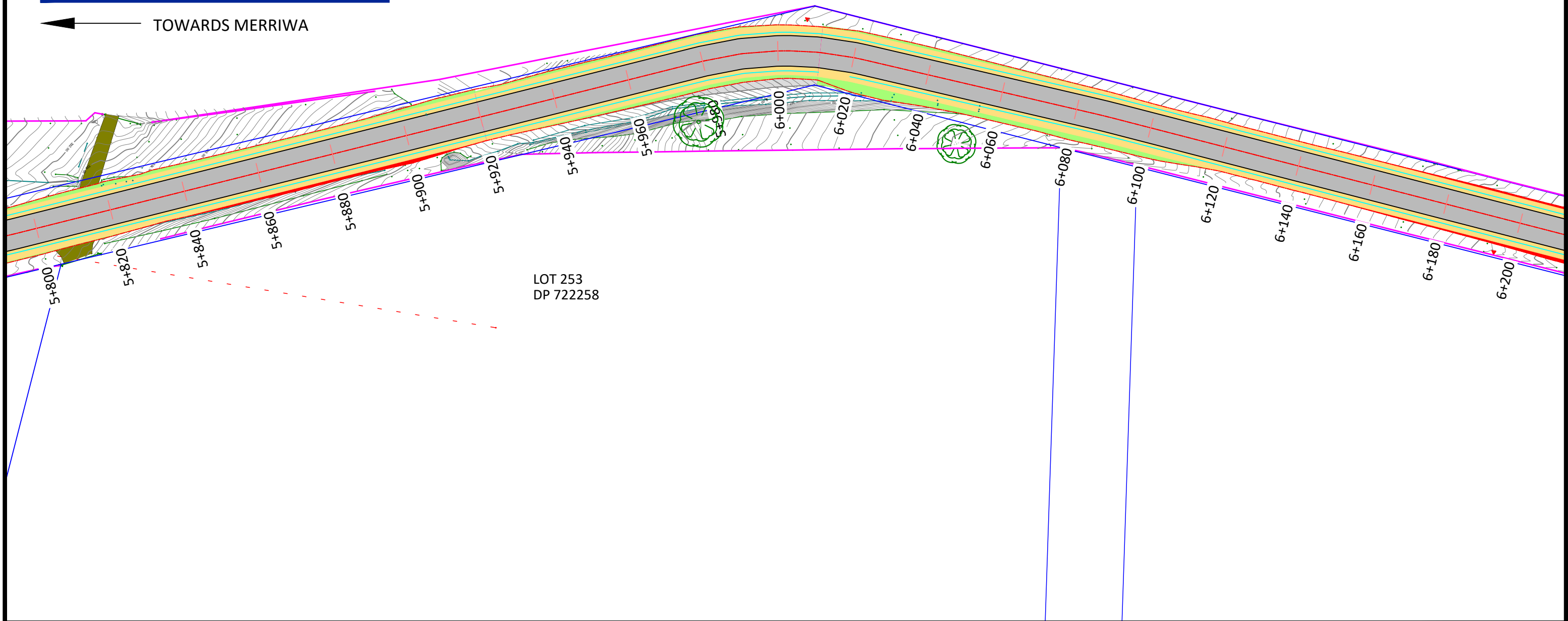
LEGEND

-  CADASTRAL BOUNDARY (DCDB)
-  FENCE LINE
-  FOG LINE
-  CENTRELINE OF ROAD
-  EDGE OF BITUMEN
-  EDGE OF UNSEALED SHOULDER
-  STORMWATER PIPE
-  SURVEY CONTROL POINT
-  DENOTES TREE
-  DENOTES CUT AND FILL



LOT 222
DP 750934

← TOWARDS MERRIWA



CLIENT:
lightsourcebp 

DATE:	REVISION:	DESCRIPTION:
24.01.2023	0	CLIENT REVIEW

PROJECT:
RINGWOOD ROAD UPGRADE

DRAWING TITLE:
Proposed Alignment

ISSUE STATUS:
CONCEPTUAL DESIGN CLIENT REVIEW

SCALE: 1:1000
DWG No: HEC22_
JOB No: 22Q3J3
COORDINATE SYSTEM: MGA ZONE 56 GDA 2020
DATUM: AHD

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DESIGNED: RS	DRAWN: RJ
SHEET: 3	REV: 0

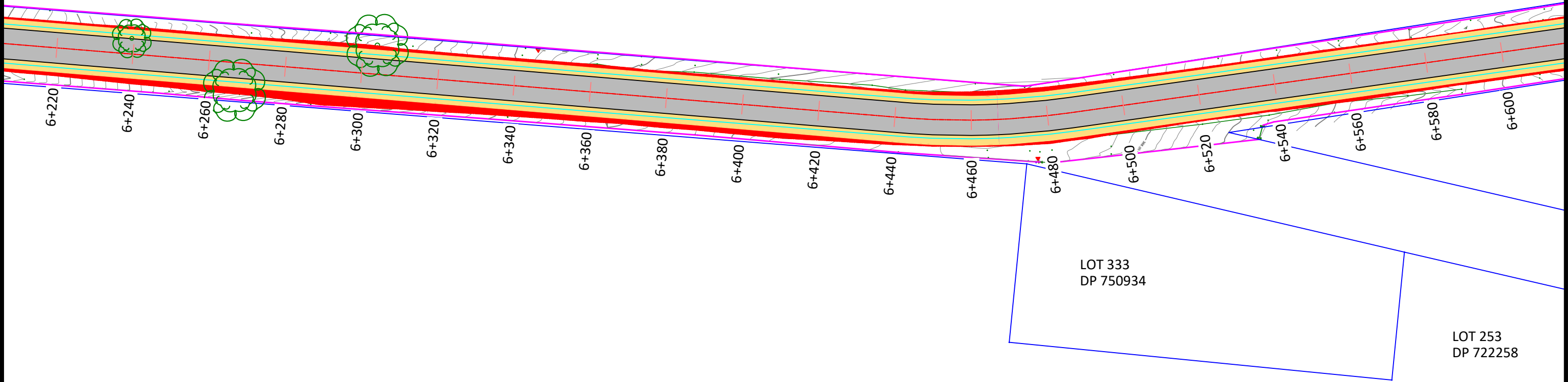
LEGEND



- CADASTRAL BOUNDARY (DCDB)
- FENCE LINE
- FOG LINE
- CENTRELINE OF ROAD
- EDGE OF BITUMEN
- EDGE OF UNSEALED SHOULDER
- STORMWATER PIPE
- SURVEY CONTROL POINT
- DENOTES TREE
- DENOTES CUT AND FILL

LOT222
DP 750934

← TOWARDS MERRIWA



DATE:	REVISION:	DESCRIPTION:
24.01.2023	0	CLIENT REVIEW

PROJECT:
RINGWOOD ROAD UPGRADE





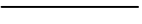





DRAWING TITLE:
Proposed Alignment

ISSUE STATUS:
CONCEPTUAL DESIGN CLIENT REVIEW

SCALE: 1:1000
DWG No: HEC22_
JOB No: 22Q3J3
COORDINATE SYSTEM: MGA ZONE 56 GDA 2020
DATUM: AHD

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DESIGNED: RS	DRAWN: RJ
SHEET: 4	REV: 0

LEGEND

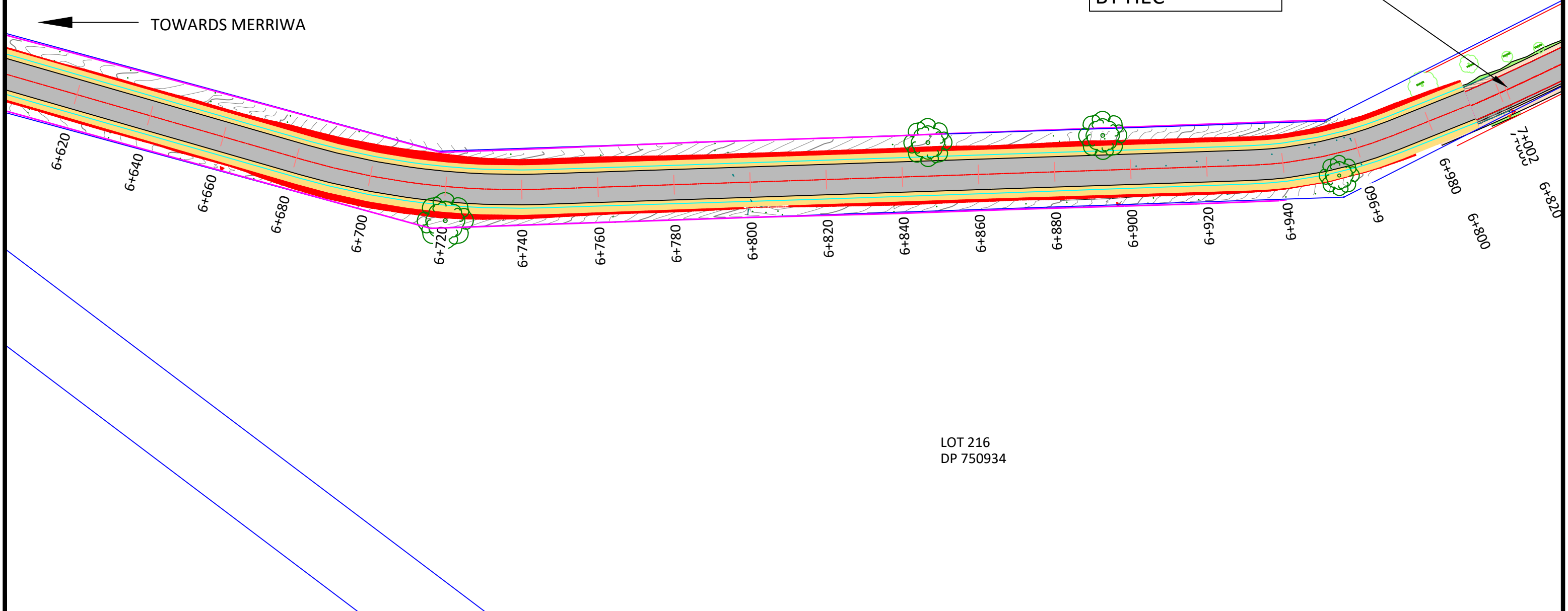
-  CADASTRAL BOUNDARY (DCDB)
-  FENCE LINE
-  FOG LINE
-  CENTRELINE OF ROAD
-  EDGE OF BITUMEN
-  EDGE OF UNSEALED SHOULDER
-  STORMWATER PIPE
-  SURVEY CONTROL POINT
-  DENOTES TREE
-  DENOTES CUT AND FILL



LOT 222
DP 750934

TIE INTO EXISTING
CONSTRUCTED
ROAD. DESIGNED
BY HEC

← TOWARDS MERRIWA



LOT 216
DP 750934



CLIENT:
lightsource bp

DATE:	REVISION:	DESCRIPTION:
24.01.2023	0	CLIENT REVIEW

PROJECT:
RINGWOOD ROAD UPGRADE











DRAWING TITLE:
Proposed Alignment

ISSUE STATUS:
CONCEPTUAL DESIGN CLIENT REVIEW

SCALE: 1:1000
DWG No: HEC22_
JOB No: 22Q3J3
COORDINATE SYSTEM: MGA ZONE 56 GDA 2020
DATUM: AHD

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DESIGNED: RS	DRAWN: RJ
SHEET: 5	REV: 0

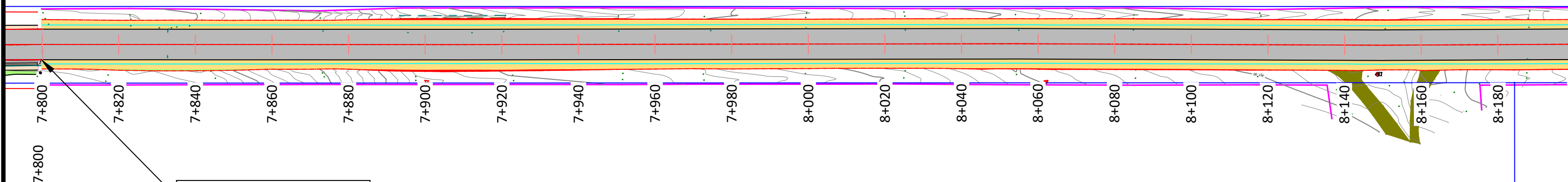
LEGEND

-  CADASTRAL BOUNDARY (DCDB)
-  FENCE LINE
-  FOG LINE
-  CENTRELINE OF ROAD
-  EDGE OF BITUMEN
-  EDGE OF UNSEALED SHOULDER
-  STORMWATER PIPE
-  SURVEY CONTROL POINT
-  DENOTES TREE
-  DENOTES CUT AND FILL

LOT 246
DP 750934

LOT 217
DP 750934

← TOWARDS MERRIWA



TIE INTO EXISTING
CONSTRUCTED
ROAD. DESIGNED
BY HEC



DATE:	REVISION:	DESCRIPTION:
24.01.2023	0	CLIENT REVIEW

PROJECT:
RINGWOOD ROAD UPGRADE











DRAWING TITLE:
Proposed Alignment

ISSUE STATUS:
CONCEPTUAL DESIGN CLIENT REVIEW

SCALE: 1:1000
DWG No: HEC22_
JOB No: 22Q3J3
COORDINATE SYSTEM: MGA ZONE 56 GDA 2020
DATUM: AHD

SURVEYED: RAP SURVEYING	
DESIGNED: RS	DRAWN: RJ
SHEET: 6	REV: 0

LEGEND

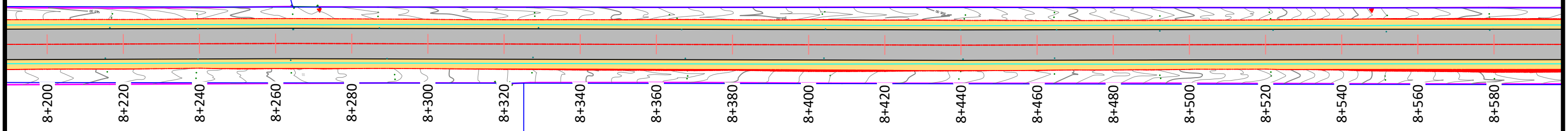
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	FENCE LINE
	FOG LINE
	CENTRELINE OF ROAD
	EDGE OF BITUMEN
	EDGE OF UNSEALED SHOULDER
	STORMWATER PIPE
	SURVEY CONTROL POINT
	DENOTES TREE
	DENOTES CUT AND FILL



LOT 222
DP 750934

LOT 223
DP 750934

← TOWARDS MERRIWA



8+200 8+220 8+240 8+260 8+280 8+300 8+320 8+340 8+360 8+380 8+400 8+420 8+440 8+460 8+480 8+500 8+520 8+540 8+560 8+580

LOT 237
DP 750934

LOT 217
DP 750934



CLIENT:



DATE:	REVISION:	DESCRIPTION:
24.01.2023	0	CLIENT REVIEW

PROJECT:
RINGWOOD ROAD UPGRADE

DRAWING TITLE:
Proposed Alignment



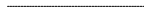







ISSUE STATUS:
CONCEPTUAL DESIGN CLIENT REVIEW

SCALE:
1:1000

DWG No: HEC22_	DESIGNED: RS	DRAWN: RJ
JOB No: 22Q3J3	SHEET: 7	REV: 0
COORDINATE SYSTEM: MGA ZONE 56 GDA 2020		
DATUM: AHD		

SURVEYED:
RAP SURVEYING

LEGEND

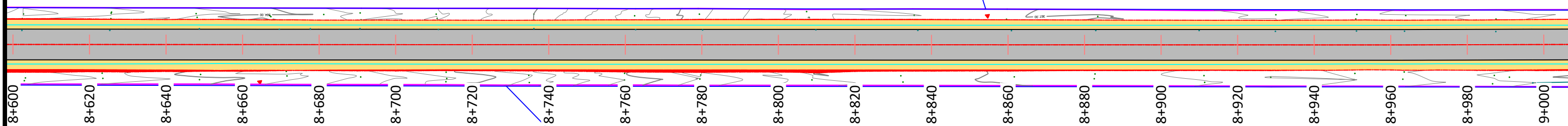
-  CADASTRAL BOUNDARY (DCDB)
-  FENCE LINE
-  FOG LINE
-  CENTRELINE OF ROAD
-  EDGE OF BITUMEN
-  EDGE OF UNSEALED SHOULDER
-  STORMWATER PIPE
-  SURVEY CONTROL POINT
-  DENOTES TREE
-  DENOTES CUT AND FILL



LOT 223
DP 750934

LOT 224
DP 750934

← TOWARDS MERRIWA



LOT 217
DP 750934

LOT 220
DP 750934



CLIENT:
lightsource bp

DATE:	REVISION:	DESCRIPTION:
24.01.2023	0	CLIENT REVIEW

PROJECT:
RINGWOOD ROAD UPGRADE

DRAWING TITLE:
Proposed Alignment

ISSUE STATUS:
CONCEPTUAL DESIGN CLIENT REVIEW

SCALE: 1:1000
DWG No: HEC22_
JOB No: 22Q3J3
COORDINATE SYSTEM: MGA ZONE 56 GDA 2020
DATUM: AHD

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DESIGNED: RS	DRAWN: RJ
SHEET: 8	REV: 0

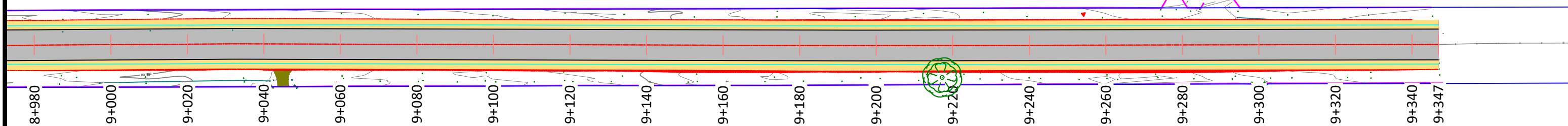
LEGEND



	CADASTRAL BOUNDARY (DCDB)
	FENCE LINE
	FOG LINE
	CENTRELINE OF ROAD
	EDGE OF BITUMEN
	EDGE OF UNSEALED SHOULDER
	STORMWATER PIPE
	SURVEY CONTROL POINT
	DENOTES TREE
	DENOTES CUT AND FILL

LOT 224
DP 750934

← TOWARDS MERRIWA



LOT 220
DP 750934



DATE:	REVISION:	DESCRIPTION:
24.01.2023	0	CLIENT REVIEW

PROJECT:
RINGWOOD ROAD UPGRADE

DRAWING TITLE:
Proposed Alignment

ISSUE STATUS:
CONCEPTUAL DESIGN CLIENT REVIEW

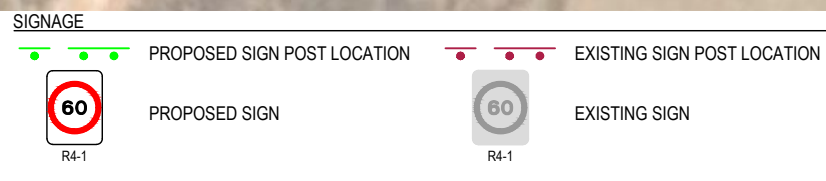
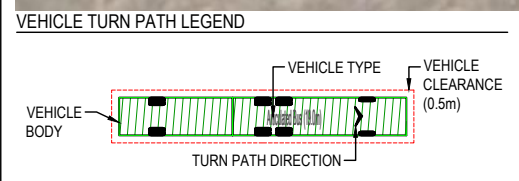
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DWG No: HEC22_
JOB No: 22Q3J3
COORDINATE SYSTEM: MGA ZONE 56 GDA 2020
DATUM: AHD

SURVEYED: RAP SURVEYING	
DESIGNED: RS	DRAWN: RJ
SHEET: 9	REV: 0

Appendix I Site access swept paths



FOR INFORMATION ONLY



GOULBURN RIVER SOLAR FARM
SIGNAGE & SWEPT PATH
SHEET 1 OF 2

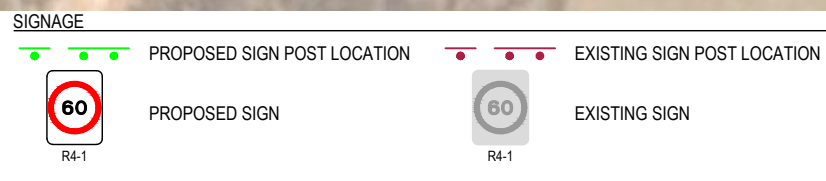
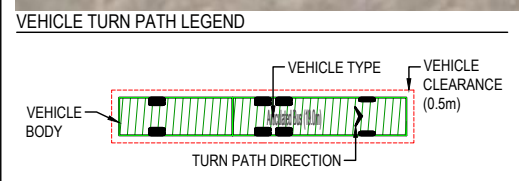
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FOR INFORMATION ONLY



GOULBURN RIVER SOLAR FARM
SIGNAGE & SWEEP PATH
SHEET 2 OF 2

25/01/2023

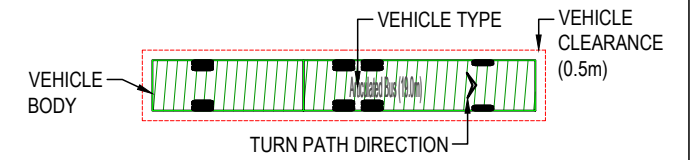


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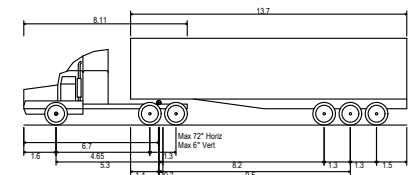
Appendix J Barnett Street swept paths



VEHICLE TURN PATH LEGEND



VEHICLE TURN PATH PROFILE

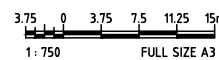


Prime mover and semi-trailer (19 m)	19.000m
Overall Length	2.500m
Overall Width	4.300m
Overall Body Height	0.540m
Min Body Ground Clearance	2.500m
Track Width	6.00s
Lock-to-lock time	12.500m
Curb to Curb Turning Radius	

GENERAL NOTES

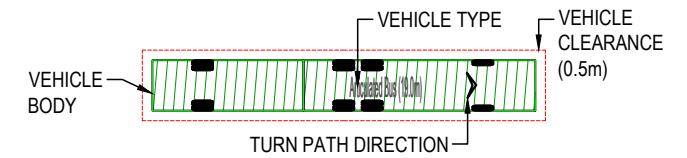
1. NO ASSESSMENT HAS BEEN UNDERTAKEN OF EXISTING INTERSECTION ARRANGEMENT OR EXISTING PAVEMENTS.
2. TURN PATHS PRESENTED IS THE INTENDED OPERATIONS OF TRAFFIC ASSOCIATED WITH GOULBURN SOLAR FARM. ONLY THE DISPLAYED MOVEMENTS WILL BE PERMITTED.

FOR INFORMATION ONLY

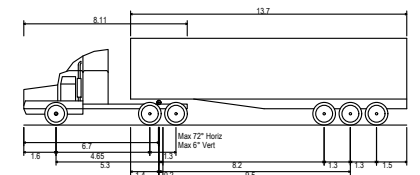




VEHICLE TURN PATH LEGEND



VEHICLE TURN PATH PROFILE

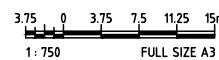


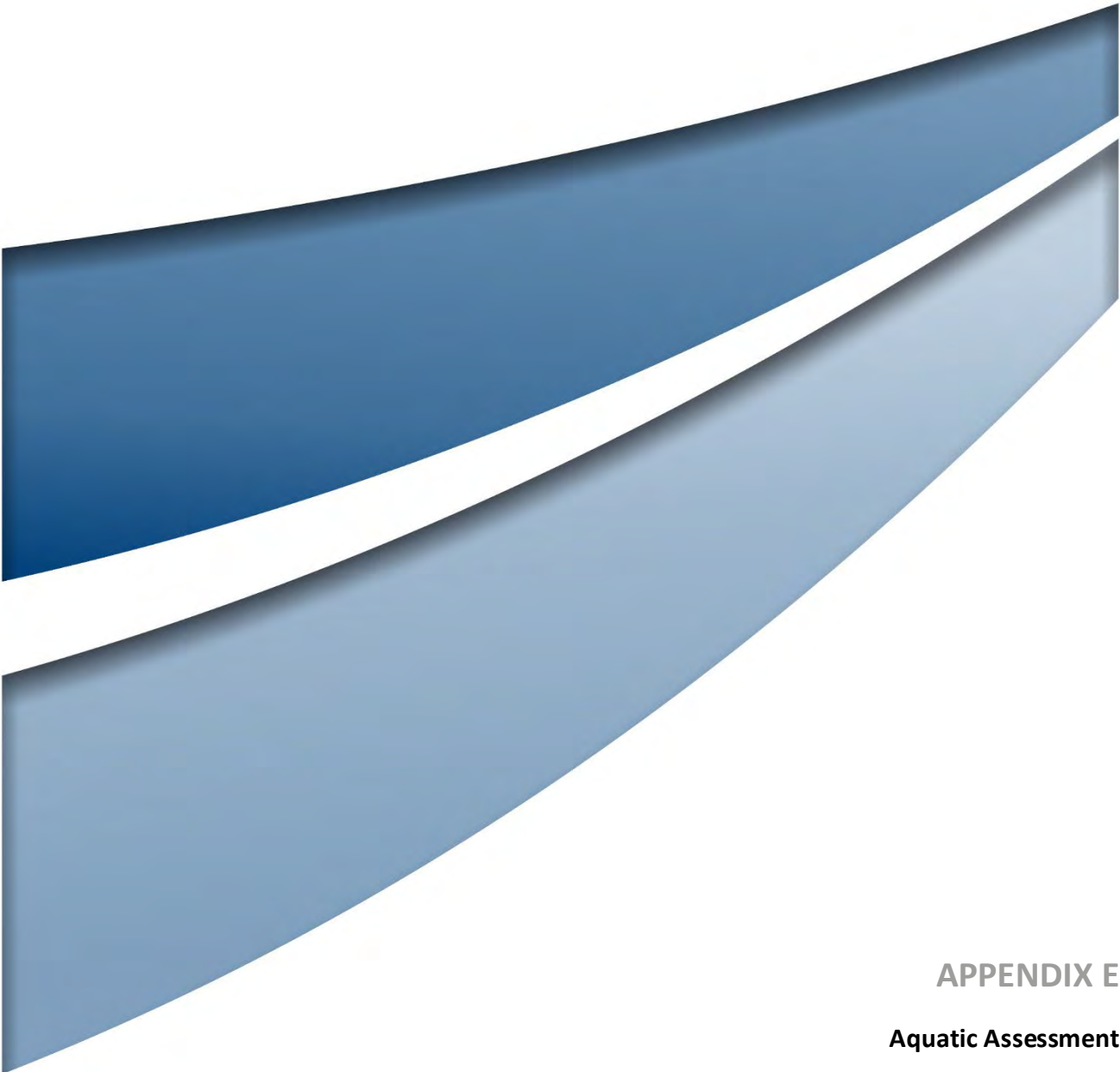
Prime mover and semi-trailer (19 m)	19.000m
Overall Length	2.500m
Overall Width	4.300m
Overall Body Height	0.540m
Min Body Ground Clearance	2.500m
Track Width	6.00s
Lock-to-lock time	12.500m
Curb to Curb Turning Radius	

GENERAL NOTES

1. NO ASSESSMENT HAS BEEN UNDERTAKEN OF EXISTING INTERSECTION ARRANGEMENT OR EXISTING PAVEMENTS.
2. TURN PATHS PRESENTED IS THE INTENDED OPERATIONS OF TRAFFIC ASSOCIATED WITH GOULBURN SOLAR FARM. ONLY THE DISPLAYED MOVEMENTS WILL BE PERMITTED.

FOR INFORMATION ONLY





APPENDIX E
Aquatic Assessment

UMWELT

Wollara Road, Merriwa
Goulburn River Solar Farm



Aquatic Assessment

Job No: 220222

Date: 01/12/2023



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Goulburn River Solar Farm: Aquatic Assessment

Version	Date	Description	Author
1	27/05/2022	1 st Draft	K. McQueen
2	28/09/2022	Final	K. McQueen
3	04/11/2022	Final - updated Project Area	K. McQueen
4	03/02/2023	Final - included cumulative impacts	K. McQueen
5	10/03/2023	Final - updated Project Area (09/03/2023)	K. McQueen
6	20/04/2023	Final - updated Project Area (09/03/2023)	K. McQueen
7	28/04/2023	Final - updated access roads (09/03/2023)	K. McQueen
8	20/11/2023	Final - updated development footprint (17/11/2023) and to support the Amendment Report	K. McQueen
9	01/12/2023	Final - updated development footprint (21/11/2023) and to support the Amendment Report	K. McQueen

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Executive Summary

The project

Lightsource Development Services Australia Pty Ltd (Lightsource bp) proposes to develop a solar farm in the Upper Hunter region of New South Wales (NSW), approximately 28 kilometres (km) south-west of the township of Merriwa within the Upper Hunter Local Government Area (LGA).

The proposed Goulburn River Solar Farm (the project) includes the construction, operation, maintenance and decommissioning of solar photovoltaic (PV) generation with a Battery Energy Storage System (BESS) with 450 MWp and 900 megawatt hour (MWh) capacity along with the option of a decentralised BESS (including the option to host both centralised and decentralised BESS) units with an approximate 580 MWp and 1,160 MWh capacity. The project will also include supporting infrastructure, a transmission tower, a substation and connection to an existing 500 kilovolt (kV) transmission line.

This report

This Aquatic Biodiversity Impact Assessment has been prepared on behalf of Umwelt to support the Environmental Impact Statement (EIS) for the project and responds to the Secretary's Environmental Assessment Requirements (SEARs) for the aquatic ecosystem. This assessment has been updated to address project changes made in response to submissions during the public exhibition and supports the Project Amendment Report. This report only addresses aquatic values associated with the solar farm. Aquatic values associated with road upgrades are assessed in the Public Roads and Culverts Biodiversity Development Assessment Report (BDAR).

The assessment presented in this report has included a review of relevant legislation, consideration of the existing conditions, an impact assessment to determine the significance of impacts to aquatic biodiversity as a direct result of the construction, operation and decommissioning of the project and the potential impacts of the project on threatened aquatic species which are predicted to occur within the study area (defined here as a 10 kilometre (km) buffer around the Project Area). Recommended mitigation and management measures are identified.

This report builds on findings of both BDARs and the Water Resources Assessment prepared by Umwelt (2023).

Existing aquatic environment

The Project Area is located within the catchment of the Goulburn River in east New South Wales, which is in the Hunter/Central Rivers Catchment Management Authority. The Goulburn River is the largest tributary of the Hunter River and accounts for 40 per cent of the Hunter Rivers catchment area but contributes only 23 per cent of its flow.

Within the Project Area, there are 90 mapped hydrolines including 69 first order watercourses, 18 second order watercourses and three third order watercourses which eventually flow into the Goulburn River. Five watercourses have been mapped as key fish habitat (KFH) (DPI, 2007) within the Project Area, however, except for Redlynch Creek, all are highly ephemeral, only holding water for a short time following rainfall and receding rapidly, leaving very few remnant pools for fish refuge. Redlynch Creek contained remnant pools and some flowing water at the time of survey and has a farm dam constructed within the watercourse. None of the watercourses within the Project Area contained important habitat features such as aquatic plants (macrophytes), bank overhang, trailing bank vegetation, riffle sections or woody debris/snags (except for Monaghans Creek which was dry at the time of survey but did contain woody debris). All watercourses and riparian zones were modified by agricultural land practices, including complete removal of the riparian vegetation to top of bank in most areas.

Potential impacts from the project

The three watercourses (or sections of) mapped as KFH (DPI,2007) that occur within the Development Footprint include:

- Redlynch Creek, including unnamed tributaries
- an unnamed tributary of Pogy Creek
- an unnamed tributary of Rocky Creek.

The design phase of the project has mostly excluded these three watercourses from the Development Footprint. It is noted that while they are mapped by DPI (2007) as KFH, following assessment they were defined as Type 3 minimally sensitive KFH due to their highly ephemeral nature and lack of important habitat features.

Twenty-two farm dams occur in the Project Area, however following design changes, only two farm dams occur within the Development Footprint and subsequently would require dewatering.

Direct impacts from the project on aquatic biodiversity would include potential blockage of fish passage (during floods) where filling is required for access roads infrastructure across KFH watercourses, potential modification to riparian habitat through the spread of exotic flora, potential mortality to protected aquatic fauna during farm dam dewatering and filling and potential impacts on water quality through disturbance of soil on waterfront land. Potential indirect impacts to aquatic biodiversity relate to the mobilisation of poor-quality stormwater runoff from construction activities including vegetation removal, earthworks, establishment and use of construction compounds, trenching and access roads and pollution downstream and potential mortality to aquatic flora and fauna.

Following assessment, all watercourses within the study area were considered to have a low or negligible risk of potential impact from the project during construction, operation and decommissioning due to the highly ephemeral nature of the watercourses, the lack of important KFH features and or the minor nature of works proposed within the catchment of these watercourses.

Potential risks can be managed in ephemeral watercourses by:

- undertaking construction when watercourses are dry (where practicable) as aquatic fauna species would not be present
- implementing appropriate erosion and sediment control measures
- installing fish friendly crossings (in accordance with relevant guidelines) where filling for access roads is proposed across watercourses mapped as KFH (DPI, 2007)
- avoiding all construction activities, including tree removal and re-fuelling of vehicles and other machinery, on waterfront land (i.e., land 40 metres from the top of bank, where watercourses have a defined bed and banks)
- re-instating watercourse bed and banks where these are disturbed by project construction activities in areas mapped as KFH (DPI, 2007).

Potential indirect risks to the perennial watercourse (Goulburn River), which occurs outside of the Project Area, can be managed through the implementation of appropriate erosion and sediment control measures on upstream watercourses during construction.

Threatened species, populations and ecological communities

Following a likelihood of occurrence assessment, the broader study area was considered to provide possible or likely habitat for the following two threatened entities listed under the *Fisheries Management Act 1994* (FM Act):

1. Darling River Hardyhead (*Craterocephalus amniculus*), Endangered population
2. Southern Purple-Spotted Gudgeon (*Mogurnda adspersa*), Endangered species.

Fisheries Management Act

Assessments of significance of impact under the FM Act concluded that the project was unlikely to have an adverse effect on the life cycle of Darling River Hardyhead or Southern Purple Spotted Gudgeon such that a viable local population of these species is likely to be placed at risk of extinction. This was based on the lack of important habitat features for these species within the Project Area and the relatively minor nature of works. Potential indirect impacts on water quality associated with the mobilisation of sediments is relevant to all watercourses within the study area, however, this can be managed using standard erosion and sediment control measures during the construction, operation and decommissioning phases of the Project. Thus, the level of impact to the aquatic environment and threatened aquatic species is considered minor.

In relation to the habitat of threatened species/populations, only Goulburn River contained potential habitat for these two threatened entities. The project does not result in any direct impacts to the Goulburn River and potential indirect impacts can be mitigated through appropriate erosion and sediment control. Thus, the habitat of these threatened species/populations will not be removed or significantly modified, nor will the habitat become fragmented or isolated from other areas of habitat because of the project.

In terms of the importance of the habitat for these species, Goulburn River was mapped as within the indicative distribution for the Darling River Hardyhead but not the Southern Purple Spotted Gudgeon. It is noted that many sections of the Goulburn River within the study area have been highly modified through land use practices in the catchment, with intensive farming practices including extensive clearing of riparian vegetation to the bank, reducing the presence of aquatic vegetation, detritus, trailing bank vegetation and snags, which are important habitat features for these species. Thus, the existing habitat in the Goulburn River within the study area is likely to be of low importance to the long-term survival of these threatened species/populations.

The project is not inconsistent with any priority action statements for the assessed threatened species and population as most recovery actions listed are not directly relevant to the project, except for habitat rehabilitation, which would be undertaken in accordance with the Biodiversity Management Plan for the project. The key threatening process (KTP) 'installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams' is the only KTP that would be impacted by the project. Any crossings over KFH would be designed to minimise impacts to natural flows.

Environment Protection and Biodiversity Conservation Act

No Matters of National Environmental Significance (MNES) relevant to this aquatic ecology study were identified as likely to occur within the study area during desktop review. As such, no further assessment was required under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Impacts on sensitive areas

KFH within the study area was based on existing KFH mapping by DPI (2007), watercourse sensitivity type (DPI, 2013) and class (Fairfull and Witheridge, 2003), which were defined following site inspection. Only instream habitat (top of bank to top of bank) is defined as KFH.

All watercourses within the Project Area were defined as Type 3 minimally sensitive KFH due to their highly ephemeral nature and the absence of fish habitat features. Regardless, the Development Footprint covers mapped KFH along the following watercourses:

- Redlynch Creek
- unnamed tributary of Poggys Creek
- unnamed tributary of Rocky Creek.

Where filling of watercourses mapped as KFH is proposed for the construction of access roads, appropriate fish passage would be maintained through the installation of a high flow design culvert. As such, fish passage would be maintained and KFH would not be permanently lost or disrupted so no aquatic biodiversity offset would be required.

Waterfront land includes the bed and bank of watercourses and all land within 40 metres of the highest bank (DPI, 2012). However, watercourses lacking defined bed and banks are not typically associated with waterfront land. Within the Development Footprint, only Redlynch Creek and an unnamed tributary of Rocky Creek have defined bed and banks and as such, these watercourses have associated waterfront land. Where possible, construction works would not be undertaken on waterfront land. Any disturbance to waterfront land would be remediated as detailed in the Biodiversity Management Plan.

No aquatic groundwater dependent ecosystems (GDEs) were identified in the study area.

This assessment also concluded that the potential cumulative impacts of the project (known at the time of assessment) combined with four other major projects occurring within the Goulburn River catchment was unlikely to be significant, provided the biodiversity management plans for each project are implemented, maintained and monitored.

Recommended mitigation measures

Potential impacts to aquatic ecosystems during construction would be reduced if:

- appropriate erosion and sediment controls are implemented
- construction works, including refuelling of machinery, avoid waterfront land
- there are onsite spill kits for construction works within 100 metres of a watercourse
- instream construction works (for access roads) are conducted when watercourses are dry (where practicable)
- any instream structures are designed using relevant guidelines (to maintain fish passage and minimise impacts to natural flow regimes), particularly on watercourses mapped as KFH
- disturbed bed and banks of watercourses mapped as KFH are rehabilitated with stabilising vegetation.

During operation and decommissioning, potential impacts would be reduced through:

- the routine maintenance of vehicles (to reduce the risk of oil spills etc)
- the routine maintenance of culverts under access roads (to ensure they are clear of debris)
- minimal use of herbicides to control exotic species (to reduce pollutants entering downstream watercourses)
- the re-establishment of native riparian vegetation endemic to the region and aquatic habitat features within and on the banks of any watercourses directly impacted.

Conclusion

The aquatic biodiversity impact assessment concludes that the impacts of the project would not significantly compromise the functionality, long-term connectivity or viability of habitats, or ecological processes within watercourses in the study area. Most of the potential construction impacts are associated with indirect impacts on water quality and would therefore be temporary and managed through the adoption of recommended mitigation measures. Impacts on threatened species and endangered populations listed under the FM Act are considered unlikely due to the minor nature of works and the highly ephemeral nature of most watercourses within the Project Area. The Goulburn River is the only perennial watercourse in the study area, however direct instream impacts at this location will not occur and potential indirect impacts can be managed. As such, the project is unlikely to significantly impact the habitat of threatened aquatic species or endangered populations.

Glossary and abbreviations

ALA	Atlas of living Australia
AUSRIVAS	Australian River Assessment System
BC Act	<i>Biodiversity Conservation Act 2016 (NSW)</i>
BDAR	Biodiversity Development Assessment Report
BESS	Battery Energy Storage System
CEMP	Construction Environmental Management Plan A site-specific plan developed for the construction phase of a project, to ensure that all contractors and sub-contractors comply with the environmental conditions of approval for the project and manage environmental risks properly.
CMA	Subregion Catchment Management Authority Subregion
Cumulative impacts	Impacts that, when considered together, have different and/or more substantial impacts
DCCEEW	Department of Climate Change, Energy, the Environment and Water
Development Footprint	The area directly impacted by the project, being approximately 792.19 ha.
DPE	Department of Planning and Environment
DPI	Department of Primary Industries - Fisheries NSW
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EPs	Endangered Populations
EP&A Act	<i>Environmental Planning and Assessment Act 1979 (NSW)</i>
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)</i>
FM Act	<i>Fisheries Management Act 1994 (NSW)</i>
IBRA	Interim Biogeographic Regionalisation for Australia (Version 7)
KFH	Key Fish Habitat
KTP	Key Threatening Process
Locality	Includes the four Local Government Areas (LGAs) surrounding the Project Area: Upper Hunter, Warrumbungle, Mid-Western Regional and Muswellbrook.
MGA	Map Grid of Australia 94, Zone 56 (easting-northing)
MNES	Matters of national environmental significance
MWh	Megawatt hour
MWp	Megawatt peak

NRAR	Natural Resources Access Regulator
NSW	New South Wales
NPW Act	<i>National Parks and Wildlife Act</i>
OEH	Office of Environment and Heritage (NSW) (NB. The functions of OEH were transferred to the Environment, Energy & Science Group within DPIE (now DPE) on 1 July 2019)
PCT	Plant Community Type
PMST	Protected Matters Search Tool
the Project	the Project would include the construction, operation, civil works, maintenance and decommissioning of the proposed solar farm and Battery Energy Storage System (BESS), as well as associated infrastructure.
the Project Area	the Project Area comprises two freehold properties that span across multiple lots, covering an area of approximately 1,996.5 ha.
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSD	State Significant Development
Strahler Stream Order	Classification system that gives a waterway an 'order' according to the number of tributaries associated with it. Mapped at 1:50 000 scale
study area	The wider area, including and surrounding the Project Area, with the potential to be directly or indirectly affected by the project and the area defined for desktop studies. The extent of the study area for the Aquatic Assessment includes a 10 km buffer around the Project Area.
Survey site	The location (100 metre reach along watercourses crossed by the study area) within which habitat assessments and surveys were undertaken.
TEC	Threatened Ecological Community

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1. Introduction

Lightsource Development Services Australia Pty Ltd (Lightsource bp) proposes to develop a solar farm in the Upper Hunter region of New South Wales (NSW), approximately 28 kilometres (km) south-west of the township of Merriwa within the Upper Hunter Local Government Area (LGA).

The proposed Goulburn River Solar Farm (the project) includes the construction, operation, maintenance and decommissioning of approximately 1,030 megawatt peak (MWp) of solar photovoltaic (PV) generation with a centralised Battery Energy Storage System (BESS) and the option of a decentralised BESS including the option to host both centralised and decentralised BESS units. The project will also include supporting infrastructure, a transmission tower, a substation and connection to an existing 500 kilovolt (kV) transmission line.

The project location and regional context are shown in Figure 1-1.

1.1 Background

The Project Area is located between Merriwa (to the north-east) and Coggan (to the south-east) NSW, surrounded by the Goulburn River National Park. The main Project Area is located on freehold land, while parts of Wollara Road which provides access to the site, are located on Crown land. The Project Area comprises two freehold properties that span across multiple lots, covering an area of approximately 1,996.5 ha with the development footprint occupying approximately 792.19 ha (Figure 1-2).

The Project Area is near the Central West Orana Renewable Energy Zone (REZ) however the Project is not related to the REZ, nor is it dependent on the REZ establishment. The REZ location was selected because of the benefits of relatively low transmission build costs due to its proximity to the existing transmission network structures. Similarly, the Project Area benefits from the existing 500 kV transmission line crossing the south-east portion of the site, allowing easy connection to the national electricity grid.

Based on the proximity of the project to the REZ, it is also expected to support the local uptake and use of renewable energy, contribute to achieving State and Federal targets for establishing renewable energy generation within NSW, and provide similar economic and social benefits to the regional community. As part of the Upper Hunter region, the Project Area is also in proximity to the Hunter-Central Coast REZ .

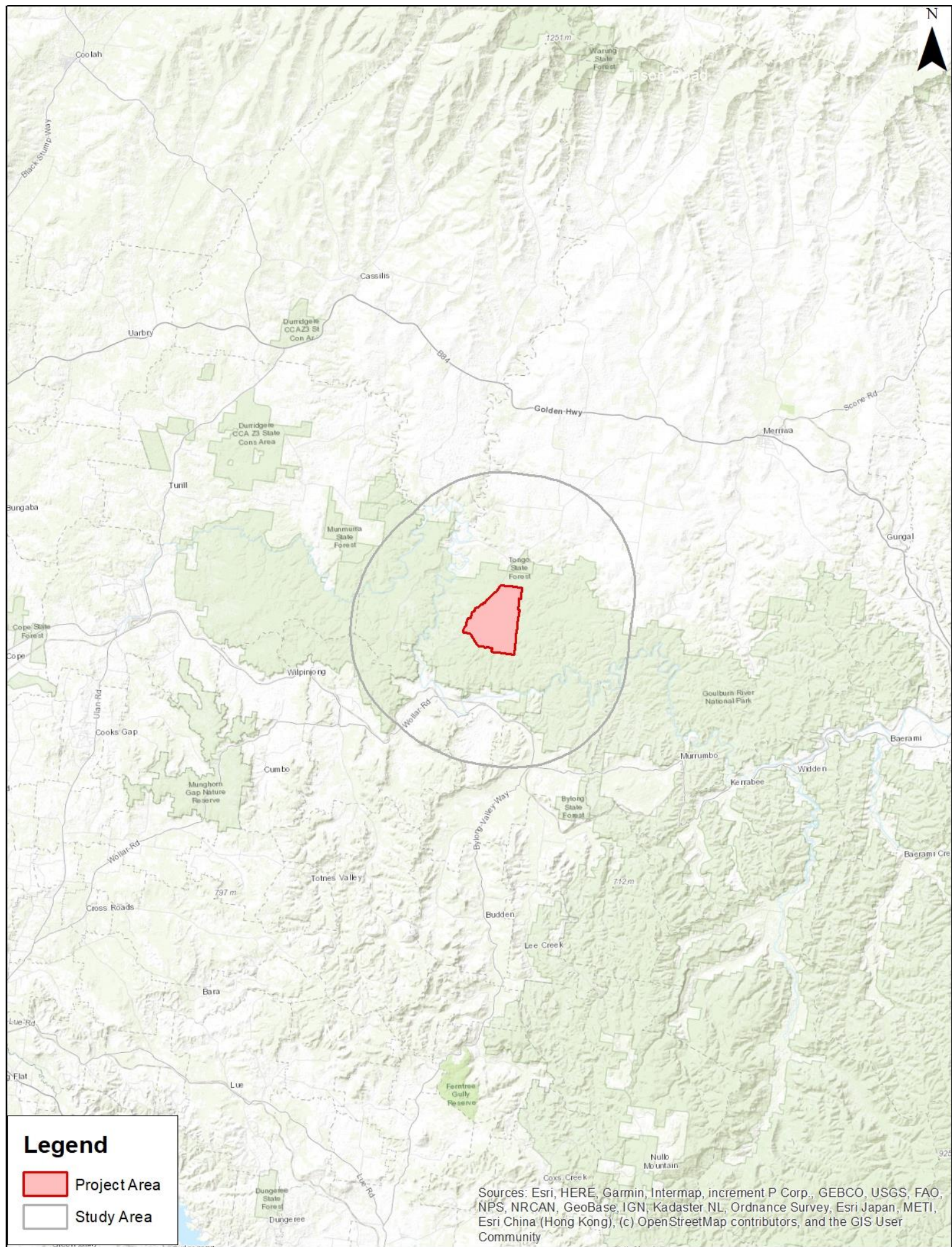
1.2 Project Overview

Subject to the final design process, the key components of the Project include:

- Approximately 1 million bifacial solar PV modules in an east-west single-axis tracking arrangement
- A centralised BESS with an approximate 450 MWp and 900 MWh capacity, housed in a series of outdoor containers, either distributed across the site or aggregated in one central location
- The option of a decentralised BESS (instead of or in combination with centralised BESS) with an approximate 580 MWp and 1,160 MWh capacity involving 560 individual 6.1 m battery containers and DC-DC converters, and associated infrastructure being situated next to the PV inverter stations located throughout the solar arrays, rather than in a centralised location
- Onsite 500 kV switchyard and substation, with underground electrical conduits and cabling leading into the yard and overhead lines reaching above to the existing transmission line
- Communications tower, up to 30 m high, providing communications, radio and cellular services to the site and the wider region
- Internal and perimeter gravel access roads allowing for site maintenance
- Temporary construction facilities
- Site office and operations and maintenance building with parking for the operations team

- Primary access point from existing driveway off Wollara Road, with two additional emergency access points proposed along the north-western boundary of the Project Area and upgrades to Ringwood Road. Note that these are assessed in the Public Roads and Culverts Biodiversity Development Assessment Report (BDAR).
- Drainage line crossings, if and where required, to manage existing surface water flows
- Perimeter security fencing, crossing gates, water tanks or dams, and internal access points to facilitate sheep grazing.

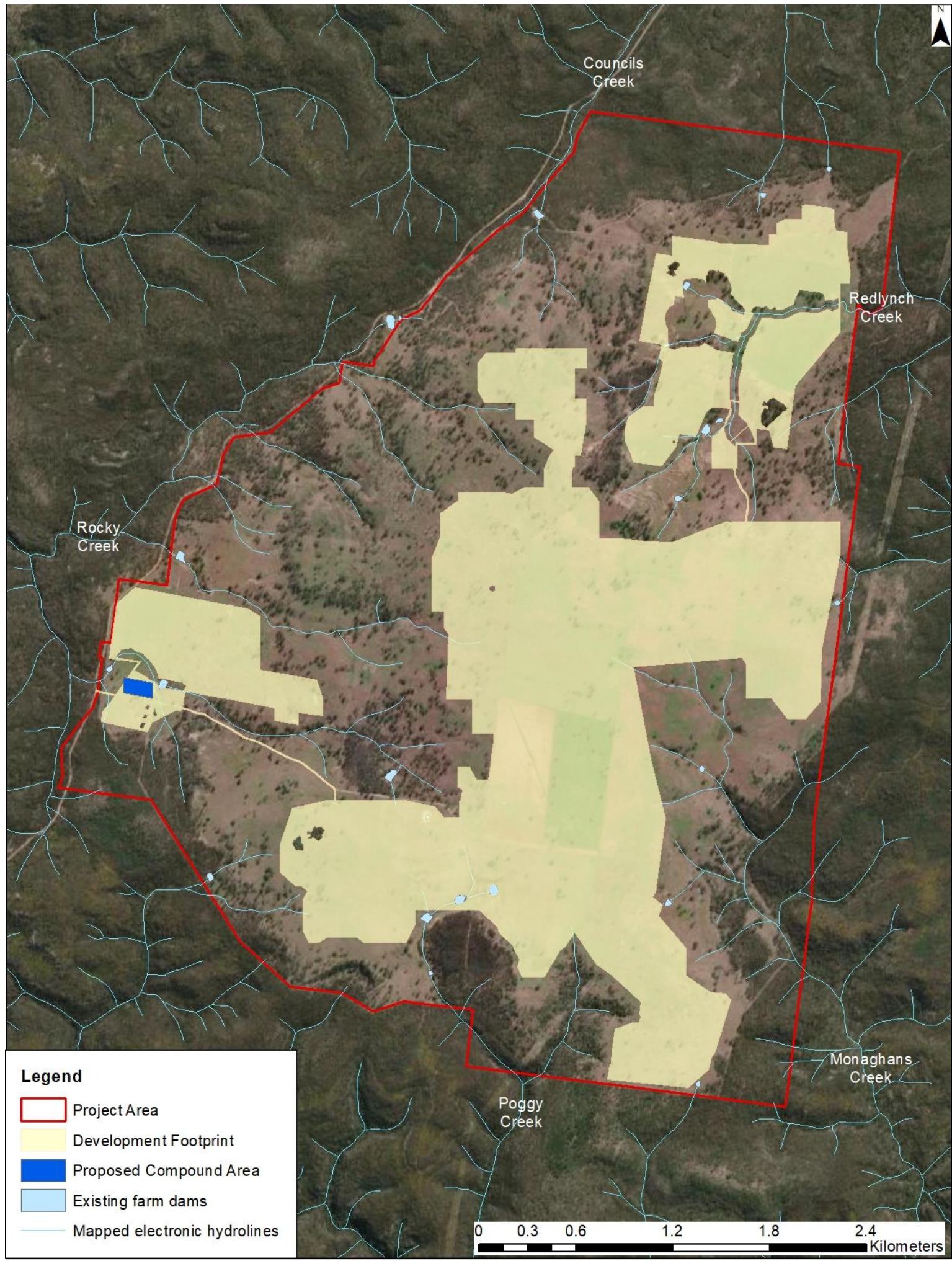
Detailed descriptions of the project components are contained in the Environmental Impact Statement (EIS) and Amendment Report.



Legend

- Project Area
- Study Area

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community



1.2.1 Timing

The project is expected to operate for 40 years or more. After the initial 40-year operating period, the solar farm would either be decommissioned, removing all above ground infrastructure, and returning the site to its existing land capability, or repurposed with new PV equipment subject to technical feasibility and planning consents.

1.3 Purpose and scope of this report

The EIS has been prepared in line with the State Significant Development Guidelines - Preparing an Environmental Impact Statement (DPIE, 2021) and assesses the potential impacts associated with the project in accordance with the Secretary's Environmental Assessment Requirements (SEARs), issued on 1 February 2022. This assessment has been updated to address project changes made in response to submissions during the public exhibition and supports the Project Amendment Report. This report only addresses aquatic values associated with the solar farm. Aquatic values associated with road upgrades are assessed in the Public Roads and Culverts BDAR.

The aquatic assessment specifically addresses the SEARs relevant to the assessment of the aquatic environment (refer Table 1-1).

Specifically, this assessment:

- Describes the existing aquatic environment in terms of ecological values, including type and condition of aquatic habitats.
- Determines the presence or likelihood of occurrence of threatened species, populations and endangered ecological communities (EECs) as listed under the *Fisheries Management Act 1994* (FM Act).
- Determines the presence or likelihood of occurrence of matters of national environmental significance (MNES) as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Identifies threatened fish species, populations and EECs within the locality that have the potential to be impacted by the project.
- Assesses the impact of the project on threatened fish species, populations and ecological communities.
- Assesses the impact of the project on protected and sensitive lands.

Table 1-1. SEARs relevant to the assessment of aquatic biodiversity

Key Issue	Report Reference
<p>Biodiversity</p> <p>The EIS must include:</p> <ul style="list-style-type: none"> • an assessment of the likely impacts on listed aquatic threatened species, populations or ecological communities, scheduled under the <i>Fisheries Management Act 1994</i> (FM Act), and a description of the measures to minimise and rehabilitate impacts, and • if an offset is required, details of the measures proposed to address the offset obligations. 	<p>Section 5.4 includes assessment of impacts on threatened aquatic species, populations and ecological communities (listed under the FM Act) that are predicted in the study area.</p> <p>Section 5.6.1 addresses offset requirements</p>

1.4 Structure of this report

The structure of the report is outlined below:

Chapter 1 - provides an introduction to the report and outlines relevant SEARs to be addressed.

Chapter 2 - provides an overview of relevant legislation, policies and guidelines applicable to the assessment.

Chapter 3 - describes the methodology and approach for the assessment.

Chapter 4 - describes the existing environment with respect to catchments, watercourses and threatened aquatic species and ecological communities found within the study area.

Chapter 5 - provides an assessment of the impacts to aquatic biodiversity from the construction, operation and decommissioning of the project and potential impacts on threatened species, populations and EECs. It also considers cumulative impacts on aquatic biodiversity from the combined effects of the project and any adjacent projects.

Chapter 6 - provides recommended avoidance and mitigation measures.

Chapter 7 - provides a summary of findings and conclusion.

Chapter 8 - provides a full reference list.

2. Legislative and policy context

2.1 Legislation

2.1.1 NSW legislation

2.1.1.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) and *Environmental Planning and Assessment Regulation 2021* (EP&A Regulation) establish a framework for the assessment and approval of developments in NSW. They also provide for the making of environmental planning instruments, including state environmental planning policies (SEPPs) and local environmental plans (LEPs), which determine the permissibility and approval pathway for development proposals and form a part of the environmental assessment process.

Section 4.36 of the EP&A Act provides for the declaration of a project as State Significant Development (SSD). Under the EP&A Act, the declaration of a project as SSD can be made by meeting the requirements of a SEPP or by the Minister for Planning and Homes.

Clause 20 of Schedule 1 of Planning Systems SEPP prescribes that development for the purpose of ‘electricity generating works’ that has a capital investment value of more than \$30 million is SSD. The project has a capital investment value of greater than \$30 million. Therefore, the project is declared as SSD and the development application for the project will be subject to the requirements of Division 4.7 of the EP&A Act. The development application will be lodged with the Planning Secretary of the Department of Planning and Environment (DPE).

The Minister for Planning and Homes is the consent authority for SSD projects. Section 4.5(1) of the EP&A Act also provides that the Independent Planning Commission (IPC) is the consent authority for SSD where it is declared to be the consent authority under an EPI. The Minister for Planning and Public Spaces has issued a general delegation of the consent authority function for SSD projects to the IPC in instances where more than 50 public objections are received on the application, where the applicant has made a reportable political donations disclosure and/or where the Local Council objects to the Project.

Section 4.41 of the EP&A Act identifies various authorisations which are not required for an SSD project. Of relevance to this assessment, the following authorisations are not required for approved SSD (and accordingly the provisions of any Act that prohibit an activity without such an authority do not apply):

- a permit under section 201, 205 or 219 of the FM Act
- a water use approval under section 89, a water management work approval under section 90 or an activity approval (other than an aquifer interference approval) under section 91 of the *Water Management Act 2000* (WM Act).

2.1.1.2 Fisheries Management Act 1994

The FM Act provides for the conservation, protection and management of fisheries, aquatic systems and habitats in NSW. The FM Act establishes mechanisms for:

- the listing of threatened species, populations and ecological communities or key threatening processes,
- the declaration of critical habitat, and
- consideration and assessment of threatened species impacts in the development assessment process.

Part 7A, section 221ZT(a) of the FM Act relates to the environmental assessment under Part 4 of the EP&A Act. Section 4 of this report identifies threatened species, populations and ecological communities listed under Schedule 4, 4A and 5 of the FM Act which are predicted to occur in the locality. In accordance with sections 221ZV and 221ZX of the FM Act, Appendix A of this report assesses likely impacts of the project (assessment of significance) on these listed species and Section 5 summarises the impacts of the project on threatened entities.

Construction works on watercourses do not require a permit for ‘dredging’ or ‘reclamation’ (section 201), harm to marine vegetation (section 205) or blockage of fish passage (section 219) in accordance with section 4.41 of the EP&A Act (approvals/legislation that do not apply for SSD). Regardless of the exemption to obtain permits, this assessment has considered potential impacts on watercourses based on fish habitat type as defined in *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013).

Schedule 6 of the FM Act outlines the key threatening processes (KTPs) related to aquatic species and ecological communities. These are considered in section 5.4.2.

2.1.1.3 Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) aims to avoid, minimise and offset impacts on biodiversity from development and conserve biodiversity at a bioregional and state scale. It lists a number of threatened species, populations and ecological communities to be considered in deciding whether there is likely to be a significant impact on threatened biota, or their habitats.

A Biodiversity Development Assessment Report (BDAR) has been prepared by Umwelt (2023) in accordance with Section 7.9 of the BC Act as part of the EIS. No threatened aquatic species listed under the BC Act were identified within the locality during database searches (section 4.8.1).

Groundwater dependent ecosystems (GDEs) protected under the BC Act have been identified within the study area and considered in section 4.4.

2.1.1.4 Water Management Act 2000

The WM Act recognises the need to allocate and provide water for the environmental health of our rivers and groundwater systems, while also providing licence holders with access to water. The object of the WM Act is the sustainable and integrated management of the state’s water sources for the benefit of present and future generations.

Part 3 of the WM Act establishes three types of approvals that may be required to obtain. These are:

- water use approvals
- water management work approvals (water supply work approvals, drainage work approvals and flood work approvals)
- activity approvals (controlled activity approvals and aquifer interference approvals).

As noted above, under section 4.41 of the EP&A Act, approved SSD does not require a water use approval under section 89, a water management work approval under section 90 or an activity approval under section 91 of the WM Act. The aquifer interference approval provisions of the WM Act have not been activated in NSW at this stage, so there is no requirement for an aquifer interference approval.

The design and construction of the project would consider the *Guidelines for Controlled Activities on Waterfront Land: Riparian Corridors* (Department of Industry 2018; section 2.1.2.5) to enable the mitigation of potential impacts to water quality.

The impacts of the project on waterfront land are considered in section 5.6.2.

2.1.2 Policy and guidelines

Policy and guidelines are discussed in the following sections.

2.1.2.1 Policy and Guidelines for Fish Habitat Conservation and Management

The *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) outlines policies and guidelines aimed at maintaining and enhancing fish habitat for the benefit of native fish species, including threatened species, in marine, estuarine and freshwater environments.

It is applicable to all planning and development proposals and various activities that affect aquatic ecosystems in NSW.

One of the key objectives of the FM Act is to conserve ‘key fish habitats’ (KFH). KFH’s are defined in the policy and guidelines to include all marine and estuarine habitats up to highest astronomical tide level (that reached by ‘king’ tides) and most permanent and semi-permanent freshwater habitats including rivers, creeks, lakes, lagoons, billabongs, weir pools and impoundments up to the top of the bank. Small headwater creeks and gullies (known as first and second order streams), that only flow for a short period after rain are generally excluded, as are farm dams constructed on such systems. Wholly artificial waterbodies such as irrigation channels, urban drains and ponds, salt and evaporation ponds are also excluded except where they are known to support populations of threatened fish or invertebrates.

The Department of Primary Industries - Fisheries (DPI) assesses activity and development proposals in relation to consideration for the ‘sensitivity’ of the affected fish habitat. In this context, ‘sensitivity’ is defined by the importance of the habitat to the survival of fish and ability to withstand disturbance.

If the aquatic habitat in question is defined as KFH, it is then assigned a fish habitat sensitivity ranking which is used within the policy and guideline statements to differentiate between permissible and prohibited activities or developments related to the importance of the ‘type’ of KFH. Table 2-1 defines those types of habitats that are considered KFH for the purpose of the application of the FM Act.

It is noted that for the purposes of the policy and guidelines, first and second order streams on gaining streams (streams where the channel bottom is lower than the level of the surrounding groundwater table so that water potentially moves from the ground into the channel) are not considered KFH. In addition, the definition of “fish” includes not only fin fish, but also crustaceans, molluscs, worms, insects and other invertebrates that spend all or part of their life cycle in aquatic habitats.

Table 2-1. Key fish habitat and sensitivity classification scheme (DPI, 2013)

Sensitivity Ranking	Waterway Description
TYPE 1 Highly sensitive key fish habitat	<ul style="list-style-type: none"> Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 metres in length, or native aquatic plants Any known or expected protected or threatened species habitat or area of declared ‘critical habitat’ under the FM Act
TYPE 2 Moderately sensitive key fish habitat	<ul style="list-style-type: none"> Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in TYPE 1 Weir pools and dams up to full supply level where the weir or dam is across a natural waterway
TYPE 3 Minimally sensitive key fish habitat may include	<ul style="list-style-type: none"> Coastal and freshwater habitats not included in TYPES 1 or 2 Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation

The policy and guidelines also state that *“to ensure “no net loss” of aquatic habitats, NSW DPI requires that proponents should, as a first priority, aim to avoid impacts upon KFH. Where avoidance is impossible or impractical, proponents should then aim to minimise impacts. Any remaining impacts should then be offset with compensatory works”*.

KFH maps have been compiled by DPI and are considered in section 3.4.1 and the impacts of the project on KFH are discussed in section 5.6.1.

2.1.2.2 Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings

Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (Fairfull and Witheridge, 2003) provides guidelines for the planning, design, construction and maintenance of watercourse crossings aimed at minimising impacts on fish passage and aquatic biodiversity. The guidelines outline types of potential impacts from instream structures and subsequently provides guidance on suitable crossing structures to avoid barriers to fish passage.

DPI considers proposals in relation to habitat sensitivity type (Table 2-1) and also waterway class. The waterway classification scheme has been adapted from Fairfull and Witheridge (2003) and factors in the functionality of the waterway as fish habitat (Table 2-2). Watercourses are classified using indicators such as:

- hydraulic geometry (stream shape and size),
- frequency of stream flows (perennial, intermittent or ephemeral),
- presence of aquatic habitat units (pools, riffles, vegetation, snags),
- presence of threatened or protected fish species and other native fish, and
- connection to adjacent habitats (e.g. floodplain wetlands).

Waterway class can be used to assess the impacts of certain activities on fish habitats in conjunction with the habitat sensitivity type. The waterway class scheme can also be used to make management recommendations to minimise impacts on different fish habitats.

Table 2-2. Classification of waterways for fish passage (Fairfull & Witheridge, 2003)

Classification	Characteristics of waterway class	Minimum [1] Recommended Crossing type
Class 1 Major key fish habitat	Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected fish species or 'critical habitat'.	Bridge, arch structure or tunnel
Class 2 Moderate key fish habitat	Non-permanently flowing (intermittent) stream, creek or waterway (generally named) with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Freshwater aquatic vegetation is present. TYPE 1 and 2 habitats present.	Bridge, arch structure, culvert [2] or ford.
Class 3 Minimal key fish habitat	Named or unnamed waterway with intermittent flow and sporadic refuge, breeding or feeding areas for aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or other CLASS 1-3 fish habitats.	Culvert [3] or ford
Class 4 Unlikely key fish habitat	Waterway (generally unnamed) with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free standing water or pools post rain events (e.g. dry gullies or shallow floodplain depressions with no aquatic flora present).	Culvert [4], causeway or ford
Notes		
[1] In all cases bridges are preferred to arch structures, culverts, fords and causeways (in that order).		

Classification	Characteristics of waterway class	Minimum [1] Recommended Crossing type
	<p>[2] High priority given to the "High Flow Design" procedures presented for the design of these culverts - refer to Design Considerations section of this document, or engineering guidelines (Witheridge, 2002).</p> <p>[3] Minimum culvert design using the "Low Flow Design" procedures; however, "High Flow Design" and "Medium Flow Design" should be given priority where affordable (refer to Witheridge (2002)).</p> <p>[4] Fish friendly waterway crossing designs possibly unwarranted. Fish passage requirements should be confirmed with the local fisheries department/authority.</p>	

2.1.2.3 Threatened Species Survey and Assessment Guidelines

The NSW threatened species survey and assessment guidelines are referred to as the *Threatened Species Test of Significance Guidelines* (OEH, 2018).

The objective of section 7.3 of the BC Act, the test of significance, is to provide standardised and transparent consideration of threatened species and ecological communities, and their habitats, through the development assessment process.

The guidelines help applicants or proponents of a development or activity to interpret and apply the factors in the test. They also provide guidance for consent authorities to encourage a consistent method of assessment for applications that may have an impact on threatened species and ecological communities or their habitats. The guidelines relate to the determination of whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats, within the meaning of that phrase in section 7.3.

No aquatic threatened species or ecological communities listed under the BC Act were identified in desktop studies, hence these guidelines were not required for the aquatic impact assessment. These guidelines are relevant and considered further in the BDAR.

2.1.2.4 Aquatic Ecology in Environmental Impact Assessment - EIA Guideline

The aim of the guideline *Aquatic Ecology in Environmental Impact Assessment - EIA guideline* (NSW Department of Planning, 2003) (the EIA guideline) is to:

- Encourage a standardised, rigorous approach to aquatic investigations in environmental impact assessment.
- Provide information which can be used to understand and manage changes to the aquatic environment in NSW.

The guidelines provide reference for:

- The extent to which the existing environment needs to be described.
- The extent to which a proposal is likely to affect aquatic biodiversity.
- The minimal acceptable standard for assessment of potential impacts on aquatic biodiversity.
- Predicting cumulative impacts within a body of water.
- When monitoring should be done and what components of the aquatic environment (biotic and abiotic) should be monitored.
- Requirements for adequate information to manage potential impacts and initiate feedback from monitoring to management.

The existing environment, assessment and sampling methodology, potential impacts, as well as recommendations for mitigation measures which are outlined in this report have taken into consideration the EIA guidelines.

2.1.2.5 Guidelines for controlled activities on waterfront land

The *Guidelines for controlled activities on waterfront land: Riparian corridors* (DPI, 2018) include provision for the protection of waterfront land. Controlled activities include any works or any activity which affects the quantity or flow of water in a water source, carried out in, on, or under waterfront land.

Waterfront land includes the bed and bank of any river, lake or estuary and all land within 40m of the highest bank of the river, lake or estuary.

A key objective of these guidelines is to establish and preserve the integrity of riparian corridors. Ideally, the environmental functions of riparian corridors should be maintained or rehabilitated by applying the following principles:

- Identify whether or not there is a watercourse present and determine its order in accordance with the Strahler System.
- If a watercourse is present, define the riparian corridor/vegetated riparian zone (VRZ) on a map in accordance with Table 2-3.
- Seek to maintain or rehabilitate a riparian corridor/VRZ with fully structured native vegetation in accordance with Table 2-3.
- Seek to minimise disturbance and harm to the recommended riparian corridor/VRZ.
- Minimise the number of creek crossings and provide perimeter road separating development from the riparian corridor/VRZ.
- Locate services and infrastructure outside of the riparian corridor/VRZ. Within the riparian corridor/VRZ provide multiple service easements and/or utilise road crossings where possible.
- Treat stormwater run-off before discharging into the riparian corridor/VRZ.

Non-riparian corridor works such as infrastructure, can be authorised within the outer riparian corridor, so long as the average width of the VRZ can be achieved over the length of the watercourse within the development site.

While non-native vegetation may provide some bank stability, the objectives of the guidelines relate to the preservation and rehabilitation of native riparian vegetation in accordance with the minimum riparian corridor requirements.

Table 2-3. Recommended riparian corridor widths (DPI, 2018)

Watercourse type	VRZ width (each side of watercourse)	Total RC width
First order	10 metres	20 metres + channel width
Second order	20 metres	40 metres + channel width
Third order	30 metres	60 metres + channel width
Fourth order and greater	40 metres	80 metres + channel width

Note: Where a watercourse does not exhibit the features of a defined channel with bed and banks, the Natural Resources Access Regulator (NRAR) may determine that the watercourse is not waterfront land for the purposes of the WM Act.

The impacts of the project on riparian vegetation are considered in section 5.1.

2.1.3 Commonwealth legislation

2.1.3.1 Environment Protection and Biodiversity Conservation Act 1999

The objective of the EPBC Act is to protect and manage prescribed MNES. Under the EPBC Act, proposed 'actions' that have the potential to significantly impact on MNES, the environment of Commonwealth land, or that are being carried out by an Australian Government agency, must be referred to the Commonwealth Minister for the Environment for assessment.

On 2 February 2022, the project was determined to be a Controlled Action, requiring approval under the EPBC Act due to its potential impact on listed threatened species and ecological communities. The project will therefore be assessed under the bilateral agreement between the Commonwealth and NSW Governments. The Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) (formerly the Department of Agriculture, Water, and the Environment) has issued its assessment requirements which have been incorporated into the SEARs for the project.

This aquatic biodiversity impact assessment concluded that there is unlikely to be any significant impacts to MNES relevant to aquatic biodiversity resulting from the project (refer section 5.5).

3. Methodology

3.1 Study area

The study area for the assessment included watercourses either directly or indirectly affected by the project, which was identified by application of a 10-km buffer around the Project Area (Figure 1-1). Section 3.5 describes the criteria for the selection of watercourses considered suitable for habitat assessments and fauna surveys.

Survey sites included a 100m reach along each watercourse (subject to property access and other constraints), within which habitat assessments and surveys were undertaken.

3.2 Desktop assessment

A desktop review of relevant guidelines, previous species sighting records, documents and reports relevant to the project was undertaken from the locality on 24/04/2022 using the following public ecological databases and websites:

- A search of the NSW Fisheries threatened species list (DPI, undated a) and Spatial Data Portal within the locality (which includes the four Local Government Areas (LGAs) surrounding the Project Area: Upper Hunter, Warrumbungle, Mid-Western Regional and Muswellbrook (DPI, undated b)), for Threatened species indicative distribution maps. The mapping provides the indicative (or known and expected) distributions for a number of NSW freshwater threatened species based on modelling. The indicative distribution means there is a high probability that the species would occur in a stream segment, given the species has been recorded there or the environmental conditions are the same as a stream segment where the species is already known to occur. Modelled indicative distribution maps are not available for all NSW freshwater threatened species due to the limited number of records for some species or the limited number of correlated environmental attributes (section 4.8.4). For threatened species where distribution maps were not available, habitat assessment and review of Primefacts (electronic resource produced by DPI) for each individual species were used to determine their likely presence (DPI, undated c).
- A search of the Spatial Data Portal (DPI, undated b) was undertaken for KFH mapping (section 3.4.1) and Fish Community Status of NSW mapping and Fish Communities and Threatened Species Distribution of NSW Report prepared by DPI (DPI, 2016). The report rates the condition of fish communities as either Very Good, Good, Moderate, Poor or Very Poor (section 3.8).
- A search on the DCCEEW Protected Matters Search Tool (PMST) for MNES within 10 km of the Project Area (section 4.8.3).
- Species Profile and Threats Database, profiles and references therein for federally listed threatened species were used to determine likely occurrence and provide distribution and habitat information (Table 4-3).
- An area search was conducted within the BioNet website for the Atlas of NSW Wildlife (OEH, 2022). BioNet is a portal for accessing government held information about plants and animals in NSW. It is supported by several NSW government held agencies. BioNet contains records for aquatic threatened species and EECs listed under the BC Act, the FM Act and the EPBC Act which have been recorded within the locality. The search was conducted for all protected species (threatened and non-threatened) within a 10 km buffer of the Project Area (section 4.8.1)
- A search of Atlas of Living Australia (ALA) records. ALA is a collaborative, digital, open infrastructure that pulls together Australian biodiversity data from multiple sources. A search of the ALA was conducted within a 10 km buffer for threatened species and protected species such as platypus and turtles (section 4.8.2).
- Review of Survey Guidelines for Australia's threatened fish (DSEWPC, 2011) to determine the likelihood of a species presence or absence at a site. The guidelines are not mandatory however, and desktop analysis of historic data can be used as an alternative survey approach.

- Review of DAWE Directory of Important Wetlands (DAWE 2022).

The information obtained was used to inform survey design and assist in the description of ecological context, assessment of potentially occurring threatened species, endangered populations (EPs) and threatened ecological communities (TECs).

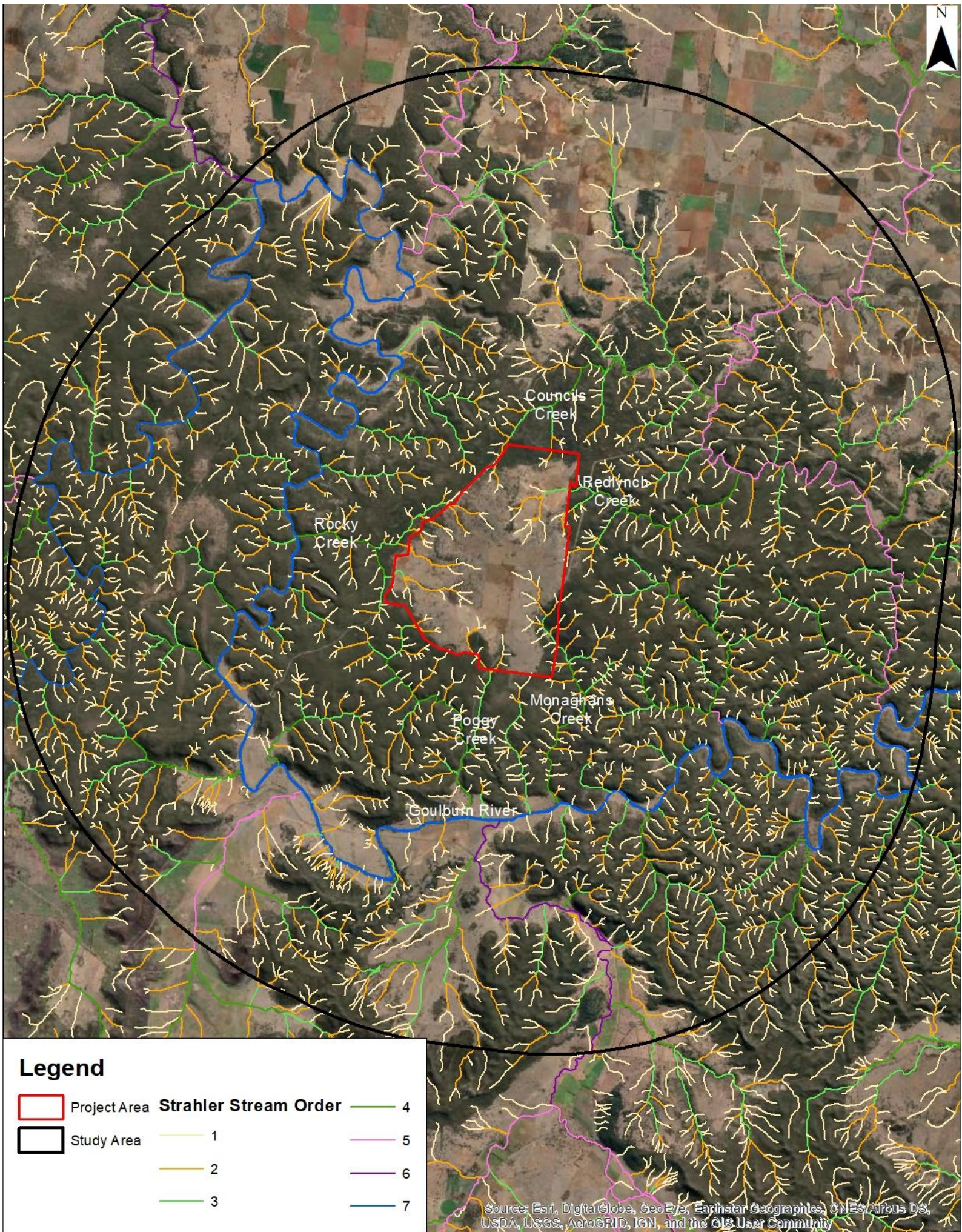
3.3 Stream order mapping

The Strahler ordering system (Strahler, 1952), as described in NSW Government Gazette no. 37 on 24 March 2006 was used to characterise the watercourses within the study area.










The Strahler ordering system is a hierarchical numbering system based on the degree of branching within a watercourse and provides an indication of the complexity of a creek system. For the purposes of this order, watercourses are deemed to be continuous even if they lose definition and then reappear downstream. The methodology used is as follows:

- Starting at the top of a catchment, any watercourse which has no other watercourses flowing into it is classed as a first order stream (1).
- Where two first order streams join, the stream becomes a second order stream (2).
- If a second order stream is joined by a first order stream - it remains a second order stream.
- When two second order streams join, they form a third order stream (3).
- A third order stream does not become a fourth order stream until it is joined by another third order stream and so on.

Strahler stream orders for watercourses within the study area are listed in Table 3-2 and shown in Figure 3-2.



Legend

- | | | | | | |
|--|--------------|---|---|---|---|
|  | Project Area | Strahler Stream Order |  | 4 | |
|  | Study Area |  | 1 |  | 5 |
| | |  | 2 |  | 6 |
| | |  | 3 |  | 7 |

0 1.25 2.5 5 7.5 10 Kilometers

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

3.4 Watercourse classification

3.4.1 Key fish habitat mapping

To meet the objectives of the FM Act to 'conserve key fish habitats', DPI identified KFH as those aquatic habitats that are important to the sustainability of the recreational and commercial fishing industries, the maintenance of fish populations generally, and the survival and recovery of threatened aquatic species.

A policy definition of the term KFH was developed to guide the compilation of maps. For freshwater environments, KFH was defined to include most permanent and semipermanent freshwater habitats including:

- Permanently flowing rivers and creeks including those where the flow is modified by upstream dam(s), up to the top of the natural bank regardless of whether the channel has been physically modified.
- Intermittently flowing rivers and creeks that retain water in a series of disconnected pools after flow ceases including those where the flow is modified by upstream dam(s), up to the top of the natural bank regardless of whether the channel has been physically modified.
- Billabongs, lakes, lagoons, wetlands associated with other permanent fish habitats (e.g. permanent rivers and creeks, estuaries etc.).
- Flood channels or flood runners that may normally be dry but would be used by fish to move/migrate across or along floodplains between habitats during high flow events.
- Any waterbody, if it is known to support or could be confidently expected (based on predictive modelling) to support threatened species, threatened populations or threatened communities listed under the provisions of Part 7A of the FM Act.

Small headwater creeks and gullies (known as first and second order streams) that only flow for a short period after rain were generally excluded, as were farm dams constructed on such systems. Wholly artificial waterbodies such as irrigation channels, urban drains and ponds, salt and evaporation ponds were also excluded except where they are known to support populations of threatened fish or invertebrates.

DPI KFH mapping for the study area is shown in Figure 3.2 and more detailed mapping at Redlynch Creek, Pogy Creek and Rock Creek is shown in Figure 3.3 to Figure 3.5.

3.4.2 Key fish habitat sensitivity and class analysis

The *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) provides a framework to classify KFH types based on their aquatic habitat features as described in Table 2-1.

In addition to the habitat sensitivity type, DPI assesses proposals in relation to waterway class. The waterway classification scheme has been adapted from Fairfull and Witheridge (2003) and factors in the functionality of the waterway as fish habitat. The criteria by which the watercourse class is derived are defined in Table 2-2.

Within the Project Area, KFH Type and Class for each watercourse are discussed in section 4.5.

3.5 Determination of survey sites

Using electronic hydroline mapping (available from SIX Maps), 90 mapped hydrolines (including drainage lines) were identified within the study area (Figure 3-1). This included 69 first order watercourses, 18 second order watercourses and three third order watercourses. Five watercourses have been mapped by DPI as KFH (2007) (Figure 3-2).

The criteria in Table 3-1 was used to rank these watercourses into one of three categories - high, moderate and low priority.

Table 3-1. Watercourse categories

Priority ranking	Criteria
High	<ul style="list-style-type: none"> Key Fish Habitat (DPI, 2007). Threatened fish species predicted to occur based on DPI mapping (DPI, 2016) and results of database searches (Protected Matters Search Tool and ALA (2021) records).
Medium	<ul style="list-style-type: none"> Key Fish Habitat (DPI, 2007). Third order or above (Strahler stream ordering system). Identified as having nearby wetland habitat.
Low	<ul style="list-style-type: none"> Threatened fish species unlikely to occur based on DPI (2016) mapping and results of database searches (Protected Matters Search Tool and ALA (2021) records). Not Key Fish Habitat (DPI, 2007). First or second watercourses order based on Strahler stream order.

Watercourses with a moderate or high priority ranking were assessed further and used for the selection of survey sites and potential targeted threatened species survey. Survey sites are summarised in Table 3-2, including coordinates and Strahler stream order. All watercourses within the project area flow into Goulburn River.

Table 3-2. Survey site identification, co-ordinates, watercourse, Strahler stream order

Survey Site	Latitude	Longitude	Map X	Map Y	Watercourse	Strahler Stream Order
1	-32.264574	150.122678	228956	6426603	Redlynch Creek (outside development footprint)	3
2	-32.264169	150.120131	228714	6426641	Redlynch Creek	3
3	-32.295687	150.113879	228219	6423130	Unnamed tributary of Monaghans Creek	3
4	-32.299578	150.092402	226208	6422643	Unnamed tributary of Pogy Creek	2
5	-32.283825	150.072266	224263	6424339	Unnamed tributary of Rocky Creek	3
6	-32.277082	150.076840	224674	6425099	Unnamed tributary of Rocky Creek	2
7	-32.258019	150.100655	226861	6427274	Unnamed tributary of Councils Creek	2
8	-32.355998	150.066366	223927	6416319	Goulburn River	7

^a Coordinates taken from field Garmin GPS Map Datum GDA 1994 zone 56

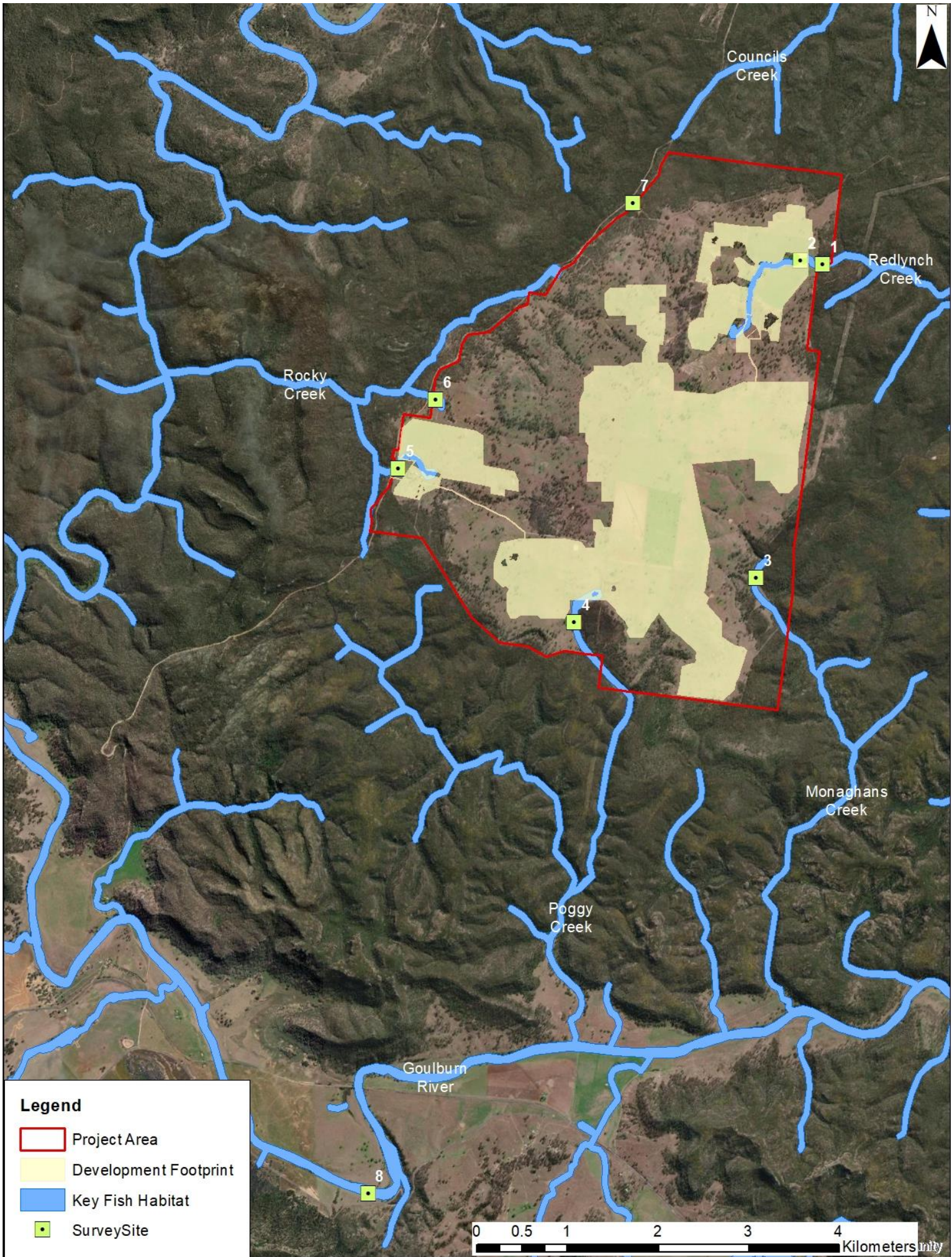
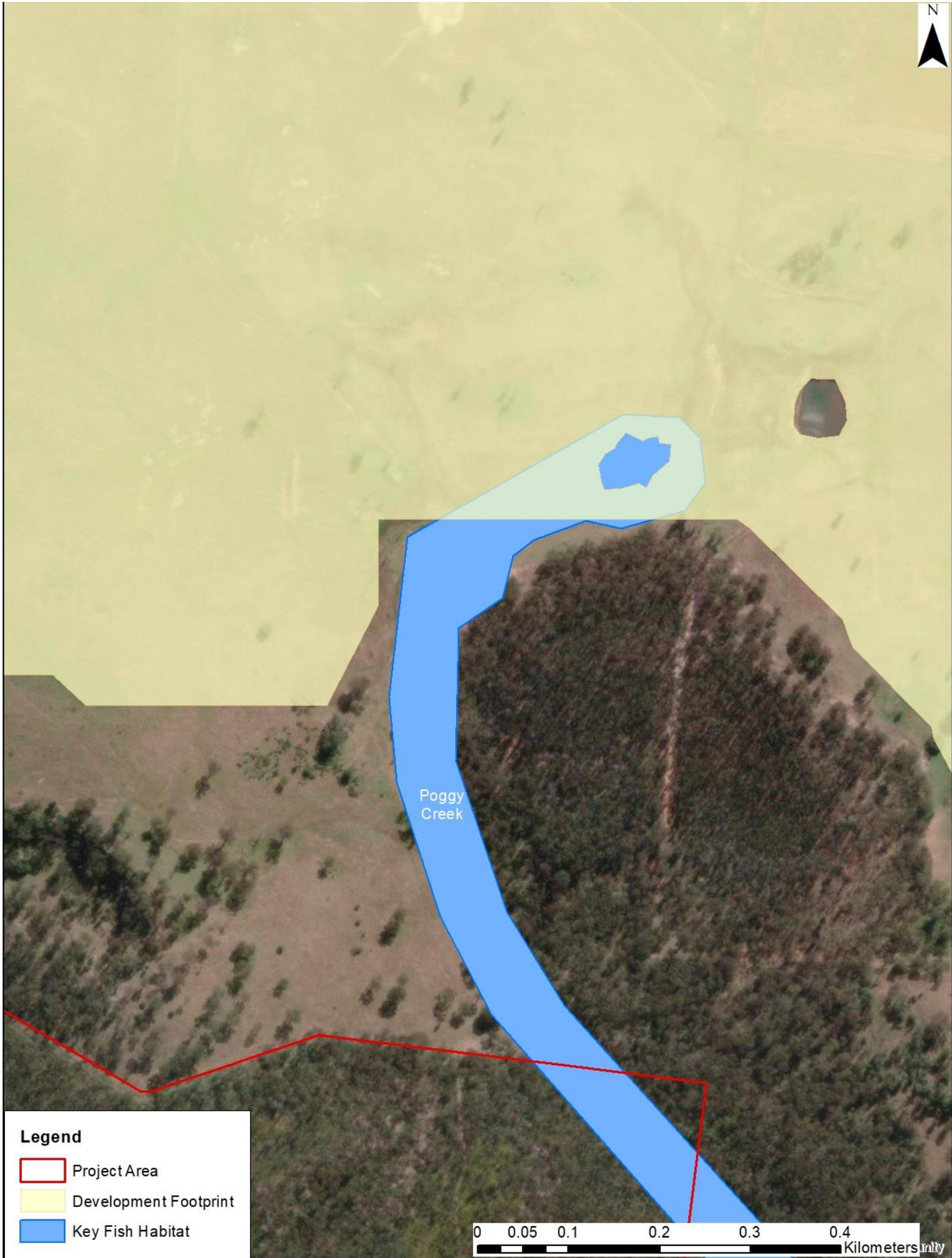




Figure 3.2. Key Fish Habitat (DPI, 2007) and Survey Sites Goulburn River Solar Farm
Job No. 220222

Date. 01/12/2023





Legend

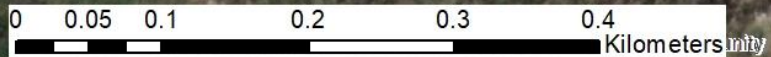
-  Project Area
-  Development Footprint
-  Key Fish Habitat





Legend

- Project Area
- Development Footprint
- Key Fish Habitat



3.6 Field survey

Preliminary mapping of the broad scale aquatic habitats within the study area was undertaken using recent aerial photography in conjunction with topographic maps prior to field surveys. Topographic maps were used to gain a broad understanding of catchment characteristics including adjacent land use, elevation, access roads and distance from source.

An aquatic survey was undertaken on 5-6th May 2022.

3.6.1 Habitat assessment

An assessment of the aquatic habitat at each of the survey sites was undertaken, and indicators of stream condition noted. The aquatic habitat characteristics were recorded using standard recording sheets (NSW AUSRIVAS, 2007) along with assessment of the suitability of the habitat for threatened species with potential to occur in the area.

Habitat features and stream condition indicators assessed include:

- Topography
 - Water level (height of bank and evidence of erosion)
 - Shading of the river
 - Riparian vegetation (percent cover of upper, middle and lower stratum)
 - Stream width (minimum, maximum., mode)
 - Stream depth (minimum, maximum, mode)
 - Identification of macrophytes
 - Percent cover of aquatic vegetation (algae, moss, macrophytes)
 - Percent cover of detritus
 - Description of natural substrate (percent bedrock, boulder, cobble, clay etc)
 - Per cent of total macrophytes that are submerged, emergent or floating
 - Presence of drought and flood refuge areas
 - Presence of pool, riffle and edge habitats
 - Presence of natural or artificial barriers to fish passage upstream and downstream
 - Visual assessment of disturbance related to human activities for:
 - water quality
 - instream habitat
 - riparian zone
 - catchment assessment
- Visual assessments are ranked using the following categories
- no evidence of disturbance
 - little disturbance
 - moderate disturbance
 - high disturbance
 - extreme disturbance

Photographs were also taken upstream and downstream from the centre point of each survey site.

The results of the habitat assessment are presented in section 4.5.

3.6.2 Targeted threatened species survey requirements

Guidelines are available for sampling threatened aquatic species listed under the EPBC Act, however they are not available for threatened aquatic species listed under the FM Act. Where available, recommended sampling techniques targeting threatened species with potential to occur in the study area are summarised in Table 3-3.

Table 3-3. Summary of recommended survey techniques for target threatened species

Target threatened species	FM Act	EPBC Act	Recommended Sampling Techniques (DSEWPC, 2011)
Darling River Hardyhead (<i>Craterocephalus amniculus</i>)	EP	-	No specific guidelines are available for this species however Murray hardyhead guidelines recommend the use of scoop nets, small seines, fyke nets or un-baited traps.
Murray-Darling Basin population of Eel Tailed Catfish (<i>Tandanus tandanus</i>)	EP	-	No specific guidelines are available for this species
Southern Purple Spotted Gudgeon (<i>Mogurnda adspersa</i>)	E	-	No specific guidelines are available for this species however other gudgeon species are targeted using bait traps.

Within the Project Area, only Redlynch Creek contained remnant pools suitable for sampling (refer Table 3-4; Plates 1 and 2). The remnant pools were small and shallow (less than 0.5 metre depth) and bait traps were considered the most appropriate sampling technique. There was insufficient space and/or flows at these survey sites for the use of other recommended sampling techniques identified in Table 3-3.

Table 3-4. Fauna survey locations and sampling techniques

Survey site	Watercourse	Sample Technique ^a
1 (outside Project Area)	Redlynch Creek	3 bait traps
2	Redlynch Creek	3 bait traps

^a Bait traps (0.5 metres long x 0.24 metres wide x 0.24 metres high) baited with chicken meal and sardines and left for 4 hours.



Plate 1. Bait trap at survey site 1, Redlynch Creek



Plate 2. Bait trap at survey site 2, Redlynch Creek

3.7 Riparian and aquatic vegetation survey and mapping

Riparian vegetation (percent cover of upper, middle and lower stratum and dominant species) and aquatic vegetation (macrophytes) were recorded using standard recording sheets (NSW AUSRIVAS, 2007). These results are provided in section 4.5.

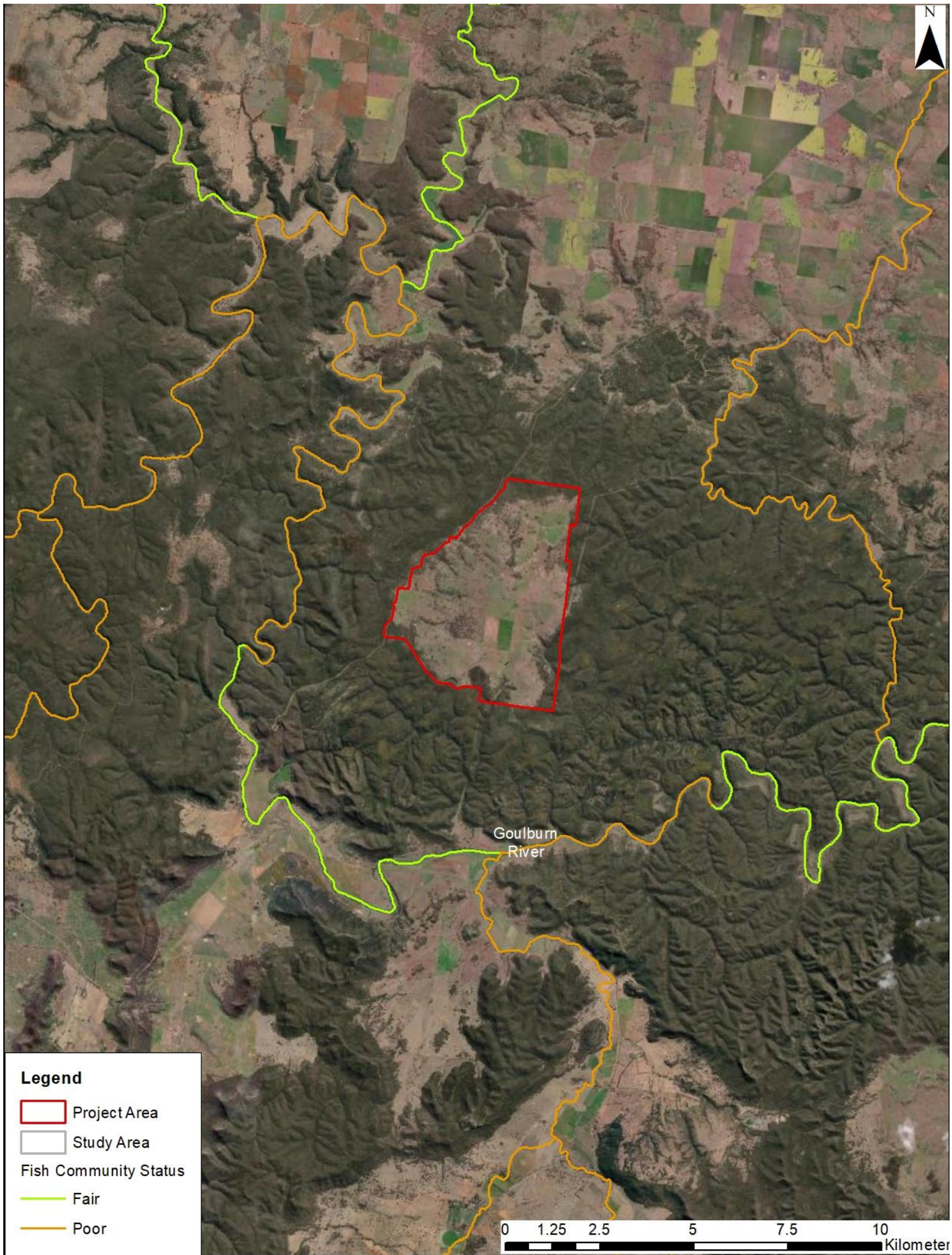
In addition, the BDAR mapped the terrestrial vegetation within the study area and categorised it into plant community types (PCTs) using plot/transect data. The methodology used is discussed further in the BDAR. The BDAR terrestrial vegetation mapping was used to determine the type and extent of riparian vegetation within the Project Area. The area of riparian vegetation along each hydroline was calculated using the *Guidelines for controlled activities on waterfront land: Riparian corridors* (DPI, 2018; refer section 2.1.2.5 and Table 2-3 for methodology). The results are presented in section 4.7 and a discussion of riparian vegetation impacted by the project is provided in section 5.1.2.1.

3.8 Fish community status mapping

The Fish Communities and Threatened Species Distributions of NSW project (FCTSD) combined data collected over twenty years of biological surveys with standard statistical analysis and spatial distribution models, to provide mapping of the status of fish communities and threatened species distributions across NSW. The FCTSD project mapped the status of fish communities across NSW as Very Good, Good, Moderate, Poor, or Very Poor (DPI, 2016).

None of the watercourses within the Project Area were mapped, however Goulburn River was defined as 'Fair' to 'Poor' within the study area (Figure 3-6)

The fish community status mapping is useful in determining the importance of the habitat within the Project Area to threatened species that occur in the locality.



3.9 Directory of important wetlands

The directory of important wetlands (DAWE, 2022) returned one important wetland: Hunter Estuary, however as this estuary is 150 km upstream of the Project Area, it will not be impacted by the project and does not require further assessment.

3.10 Risk of impact criteria

The criteria used to define the risk of impact of the project on watercourses within the study area are listed in Table 3-5. The risk of impact of the project during construction, operation and decommissioning is considered in section 5.

Table 3-5. Criteria for defining the risk of impact of the project on receiving watercourses

Risk of Impact	Criteria
Moderate	<ul style="list-style-type: none"> Watercourse occurs within the Project Area, would be directly impacted by instream works or works within the riparian vegetation.
Low	<ul style="list-style-type: none"> Watercourse is within the study area but outside the Project Area and provides potential habitat for threatened species and may be impacted indirectly by the project. Watercourse is within the Project Area however construction activities would be minor, would not directly impact the watercourses and indirect impacts can be managed.
Negligible	<ul style="list-style-type: none"> Watercourse is within the study area but outside the Project Area, is unlikely to provide habitat for threatened species and would not be directly impacted by construction activities. Indirect impacts can be managed. Watercourse is within the Project Area and would be directly impacted by construction activities however the watercourse has been defined a low priority watercourse.

4. Existing environment

4.1 Weather and climatic conditions

The weather during surveys conducted between 5-6 May 2022 was fine and mild with air temperatures ranging between 4.5-22.7 degrees Celsius. Rainfall recorded 5 May 2022 was 14.2 millimetres (mm), mostly in the morning prior to the commencement of surveys (BOM, 2022a).

Most of NSW has received above average rainfall over the past 2.5 years, largely due to La Niña (BOM, 2022a). Thus, the area was not considered to be in drought at the time of survey.

4.2 Goulburn River

The watercourses within the Project Area are all tributaries of Goulburn River. Goulburn River in east New South Wales is in the Hunter/Central Rivers Catchment Management Authority and starts below Ulan at an elevation of 434m and ends at an elevation of 97.3m merging with the Hunter River near Denman. Goulburn River drops around 337m over its 221km length. It is the largest tributary of the Hunter River and accounts for 40 per cent of the Hunter River's catchment area, but contributes only 23 per cent of its flow.

4.3 Water Quality

Stream salinity is a significant management issue in the Hunter River basin. Sources of salt include rainfall and weathering products, which enter the stream via surface runoff pathways, and groundwater sources, particularly from Permian coal measures. Streams with identified groundwater interactions often have high salinities. In the Upper Goulburn River and Wollar Creek, median electrical conductivities exceed 2300 $\mu\text{S}/\text{cm}$ (NSW EPA, 2013). Coal mining is thought to contribute to stream salinity, although this is difficult to confirm due to lack of long-term monitoring data and a highly variable climate.

Visual assessment of water quality was undertaken at each survey site using categories described (section 3.6.1). Watercourses with remnant pools present at the time of survey were categorised as having a low to moderate level of disturbance, attributed to catchment land use practices (i.e., farming). Visual assessments for each survey site are provided in section 4.5.

4.4 Groundwater Dependent Ecosystems

The Bureau of Meteorology's GDE Atlas (BOM, 2022b) provides the following groundwater dependent ecosystem definitions:

- Aquatic ecosystems that rely on the surface expression of groundwater - this includes surface water ecosystems which may have a groundwater component, such as rivers, wetlands and springs.
- Terrestrial ecosystems that rely on the subsurface presence of groundwater - this includes all vegetation ecosystems.
- Subterranean ecosystems - this includes cave and aquifer ecosystems.

The GDE Atlas does not map any aquatic GDEs within the study area however a portion of the study area has been defined as a low potential Terrestrial GDE (Figure 4-1).

The riparian vegetation associated with GDEs within the Project Area are discussed further in section 4.7. Further details regarding GDEs are available in the Water Resources Assessment (Umwelt, 2023) and the BDARs (Umwelt, 2023 further considers terrestrial GDEs.

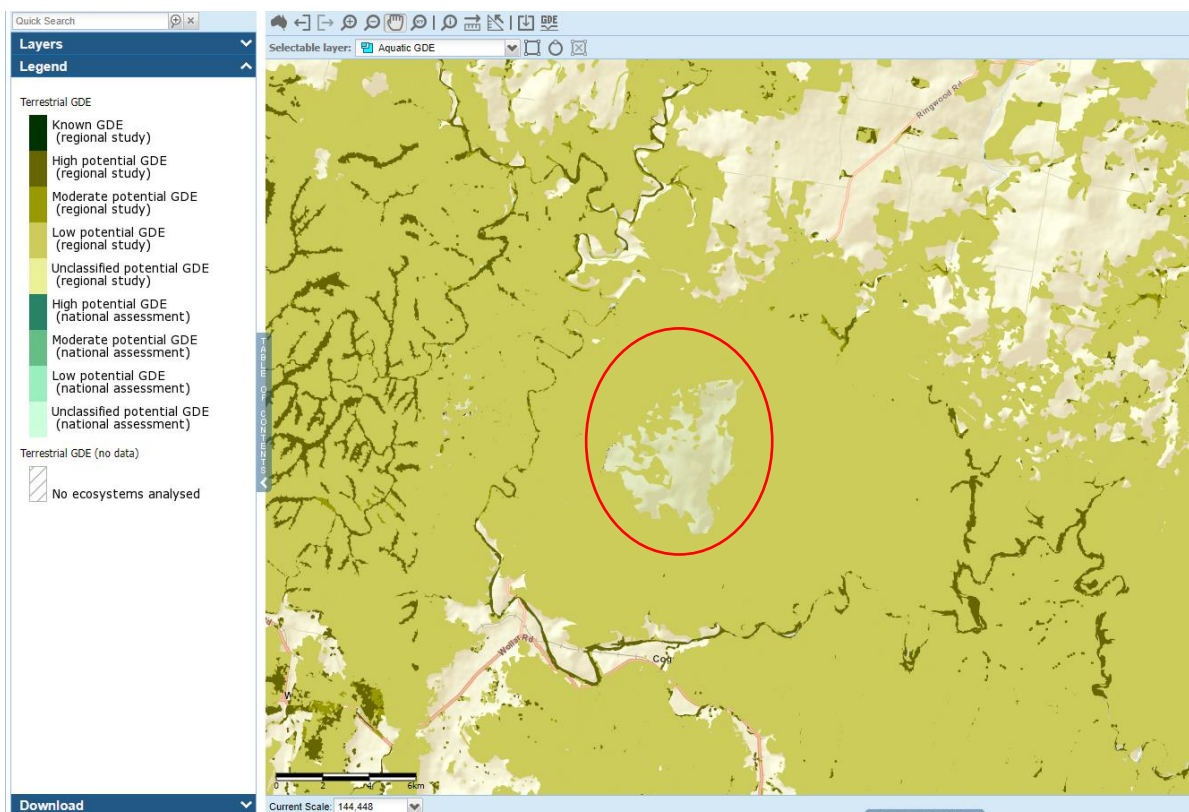


Figure 4-1. Terrestrial Groundwater Dependent Ecosystem (GDE) mapping

4.5 Aquatic habitat within the study area

Watercourses were categorised into KFH habitat types based on their sensitivity (DPI, 2013), watercourse classifications (Fairfull and Witheridge, 2003) and identified aquatic features in the field surveys. This is discussed in section 4.5.1 to section 4.5.6 and summarised in Table 4-1.

4.5.1 Redlynch Creek

Site inspections were undertaken at two survey sites along Redlynch Creek (Figure 3-2). Survey site 1 is located outside of the Project Area in a steep valley within Goulburn River National Park. At this survey site, the average bank width of Redlynch Creek was five metres. Water was flowing along a low flow channel approximately one metre wide and numerous pools were present. Riffle sections included a diversity of habitat with bedrock, boulders, cobbles, pebbles, gravel, sand and silt all represented. Some large snags were present, along with detritus, trailing bank vegetation and bank overhangs. Riparian vegetation was intact and dominant canopy species included Narrow-leaved Ironbark *Eucalyptus fibrosa* and Brown Bloodwood *Corymbia trachyphloia*, with a middle stratum dominated by shrubs including Narrow-leaved Geebung *Persoonia linearis*, *Acacia sp.* and *Dodonaea triangularis*. The lower stratum was sparse due to exposed bedrock and boulders (which had a high proportion of surface area covered by moss), however species included some native grasses (Couch Grass *Cynodon dactylon*) and native ferns along with exotic grasses and herbs. Within the watercourse itself, macrophytes included *Juncus sp.* and Buttercup *Ranunculus sp.* The land use on both sides of the bank consisted of National Park.

Visual assessment indicated that the water quality, instream habitat and riparian zone had little evidence of disturbance, despite the intensive agriculture upstream, with clear water, limited instream disturbance and an intact riparian zone (Plates 3 and 4). At this survey site, the watercourse was defined as Type 2 moderately sensitive KFH.



Plate 3. Survey site 1: upstream



Plate 4. Survey site 1: downstream

Survey site 2 is in the northeast corner of the Project Area in a broad valley and is located approximately 280 metres upstream of survey site 1 (Figure 3-2). At survey site 2, the average bank width was 4 metres. Water was flowing along a low flow channel approximately one metre wide with several pools. Substrate consisted mainly of bedrock and clay however riffle sections were absent from this survey site. Due to the absence of riparian vegetation, no snags or detritus were recorded, and the degraded nature of the bank limited the presence of trailing bank vegetation and bank overhang. Riparian vegetation was highly disturbed from agricultural practices, and few remnant trees remained (only isolated Grey Box *Eucalyptus macrocarpa* and White Box *Eucalyptus albens*). The middle stratum was absent and the lower stratum consisted entirely of exotic grasses and herbs. Within the watercourse itself, macrophytes included *Juncus sp.* and Buttercup *Ranunculus sp.* The land use on both sides of the bank consisted of cleared agricultural land.

Visual assessment indicated that the water quality was moderately disturbed, while the instream habitat and riparian zone had a high level of disturbance through the presence of pumps for water extraction, filamentous algae, vegetation clearing and bank degradation as cattle were not excluded from the edge of the watercourse (Plates 5 and 6).

Within the Project Area, Redlynch Creek had a high level of disturbance and provided limited aquatic habitat, however it was the only watercourse within the Project Area to have flowing water at the time of survey. At this survey site, the watercourse was defined as Type 3 minimally sensitive KFH.



Plate 5. Survey site 2: upstream



Plate 6. Survey site 2: downstream

4.5.2 Unnamed tributary Monaghans Creek

Survey site 3 is in the southeast corner of the Project Area in a steep valley (Figure 3-2). At this survey site, the average bank width was 8 metres with a low flow channel approximately one metre wide. No water was flowing at the time of survey. Riffle sections included a diversity of habitat with boulders, cobbles, pebbles, gravel, sand and silt all represented. Some large snags were present, along with detritus, trailing bank vegetation and bank overhangs. Riparian vegetation was intact and dominant canopy species included Narrow-leaved Ironbark *Eucalyptus fibrosa*, Grey Box *E. macrocarpa*, Spotted Gum *Corymbia maculata* and Black Pine *Callitris endlicheri* with a middle stratum dominated by a diversity of shrubs. The lower stratum was dominated by exotic grasses and herbs. No aquatic vegetation was recorded within the watercourse itself. The land use on both sides of the bank consisted of agricultural land, however due to the steepness of the valley, a wide riparian vegetation zone has been retained (Plate 7 and 8).

Visual assessment indicated that the instream habitat and riparian zone had little evidence of disturbance, despite the intensive agriculture upstream.

Due to the steepness of the surrounding topography, there are limited opportunities for water pooling and as such, there was limited aquatic habitat available. At this survey site, the watercourse is defined as Type 3 minimally sensitive KFH.



Plate 7. Survey site 3: upstream



Plate 8. Survey site 3: downstream

4.5.3 Unnamed tributary Pogy Creek

Survey site 4 is in the south of the Project Area in a broad valley (Figure 3-2). At this survey site, the banks were not well defined, however the average bank width was one metre wide. No water was flowing at the time of survey however the area was wet (approximately 10 cm deep). No riffle sections were present and despite the presence of regrowth in the canopy, large snags were absent. There was limited detritus and no bank overhangs or trailing bank vegetation. Riparian vegetation was disturbed, with sparse regrowth including Narrow-leaved Ironbark *Eucalyptus fibrosa*, Grey Box *E. macrocarpa* and Brown Bloodwood *C. trachyphloia*, a sparse middle stratum including *Acacia implexa*, *Pomaderris sp.* and a lower stratum consisting of exotic grasses and herbs. The watercourse was dominated by the exotic creeper *Tradescantia albiflora*.

Visual assessment indicated that the instream habitat and riparian zone had a moderate level of disturbance from the invasion by exotic species in the instream zone, and the revegetation of the riparian zone (Plates 9 and 10).

The watercourse at this survey site had a high level of disturbance and provided limited aquatic habitat. At this survey site, the watercourse was defined as Type 3 minimally sensitive KFH.



Plate 9. Survey site 4: upstream



Plate 10. Survey site 4: downstream